



Transportation Association of Canada

Integrating Health and Transportation in Canada

November 2019





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Abstract <p>Existing transportation systems have been traditionally designed primarily for motorized vehicles and goods movement. This exerts a significant influence on the way Canadians travel in their daily lives to the point where it increases their risk of numerous negative health outcomes.</p> <p>The paradigm has begun to shift towards health-promoting transportation systems and environments. There is an opportunity to further build health considerations into transportation policies, planning, investment and design decisions. This report identifies the state of the practice, gaps, recommendations, and resources for strengthening the integration between health and transportation.</p>		Keywords Traffic and Transport Planning <ul style="list-style-type: none"> • Accessibility • Air pollution • Cost Benefit Analysis • Cycling • Health • Hospital • Mental Illness • Modal choice • Multimodal mobility • Noise Annoyance • Safety • Walking
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EXECUTIVE SUMMARY

This document is a resource to further enhance the integration of the transportation, land use and health related work done in Canada. It is an aid for transportation practitioners, including engineers and planners, and health professionals, operating within different institutional settings, at various levels of government, and in multiple planning contexts. While existing evidence and best practices described predominately refer to urban and/or suburban settings, rural examples are included when available. Technical appendices, which provide further details regarding the methodology used to develop the final set of recommendations in this report, can be found in a separate document titled, *Appendices: Integrating Health and Transportation in Canada*.

E.1 WHY INTEGRATE HEALTH AND TRANSPORTATION?

Awareness continues to grow of the opportunity and need to use transportation and land use activities to achieve public health goals such as injury prevention, increased physical activity, reduced chronic diseases, and reduced exposure to air and noise pollution. Considerable evidence has been amassed to help transportation and health practitioners better understand how the built, natural, and social environments impact health and well-being. The potential health consequences of transportation decisions and land use actions are now part of the fields' lexicons.

Good health can be facilitated or negatively impacted by transportation policies, plans, analyses, funding levels, and infrastructure design decisions – all of which impact the relative safety, efficiency, costs, and overall desirability and relative utility across modes of travel. Transportation actions also impact land development actions that work in tandem with changes in the transportation system. Transportation and land use actions shape each other, as well as activity patterns and health outcomes, and their associated costs.

E.2 METHODS

To provide a deeper understanding of the evidence regarding the connections between health, transportation and land use, the following were conducted: a literature and best practices review, a practitioner-focused survey, targeted stakeholder interviews and interactive webinars. The literature review included a summary of academic and grey literature, along with guidance and examples from local, provincial/state, regional and national agencies. While Canadian examples are elevated, literature from North America, Europe and Australia is also included. The review was organized by seven key areas where health and transportation intersect (Figure E1).

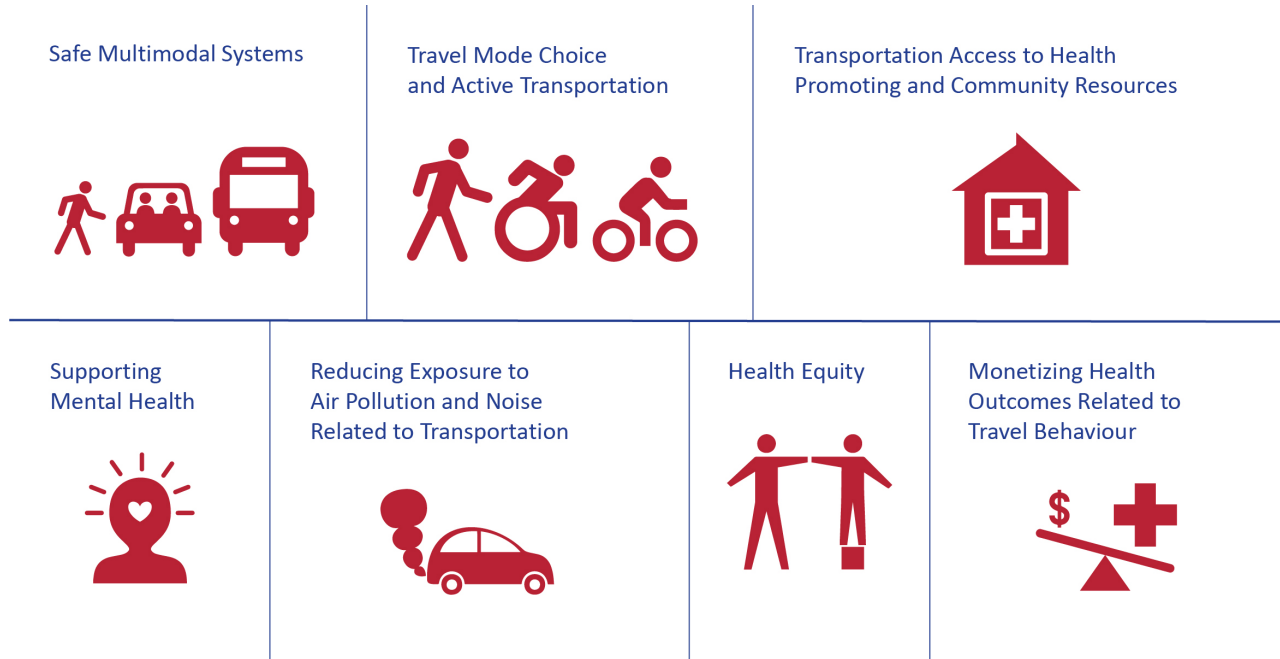


Figure E1: Intersection Areas Between Health and Transportation

An online survey and telephone-based interviews were used to 1) prioritize which of the seven integration areas were in most need of further knowledge and resources from the practitioner-perspective; and 2) identify which type(s) of technical or institutional help was most needed to support efforts to address prioritized areas.

The online practitioner-focused survey was promoted through various professional networks. Survey participants themselves were also asked to encourage their colleagues to complete it. This effort resulted in 410 survey responses. Approximately 91% of these respondents work in Canada, 8% in the United States and 1% elsewhere. The respondents' workplace primary function was predominately transportation (41%), followed by health (34%), and other (25%), which respondents commonly classified as municipal government, consulting, or education.

The telephone-based stakeholder interviews consisted of open-ended questions about the interviewees' experiences (efforts, challenges and successes) integrating health and transportation in their professional field. Nineteen people were interviewed.

Using the input received from the survey and interviews, a prioritized set of 11 key recommendations were developed and presented to a total of 85 health and transportation professionals who participated in one of two interactive webinars.³ Webinar participants had also been invited to complete the online survey and/or interview. The feedback from the webinar participants was used to guide the creation of the final set of actionable recommendations.

This direct contact with practitioners provided critical insight into their current knowledge and needs to better integrate health and transportation. Each interaction was used to further identify opportunities and gaps, and also to develop and refine recommendations.

³ In order to maximize participation opportunities, the same webinar (content wise) was held on two separate occasions – November 1 and 6, 2018. The total number of participants refers to the combined total from both webinars.

E.3 KEY FINDINGS

TAC MODELS A COLLABORATIVE APPROACH

The substantial number of people involved throughout the project and the input they provided to this effort demonstrates the high level of interest that health and transportation practitioners have in this topic. The open, inclusive collaborative approach used by TAC to involve transportation and health practitioners in the development of this document is an important example of what is needed to better integrate transportation and health planning. The process TAC used provided a venue for discussion and collaboration across disciplines to achieve the goal of building healthier communities in Canada.





EVIDENCE AND BEST PRACTICES ARE ABUNDANT, BUT CAN BE ENHANCED

There is a large body of evidence that supports integration of health and transportation. There are many existing guides and practices which can be more widely used and enhanced to better integrate health and transportation, including many from Canada. When asked what is needed to better integrate the work in these two fields, health and transportation practitioners indicated that better data, additional research to expand the evidence base, agreed upon methods and tools, along with educational opportunities, were among the most beneficial. Emphasis was also placed on the importance of changes needing to happen in legislation, policy and funding in order to better integrate health and transportation.

RECOMMENDATIONS

The final recommendations presented (Table E1) are based on the summary of the evidence and practice, and the input received. Three overarching categories in need of improvement emerged from the webinar input: Education & Professional Development, Policy & Practice, and Expanding the Evidence. Each recommendation is categorized in two ways – these broad categories and the integration areas it relates to.

Table E1: Recommendations by Category and Intersection Areas

Recommendation	Category	Integration Area(s)
1. Require base degree curricula for transportation engineering, transportation planning and relevant public health programs to include a transportation/health interdisciplinary course(s).	Education & Professional Development	 All
2. Improve communication and promotion efforts to ensure awareness and foster participation in professional development opportunities that provide information on the intersection of health, health equity, and transportation.	Education & Professional Development	 All
3. Establish cross-sector funding opportunities, interdisciplinary conferences, coordinated policy and mandates that increase interdisciplinary efforts between transportation and public health organizations and agencies.	Policy & Practice	 All
4. Integrate existing public health evidence into the development, implementation, and evaluation of government policies that guide the transportation planning process.	Policy & Practice	 All








Recommendation	Category	Integration Area(s)
5. Standardize a Canadian cost-benefit analysis model that considers the impacts of investments in walking and bicycling infrastructure (construction/maintenance) at a variety of scales.	Policy & Practice	 Monetizing Health Outcomes Related to Travel Behaviour
6. Develop or improve guidelines for transportation professionals that include evidence-based strategies to address safety concerns related to active travel through transportation planning and design.	Policy & Practice	 Safe Multimodal Systems
7. Develop or improve guidelines for transportation professionals that include evidence-based strategies to increase equal access to health promoting and community resources (e.g., health care facilities, food outlets, parks, work, and school settings).	Policy & Practice	 Transportation Access to Health Promoting Resources
8. Improve community engagement and involvement in the transportation planning process to better meet community health needs and promote health equity.	Policy & Practice	 Health Equity
9. Utilize a checklist to self-assess how well and in what ways individual organizations and communities are integrating health and transportation.	Policy & Practice	 All
10. Use a standardized and integrated database that includes injuries, fatalities and health outcomes to develop, monitor, and evaluate policy and practices for all modes of travel and vulnerable populations.	Expanding the Evidence	 Safe Multimodal Systems
11. Expand the evidence-base and understanding of transportation design and active transportation's role in promoting mental and emotional health.	Expanding the Evidence	 Supporting Mental Health

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1. INTRODUCTION

The past two decades have witnessed a growing awareness of the opportunity and need to use transportation and land use activities to achieve public health goals. Considerable evidence has been amassed to help practitioners better understand how the built, natural, and social environment impacts health and well-being. The potential health consequences of transportation decisions and land use actions are now part of the fields' lexicons. Planners are increasingly expected to effectively bring health considerations into transportation planning and decision-making processes.

Transportation professionals are increasingly being asked to consider the health impacts of their work. Guidance is needed to aid transportation engineers, planners, and also health professionals, operating within different institutional settings, at various levels of government, and in multiple planning contexts. This document responds to this identified need by providing a summary of the evidence and practice, and guidance to effectively bring health considerations into transportation planning and decision-making.

1.1 ORGANIZATION OF THE DOCUMENT

This document is organized to provide a logical flow to better understanding the nexus of health and transportation and this information in the following sections:

- 2. Why Integrate Health & Transportation?
- 3. Current Knowledge and Practice
- 4. Practitioner Engagement
- 5. Recommendations

2. WHY INTEGRATE HEALTH & TRANSPORTATION?

People’s health can be positively and negatively impacted by transportation policies, plans, analyses, funding levels, and infrastructure design decisions – all of which impact the safety, efficiency, costs, and overall desirability and relative utility across modes of travel. Transportation actions also impact land development actions that work in tandem with changes in the transportation system. Transportation and land use actions shape each other, activity patterns and health outcomes, and their associated costs.

2.1 WHY HEALTH IN ALL POLICIES?

The World Health Organization’s definition of health is “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” [1]. Urban and spatial health theorists have adopted an ecological approach to public health acknowledging that the social and built environment is influential at multiple levels – individual, neighbourhood, provincial, and national [2-4]. The social and environmental determinants of health (e.g., education and job opportunities, exposure to crime, housing and set conditions, transportation options) in the ecological context are key constructs and points of potential intervention in public health over the past several decades [3].

The Public Health Agency of Canada affirmed the need for a multi-disciplinary approach in order to address determinants of health by writing that “Going forward, decision-makers and planners at all levels should take a multi-sectoral, collaborative approach and consider health as an important outcome, as appropriate, when making infrastructure planning decisions” [5]. Transportation and land use make up the everyday environment in which people work, live and play. Making small, systematic changes to how we travel and design our communities could result in large health benefits from increased physical activity, increased access and safety, increasing social interaction and reducing stress; and decreased exposure to air pollution [6-8].

“The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition.”

Preamble to the Constitution of the World Health Organization [1]

The process of engaging the policies, plans and programs of other disciplines to increase health benefits – also known as Health in All Policies (HiAP) – is seen as a key lever in population health transformation [7]. This approach has been adopted by the World Health Organization which defines HiAP as:

“An approach to public policies across sectors that systematically takes into account the health and health-system implications of decisions, seeks synergies, and avoids harmful health impacts, in order to improve population health and health equity. The HiAP approach is founded on health-related rights and obligations. It emphasizes the consequences of public policies on health determinants, and aims to improve the accountability of policy-makers for health impacts at all levels of policy-making” [9].

It is important to note that some results from public health initiatives often require substantial time to become apparent. For example, transportation planning and facility design policies with a positive impact on people’s health do not typically result in immediate health changes, but rather ones that accumulate over time at the individual level, and then collectively at the community level.

2.2 PUBLIC HEALTH'S INTEREST IN TRANSPORTATION

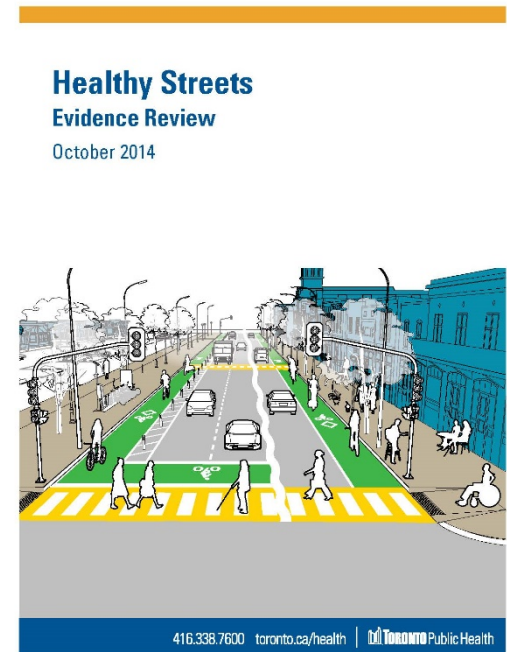
Toronto Public Health's *Healthy Streets: Evidence Review* states:

"Most people know intuitively that our surroundings impact our health – clean water, safe housing, sanitary waste disposal, and clean air are all essential to any community that hopes to thrive. Urban planning and public health professionals are examining the connection between urban planning and health. The arrival of the car and suburban development in the mid-20th Century brought many benefits, it has also had a number of unintended consequences, and often health related - pollution exposure, traffic collisions, and a reliance on the car for almost all travel." [10]

In response to such knowledge, the Government of Ontario requires collaboration with other disciplines to address health in the built environment. For example, the *Ontario Public Health Standards* includes a "Healthy Environments" section, which aims to "reduce exposure to health hazards and promote the development of healthy built and natural environments that support health and mitigate existing and emerging risks, including the impacts of a changing climate." [11]

Public health is an umbrella term for a variety of specialized areas of research and practice that impact health at a population-level (as opposed to at an individual level). For example, toxicology and epidemiology are two separate, specialized areas of study that involve different underlying methodologies to link exposure to disease, whereas public health practitioners might work to translate findings into practice, educate the public and implement health programming for people. Epidemiologists and toxicologists have traditionally studied environmental risks and exposures related to human health in a branch of public health known, collectively, as environmental health. Because of their interest in environmental exposures, toxicology and epidemiology have traditionally guided how public health practitioners engaged in transportation and land use planning. For example, toxicologists may identify initial risks of exposure to particulate matter through animal studies. Epidemiologists then extend that knowledge to humans through large-scale spatial and temporal analysis of known particulate sources – including transportation. Epidemiologists have clearly shown a short-term effect (<24 hours) in cardiovascular mortality with higher levels of particulate matter by leveraging the temporal and spatial data [12]. Together, the specialties work together to set benchmarks and regulatory frameworks, monitor the regulations, and help other fields to design interventions to reach benchmarks.

In the past few decades, epidemiologists, toxicologists, and other public health professionals have focused on more indirect environmental determinants of health because of their impact on chronic disease and mortality [13-15]. For example, active transportation is particularly relevant to population-level health due to the known influence on physical activity and sedentary time, which are, in turn, known to predict multiple health conditions, including cardio-metabolic disease [16, 17], type 2 diabetes [18, 19], and mental health [20-22]. The increased attention on active transportation modes has augmented a long-standing interest in traffic safety, including concerns related to disproportionate crash impacts for cyclists and pedestrians [23]. In addition, public health professionals study the differential spatial effects of air quality and health [24, 25]. Finally, public health practitioners recognize that mobility and accessibility to local services and amenities that people require for daily life, school/work/play, is not only a core function of transportation, but also influences how individuals can access health-supporting services, as well as healthy food outlets and recreational spaces [26-28].



2.3 TRANSPORTATION'S INTEREST IN PUBLIC HEALTH

Traditionally transportation professionals' public health interest has been focused on reducing travel-related crashes, injuries and deaths, and also travel-related air pollution. In response to public interest, and to reduce congestion and pollution, this has expanded to include the promotion of the use of active transportation modes (walking and cycling).

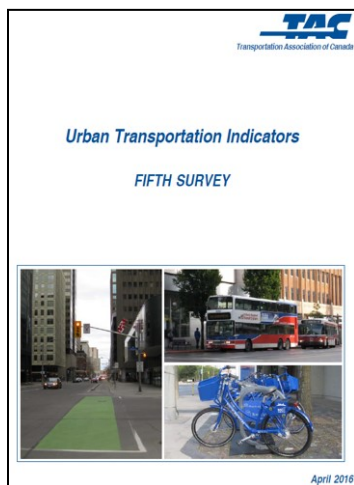
In recent work in Canada, the Transportation Association of Canada recognized additional connections between transportation activities and health. TAC's 2016 *Urban Transportation Indicators Fifth Survey* [30] states:

"Transportation policies and infrastructure can influence the way people access health services, encourage or discourage active transportation, and place environmental health risks on vulnerable communities." TAC expanded its set of indicators used in past surveys to include "health indicators to demonstrate the various links among transportation policies, infrastructure and human health and, furthermore, how health outcomes vary across [Census Metropolitan Areas]."

"Streets are the front door of our businesses, homes, parks and institutions. They reflect the values of our city and, at their best, are a source of pride for the residents and visitors alike. Streets also form essential networks that move people and goods safely and efficiently in our growing city."

Complete Street Guidelines, City of Toronto
City of Toronto (29)

These new indicators include walking and bicycling behaviours, availability of sidewalks, proximity to school and natural space, traffic fatalities, fuel emissions, and asthma prevalence, all of which have been found to be associated with transportation and land use.



Additionally, in the United States (U.S.), the Federal Clean Air Act Amendments of 1991 tie transportation funding to the National Ambient Air Quality Standards (NAAQS). The Clean Air Act's link to transportation funding at the federal level in the U.S. is one of the largest, most capitalized health-based mandates in the world. This rule is a cornerstone of long-range metropolitan planning and since its passage has reshaped transportation planning in the U.S. The air pollution impacts of proposed transportation system changes in areas not in conformity with the NAAQS must be modeled and shown to meet established pollution thresholds. There is no equivalent mechanism in Canada to link air quality and transportation investment at the federal level in this manner. In the Canadian context, transportation goals differ by province and are determined by larger societal priorities such as mobility preferences, environmental concerns, social justice inequities, and most recently housing affordability.

A recent survey in the U.S. of planners shows that while most planners understand the societal value of health and, thus, are open to it in their practice, the relationship between the two fields in the past two decades has largely been driven and sustained by public health professionals [31]; however, this is changing.

3. CURRENT KNOWLEDGE AND PRACTICE

Over 270 academic and grey literature sources, including guidance and examples from local, provincial/state, regional and national agencies were reviewed to determine the current state of the integration of health and transportation. Seven key topic areas where transportation and health intersect (Figure 1) were used to organize this work. While Canadian examples are elevated, literature from North America, Europe and Australia is also included. For an annotated and categorized (primary and secondary) list of resources see *Appendices: Integrating Health and Transportation in Canada*.

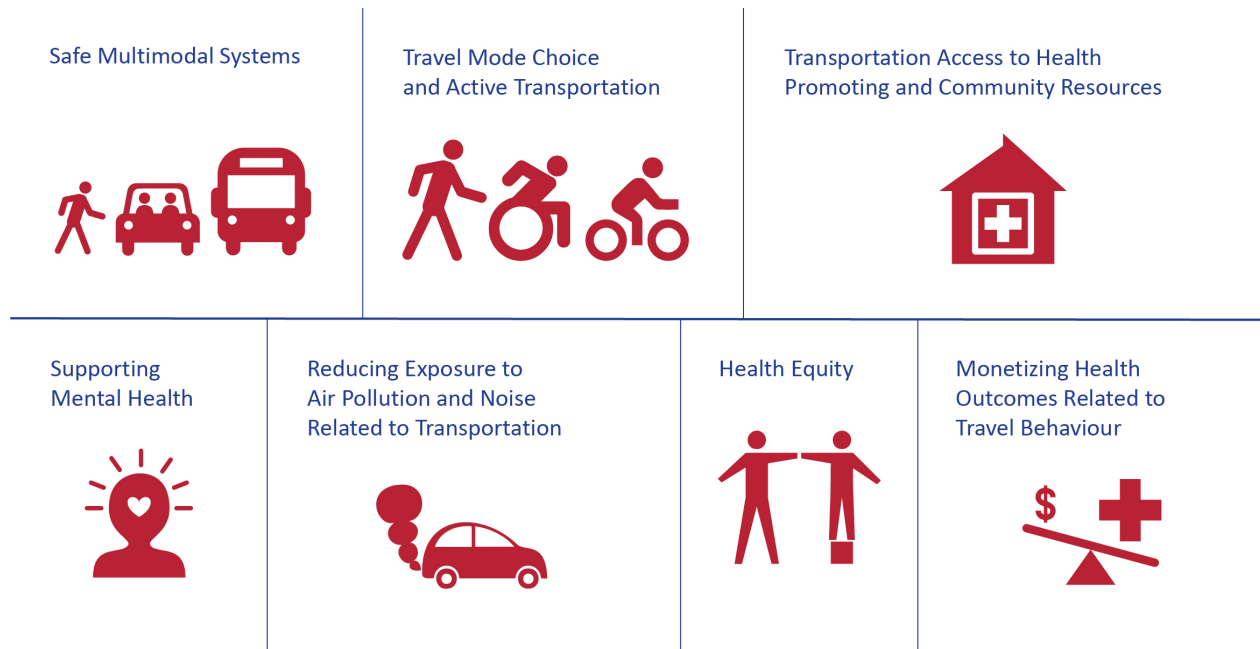


Figure 1: Intersection Areas Between Health and Transportation

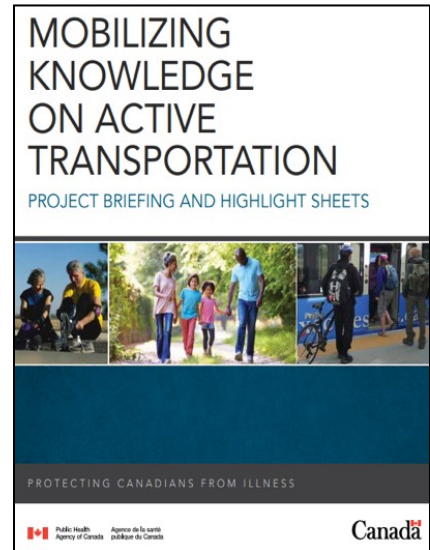
3.1 INSTITUTIONALIZING THE INTEGRATION OF HEALTH AND TRANSPORTATION

Overcoming barriers to better integrating health consideration into the transportation policy, planning and design decision-making process requires institutional changes across agencies and levels of governments, and includes professional organizations, academia and other non-governmental organizations.

The Public Health Agency of Canada (PHAC) [32] and the Ontario Public Health Association (OPHA) [33] have both called for collaboration between health and transportation. Both identify collaboration as a core element for achieving healthier communities through active transportation. The PHAC lists the following actions as keys to success:

- *Effective provincial/territorial collaboration models tend to share four key components: a lead ministry, a cross-departmental working group, a plan or strategy that commits to collaboration, and the active involvement of municipalities and non-governmental organizations*

- *Allocating responsibility for active transportation issues to designated staff in each provincial/ territorial ministry, particularly transportation, can accelerate progress*
- *Involving representatives from all levels of government and all relevant departments in planning projects can leverage resources and expertise, and prevent duplication*
- *Synchronizing land use and transportation planning organizations within municipalities and regions maximizes the potential for people to meet every day needs using active transportation*
- *The most suitable approach to collaboration varies for each community and project, and could involve existing mechanisms or new ways to engage various interests*



Environmental assessments (EA) are a mechanism for integrating health and transportation through the evaluation of proposed transportation projects. In proposed federal legislation, EAs are to be conducted to “protect the components of the environment, and the health, social and economic conditions that are within the legislative authority of Parliament from adverse effects caused by a designated project”[34]. In 2016, an expert panel review of federal EA processes was conducted [35], which led to the proposed federal Impact Assessment Act [34]. The proposed act includes several references to health and assessing health impacts, including the following from the summary of the bill:

- *Provides for a process for assessing the environmental, health, social and economic effects of designated projects with a view to preventing certain adverse effects and fostering sustainability*
- *Prohibits proponents, subject to certain conditions, from carrying out a designated project if the designated project is likely to cause certain environmental, health, social or economic effects, unless the Minister of the Environment or Governor in Council determines that those effects are in the public interest [34]*

Health and planning departments collaborated in the Region of Peel to develop a *Healthy Development Framework* [36], and a user guide regarding assessment. This work created a “flexible approach towards planning for built environments” which facilitate development of “healthier, more complete communities” [36].

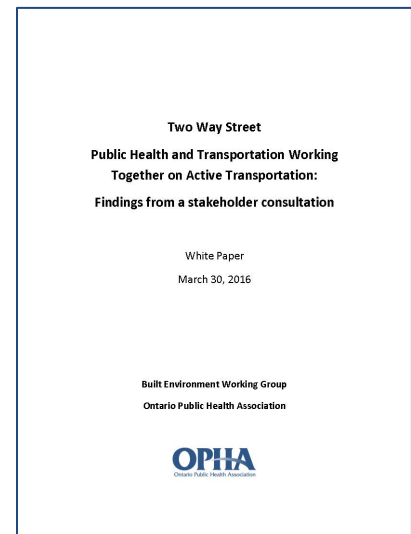
The OPHA Built Environment Working Group (BEWG) identified the following opportunities for public health and transportation professionals to support one another in overcoming potential barriers [33]:

- *Harness additional policy and funding support locally, provincially or federally*
- *Contribute to promoting mutual understanding and knowledge of opportunities for collaboration between transportation and public health*
- *Contribute with more data and evidence on active transportation*
- *Contribute to public outreach and education efforts*
- *Advance active transportation and safety perspective in key scenarios such as Environmental Assessment Studies*



Institutionalizing the use of health impact assessments (HIA) of government actions is a recognized strategy in Canada. Canada's National Collaborating Centre for Healthy Public Policy concluded that the following conditions promote successful implementation of HIAs [37]:

- *A strong link to higher levels of authority*
- *A rapid impact analysis process, but with reliable results*
- *An approach that relies more on incentives than coercion*
- *An approach based on supporting other sectors in achieving their goals, thus gaining their commitment to the process*
- *A legal basis, which constitutes a powerful incentive*
- *A prospective approach, aimed at seizing opportunities to influence the policy development process as early as possible*
- *Some degree of funding, even if minimal, for operations, knowledge production and evaluation*



Similarly, the United States Department of Transportation (U.S. DOT) concluded [38] that:

Recent case studies from across the nation demonstrate that health considerations can be meaningfully integrated into the transportation planning process by fostering improved communications and coordination, building partnerships, and conducting technical analysis at the regional, local, or state organizational levels [38].

Some of these examples include the incorporation of health-promoting policies in long-range plans or the addition of health considerations in large-scale development decisions.

In addition, the U.S. DOT [38] found that:

Other activities at the state or local level that can help integrate health into planning are diverse, scalable, and adaptable, and include a range of inter-organizational activities, such as:

- *Encouraging the inclusion of public health in long-range planning processes*
- *Convening decision-makers in transportation and health organizations concerning the importance of strategic and/or ongoing plans and initiatives*
- *Staffing positions at planning organizations to include public health education and expertise, and staffing positions at public health organizations to include transportation planning expertise*
- *Using performance measures that include: improving the public's health through increased safety across transportation modes, increased active transportation, decreased fatalities and injuries, improved air quality, etc.*



The United States' National Cooperative Highway Research Program's report, *Framework for Institutionalizing Safety in the Transportation Planning Process* [39], has several recommendations on how to establish safety as a convention in region and state level planning. The structure and focus of these safety-related recommendations are good examples for how to integrate health and transportation across other areas (e.g., health equity, active transportation and air pollution):

- *Ensure . . . [state and regional planning agency] . . . committees, policy boards, and other planning structures include safety expertise, e.g., safety professionals, practitioners, and stakeholders*
- *Define and include safety in the vision, goals, and objectives of planning documents*
- *Address safety issues, such as pedestrian and bicycle safety, safe mobility for older citizens, etc., in planning programs and products*
- *Integrate safety performance measures into the overall performance management system*
- *Collect and analyze data for identifying and prioritizing safety issues, projects, and programs*
- *Establish safety as a decision factor to prioritize safety issues, projects, and programs and allocate funds*
- *Implement a monitoring system to track the transportation system’s safety performance and regularly evaluate the effectiveness of safety programs and policies.*

Professional organizations also play large roles in supporting the institutionalization of healthy transportation. The American Public Health Association (APHA) [40] issued a 2009 policy statement — *Improving Health Through Transportation and Land-Use Policies* — that includes the following language:

APHA urges public health and social justice practitioners, advocates, researchers, and philanthropists to advocate and support advancing transportation and land-use legislation that will ensure the following goals:

- *Federal transportation policy must prioritize health, equity, and safety for all travelers*
- *Transportation policy and subsequent implementation must prioritize using clean energy sources and reducing harmful emissions, including greenhouse gases*
- *Community development and redevelopment activities should preserve historic, environmental, agricultural, and aesthetic resources*
- *State department(s) of transportation and local agencies should partner with community groups to conduct Health Impact Assessments for major transportation and land use activities*
- *State and local transportation and land use decisions should promote equity*

The American Hospital Association, as part of its Social Determinants of Health Series, issued a 2017 report titled, *Transportation and the Role of Hospitals* [41]. One strategy from this report recommended hospitals and health systems address the transportation needs of their patients “by supporting policy and infrastructure programs that create safer and more accessible transportation options.”

Similarly, advocacy and philanthropy organizations have also urged more consideration of health in transportation. For example, the Robert Wood Johnson Foundation (RWJF) plays an important role across transportation, health research, policy and practice. RWJF issued several briefs on these topics [42] and funded the Active Living Research Initiative (www.activelivingresearch.org) focused on active transportation research and practice. In partnership with Pew Charitable Trusts, RWJF founded the Health Impact Project with the express purpose of pushing the Health Impact Assessment (HIA) field forward, including the funding of 17 HIAs in the U.S. [43]. An HIA is a methodological process of measuring or predicting the potential health effects of a plan, policy or program before implementation. It considers the positive and negative health effects of such program or project. The overall goal of an HIA is to find better ways to maximize the positive health impacts of the project or plan. A recent evaluation of transportation-related HIAs is also available [44].

Finally, both elected officials and government employees at all levels can play an important role in setting policy and regulations, implementing programs and providing services. For example, in 2012, United States President Obama convened a White House Roundtable on Health and Transportation to discuss the intersection and the challenges of implementing healthy transportation systems. Participants discussed the importance of collaboration, resource coordination and data-driven approaches. The National Center Director and the U.S. Federal Highway Administration’s (FHWA), Safe Routes to School (SRTS) Program Manager were in attendance. It was stated in the meeting that, “It became clear that the Federal SRTS Program has been able to use its unique purpose, which deliberately and consciously required both public health and transportation solutions” [45].

In the United States, legislators in the state of Massachusetts signed the *Massachusetts Healthy Transportation Compact* (Compact) to formalize the need for interagency cooperation between public health and transportation “to balance the needs of all transportation users, expand mobility, improve public health, support a cleaner environment, and create stronger communities” [46]. This cooperation occurs through the secretaries of transportation and health and human services, who co-chair the Compact. It includes participation from the Secretary of Energy and Environmental Affairs, the Massachusetts Department of Transportation, transit administrators, and the Commissioner of Public Health. The Compact is also working with stakeholders, advocacy groups, and the private sector to meet the underlying goals [46]. Similarly, the U.S. state of Oregon signed a Memorandum of Understanding to formalize the link between the Oregon Health Authority and the Oregon Department of Transportation to support safe and active transportation through shared resources and data [47]. High-level managers from both agencies meet at least quarterly to discuss potential collaborations on projects, while identifying and coordinating relevant data and resources.

3.2 SAFE MULTIMODAL SYSTEMS



3.2.1 KNOWLEDGE

There are more than 1,600 on-road fatalities each year in Canada [48]. Disproportionate amounts of the fatalities and serious injuries are pedestrians and cyclists [49]. Also, according to the Traffic Injury Research Foundation, in 2015 almost 25% of fatal crashes occurred from distractions[50]. Moreover in 2010, more than 25% of drivers admitted to braking or having to steer to avoid a crash in the past 30 days due to external distractions (such as construction zones, billboards and other vehicle collisions) and 12% reported doing the same due to internal distractions (such as changing the radio, eating food or talking to a passenger) [51]. Safety considerations in transportation planning traditionally focus on reducing vehicular collisions through facility design, which impact such things as travel speeds [52-54]. However, it should be acknowledged that safety through facility design has its limitations. In addition to external and internal distractions while driving, alcohol, speeding and not wearing a safety belt are significant contributors to fatal collisions [55, 56]. Common ways to address these other non-design related safety factors includes training to change the behaviour of road users, vehicle design, enforcement of travel laws, and transportation facility design.

Safety is often the impetus for changes to existing roadways and intersections. It is always a key consideration for the design of new ones. This focus is backed by overarching policies and plans. For example, the Canadian Council of Motor Transport Administrators’ Road Safety Strategy 2025 includes a vision of “Towards Zero—The Safest Roads in the World.” The Council’s goal is ambitious, giving itself a goal to achieve over time. Their vision is based on best practices that were first implemented in Sweden. Now, many countries have embraced this same vision, which is referred to as Vision Zero. Reducing fatalities and injuries requires a systems approach, including both plans and project design [58, 59]. Therefore, Vision Zero is powerful, because its principles guide action at the national, regional, local, and project levels.

Pedestrians and cyclists must be considered when designing transportation infrastructure to reduce injuries and fatalities from collisions. Pedestrians and cyclists are more likely to suffer injury or death in a collision. In fact,

Vision Zero Principles

Vision Zero is a Swedish initiative pioneered in 1994 to eliminate deaths or serious injuries on Sweden’s roads. It has been widely adopted in Europe and North America and includes the following core principles:

- Traffic deaths and serious injuries are preventable
 - No loss of life is acceptable on roadways.
 - Transportation systems must be designed to allow human error
 - The first priority is eliminating collisions that result in death or serious injuries.
- Business Sweden (57)

pedestrians and cyclists are 1.5 times more likely than motorists to die on a trip [60, 61], and there are also many life-altering injuries that go unreported. Moreover, traffic injury risk across modes of transportation is higher for low-income populations, where car ownership is low and, despite unsafe infrastructure, many rely on walking or biking for transport [54, 62].

There is a growing body of evidence and resources to help mitigate the risk for injury and fatalities across all modes of transportation, especially for vulnerable pedestrians or cyclists [53, 63]. Some of these interventions to reduce traffic injuries focus on the alteration of environmental factors such as traffic volume and speed [64, 65] and for cyclists, increased separation from vehicles [66]. An ongoing debate within the literature is the extent to which a safety-in-numbers effect (a reduction in risk with an increased number of cyclists and pedestrians on the road) is defensible [23]. In other words, reducing the number of cars on the road by increasing the number of cyclists and pedestrians inherently improves safety. For example, one study found that a 30% reduction in traffic volume was estimated to reduce the total number of injured pedestrians by 35% and the average risk of pedestrian collision by 50% [65].

Safety is considered an important lever in changing travel behaviour. People’s perceptions of injury risk correspond with their perceived safety of their built environments [67]. People who perceive their travel environments to be safe, including their perceptions of injury risk, are more likely to take active modes of transportation [68]. Children [69-71] and older adults [72-76] are vulnerable sub-populations whose walking and cycling behaviours are sensitive to traffic speed, volume, and pedestrian features within the built environment. These findings suggest that facility designs are needed to care for both ends of the age span.

For additional details and resources see the following recent, academic, systematic review documents:

- Vision Zero Adoption in Canada [77]
- Safety-in-numbers: A systematic review and meta-analysis of evidence [23]

The next section describes a summary of current practices for integrating health into safety considerations. These practices are organized into three categories—Policy, Planning and Analysis, and Design.

3.2.2 PRACTICE - POLICY

Policies that improve multimodal safety support Vision Zero’s overarching mission to eliminate all traffic fatalities and severe injuries while increasing safe, healthy, equitable mobility for all. Although the Vision Zero strategy is becoming increasingly common in many countries and across many cities, adoption of supportive policies by local municipalities is uneven, as a recent study found that only 6 out of 16 municipalities and 2 of 5 surveyed provinces/territories in Canada had formally adopted Vision Zero-supportive policies [77]. One entity that adopted these policies was the Canadian Council of Motor Transport Administrators, as they are included in their *Road Safety Strategy 2025*.

For additional information about Vision Zero in the Canadian context see:

- Parachute Vision Zero Network - www.visionzeronetwork.ca/
- Vision Zero Canada - <https://visionzero.ca/>

Vision Zero consists of many policy items that can be achieved through planning, design, road-user training and enforcement. Some of these Vision Zero-supportive policy examples are provided in Neil Arason’s book: *No Accident: Eliminating Injury and Death on Canadian Roads* [78] are below:

- *Create a federal multi-disciplinary public safety agency charged with significantly reducing, and with the ultimate goal of eliminating, motor vehicle-related fatalities and serious injuries*
- *Pass federal legislation to earmark a set percentage of highway funding for pedestrian and cyclist infrastructure*

- *Set speed limits to 30 km/h in places, where pedestrians and cyclists mix with cars*
- *Expand the number of roundabouts and ensure they are easy to use and designed for the optimal safety of pedestrians and cyclists*

Other policy levers include helmet laws for cyclists and lower speed limits, with speed being a particular concern in residential areas. For example, in 2013-14, 45% of those who reported regularly riding a bicycle in Canada, also reported always wearing a helmet [49]. Such a finding could affect public health policies and their community impact. For example, helmet laws might curtail the use of a bike share system. This was observed in Vancouver, where the bike sharing program was delayed due to concerns about British Columbia's mandatory bicycle helmet legislation.

3.2.3 PRACTICE – PLANNING AND ANALYSIS

Safety considerations are common elements in long and short-range transportation planning documents [52]. More attention is turning to the multimodal elements of safety. For example, the U.S. Federal Highway Administration (FHWA) recently released a guide to help state and local municipalities prepare a safety vision, document current conditions, and use data to match safety concerns with programs and improvement [79].

From a research perspective, one of the largest challenges for multimodal safety is consistent data collection. Discrepancies exist in how agencies collect and report pedestrian, cyclist, and motor vehicle traffic collision injury and fatality data, whether reporting occurs through police reports or hospitalization records (i.e., emergency department visits, hospitalizations, mortality data)[48]. Often times, collision injury data, and the databases from which studies draw conclusions and policies are made, underrepresent adolescents and adults who are less likely to go to an emergency room[80]. Government agencies can play large roles in creating consistent datasets. This would enable law enforcement, first responders, and hospitals to define and record fatalities and serious injuries of all modes in the same way [81, 82].

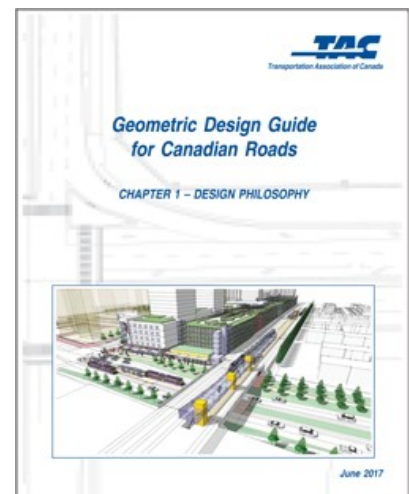
“The design of streets should involve a comprehensive planning process, one that identifies the needs and balances the requirements of the full range of potential users within a community including users of all ages and abilities, pedestrians, cyclists, transit vehicles and motorists.”

Ontario Ministry of Transportation [78]

3.2.4 PRACTICE - DESIGN

Transportation design guides offer varying levels of detail concerning safety, from high-level design principles in the City of Toronto's *Active City: Designing for Health* [83] guide to the detailed guidance in Transportation Association of Canada's *Geometric Design Guide for Canadian Roads* [84]. Design guides consistently emphasize the importance of designing streets for safe multi-modal travel. Although two distinct concepts that require specific strategies for improvements, safety is often synonymous with health in design guides.

Design guidance documents increasingly recognize the land use context of facilities as vital components of street and transportation facility design. Leveraging the land use context in designing streets allows designers to maximize safety and comfort for the full range of users. Using land use contexts to support transportation facility design is a core component of Complete Street Guides, such as those published by Toronto[29], Edmonton [85] and Boston [86]. These guides explicitly tie multimodal design guidance to street type and land use contexts, adapting the guidance to safely accommodate all users. They distinguish facility design guidance based on “the distinct transportation characteristics of different land uses” [85] and “how different streets interact with adjacent land uses and contexts” [86]. For example, Figure 2 shows streetscape design for a Neighbourhood Main



Street, typically located in the heart of an urban residential community and characterized by dense, first floor commercial and retail use.

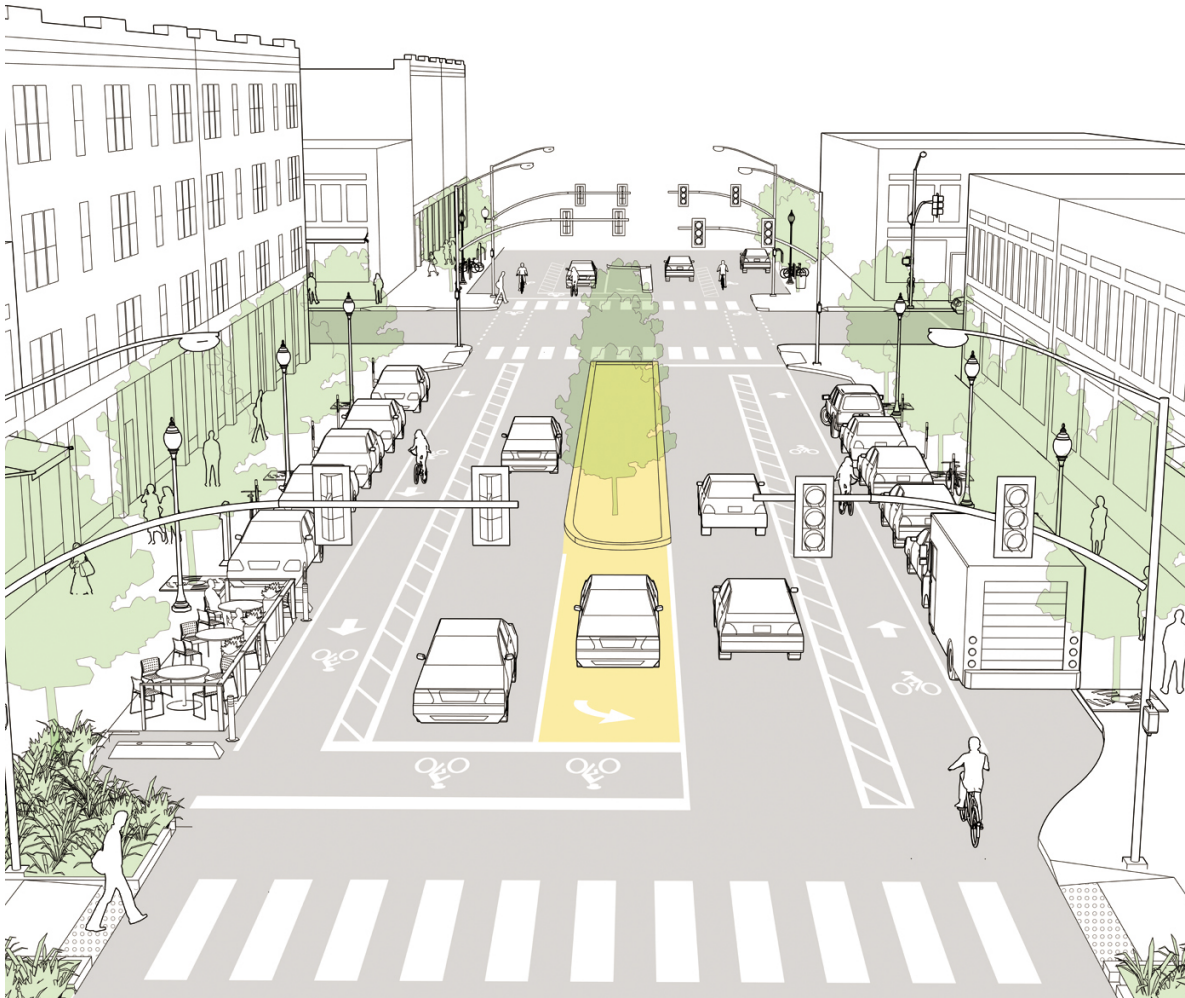


Figure 2: Neighbourhood Main Street
 (Source: National Association of City Transportation Officials, 2013) [87]

Design guidelines have also expanded to consider the needs of a comprehensive range of potential users, including placing more emphasis on vulnerable road users, but still within the context of the roadway and nearby land use (Figure 3). Designs for vulnerable road users consider people who are walking, biking, and using visual aids, wheelchairs, and other mobility aids. For example, mixed traffic facilities allow people to be moderately safe on roads with very low traffic volumes and low speeds, even though people use various modes to share the roadway (Figure 4).

OUR DESIGN GOALS HAVE CHANGED

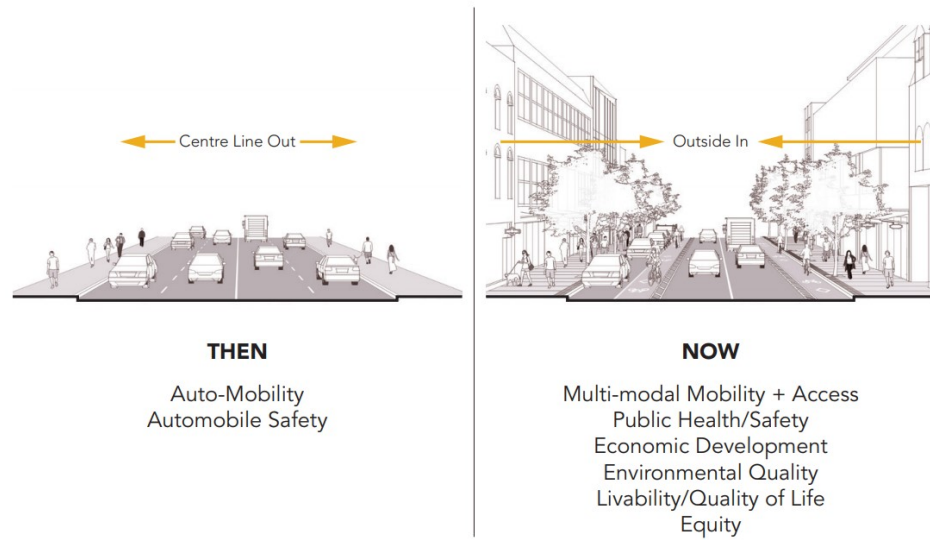


Figure 3: Our Design Goals Have Changed (Adapted from Michael Flynn for NYC DOT) [29]

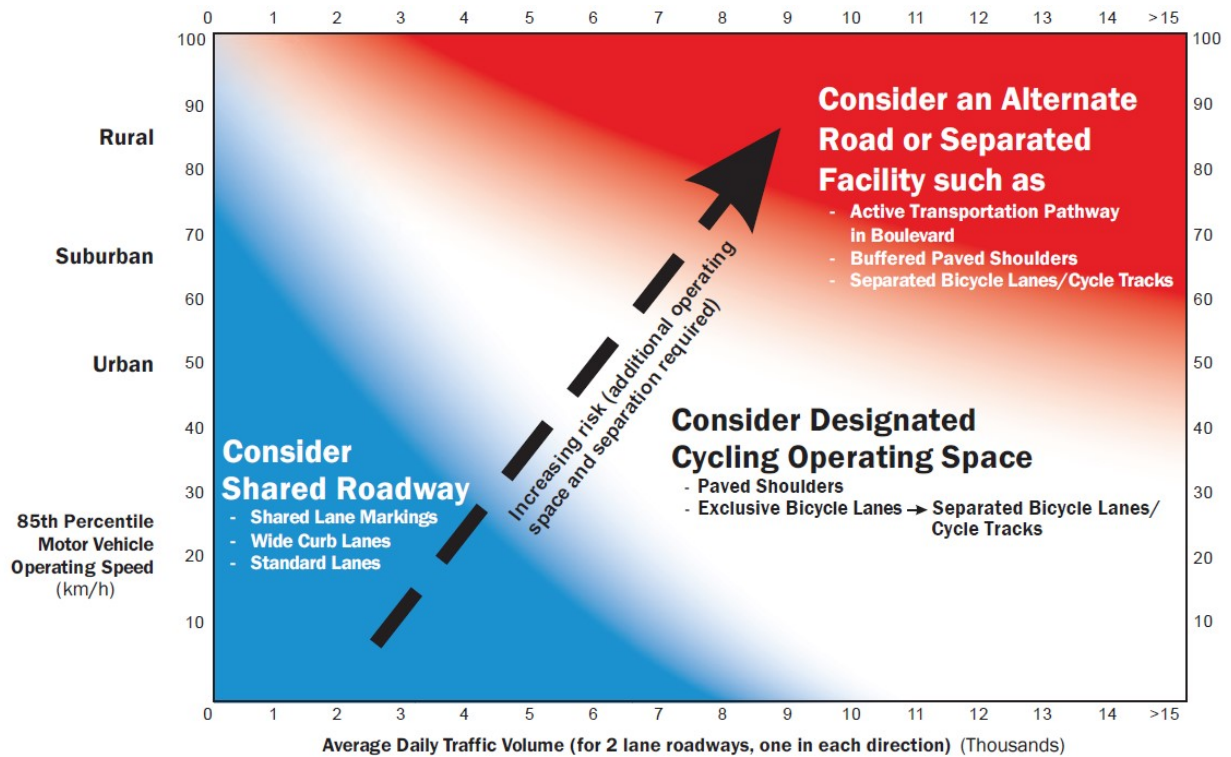


Figure 4: Desirable Bicycle Friendly Facility Pre-Selection Nomograph (Source: OTM Book 18, Figure 3.3) [29]

Creating these roads typically includes implementing traffic calming measures, which aim to reduce speeds and traffic volumes while improving vulnerable road user safety. Examples of these mid-block and crossing improvements include speed humps, narrowing of travel lanes, and curb extensions, which are appropriate in medium to low density residential neighbourhoods [88, 89] (Figure 5). By comparison, physically separated facilities, such as protected bike lanes, pedestrian and bike only paths, and buffered sidewalks, are considered the safest and most comfortable for most other contexts [89]. While physically separated infrastructure can provide the safest conditions for all road users, design choices must be considered not only within context of land use, traffic volumes and speed, but also in cost, with the need to balance the expense with and the value of safety improvements [84].



Figure 5: Geometric Design Example of Various Traffic Calming Measures for a Rural or Small Town Bicycle Boulevard (Source: Figure 2-5 in Federal Highway Administration’s 2016 Small Town and Rural Multimodal Networks guide) [89]

Network design guidance offers another opportunity to better integrate transportation and health. Whether it be roads, sidewalks, trails, or cycling lanes, choices about the interconnectivity of modal networks can be used to provide more direct, attractive routes between destinations while also minimizing roadway users exposure to less safe conditions[83]. Thus, by improving accessibility to a destination, increased connectivity of infrastructure that promotes walking, cycling and/or public transit, then makes active, healthy modes of transportation a more appealing commute choice [83]. Furthermore, interconnecting various facility types can create a network that appeals to all ages and abilities [89]. As such, network design guidance can influence not only safety but also a broader list of health outcomes including, but not limited to, increased levels of physical activity, prevention of chronic health conditions, access to medical and health services, and implications for mental health. In addition, network design offers an effective lens through which to consider and influence health risks from exposure to air pollution (See the section labeled 3.6 Reducing Exposure to Air Pollution for more discussion of this).

Safety is an essential component of designing transportation systems and planning healthy communities. However, design guides predominately discuss safety in the context of reducing collisions, and resulting injuries and deaths, without discussing other aspects of health impacts from travel. This gap presents an opportunity for TAC and other agencies to discuss more broadly transportation’s impact on health. Other components to include in such discussions include opportunities for increasing physical activity, reducing noise and air quality exposure, chronic disease prevention, and improved mental health and social wellbeing.

The list below provides a recommended set of practitioner-focused recommended guidance documents for additional details and resources.

- City of Boston, *Boston Complete Streets Guidelines* [86]

- City of Edmonton, DRAFT #2 *Downtown & The Quarters Downtown: Streetscape Design Manual for – Green & Walkable* [90]
- City of Toronto, *Active City: Designing for Health* [83]
- Federal Highway Administration, *Small Town and Rural Multimodal Networks* [89]
- Transportation Association of Canada, *Geometric Design Guide for Canadian Roads* [84]

3.3 TRAVEL MODE CHOICE AND ACTIVE TRANSPORTATION



3.3.1 KNOWLEDGE

There are many benefits associated with physical activity, including healthy growth and development in children; reduced risks of chronic diseases such as heart disease, diabetes and stroke; improved mental health, cardiovascular fitness, bone and functional health; and enhanced energy balance and weight control. Obesity, in particular, remains a public health challenge in Canada, with the national prevalence increasing from 10% in 1970-72 to 26% in 2009-2011 [92]. Researchers suggest that 61% to 74% of type 2 diabetes cases, 14% to 21% of colorectal cancers, 8% to 14% of depression cases, and 20% of premature deaths for Canadian adults are directly attributable to obesity [92].

Creating opportunities to walk or cycle align with current public health efforts to reduce obesity and related chronic diseases, as both displace sedentary time with activity throughout the day [93].

To achieve health benefits, adults aged 18+ years should accumulate at least 150 minutes of moderate to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more.

Youth, ages 5-17, should accumulate at least 60 minutes of moderate-to-vigorous intensity physical activity daily.

For more detailed, age-specific guidelines, see Canadian Society for Exercise Physiology [91]

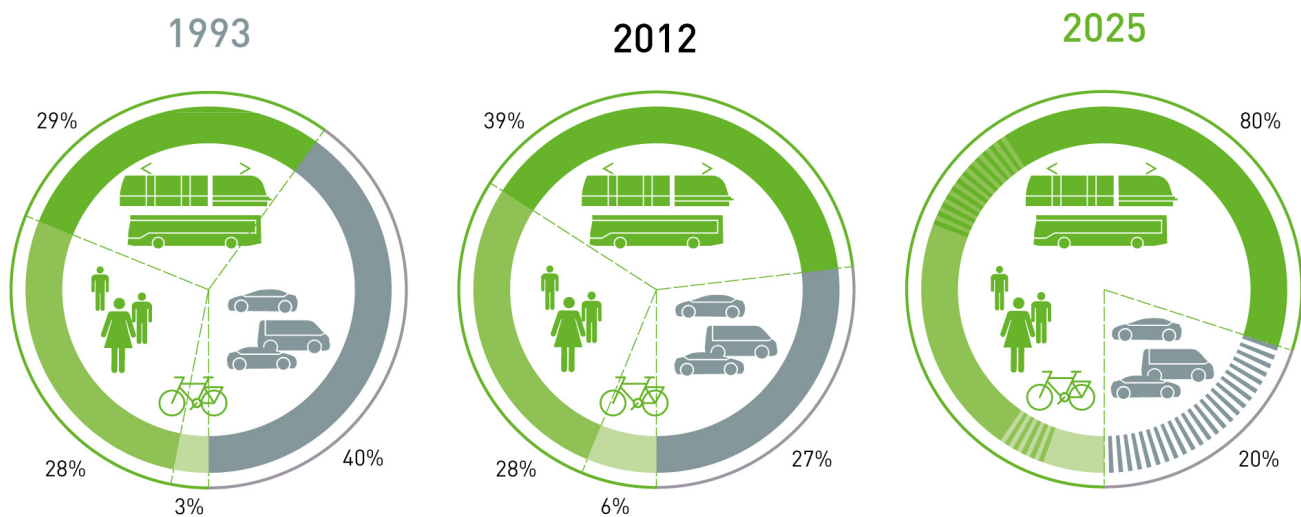


Figure 6: Vienna’s Modal Split in 1993, 2012 and 2025 (Source: Wiener Linien / STEP 2025) [94]

More active forms of transportation offer a unique opportunity to displace sedentary time during a commute (i.e., sitting in a car) with increased physical activity. As such, much attention over the past 20 years has turned to walking, cycling, and their use in connecting to transit as important, daily utilitarian activities that can improve health gains. For example, efforts to increase these modes in the city of Vienna, Figure 6, has resulted in a decrease in automobile usage (down from 40% in 1993 to 27% in 2012) while cycling rates doubled in the

city. Vienna plans to continue to work to decrease automobile usage to 20% by 2025 to help improve health outcomes in the region[94].

The link between walking and cycling and all-cause mortality is solid. In a 2015 meta-analysis, after adjusting for other types of physical activity, walking and cycling were shown to reduce the risk of all-cause mortality. Specifically, for a standardized dose of 11.25 metabolic equivalents of task (METs)⁴ per week, the reduction in risk was 11% (95% CI = 4 to 17%) for walking and 10% (95% CI = 6 to 13%) for cycling [95]. In other words, walking and cycling at an average intensity of 4.5 METs (moderate intensity) for 150 minutes per week can reduce the risk for all-cause mortality regardless of other forms of physical activity. In a 2019 manuscript about the City of Vancouver’s Comox-Helmcken Greenway Corridor’s impacts on health it was found that survey participants near the greenway doubled their odds of achieving 20 minutes of moderate and vigorous physical activity daily[96].

Additionally, this meta-analysis clearly showed that the shape of the dose-response relationship for walking or cycling has the greatest effect at the lower end of the dose (minutes) [95]. This means that even small increases in someone’s walking and cycling activity can have significant impacts on their health.

In 2018, the Public Health Agency of Canada (PHAC) released a report entitled: *A Common Vision for increasing physical activity and reducing sedentary living in Canada: Let’s Get Moving*. This report encourages organizations, leaders and planners to promote physical activity across their frameworks (e.g., Framework for Recreation in Canada), programs, and strategies to address health outcomes in Canada. Six core areas of this report include cultural norms, spaces and places, public engagement, partnerships, leadership and learning, and progress. Overall, this report promotes cross-sector collaborations and innovative approaches to combat the complex factors contributing to chronic illnesses in Canada [97].

PHAC’s *Let’s Get Moving* report also discusses active transportation rates for children going to school in Canada, as these rates dropped from 32.5% in 2009-2010 to 26% in 2013-2014. Active transportation for children going to school was defined as children who walked, cycled, skated or scooted to school. For adults 18 years and older, the average Canadian spent about 1.9 hours per week using some form of active transportation in 2016. Moreover, this report highlights the benefits of active transportation such as the reduction of air pollutants and encourages readers to support transit solutions such as the enhancement of biking routes and the creation of incentives for people to drive less [97].

Indeed, cities with land-use elements that promote walking, cycling and public transit have been shown to yield greater health gains than motor vehicle dependent cities[98]. With the relationship between active transportation and health well established, researchers are turning to understanding the mechanisms through which the built environment affects travel behaviour. Neighbourhood walkability, residential density and distance to parks are all associated with physical activity [99-101]. Residential density, connectivity, land use mix, and sidewalk completeness and quality also play a role in increasing active transportation for pedestrians [101, 102]. The presence of bike lanes and physical barriers between cyclists and motor vehicle traffic has been shown to increase individuals’ use of bike infrastructure [103, 104]. Increased spatial concentration of public transit stops is conducive to increasing transit ridership, while increasing physical activity related to walking to transit [102]. In Canada it was found that those who take the bus are 1.66 times more likely to meet physical activity guidelines; and those who walk to a subway or rail line are 2.87 times more likely to meet physical



⁴ A MET is a physiological measure that expresses the energy cost of physical activities.

activity guidelines [105, 106]. Motor vehicle time is also positively associated with increased weight and thus other obesity-related chronic diseases such as cardiovascular disease, hypertension, type 2 diabetes and obesity [107].

Research is now examining specific facilitators of, and barriers to, active transportation. This includes general and specific characteristics of the major built environment attributes within a residential neighbourhood, with some comparison of relative effectiveness [108]. For example, built environment attributes such as the addition of trees and shading in neighbourhoods may positively impact mode choice and health outcomes. These natural features help block exposure to ultraviolet rays for people being physically active. With skin cancer being the most commonly diagnosed cancer in Canadians [109], adding trees and shading to neighbourhood designs has the potential to contribute to reduced incidence of disease and reduced health care costs.

The list below provides recommended research-based documents for additional details and resources. Two resources summarize the latest scientific findings of physical activity [95, 108]. The other resources are more practice-based and include a policy-centered report [110]; a report showing how the U.S. is tracking bike infrastructure, physical activity, and institutional efforts to increase biking [111]; and Canadian-specific evidence [112, 113].

- (U.S.) *Bicycling & Walking in the United States, 2016 Benchmarking Report* [111]
- (International) *A review on the effects of physical built environment attributes on enhancing walking and cycling activity levels within residential neighbourhoods* [108]
- (U.S.) *Moving Toward Active Transportation: How Policies Can Encourage Walking and Bicycling* [110]
- (International) *Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship* [95]
- (Canada) *Active Transportation, Health and Community Design: What is the Canadian evidence saying?* [112]
- (Canada) BC Centre for Disease Control. *Healthy Built Environment Linkages Toolkit: making the links between design, planning and health, Version 2.0.* Vancouver, B.C. Provincial Health Services Authority, 2018 [113]

The next section describes a summary of current practices for integrating health and transportation. These practices are organized using the following categories: Policy, Planning and Analysis and Design.

3.3.2 PRACTICE - POLICY

Policy constructs that support physical activity are generally those that support active modes of travel. Promoting public transit, incentivizing active modes through parking fees, designing car-free city streets, and lowering speed limits all encourage walking and biking activity [114]. For example, federal, provincial, and municipal governments— such as the Cities of Vancouver, Toronto and the Regional Municipality of York, United Kingdom – have adopted policies that explicitly prioritize and consider pedestrians, cyclists, and public transit users over automobile drivers [115-117].

Other municipalities are encouraging active transportation through a Complete Streets approach that is designed for all users. One definition of a Complete Street is a street which is “designed for all ages, abilities, and modes of travel” [118]. Under a Complete Streets design approach, streets are modified to better accommodate pedestrians, cyclists, transit users, and other vulnerable users, and not just the needs of automobiles. Complete Streets is often a policy adoption and/or an element of a transportation plan. For example, Ontario’s 2017 initiative to plan for growth and development, *Places to Grow, Growth for a Greater Golden Horseshoe*, includes a policy which states that “in design, refurbishment or reconstruction of the existing and planned street network, a Complete Streets approach will be adopted that ensures the needs and safety of all road users are

considered and appropriately accommodated.”[119]. With the launch of the *Active Alberta 2011-2021* policy, the Government of Alberta has also been a progressive force with regard to integrating health into transportation policies[120]. According to the Toronto Centre for Active Transportation’s⁵ (TCAT) [121], the following 19 cities have adopted similar Complete Streets policies (Table 1). Approximately 25% of U.S. municipalities currently report having a Complete Streets framework [120].

Table 1: Canadian Cities with Adopted Complete Streets Policies [121]

Airdrie, Alberta	Dieppe, New Brunswick
Calgary, Alberta	Moncton, New Brunswick
Canmore, Alberta	Ajax, Ontario
Edmonton, Alberta	Ottawa, Ontario
Strathcona County, Alberta	Province of Ontario
Courtenay, British Columbia	St. Thomas, Ontario
Kelowna, British Columbia	Toronto, Ontario
Nanaimo, British Columbia	Waterloo, Ontario
Oak Bay, British Columbia	Quebec City, Québec
Vancouver, British Columbia	

TAC, through its regularly updated Urban Transportation Indicator Surveys, provides longitudinal, pan-Canadian compiled mode usage indicators, such as the proportion of journey-to-work trips by active transportation (walking and cycling) [30]. This type of information allows municipalities to compare themselves with peers and set numeric policy goals for different metrics, while monitoring progress over time.

3.3.3 PRACTICE - PLANNING AND ANALYSIS

Efforts to quantify the health impacts of transportation – primarily by estimating the health effects of physical activity from active transportation – have been advanced by a growing suite of qualitative and quantitative tools prepared for this purpose.

There has been an increased interest in the use of Health Impact Assessments (HIA) in Europe and North America as process-driven tools to incorporate health into the planning process. These applications have often been more qualitative in nature. HIAs on transportation projects and programs have largely focused on the physical activity benefits while grappling with trade-offs of safety and air quality exposure [44, 122, 123]. Despite their promise to help integrate health into planning, HIAs are quite variable in their methodologies and rigor [124, 125], including in Canada [126].

⁵ Toronto Centre for Active Transportation (TCAT) is a project of Clean Air Partnership. <http://www.tcat.ca/>.

Canada's National Collaborating Centre for Healthy Public Policy notes that,

"HIAs are not currently required by legislation in Canada; however federal Environmental Impact Assessments (EIA) (Health Canada, 2004) and provincial Environmental Assessments (EA) are required by legislation for some projects. HIAs are different from other health assessments (e.g., Environmental Impact Assessments, Environmental Assessments, Community Health Assessments, Cost-Benefit Analysis) in that they consider both the unintended positive and negative consequences on health determinants and specific health-related outcomes (US CDC, 2016)." [37]

The National Collaborating Centre for Healthy Public Policy's website [127] also contains resources including a discussion on the meaning of HIAs, information on the processes of HIAs and why they are useful, tools to use when conducting HIAs, and examples of how HIAs influence projects.

In the U.S., the HIA field has been supported by the federal government and by philanthropic foundations. Governmental resources include the U.S. Centers for Disease Control and Prevention's (CDC) Transportation Health Impact Assessment Toolkit⁶. This toolkit "provides a framework for public health departments, city planners, project managers, and other stakeholders to conduct HIAs on proposed transportation projects, plans, and policies". The CDC has partnered with the U.S. Department of Transportation to create the Transportation and Health Tool (THT)⁷. While technically not a full HIA, the tool provides information on how transportation and health are linked, including access to data and indicators for each state and region related to key transportation issues. The Health Impact Project⁸ – a collaboration between the Robert Wood Johnson Foundation and The Pew Charitable Trusts – has also played a significant role in building the U.S. HIA field. The Health Impact Project also crowd-sources HIAs in the U.S., which is searchable by subject; this list can be helpful in identifying HIA reports and methodologies as templates.

Table 2 provides a list of quantitative decision support and planning tools that are commonly used to extend planning exercises through quantitative comparative health risk assessment. The first two – the Health Economic Assessment Tool (HEAT) and the Integrated Transport Health Impact Model (ITHIM) – estimate health impacts from changes in physical activity that are estimated external to the tool. Both tools leverage the burden of disease and relative risks pulled from meta-analysis in the literature. HEAT, developed by the World Health Organization, Europe Region, predicts avoided mortality⁹ of physical activity from walking and cycling. It is a web-based tool. ITHIM, developed in the U.K. uses a similar relative risk approach and predicts avoided mortality and morbidity. ITHIM, which is currently operated using a spreadsheet and the programming language R, also has safety and air pollution (based only on particulate matter) modules.

⁶ http://www.cdc.gov/healthyplaces/transportation/hia_toolkit.htm.

⁷ <https://www.transportation.gov/transportation-health-tool>

⁸ <http://www.pewtrusts.org/en/projects/health-impact-project>

⁹ The developers of HEAT are currently exploring adding modules for safety and air pollution. Morbidity is also being discussed as a HEAT capacity.

Table 2: Quantitative Decision Support Tools for Understanding Transportation, Physical Activity, and Health

Resource Title
(International) Health Economic Assessment Tool (HEAT) ¹⁰
(International) Integrated Transport and Health Impact Modeling Tool (ITHIM) ¹¹
(Canadian – Toronto) CommunityViz Health Module ¹²
(U.S.) California Public Health Assessment Model (CPHAM)
(U.S) National Public Health Assessment Model (NPHAM) ¹³

The next three tools in Table 2, each developed by Urban Design 4 Health, take a different approach to estimating the physical activity health effects associated with changes in land use and transportation. They each enhance existing scenario planning tools (e.g., CommunityViz,¹⁴ Envision Tomorrow,¹⁵ and UrbanFootprint¹⁶) by embedding health considerations into the standard analysis flow of these tools and thus planning process. Scenario planning tools allow for the analysis and comparison of the impacts of various land use and transportation alternatives.

The first tool, CommunityViz Health Module,¹⁷ was developed in 2012 with support from Toronto Public Health, on behalf of Healthy Canada by Design. An existing scenario planning tool (CommunityViz) was enhanced using regression models developed from City of Toronto postal-code level built and social environment inputs, and health related outcomes¹⁸ (e.g., body mass index, walking and bicycling trip making (Figure 7), high blood pressure). The enhancement allows for the evaluation of the implications of planning decision on people’s activity and health and productions of greenhouse gases from vehicles used for transport [128].

¹⁰ HEAT - <http://www.heatwalkingcycling.org>

¹¹ ITHIM - <http://www.cedar.iph.cam.ac.uk/research/modelling/ithim/>

¹² CommunityViz Health Module resources - <https://hcbdclasp.blog/2014/01/15/health-enhanced-land-use-planning-software-tool/> and http://urbandesign4health.com/wp-content/uploads/2012/03/CLASP_final_report_submitted_04242012.pdf

¹³ National Public Health Assessment Module - <http://urbandesign4health.com/projects/hia-plug-in-scenario-planning>

¹⁴ CommunityViz - <http://communityviz.city-explained.com/>

¹⁵ EnvisionTomorrow - <http://envisiontomorrow.org/>

¹⁶ UrbanFootprint - <https://urbanfootprint.com/>

¹⁷ CommunityViz Health Module resources - <https://hcbdclasp.blog/2014/01/15/health-enhanced-land-use-planning-software-tool/> and http://urbandesign4health.com/wp-content/uploads/2012/03/CLASP_final_report_submitted_04242012.pdf

¹⁸ Canadian Community Health Survey - <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226>, and Transportation Tomorrow Survey - <http://www.transportationtomorrow.on.ca/index.html>.

The next two tools, the California and the National Public Health Assessment Models (CPHAM¹⁹ and NPHAM²⁰ respectively), are also based on regression models developed by Urban Design 4 Health using California built, natural and social environment inputs, and health related outcomes.²¹ The primary differences between the versions are spatial, with some differences in the inputs/outputs and resulting models. CPHAM is based on land use and other built environment data at a fine scale, the individual parcel, and aggregated to buffers around the street address of survey participants in the major metropolitan regions of California. It was created as a module for UrbanFootprint version 1.5.²² NPHAM is a Census block group (CBG) level tool, with applicability to the entire U.S. The outcomes that are modeled by the resulting regression equation are for the average person in a CBG [129]. This tool can be applied to any CBG in the U.S.

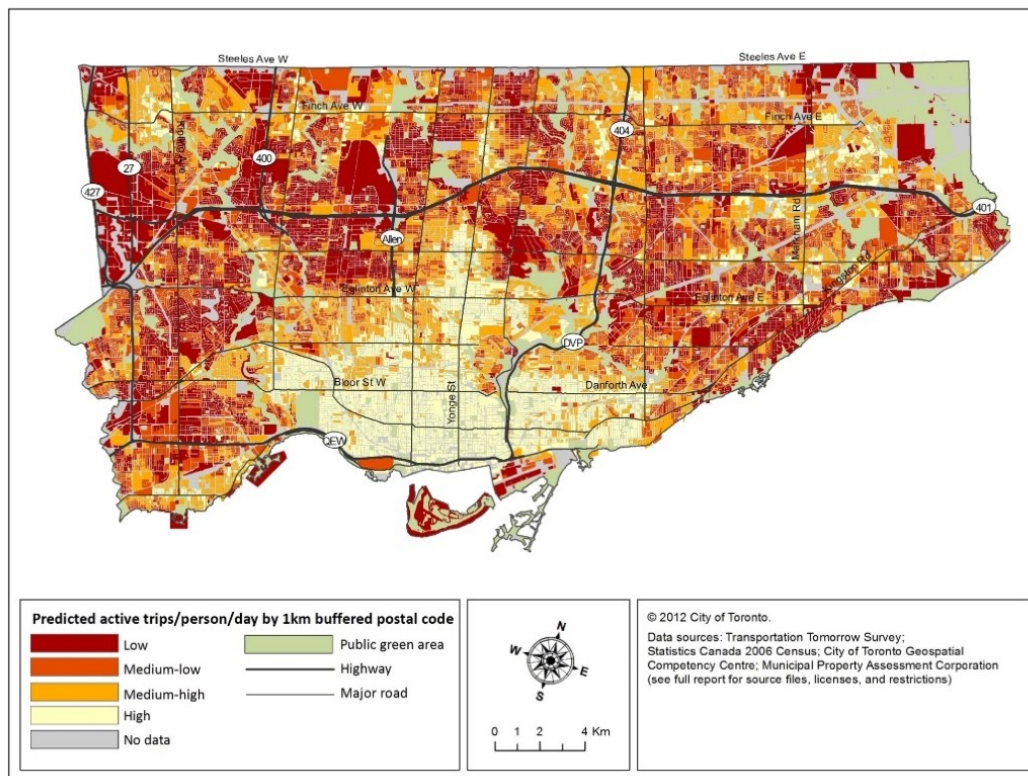


Figure 7: CLASP, Toronto – Community Viz Health Module – Predicted Active Trips/Person/Day

3.3.4 PRACTICE - DESIGN

The design guides reviewed encouraged consideration of active transportation users in some capacity, and no guide looked at one transportation mode in isolation from others. However, the degree to which a guide

¹⁹ California Public Health Assessment Module - <http://urbandesign4health.com/projects/california-statewide-public-health-assessment-model>

²⁰ National Public Health Assessment Module - <http://urbandesign4health.com/projects/hia-plugin-in-scenario-planning>

²¹ California Health Interview Survey - <http://healthpolicy.ucla.edu/chis/Pages/default.aspx>, and the California Household Travel Survey - http://www.dot.ca.gov/hq/tpp/offices/omsp/statewide_travel_analysis/chts.html

²² UrbanFootprint version 1.5 - http://urbanfootprint-v1.readthedocs.io/en/latest/analysis_modules/index.html

supported an individual's ability to choose active transportation through designing safe, attractive streets varied. This variance stemmed from the emphasis of the design document; for example, whether the guide intended to support vehicular facility design, act as a gold standard for active transportation facilities, or serve to balance facility design for multiple modes.

On one end of the spectrum, some resources offered highly technical guidance on how to accommodate active modes when designing vehicular facilities. For example, the U.S. National Cooperative Highway Research Program's (NCHRP) *Design Guidance for Channelized Right-Turn Lanes* offers recommendations for safe crossings for pedestrians in channelized right-turn lanes [130]. Whereas active transportation specific guides that primarily focus on bike and pedestrian infrastructure, such as the American Association of State Highway and Transportation Officials' (AASHTO)²³ and the National Association of City Transportation Officials' (NACTO)²⁴ bike facilities design guides, offer detailed guidance that prioritizes active transportation through design strategies to make the most comfortable, attractive, and safe environment for those users. Complete Streets guides focused on encouraging safe transportation for all users, with a focus on active, multi-modal users. The provided guidance is context sensitive and aim to balance the demands of vehicular traffic with the needs of active modes.

Provided below is a list of practitioner-focused recommended guidance documents to reference for additional details and resources.

- (Canada) BC Centre for Disease Control. Healthy Built Environment Linkages Toolkit: making the links between design, planning and health, Version 2.0. Vancouver, B.C. Provincial Health Services Authority, 2018 [113]
- (Canada) *Active Transportation in Canada – A resource and planning guide* [131]
- (Canada) *Greater Strides: Taking Action on Active Transportation* [132]
- (Canada) *The Built Environment and Physical Activity: Data Collection Tools to Support Intervention* [133]
- (UK) *Working Together to Promote Active Travel* [134]
- (U.S.) *A Resident's Guide for Creating Safer Communities for Walking and Biking* [135]

3.4 TRANSPORTATION ACCESS TO HEALTH PROMOTING AND COMMUNITY RESOURCES



3.4.1 KNOWLEDGE

Urban health scholars view urban areas as mosaics of both risk and protection [136]. Risks include blight, safety issues, substandard housing, and lack of services – an interest of sociologists for over a century. Fitzpatrick and LaGory, however, highlight that an urban area's density of destinations including employment, education, parks, health care providers, and other social services available nearby are considered "protective." Thus, public health and environmental justice advocates often expand the concept of accessibility to capture (a) affordability and convenience by all modes and (b) desirability of the destination as a health promoting service (e.g., access to schools, local services and amenities, including retail sources of healthy food options). This suggests the need for a broader definition and accompanying suite of metrics in transportation [137]. Listed below are the title of reviews that summarize the literature regarding the links between transportation, access, and health in different domains.

²³ <https://www.transportation.org/>

²⁴ <https://nacto.org/>

- *Transport and Poverty: A review of the evidence* [138]
- *Association of proximity and density of parks and objectively measured physical activity in the United States: A systematic review* [27]
- *Are differences in travel time or distance to health care for adults in global north countries associated with an impact on health outcomes? A systematic review* [139]
- *Access to parks and physical activity: an eight country comparison* [140]
- *Geographic access to healthy and unhealthy food sources for children in neighbourhoods and from elementary schools in a mid-sized Canadian city* [141]
- *A systematic review of fast food access studies* [142]

The concepts addressed by the above literature reviews are summarized below.

Employment: Access to employment is a central concern of most regional planning exercises and reflects a central purpose of transportation. Employment is also a determinant of health. Spatial mismatch research shows that low-wage workers living in inner-city neighbourhoods, on average, have limited employment accessibility because many do not own a private automobile, demonstrating the potential of non-automobile dependent transportation investments to provide improved access to non-local jobs, thereby promoting greater social equity [144-146]. Other studies show that transit investments result in statistically significant gains in accessibility to low-wage jobs [147].

“Lack of access to affordable transportation is a major contributor to health disparities. It isolates low-income people from health care facilities and forces families to spend a large percentage of their budgets on cars and other expensive options, at the expense of other needs, including health care.”

The Leadership Conference Education Fund [143]

Parks/Recreational Areas: The public health benefits associated with access for all ages and abilities to parks and other recreational areas are complex, and often reliant on park quality (e.g., size, safety and features), distance to them, and available modes of transportation. However, distance to and density of parks is generally considered an element that encourages physical activity [27, 28, 148]. Green space offered by parks are believed to confer a mental health benefit [149], some decrease in exposure to ultraviolet radiation due to shading [150], and improve ambient air quality by reducing levels of toxic pollutants [151]. This is further discussed in the “Supporting Mental Health” section below.

Health Care Services: Health care services are medical services which prevent, diagnose and treat physical and mental impairments. Access to these services is a multi-faceted concept that involves affordability (i.e., costs of health care utilization), acceptability (i.e., health service compliance and satisfaction), availability (i.e., adequacy of health service provision), geographic accessibility (i.e., travel impedance between patients and providers), and accommodation (i.e., appropriateness and suitability of health services) [152]. Populations in areas with environmental justice burdens often have significantly less access to health promoting services such as health care [26, 153] and patients of low socioeconomic status and low-income patients in general experience a disproportionate amount of transportation barriers [143, 153, 154].

Healthy Foods: Over the past decade, obesity rates consistently increased among Canadians with the annual economic burden of the illness estimated at \$4.6 billion [155]. Consuming unhealthy foods is a major contributor to obesity. To improve the food environments in Canada, comprehensive data at the federal, provincial/territorial, and municipal levels will be needed to examine Canadian food environments, including transportation options to access to healthy food options, and the dietary habits of its citizens [156]. One such

effort within Canada is the Healthy Eating Strategy[157] that addresses multiple constructs of Canadian food environments through comprehensive policies and programs [156].

3.4.2 PRACTICE - POLICY

Policies that impact designing safe multi-modal systems and supporting travel mode choice as described above also help with accessing health promoting and medical services. These policies prioritize providing safe, convenient and affordable health promoting transportation options, and are best achieved when destinations are near and accessible to people, such as in areas of high residential and employment density.

3.4.3 PRACTICE - PLANNING AND ANALYSIS

Practitioner resources within guidebooks discussing design that facilitates access to health promoting and medical services are limited. The most common health promoting service found within guidance documents is access to parks. Generally, guidance is provided to increase connections to parks and/or to build basic facilities to allow users to arrive to parks without driving such as:

- Shared use paths [84, 89]
- Sidewalks and bike facilities [86, 158]
- Crosswalks or mid-block crossings [84] and transit facilities [159]
- Bike parking, lighting and signage with internationally recognizable symbols [89, 158]
- Diverse land use-mix areas to facilitate access for demographically diverse groups [89]
- Integrated within residential land use [86]

While the data and metrics associated with transportation access to health care are being developed [152, 160], very few design guides discuss multi-modal access to essential health services. Ontario's Ministry of Transportation *Transit Supportive Guidelines* recommends concentrating health centres near other key community resources, such as shopping centers, schools and places of worship, to facilitate convenient transit-trip coordination. Additionally, this resource suggests transportation practitioners work with social and health service providers to understand the transportation needs of clients and tailor transportation accordingly. The City of Boston's *Complete Streets Guide* provides facility recommendations to install bus shelters near medical or social services, and implement signalized intersections where there are 250 or more conflicting turning vehicles near medical facilities, among other areas [86].

3.4.4 PRACTICE - DESIGN

Practitioner resources that consider access to food within design guidance are also limited. The City of Boston and City of North Vancouver were the only examples of access to more affordable prepared food and community gardens, respectively. Boston's *Complete Streets Guide* suggests incorporating space for food trucks as an alternative curb-side use. Some of the trucks, which have gained popularity in Boston, "serve healthy, innovative food at a reasonable price.... generate street life, and a positive buzz at their locations" [86]. Food trucks serve a variety of food, not all of which is considered healthy. Their mobility and presence can potentially undermine other food policies.

The City of North Vancouver's *Active Design Guidelines* focuses on locally grown and affordable food. These guidelines emphasize designing and building community gardens as a component of public space and buildings to create a sense of community and connection to environment, and provide an opportunity for intergenerational light physical fitness [161].

3.5 SUPPORTING MENTAL HEALTH



3.5.1 KNOWLEDGE

There are several ways in which the neighbourhoods people work and live within support mental health, including accessing natural green and blue (water) spaces; increasing social interaction and reducing stress; providing a sense of safety and well-being; and promoting physical activity [8]. Transportation systems and design play a role in each of these.

Whether included in general mental health promotion efforts, prevention of or in the treatment of a mental health diagnosis such as depression, chronic stress, anxiety, or attention-deficit disorder, transportation systems and design which support more active modes of transportation are a viable strategy to help individuals reach the levels of physical activity known to promote mental and emotional health [22, 28, 162, 163]. Research suggests that long commutes by automobile increase stress, increase sedentary time, and reduce opportunities for physical activity that protects mental health [164-166], which further suggests that switching from a sedentary to a more active mode of commuting can help wellbeing.

The natural environment – even within urban and suburban contexts – has been shown to impact mood and regulate heat island effects; it also may positively impact physical activity and, thus, cardiovascular and other chronic disease [149, 167]. The transportation system links a person’s residence with parks and open spaces. Distance to and density of parks can facilitate or prohibit routine access to green space; distance and walkability is also predictive of whether individuals access green spaces by active modes, garnering additional physical activity benefits [27, 28, 148].

Research shows that transportation and land use systems can facilitate or inhibit social participation and access to healthy resources. This is particularly true for older adults who may have limited mobility options to safely access social resources [168, 169].

3.5.2 PRACTICE

Current practice of integrating mental health and transportation is, at best, an acknowledgement of the above research findings. For practitioner-focused resources that discuss mental health in the context and plans, please see *The State of Public Health in Canada* [5] for theoretical links.

Discussing and designing around mental health in planning documents is not yet common. Toronto Public Health’s *Active City: Designing for Health* [83] and the City of Boston’s [86] *Complete Streets Guide* are two exceptions. These practitioner resources reference mental health and wellbeing as a component of (1) active living, (2) social inclusion and social interaction in public gathering spaces, and (3) access to parks and open green space.

3.6 REDUCING EXPOSURE TO AIR POLLUTION AND NOISE RELATED TO TRANSPORTATION



More compact land use that supports active transportation modes has been shown to be associated with lower vehicle kilometers of travel, and, thus, better regional environmental outcomes. However, increasing evidence indicates that the local exposure associated with active travel modes may have negative public health effects. This is particularly true for air quality and noise exposures.

3.6.1 KNOWLEDGE - TRANSPORTATION AND AIR QUALITY

Emissions from fossil-fuel-burning motorized forms of transport are inherently unhealthy. As part of the policy to reduce health risks, agencies such as Environment and Climate Change Canada, the World Health Organization and the U.S. Environmental Protection Agency regularly monitor regional air concentrations. These

organizations also regularly review the state of the science and update regulations to reflect current knowledge. The World Health Organization, in their most recent review, identified atmospheric particulate matter (PM) with a diameter of less than 2.5 micrometres (PM_{2.5}), ground-level ozone (O₃) and oxides of nitrogen (NO_x) as the primary pollutants of concern [170]. In addition, carbon monoxide (CO) is also a pollutant from road vehicles that negatively affects the environment. Breathing CO can cause vomiting, headaches and nausea. Inhaling high amounts of CO can even cause unconsciousness or death. Being exposed to moderate or high levels of CO over extended periods of time is linked to an increased risk for heart disease [170].

Table 3 reflects the current state of the scientific knowledge on the causal links of both short and long-term exposure for each of these pollutants to respiratory, cardiovascular, cancer, reproductive and mortality health outcomes [171-174]. More recently, researchers have also grown concerned about the link between emissions, systemic inflammation and diabetes risk [175-177]; future science assessments and updates will be needed for these health issues.

PM_{2.5} is one of the most commonly used air-pollution indicators for transportation health analyses. The World Health Organization (2013) reports that scientific conclusions about the relative risk associated with both short-term and long-term exposure to PM_{2.5} on cardiovascular and respiratory mortality and morbidity remain consistent and stable. Consequently, short and long-term outcomes are primarily cardiovascular with secondary respiratory effects. Cardiopulmonary mortality and morbidity are also associated with PM_{2.5} exposure. A recent meta-analysis found PM_{2.5} and PM₁₀ to increase the relative risk for lung cancer [174], providing additional support for the International Agency for Research on Cancer's (IARC) decision to make particulate matter a known carcinogen. However, recent studies also suggest pulmonary and respiratory responses may be due to highly correlated exposure to emissions co-pollutants such as ozone [178].

Evidence of *short-term* exposure to PM_{2.5} is best developed for cardiovascular mortality and non-fatal cardiovascular events [179]. Documented short-term morbidity outcomes associated with PM_{2.5} include hospitalizations and emergency department visits for ischemic heart disease and congestive heart failure; causal respiratory outcomes are less certain but include emergency room visits and hospitalizations for chronic obstructive pulmonary disease (COPD) and respiratory infections [172]. *Long-term* exposure to PM_{2.5} also increases the risk of cardiovascular and cardiopulmonary mortality [179]. Morbidity outcomes associated with long-term exposure include bronchitis in children, chronic bronchitis in adults over 30 years, asthma attacks, cardiovascular and respiratory hospital admissions, urgent care or emergency department visits due to asthma and cardiovascular disease, and restricted activity days for adults [170].

Table 3: Summary of U.S. EPA Integrated Science Assessment Weight of Evidence for Health Effects Associated with PM, Ozone, and NO₂ (Source: U.S. EPA 2008, 2009, 2013) [171-173]

Health Outcome	PM (PM _{2.5}) 2009 ISA	O ₃ 2013 ISA	NO _x (NO ₂) 2008 ISA
Short Term Exposure			
Respiratory Morbidity	●●●●	●●●●●	●●●●
Cardiovascular Morbidity	●●●●●	●●●●	●●
Central Nervous System Morbidity	Not Reviewed	●●●	Not Reviewed
Mortality	●●●●●	●●●●	●●●
Long Term Exposure			
Respiratory Morbidity	●●●●	●●●●	●●●
Cardiovascular Morbidity	●●●●●	●●●	●●
Reproductive/Birth Outcomes	●●●	●●●	●●
Central Nervous System Morbidity	Not Reviewed	●●●	Not Reviewed
Cancer	●●●●	●●	●●
Mortality	●●●	●●●	●●

- **Causal** - Evidence is sufficient to conclude there is a causal relationship ... and has been shown to result in health effects in studies in which chance, bias, and confounding variables could be ruled out with reasonable confidence.
- **Causal Likely** - Evidence is sufficient to conclude that a causal relationship is likely to exist, but important uncertainties remain.
- **Suggestive of Causal** - Evidence is suggestive of a causal relationship but is limited. (i.e., relies only on toxicology, or high-quality epidemiological study is inconsistent with past evidence)
- **Inadequate to Infer** - Evidence is inadequate to determine that a causal relationship exists; available studies are of insufficient quantity, quality, consistency, or statistical power.
- **Not Likely to be Causal**

The relationship between ozone and respiratory effects – both in terms of mortality and morbidity such as respiratory and cardiovascular hospital admissions – from *short-term* exposure is well documented. Ozone can increase new onset asthma as well as asthma symptoms, medication use, emergency room visits, and hospitalizations [170, 180]. Analysis of longitudinal cohorts also documents a likely causal effect on mortality and morbidity from *long-term* exposure to ozone with similar pathways as short-term exposure. In single-pollutant models, cardiovascular effects from long-term exposure to ozone typically occur; however only respiratory mortality remained significant when controlling for PM_{2.5} exposure [181]. Other research suggests mortality risk increases with ozone exposure in populations with predisposing conditions such as COPD, diabetes, and congestive heart failure. Research also supports the conclusion that long-term ozone exposure exacerbates asthma incidence, severity and hospitalization [170, 180].

There is a growing understanding that there are likely trade-offs and risks associated with micro-scale exposures associated with compact development. Many transportation emissions decay rapidly with distance, with populations nearest to those emissions at a disproportionate risk of exposure to harmful air and noise pollution [182]. Community resources serving vulnerable populations such as schools [183], parks, and housing sited near busy roads should be tracked, if not avoided altogether. This is consistent with policy recommendations for Canadian cities [184, 185] and the California Air Resources Board's (CARB) recommendations of at least 500 feet between sensitive land uses and any road with 100,000 vehicles per day [186]. Despite such recommendations, many schools in low income neighbourhoods and densely populated neighbourhoods are located close to major

roads and face greater exposure to elevated levels of air pollution and noise, which might impact healthy development and academic performance [187].

Pedestrians and cyclists also may be disproportionately exposed to the harmful substances in vehicle emissions, which may contribute to other chronic conditions, such as lung cancer and heart disease, over time [24, 188-190]. There is scientific consensus that traveling itself represents a high exposure time period for air pollution; active modes may be at even greater risk due to heavier breathing and possibly slightly longer commutes. (See Bigazzi & Figliozzi [188] for a recent review of these trade-offs). Despite these secondary negative exposures, the literature indicates that the physical activity impacts of active travel far outweigh the risks [122].

While much of the reviewed existing literature has a focus on air pollution in more urban and suburban areas, rural areas also have air quality related health concerns. For example, dust from unpaved roads can impact the heart and respiratory health of people breathing it [191, 192].

3.6.2 KNOWLEDGE – TRANSPORTATION AND NOISE

Noise from transportation sources, like air pollution, is a significant health concern, especially for low income and vulnerable populations who are more likely to live near major roads [193]. Noise generated by traffic, rail and airports impacts health via various pathways, including sleep disturbance, adverse alterations to the cardiovascular system, cognitive impairment, stress, and endocrine disruption. These relationships are dependent on the relative levels (measured in decibels) of noise emissions, the temporal length and time of day of exposure to noise emissions, the source(s) of noise emissions, and distance from emissions sources. Moreover, while correlated with near-road air quality, noise does appear to have an independent effect on health outcomes [194].

The strongest supported pathway through which noise influences health is via the cardiovascular system due to its impact on blood pressure. Acute exposure to different types of noise has been shown to be associated with arousals of the autonomic nervous system and the endocrine system [194]. Cross-sectional associations between individuals' self-reported 'heart disease and stroke' and aircraft noise and road traffic noise in six European countries found significant associations between night-time average aircraft noise and 24-hour average road traffic noise and heart disease and stroke [195]. Chronic long-term exposure to transportation noise has been shown to be associated with the prevalence and incidence of cardiovascular diseases, such as hypertension, ischemic heart diseases and stroke [194, 196-199]. A meta-analysis suggests cardiovascular risk increases significantly at levels above 60 dB(A)²⁵ [196].

Transportation noise also acts as a psychosocial stressor that impacts psychological well-being and physical health [198]. In particular, night-time noise disrupts sleep structure, increases blood pressure and heart rate, and increases stress hormone levels and oxidative stress, which are linked to endothelial dysfunction and arterial hypertension [200]. Environmental noise exposure has a negative effect on learning outcomes and cognitive performance in children, and this is especially true when noise emissions are high and close to schools [194]. A recent investigation of the relationship between road traffic noise and blood pressure in children found that higher minimum levels of day-evening-night noise and night-time noise around the home residence increases blood pressure in children and that children whose windows faced a street with vehicle traffic had higher blood pressure than children whose windows were not facing a street [201].

It is also important to recognize that noise from near-road transportation sources is spatially correlated with higher local levels of air pollution; further both noise and air pollution can influence health in similar ways. The City of Toronto's [83] *Active City: Designing for Health* is a good example of discussing how exposure to noise and air pollution affect physiology. It discusses how exposure to air pollution is associated with harming

²⁵ The decibel (dB) is used to measure sound level. The db(A) scale been adjusted to consider the human ear's varied sensitivity to different frequencies of sound.

cardiovascular and respiratory health, and chronic noise exposure causes heightened molecular stress response, which in turn harms cardiovascular health. The document applies these health effects as a rationale to support active transportation infrastructure and use.

The next section describes a summary of current practices for integrating health into air pollution and noise exposure considerations. These practices are organized using the following categories – Policy, Planning and Analysis, and Design.

3.6.3 PRACTICE - POLICY (AIR POLLUTION)

In 2012, all Canadian provinces and territories (except Quebec²⁶) adopted the Air Quality Management System (AQMS) as a comprehensive approach to coordinate, monitor and regulate national air quality [202]. The AQMS succeeded the Canada-wide Standards developed in 2000 and is more ambitious in terms of targets, pollutants covered and government collaboration. The AQMS is comprised of regional air-sheds (six across Canada) that comprise local air zones, which are provincially or territorially delineated and managed [203]. It aims to provide consistency across Canada while allowing flexibility for provinces or territories to achieve optimal outcomes. The federal government works with industrial polluters to enforce Base-Level Industrial Emission Requirements, which aim to achieve consistent base-level performance for major industrial emitters. Provinces and regions may enact further measures to curb emissions. The same is true for expanding on federal regulations [204] for mobile sources, such as on-road vehicles [202].

The AQMS includes the Canadian Ambient Air Quality Standards (CAAQS), which are regularly updated benchmarked objectives for sulfur dioxide, fine particulate matter (PM_{2.5}), ozone, and nitrogen dioxide. The CAAQS are voluntary objectives under the Canadian Environmental Protection Act. In contrast, in the U.S. transportation planning processes must meet (conform to) National Ambient Air Quality Standards (NAAQS) and requirements by showing that “highway and transit activities . . . will not cause new air quality violations, worsen existing air quality violations, or delay timely attainment of the relevant air quality standard, or any interim milestone.” [205]

The AQMS sets threshold levels for each type of pollutant covered at the air zone level [203]. For example, if ozone exceeds 63 ppb in an air zone, that jurisdiction should enact actions to reduce the level below the CAAQS goals.

To address near-road air quality challenges for vulnerable or “sensitive” populations, the California Air Resources Board (CARB) has issued physical separation guidelines in Table 4. This could reduce localized exposure by as much as 80% [186]. Site design (i.e., putting the least sensitive use closest to the road) and building design including certain heating, ventilation and air conditioning (HVAC) systems appear to also be protective and should be utilized to the extent possible [186]. Similarly, while the physical activity gains far outweigh the risks of additional air pollution [25], this suggests care in placement of bike and pedestrian facilities. For example, locating greenways more than 150 meters from major roads, when possible, is a strategy to reduce exposure to cyclists.

²⁶ Quebec supports the objectives of the AQMS and will collaborate in developing parts of the system such as air zones and airsheds. Quebec did not sign because elements of the AQMS were redundant with the Quebec Clean Air Act

Table 4: California Air Resources Board Recommendations on Siting New Sensitive Land Uses Such as Residences, Schools, Daycare Centers, Playgrounds, or Medical Facilities [186]

Source Category	Advisory Recommendations
Freeways and High-Traffic Roads	Avoid siting sensitive land uses within 500 feet (150 meters) of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day
Distribution Centers	Avoid siting sensitive land uses within 1,000 feet (300 meters) of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating TRUs per day, or where TRU unit operations exceed 300 hours per week)
	Take into account the configuration of existing distribution centers and avoid locating residences and other sensitive land uses near entry and exit points
Rail Yards	Avoid siting sensitive land uses within 1,000 feet (300 meters) of a major service and maintenance rail yard
	Within one mile (1.6 kilometers) of a rail yard, consider possible siting limitations and mitigation approaches
Ports	Consider limitations on the siting of sensitive land uses immediately downwind of ports in the most heavily impacted zones
	Consult with local air districts for the latest available data on health risks associated with port emissions
Refineries	Avoid siting sensitive land uses immediately downwind of petroleum refineries
	Work with local air districts to determine an appropriate separation
Chrome Platers	Avoid siting sensitive land uses within 1,000 feet (300 meters) of a chrome plater
Dry Cleaners Using Perchloro-ethylene	Avoid siting sensitive land uses within 300 feet (90 meters) of any dry-cleaning operation. For large operations with two or more machines, provide 500 feet (150 meters)
	Do not site sensitive land uses in the same building with perc dry cleaning operations
Gasoline Dispensing Facilities	Avoid siting sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50-foot (15 meters) separation is recommended for typical gas stations

3.6.4 PRACTICE - POLICY (NOISE)

Policy responses to noise pollution concerns generally focus on restricting noise levels, reducing the noise at the source, and various mitigation strategies including noise barriers [198], separating sensitive locations from the sources (land use planning), site design, and building soundproofing. These policies are enacted at various levels of government, including the following examples:

- **Federal Level** - Transport Canada administers aircraft noise standards [206].
- **Provincial Level** - In Ontario the Ministry of Environment, Conservation and Parks (MECP) issues the *Ontario Environmental Noise Guideline* [207, 208]. These guidelines put forth requirements related sound level limits, and measuring, estimating, reducing and mitigating noise impacts from road, rail, and air traffic sources. The Ministry of Transport of Quebec (Ministère des Transports du Québec) has had a policy on road noise since 1998 [209]. The Ontario Ministry of Transportation noise policy includes when mitigation should be considered [208].
- **Municipal Level** - The City of Edmonton's *Urban Traffic Noise Policy* [210] states that the City seeks to:
 - [Land use planning] . . . *ensure that no new residential development less than three storeys will be allowed adjacent to transportation facilities (arterial roadways, light rail transit) unless the developer proves to the satisfaction of the City that the projected noise level in the private back yards of residences abutting the transportation facility will not exceed 65 dBA Leq24* [210]
 - [Facility Design] . . . *achieve a projected attenuated noise level below 65 dBA Leq24 or as low as technically, administratively, and economically practicable, where any urban transportation facility (arterial roadways, light rail transit) is proposed to be built or upgraded through or adjacent to a developed residential area where private back yards will abut the transportation facility* [210].

3.6.5 PRACTICE - PLANNING AND ANALYSIS (AIR POLLUTION)

Air pollution planning and analysis is generally tied to reaching *Canadian Ambient Air Quality Standards* (CAAQS) policy guidelines.²⁷ Provinces and territories, based on monitoring they do, are responsible for producing annual reports on the achievement of CAAQS, issues, trends, and air management levels for each air zone. They are also responsible for reporting to the general public, and implementing actions to improve air quality [203].

The CAAQS drive the implementation of the Canadian-wide Air Quality Management System (AQMS), which is expected to occur with federal, provincial, and territorial governments collaboration within the Canadian Council of Ministers of the Environment (CCME). The CCME is “the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern” [211]. Responsibility for achieving mobile (transportation) source related air quality goals through the AQMS is shared across the levels of government. According to the roles and responsibilities document [202] provided by CCME, government mobile-source related actions include:

- *The federal government has the lead responsibility for regulating and implementing emission and fuel standards for new on- and off-road vehicles and engines, as well as emissions from marine, aviation and rail*
- *Provinces and territories may enact further measures to reduce emissions from mobile sources, particularly with regulating the in-use fleet*

Electric vehicles, cleaner heavy-duty vehicles, employer-based promotion of alternative transportation programs, and vehicle inspection and maintenance programs are all resources that help address mobile-source.

²⁷ Canadian Ambient Air Quality Standards - https://www.ccme.ca/en/current_priorities/air/caaqs.html

Provinces and territories also lead the development of Air Zone Management Framework (AZMF), which “provide guidance on the nature of the management, monitoring and reporting actions to be implemented at an air zone level under the AQMS” [203]. The Calgary Region Air Zone’s *Regional Air Zone Management Plan* (Updated 2014 PMO3 Plan) includes several objectives. For example, the plan has an objective that “Regional land use planning will encourage and promote improvements in air quality” [212]. It then includes actions to help facilitate each objective. One transportation-related action for the objective mentioned above is to “Support multimodal transportation systems.” The plan goes on to detail steps, potential indicators, a time frame, and responsible agencies for each objective. Two of the steps listed, each with medium term time frames, make an explicit connection to the transportation planning process:

- *Develop templates for municipalities that promote/incentivize positive air quality initiatives for transportation*
- *Evaluate the particulate matter and ozone (PMO3) impacts of transit/transportation initiatives*

Climate change planning also typically includes transportation related actions that reduce greenhouse gas emissions and other pollutants. For example, one of the goals in Transport Canada’s *Transportation 2030: A Strategic Plan for the Future of Transportation in Canada* [213] is green and innovative transportation. One identified general action to reduce transportation-related environmental impacts, including air pollution, is to:

- *Work with provinces and territories through a Pan-Canadian Framework on Clean Growth and Climate Change to support a low-carbon transportation system*

In line with Canada’s federal strategic plan, the 2018 *Environmental Profile* for the *Greater Golden Horseshoe Transportation Plan* states that “[expected increases in ground-level ozone due to climate change] reinforce[s] the need for Ontario to take action to support the uptake of zero emission vehicles, encourage the shift to public transit, and support active transportation through smart growth principles and intensification of land use in the GGH [greenhouse gas emissions]” [214].

A similar example is Ontario’s *Climate Change Action Plan* (2016-2020), which identifies several transportation related actions. For example, the plan encourages increasing availability and utilizing lower-carbon fuel, increasing the use of electric vehicles, supporting cycling and walking, increasing the use of low-carbon trucks and buses, and supporting the accelerated construction of GO Regional Express Rail [215]. The “intended” Greenhouse Gas Reduction Account funding for active transportation action is estimated to be \$150 million to \$225 million. The plan identifies implementation actions (e.g., increase the cycling network/facilities) and states that “All actions will be implemented after thorough collaboration with business, industry, municipalities, First Nations and Métis communities and organizations, and other partners – with additional consultation, where appropriate.” However, it does not identify responsible parties for implementation or a reasonable time frame for completion.

Toronto’s Environment & Energy division’s *TransformTO Climate Action Strategy* parallels these actions, with a goal of active transportation accounting for 75% of all trips under 5 km city-wide by 2050 [216]. TransformTO published a modeling of greenhouse gas emissions report that analyses shares of trips and vehicle kilometres traveled, depending on what services and programs are implemented [217]. The transportation analysis calls for mode shift through active transportation and transit investments in the city and to coordinate such efforts at a regional level.

Metro Vancouver’s 2016 *Caring for the Air* report suggests the use of health impact assessments (HIA) as a means to consider the air quality impacts of transportation and land use decisions [218]. In 2018 Waheed et al. found that “HIAs have been more popular in Europe, the Australian subcontinent, and the United States. In Canada, the use of HIA has been slow to be accepted as the practice lacks regulatory triggers both at the federal and provincial levels, with the exception of Quebec” [219]. To support the increased use of HIAs in Canada, the *Caring for the Air* report recommends Metro Vancouver’s *Guidebook for Health Impact Assessment of*

Transportation and Land Use Planning Activities [220] for additional information regarding a step-by-step planning process, identification of common issues and challenges that can be expected in the HIA process, and highlights lessons from the field to successfully address them.

Air quality plans are developed and HIAs are used in the United States, but in contrast to the Canadian approach there is also a federal Environmental Protection Agency requirement that areas with poor air quality analyze the air quality impacts of their long-range transportation plans. These analyses are based on current and future vehicle emission estimates [221]. Transportation investments are to support the achievement of air quality goals. There is growing concern in the United States that the regional approach in planning does not adequately account for temporal variation, spatial variation and/or concentration of transport-related air pollutants. The field is quickly moving towards air dispersion modeling to address this challenge and identify hotspots [221-224]. Most of these modeling efforts are indicating the need to address environmental justice and health equity concerns arising from concentration of air pollution in low-income areas [221, 222, 225].

Although public health and environmental policies, goals and action steps have emerged that identify and seek to mitigate the effects of transportation-related air pollution, this connection is not an evident guiding component of long-term transportation planning processes in Canada.

3.6.6 PRACTICE - PLANNING AND ANALYSIS (NOISE)

The European Union noise directive (European Commission, 2002) requires urban areas with a population of over 100,000 to assess their noise environment on a regular basis, including the impact of road, rail and airport noise. Municipalities are also required to develop noise management action plans in consultation with the public. These plans cover the exposure to environmental noise, prevention and reduction strategies and preserving environmental noise quality where levels are good. A review of this requirement has found this practice effective as it has brought attention to the importance of noise as a public health risk [226].

The commonly used prediction method for road traffic noise, as recommended by MECP, is a method entitled ORNAMENT, Ontario Road Noise Analysis Method for Environment and Transportation, published in 1989 by MECP, as amended from time to time [207]. Another guide that offers details on road traffic noise models is the Ministry of Transportation Ontario's: *Environmental Guide for Noise* [208].

3.6.7 PRACTICE - DESIGN (AIR POLLUTION)

While many design guidelines reference reduction of air pollution and/or noise exposure as an important factor to consider in design work, only one reviewed guide [83] suggests doing so as a strategy for supporting health.

Common roadway design practices to reduce air pollution generation and improve its dispersion include reducing road grades, decreasing congestion in order to reduce vehicle idling time, stop and start traffic flow. Congestion reductions or typically location specific, and can be achieved through attention to the number of ramps, intersections and lane merges and pavement type [227].

In addition, to reducing the quantity of emissions generated, it is also important to consider design strategies which impact their transport (movement or flow) and dispersion. Design features which can increase emission concentrations include roadways that are below ground-level or enclosed, and elevated roads that are on solid fill [227]. In recent years, there has also been increased attention to "porous" tree and vegetative barriers to reduce local air pollution [228, 229]. The U.S. Environmental Protection Agency includes many of these strategies as best practices for reducing near-road exposure to air pollution for school-aged populations, specifically [230].

"Road design and intelligent transportation systems Congestion is a major cause of increased emissions at some locations. Appropriate design (for example, grade separation, roundabouts, ramp metering) and use of intelligent systems that promote smooth traffic flow have the potential to significantly improve air quality at some locations (for example, near intersections). This strategy will generally only be applicable to large scale developments."

3.6.8 PRACTICE - DESIGN (NOISE)

Developing design solutions which address both air and noise pollution concerns can be challenging. This requires a comprehensive review of the needs of the location and the design goals to be achieved. For example, the Queensland's (Australia) Department of Transport and Main Roads finds that:

“Some of the most effective vehicle noise control measures (depression of the road in a cutting, enclosure in a tunnel and construction of mounds or tall barriers) can adversely affect air quality.” [231]

Common design practices to reduce noise levels include narrowing traffic lanes, using trees and other vegetation, incorporating bump-outs near intersections, and as a last resort, implementing fencing or walls [232]. TAC's *Geometric Design Guide for Canadian Roads* [84] extends this discussion by encouraging the creation of “desirable pedestrian environments” with components that protect pedestrians from weather, noise and air pollution, among other components. The choice of paving materials can impact road noise. The electrification of cars, buses, trains and trucks are expected to reduce traffic noise [226]. The low noise of electric vehicles traveling, especially traveling at low speeds, can represent a danger for vulnerable users (pedestrians, cyclists, people with vision problems, children, etc.). In response to this concern the U.S. has adopted a regulation requiring electric vehicles to emit a certain level of noise at low speeds [202].

Temporally and dynamically managing traffic can also serve to mitigate noise levels. Examples of this approach “include traffic restrictions around vulnerable populations (schools, hospitals), reduced nighttime vehicle operations, coordinated traffic signals, and street design that favours non-automobile uses. Higher vehicle speeds results in higher road noise” [226].

The list below provides a recommended set of practitioner-focused recommended design guidance documents for additional details and resources on noise attenuation and air pollution.

- Region of Waterloo. *Context Sensitive Regional Transportation Corridor Design Guidelines* [232]
- Transportation Association of Canada. *Geometric Design Guide for Canadian Roads* [84]
- City of Toronto. *Active City: Designing for Health* [83]

3.7 HEALTH EQUITY



3.7.1 KNOWLEDGE

One definition of health inequities from the World Health Organization (WHO) focuses on those which are “avoidable . . . [and are] between groups of people within and between countries” [233]. A 2004 Canadian health disparities task group defined it this way, “Health inequalities are differences in health status experienced by various individuals or groups in society. These can be the result of genetic and biological factors, choices made or by chance, but often they are because of unequal access to key factors that influence health like income, education, employment and social supports” [234]. Although a number of factors contribute to the fact that low income populations generally have higher levels of chronic disease risk and outcomes [235-238], unequal access to key social determinants is especially pertinent to transportation and land-use professionals.

Integrating health and inviting health professionals into planning processes may “draw attention to the health impact of land-use and transportation decisions on vulnerable populations, which complements the environmental justice lens used in planning and transportation” [239]. For example, healthy behaviour, including physical activity, has been shown to reduce the risk of chronic disease such as metabolic disorders (diabetes), cardiovascular disease, stroke, and some cancers. Active transportation, such as walking, biking, and using those modes to access public transit has the potential to increase physical activity levels for all populations, but levels of active transportation are significantly influenced by neighbourhood-related built environment characteristics [240]. Infrastructure that promotes active modes of transportation helps to not only promote health-enhancing

physical activity, but also provides affordable access to key social determinants of health among vulnerable populations.

The next section describes a summary of current practices for integrating health and transportation. These practices are organized using the following categories – Policy, Planning and Analysis and Design. Please note that internationally – and specifically in the U.S. – the framework to address health equity in transportation is often the environmental and/or social justice framework embedded within the environmental protection policies. This is reflected in the academic literature around best practices for addressing equity – including health equity – that draw heavily from “environmental justice” analyses, even as there is movement towards a more comprehensive look at “social justice” indicators including health.

3.7.2 PRACTICE - POLICY

Canada’s public health leadership has long prioritized the importance of addressing health inequities. The 1986 World Health Organization’s *Ottawa Charter for Health Promotion* [241] identified the need to reduce “differences in current health status and ensuring equal opportunities and resources to enable all people to achieve their fullest health potential.” The 2008 *Report on the State of Public Health in Canada* [242] released by Chief Public Health Officer, Dr. David Butler Jones, focused on better understanding and reducing health inequalities. Provincial medical health officers have also highlighted health inequities as a priority issue to address in British Columbia [243, 244], and have explored how the built environment can be used to foster health equity [245].

Amekudzi and collaborators provide a useful framework for understanding the challenges of health equity in transportation policy, even if it is specific to environmental justice (EJ) [246, 247]. Their environmental justice maturation model is a three-phased process with an integrated feedback loop. Regional governments tend to begin by setting policies and plans to investigate environmental justice. Attention to equity is only mature when results from evaluations and monitoring are then fed back into the policy and funding decisions [246, 247].

The literature review within Amekudzi et al. [246, 247] discusses the challenge of poorly conceptualized and operationalized equity terms – a theme that continues to appear in the literature as a policy challenge [248]. Amekudzi et al. focuses on four types of equity: opportunity in involvement in the planning process, equality in benefits, market-based ability to get what you (or your neighbourhood) can pay for, and basic needs. Basic need splits the difference between equality in benefits and market-based equity. Similar to equity, varying conceptualizations appear in the literature about “adverse human health” [248]. The way in which equity and adverse health are defined will guide policy actions. Thus, provinces, regions, and municipalities must carefully and cohesively define such terms to target a specific change that is desired from policy.

3.7.3 PRACTICE - PLANNING AND ANALYSIS

A 2016 editorial in the *Canada Communicable Disease Report (CCDR)*, asserts that “Health inequities, or avoidable inequalities in health between groups of people, are increasingly recognized and being tackled to improve public health” [249]. This work is being led by the public health sector. It covers a wide-range of topic areas including “who is vulnerable to infectious and chronic diseases, the impact of health promotion and disease prevention efforts, how disease progresses, and the outcomes of treatment.” Canadian organizations, such as Public Health Agency of Canada (PHAC), the Pan-Canadian Public Health Network the Canadian Institute for Health Information (CIHI) and Statistics Canada, have developed data, tools and reports related to health inequities, where data are stratified by various attributes (e.g., sex, socioeconomic status, cultural and/or racial background, and others). For example, a multi-agency collaboration²⁸ created the *Health Inequalities Data*

²⁸ Public Health Agency of Canada, the Pan-Canadian Public Health Network (PHN), Statistics Canada, and the Canadian Institute for Health Information.

*Tool*²⁹, which “contains data on indicators of health status and health determinants, stratified by a range of social and economic characteristics (i.e. social stratifiers) meaningful to health equity” [250]. A 2018 report titled, *Key Health Inequalities in Canada: A National Portrait* [251], describes important health inequalities in Canada. It references the role of “transportation incidences” in causing deaths due to unintentional injuries and describes how the built environment may contribute to inequalities in health outcomes. Similar recent examples of collaborative, transportation agency/organization efforts to include consideration of health inequities in the Canadian transportation planning context were not identified.

Looking to the U.S., a 2014 review of 18 major regions’ Regional Transportation Plans (RTPs) looked at trends in public health performance measures for traffic safety, air quality, physical activity, and access [248]. This study’s major finding is that plans often reflect an incomplete view of public health, focusing primarily on (narrowly defined) safety and accessibility. A major finding is that addressing public health may help identify and operationalize some elements of equity because the health impacts to transportation and land use appear to be salient to communities, as indicated by negative reactions to plans when they perceive a potential health threat [248]. Despite this, only 3 out of 18 plans included a direct measure of non-safety health, such as, body mass index (BMI) or particulate matter mortality [248].

Even more challenging to addressing equity implications of health analyses in transportation plans is the “ecological flaw” as described by Karner and Niemeier [252]. These authors note that long-range plans define target equity population areas based upon a single percent threshold of the target population (e.g., percent of low-income households) within a transportation analysis zone (TAZ). The equity metrics assess differences between these target areas and other locations in the region. This results in an “ecological flaw” where conditions for equity populations is limited to consideration of only those who live in target areas; even though others in these populations may live outside these target areas (but not in sufficient concentrations to be designated as such) [252].

Manauh, Badami, and El-Geneidy [253] provide the most recent review of regional equity practices in the U.S. Their work suggests that meaningful operationalization of sustainability and equity requires careful attention to performance measures. This critical evaluation of social equity measures for 18 metropolitan planning organizations (federal designated regional planning agencies in the U.S.) suggests that good performance measures are those that are: precise, link, and capture the meaning of policy objectives, realistic to operationalize, and easy to communicate to decision-makers and the community. Finally, these authors join a growing consensus that performance measures must be disaggregated by different groups (income, age, gender, race, disability), travel modes, and reported at finer spatial scales in order to actually provide objective and meaningful information about impacts on environmental justice communities [252, 253].

3.7.4 PRACTICE - DESIGN

Other health-related concepts are discussed within geometric design guides include equity, income and regional disparities. The City of Toronto’s [83] *Active City: Designing for Health* guide suggests addressing health inequities through design. This guide encourages prioritizing planning and building efforts in areas where the most health-disadvantaged populations reside and in areas with the fewest resources to promote active living. For example, the City of Toronto incorporated this equity strategy in the design, distribution and development of new parks and other recreational facilities. Conducting regional equity analyses to identify these areas is becoming more common practice for pedestrian, bike, and park master plans. However, there is a significant gap in design guidance that explicitly considers equity.

Additionally, equity is being addressed through increased attention to the contextual needs and designs of rural and small towns. The *Healthy Communities Practice Guide* from the Canadian Institute of Planners provides

²⁹ <https://infobase.phac-aspc.gc.ca/health-inequalities/>

valuable recommendations to improve the environments and conditions for those in rural communities. This guide encourages planners to utilize frameworks such as the Rural-to-Urban Transect to help design the structures and transportation modes of rural and urban communities. This framework instructs planners to consider many factors such as population density and environmental features when making land use and transportation design decisions.[112]

Also, the U.S. Federal Highway Administration’s *Small Town and Rural Multimodal Networks Guide* [89] highlights regional economic and health disparities to elevate a conversation on why specific active transportation guidance is necessary for small towns and rural areas (Figure 8). This guide recommends the implementation of shared use paths as a benefit to provide active ways to reach parks and other recreational facilities, “which can especially help low-income people obtain access to recreation.”

Why a Rural and Small Town Focused Guide?

There is a need and desire to make travel safer and more active in small and rural communities.

While rural places vary considerably in geographic scale and character, there are common issues that prevail:



Longer Non-local Trip Distances

Rural trip distances have been increasing.⁽ⁱ⁾



Health Disparities

Rural areas have higher rates of physical inactivity and chronic disease than urbanized areas.⁽ⁱⁱ⁾



Higher Crash Rates

While only 19 percent of the population lives in rural areas, 58 percent of all fatal crashes and 60 percent of traffic fatalities were recorded in rural regions.⁽ⁱⁱⁱ⁾



Income Disparities

Urban households earn 32 percent more in yearly income than rural households.^(iv)

Figure 8: Regional Economic and Health Disparities (Source: The Federal Highway Administration’s *Small Town and Rural Multimodal Networks Guide*) [89]

3.8 MONETIZING HEALTH OUTCOMES RELATED TO TRAVEL BEHAVIOUR



3.8.1 KNOWLEDGE

One of the challenges of integrating health into the transportation decision making process is assessing the value of changes in health care and related costs due to changes in health status. Better understanding this dynamic allows health care and other costs and benefits, e.g., work-force productivity, to be considered along with the more standard elements of cost/benefit analyses done for different transportation investments, such as the value of time saved by reducing motor vehicle congestion. Monetizing the benefits of healthy urban design allows for an “apples to apples” comparison of the costs of various possible changes to the land use and transportation systems, even as adding a third discipline – economics – is challenging [254-256].

Monetization methods for health-related impacts are dependent on the methodology used to model health change. The value of statistical life (VSL) can be used to monetize modeling built environment induced mortality changes; this is the approach used by the World Health Organization’s Health Economic Analysis Tool (HEAT)[257]. VSL guidance is often provided by national agencies and, thus, should be considered a viable way to value health. However, it is important to recognize VSL is a societal value tied to reduced risk. It is not actual expenditures that would be avoided and, thus, could be assigned elsewhere.

Mortality-VSL applications appear to be the most common application of monetizing health in the transportation context. This is likely due to the availability of WHO’s HEAT [254, 258-261]. Additional guidance on the use of VSL was not easily sourced; guidance from the U.S. DOT [262, 263] may be helpful.

Monetizing morbidity captures real economic output changes from both decreased health expenditures – known as “direct” costs – and increased productivity from less absenteeism and disability – known as “indirect” costs. Direct and indirect costs for specific disease endpoints can be found in the “cost of illness” (COI) literature. COI literature depends heavily on well-developed health econometric modeling that account for common comorbidities; the estimates are derived from large national surveys or private insurance claims databases [264, 265].

Annual COI costs are generally reported as both national and per case estimates. The choice of which to use is dependent on how the health modeling is performed. For example, a tool reporting “disability adjusted life years” or DALYs should be matched to an attributable fraction approach from national costs. Estimates of number of avoided cases should be matched to per case annual cost.

Morbidity-COI examples are increasingly popular. Similarly, modeling and monetizing physical activity generally appears to be most common [266]. Others model and monetize using disease-specific COI literature [261, 267, 268].

Because monetizing the health impacts of built environment is a relatively new development, methodological refinements are needed, including making it applicable across of a range of spatial scales. With the exception of HEAT, applications have limited adoption of standard econometric techniques such as phasing in the intervention and/or discounting to present value [254]. Exploration of linking morbidity estimates of direct and indirect benefits could be better integrated into larger economic exercises standard in transportation analyses such as estimating the *induced* benefits through input-output modeling [268]. Additional research is also needed to better understand the mechanisms on how the built environment and physical activity influence health care expenditures – likely through pharmaceutical and emergency medicine [269].

The next section describes a summary of current practices for integrating health into travel modeling considerations. These practices are organized using the following categories – Policy, Planning and Analysis, and Design.

3.8.2 PRACTICE - POLICY

In a report from the Medical Officers of Health in the Greater Toronto-Hamilton Area, several land use and transportation policies, at all levels of government, are supported from a health perspective [270]. Except for national guidance for value of statistical life, there is little in the way of policies to monetize the health impacts of supporting transportation policies, plans and projects [271].

3.8.3 PRACTICE - PLANNING AND ANALYSIS

A Transport Canada report describes the results of an Ontario-based model which is used to estimate the social costs of motor vehicle collisions [272]. The estimated costs include those related to injuries, deaths, damage to vehicles, and traffic delay (extra time, fuel, and pollution), among others.

In the European context, the HEAT tool³⁰ is being widely used to monetize prevented mortality from physical activity from transportation. WHO maintains a list of applications, primarily in Europe [273]. The Integrated Transport and Health Impact Modeling Tool (ITHIM) has a similar health impact estimation methodology as HEAT and is also well utilized; however far fewer ITHIM applications have been extended to monetization.³¹

There are several studies integrating a cost of illness (COI) approach to estimates of decreased morbidity. Table 5 lists several studies that apply COI to estimates of health endpoints. A common methodology of these studies is leveraging physical inactivity as the health “endpoint” [254, 259, 274-276]. Moving from insufficiently to sufficiently active – defined as 150-300 minutes of moderate activity a week for adults and 60 minutes per day for children and adolescents (aged 6-17 years) as recommended by the U.S. Department of Health and Human Services *Physical Activity Guidelines* (2018) – was then translated into the proportion of cardiovascular, diabetes, and cancer outcomes. The Canadian Society for Exercise Physiology also recommends that adults aged 18 – 64 years accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week [91]. Active transportation levels in the United States were usually drawn from either surveillance systems such as Behavioral Risk Factor Surveillance System (BRFSS), the National Household Travel Survey (NHTS) or from travel demand modeling. For example, some studies assumed that anyone who currently cycled would not meet the sufficient activity threshold without that active transportation [276]. Other studies assumed that all physically inactive individuals would become physically active [275] or used travel demand modeling and/or regional plan assumptions with their infrastructure changes to estimate physical activity [259, 274].

Table 5: Studies Monetizing Morbidity from Active Transportation by Health Endpoint

Benefit-Cost Analysis of Public Health Outcomes in Long Range Transportation Planning in the San Francisco Bay Area [274]
Costs and benefits of bicycling investments in Portland, Oregon [259]
Valuing Bicycling's Economic and Health Impacts in Wisconsin [275]
Climate Smart Strategy Health Impact Assessment [261]
Community and Economic Benefits of Bicycling in Michigan [276]
Economic and Health Benefits of Bicycling in Iowa [267]
Active Transportation, Health, and Economic Benefit Study [268]

³⁰ HEAT by WHO - <http://www.heatwalkingcycling.org>

³¹ ITHIM the Centre for Diet and Activity Research - <http://www.cedar.iph.cam.ac.uk/research/modelling/ithim/>

A study in the Los Angeles region is a notable exception in the list for several reasons [268]. First, using the California Public Health Assessment Model³² the health endpoints are estimated directly from changes in the built environment as defined by the long-term regional transportation plan. Second, the directed health impacts of decreased health costs and indirect health impacts of increased productivity within this study are then integrated into an input-output economic model, TranSight by REMI.³³ This methodology – routinely used to estimate induced GDP and employment benefits of large transportation infrastructure plans – facilitates better comparison of the economic benefits from health with other transportation and land use decisions.

3.8.4 PRACTICE - DESIGN

It is challenging to model the health impacts and related costs/benefits of different project-level designs. Health impacts are a result of such things as changes in people’s physical activity levels, risk of crashes and exposure to pollutants. Design impacts these items, but, as described above, impacts are typically captured at a larger spatial scale based on such things as estimates of trip making by active transportation. This is due to the limits of available tools not being sensitive to design differences at the project level.

³² CPHAM by UD4H - <http://urbandesign4health.com/projects/california-statewide-public-health-assessment-model>

³³ TranSight by REMI - <http://www.remi.com/model/trans-sight/>

4. PRACTITIONER ENGAGEMENT

The online survey and telephone-based interviews were used to 1) prioritize which of the seven integration areas were in most need of further knowledge and resources from the practitioner-perspective and 2) identify which type(s) of technical or institutional help was most needed to support efforts to address prioritized integration areas. The results were reviewed to highlight where opportunities and gaps in knowledge and resources exists, which were then used to develop an initial set of draft recommendations. These were presented to practitioners using an interactive webinar format. The feedback from the webinars was used to finalize the recommendations. The practitioner engagement methods are summarized below. For additional details see *Appendices: Integrating Health and Transportation in Canada*.

4.1 ONLINE SURVEY

Invitations to participate in the online survey were promoted through TAC, as well as professional networks (including the Association of Pedestrian and Bicycle Professionals, Canadian Institute of Transportation Engineers, Toronto Centre for Active Transportation, American Public Health Association, Pedestrian and Bicycle Information Centre, Ontario Professional Planners Institute, Canadian Institute of Planners, Share the Road Ontario, Green Communities Canada, and Canada Bikes), and social media accounts. The survey was further disseminated through email and cross postings by organizations and individual practitioners throughout the time it was open (May 10 through May 31, 2018). Some of this effort specifically focused on reaching people in lesser populated areas.

As a result of this outreach, 410 individuals participated. When asked what their agency's primary purpose is, 41% responded transportation, 34% health and 25% other (e.g., academia, social services, municipal or regional government). Participants were from eight provinces, with over half from Ontario (52%).

Online survey respondents were asked to prioritize areas in most need of additional knowledge and resources. The highest identified needs were related to mode choice and active transportation, safety, and monetizing health outcomes related to travel behaviour. Other areas self-identified in respondent comments included impact of accessible transportation, access to health care services, climate change initiatives (traffic-related air pollution mitigation measures), and better data and measures for modeling (such as monetization of impacts and traffic modeling). For those alluding to accessible transportation in the open ended "Other" response, comments mentioned making transportation services more physically and financially accessible for youth, older adults and those living in rural communities, and more affordable for all.

The online survey asked participants to prioritize the top two areas "where additional knowledge and resources would better support the integration of health in transportation at your agency." Following this question, they were asked, "What types of technical or institutional help (e.g., professional development, education, training) would be most beneficial for you/your organization to support the integration of . . . [their first and second choices] . . . into routine transportation practice? Respondents provided over 250 responses to this open-ended question, which were reviewed and coded into the following six categories:

- Legislation, policy, funding
- Guidelines
- Data, research, methods, tools
- Collaboration
- Education
- Miscellaneous

Some comments pertained to more than one and, as a result, were coded into all relevant categories. Of the resulting 323 comment/category pairs, 42 percent of comments related to additional educational opportunities and resources as what would be the most beneficial to support better integration of health and transportation. Within each integration area, education was the most common category for all comments received except for

monetization. *Data, research, methods and tools* had the most responses within monetization, 17 compared to 13 for education.

The most comments were received for three integration areas—mode choice (n=88), safety for all mode (n=80) and health equity (n=56). Collectively they comprised nearly 70 percent of the 323 comments. Note that some comments made by different individuals were similar, if not the same (e.g., the need for more professional development opportunities in these areas).

4.2 INTERVIEWS

The 30 to 45-minute telephone-based interviews asked:

- What needs to happen, from your perspective, to achieve more successful outcomes?
- Where do you need more support in integrating health and transportation? What kind of support?

In contrast to the online survey, the 19 people who were interviewed placed more emphasis on changes needing to happen in the legislation, policy and funding categories in order to better integrate health and transportation (30% of interview comments vs 12% of the online responses). This was followed by data, research, methods and tools (23% of responses), and education (20%). The most common category of responses from the survey included the last two—education, and data, research, methods, and tools, but the third was guidelines. A review of key words and themes found in the survey and interview responses resulted in the identification of integration areas with gaps in knowledge and resources, and opportunities for technical and institutional support to help support closing such gaps. Ultimately, a review of the gaps and opportunities led to the development of an initial set of recommendations.

4.3 WEBINARS

Using the input received from the survey and interviews, a prioritized set of 11 key recommendations were developed. These were presented to a total of 85 health and transportation professionals who participated in one of two interactive webinars.³⁴ Individuals were invited to participate in the webinars who had also been invited to complete the online survey and/or interview. While some webinar attendees opted to participate in listen-in-only mode, most attendees participated in the interactive webinar mode which resulted in an average response rate of 61% per recommendation-related polls. Of those who indicated their professional field, 57% indicated health, 30% transportation and the remainder both fields. Of those who indicated their province, over two-thirds of participants were from Ontario (68%), with the remainder from five other provinces.







Each recommendation was presented and then followed by a short survey poll regarding participants' view on the importance of the recommendation to health and transportation and whether the participants had concerns about the recommendation. Further, the webinar included an opportunity for participants to interact in a chat box and provide more detailed feedback regarding opportunities, needs and gaps through written responses. More detail on the webinars and input received can be found in *Appendices: Integrating Health and Transportation in Canada*, a separately provided report. The feedback from webinar participants was used to guide the creation of the final set of actionable recommendations presented next.






³⁴ In order to maximize participation opportunities, the same webinar (content wise) was held on two separate occasions – November 1 and 6, 2018. The total number of participants refers to the combined total from both webinars.

5. RECOMMENDATIONS

The final recommendations presented in Table 6 are based on the input received and summarized above. Three overarching categories in need of improvement emerged from the webinar input: Education & Professional Development, Policy & Practice and Expanding the Evidence. Each recommendation is categorized in two ways – these broad categories and which of the seven integration areas it relates to.

Table 6: Recommendations

Recommendation	Category	Integration Area(s)
1. Require base degree curricula for transportation engineering, transportation planning and relevant public health programs to include a transportation/health interdisciplinary course(s).	Education & Professional Development	 All
2. Improve communication and promotion efforts to ensure awareness and foster participation in professional development opportunities that provide information on the intersection of health, health equity and transportation.	Education & Professional Development	 All
3. Establish cross-sector funding opportunities, interdisciplinary conferences, coordinated policy and mandates that increase interdisciplinary efforts between transportation and public health organizations and agencies.	Policy & Practice	 All
4. Integrate existing public health evidence into the development, implementation, and evaluation of government policies that guide the transportation planning process.	Policy & Practice	 All
5. Standardize a Canadian cost-benefit analysis model that considers the impacts of investments in walking and bicycling infrastructure (construction / maintenance) at a variety of scales.	Policy & Practice	 Monetizing Health Outcomes Related to Travel Behaviour
6. Develop or improve guidelines for transportation professionals that include evidence-based strategies to address safety concerns related to active travel through transportation planning and design.	Policy & Practice	 Safe Multimodal Systems

Recommendation	Category	Integration Area(s)
7. Develop or improve guidelines for transportation professionals that include evidence-based strategies to increase equal access to health promoting and community resources (e.g., health care facilities, food outlets, parks, work and school settings).	Policy & Practice	 Transportation Access to Health Promoting Resources
8. Improve community engagement and involvement in the transportation planning process to better meet community health needs and promote health equity.	Policy & Practice	 Health Equity
9. Utilize a checklist to self-assess how well and in what ways individual organizations and communities are integrating health and transportation.	Policy & Practice	 All
10. Use a standardized and integrated database that includes injuries, fatalities and health outcomes to develop, monitor, and evaluate policy and practices for all modes of travel and vulnerable populations.	Expanding the Evidence	 Safe Multimodal Systems
11. Expand the evidence-base and understanding of transportation design and active transportation's role in promoting mental and emotional health.	Expanding the Evidence	 Supporting Mental Health

The following pages expand on these recommendations by identifying:

1. The champion for each recommendation (i.e., who is responsible)
2. Preliminary actions that must take place to fulfill the recommendation
3. Challenges to recognize before implementation
4. Existing resources to build on

The provided resources were selected based on specificity to Canadian context, contemporariness and their generalizability, with consideration given to meta-analyses and study design.

Recommendation 1

Require base degree curricula for transportation engineering, transportation planning and relevant public health programs to include a transportation/health interdisciplinary course(s).



Integration area:

- All



Champions:

- Academics



Preliminary actions:

- Host collaborative meetings among academics from transportation and public health disciplines to better understand other disciplines' background, approaches, methods and tools for planning, design, maintenance, and operations of the transportation system.
- Identify topics in the planning, design, maintenance, and operations of the transportation system, that can better integrate health and equity considerations (i.e., travel needs of all ages and abilities).
- Create an interdisciplinary course(s) outline that explores relationships between transportation planning, land use design and health, and also fosters strategic thinking among new professionals.



Challenges to recognize:

- Because university regulation is at the provincial level, not federal, curricula/degree changes require province by province work.



Resources:

Accreditation organizations:

- Professional Standards Board - operates the "Certification and Accreditation Administrative Services Program" (CAASP) for the Canadian Institute of Planners (CIP) and the Provincial/Territorial Institutes and Associations (PTIAs) <http://www.psb-planningcanada.ca/CERTIFICATION/accreditedplanningprograms.php>
- Engineers Canada - accredits Canadian undergraduate programs in engineering <https://engineerscanada.ca/accreditation/about-accreditation>

Examples of institutions implementing interdisciplinary curriculum:

- The University of British Columbia School of Community and Regional Planning
 - PLAN 579/SPPH 571 *Public Health, Transportation, and the Built Environment*
 - Health & Community Design Lab. <http://health-design.spph.ubc.ca/>
- University of Toronto Dalla Lana School of Public Health – GGR433 *Built Environment and Health* http://geography.utoronto.ca/wp-content/uploads/2017/01/GGR433_2017Syllabus_External_Dec-16-16.pdf
- Universities in the United States Sample Syllabi (n=11) <http://www.bephc.gatech.edu/planning/academic/syllabi>

Content resources:

- Public Health and Planning 101: An Introductory Online Course for Public Health and Planning Professionals to Create Healthier Built Environment. Ontario Public Health Association. <https://opha.on.ca/What-We-Do/Projects/Built-Environment.aspx>
- Botchwey et al. (2009). *A Model Curriculum for a Course on the Built Environment and Public Health: Training for and Interdisciplinary Workforce*. https://ac-els-cdn-com.proxygw.wrlc.org/S0749379708008726/1-s2.0-S0749379708008726-main.pdf?_tid=01e66ccf-6fde-4482-ac22-bf47f2806c1e&acdnat=1547501678_9f3b3f71c3e3d479a401ca1c7f1960de

Recommendation 1

- Public Health Agency of Canada (2014). *Mobilizing Knowledge on Active Transportation: Project Briefing and Highlight Sheets*. G. Noxon. Ottawa, Canada, Public Health Agency of Canada. http://publications.gc.ca/collections/collection_2015/aspc-phac/HP35-52-2014-eng.pdf
- Robert Wood Johnson Foundation (2012). *How does Transportation Impact Health? Health Policy Snapshot*, Robert Wood Johnson Foundation. https://www.rwjf.org/content/dam/farm/reports/issue_briefs/2012/rwjf402311.
- Canadian Public Health Association (2014). *Healthy Canada by Design Supplement: Canadian Journal of Public Health*. Ottawa, ON, Canadian Public Health Association. <https://journal.cpha.ca/index.php/cjph/article/viewFile/5009/2998>.
- *The Public Health Officer's Report of the State of Public Health in Canada 2017*. https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/chief-public-health-officer-reports-state-public-health-canada/2017-designing-healthy-living/PHAC_CPHO-2017_Report_E.pdf
- *National Collaborating Centre for Determinants of Health*. (2013). *Let's Talk: Health equity*. Antigonish, NS: National Collaborating Centre for Determinants of Health, St. Francis Xavier University. <http://nccdh.ca/resources/entry/health-equity>

Recommendation 2

Improve communication and promotion efforts to ensure awareness and foster participation in professional development opportunities that provide information on the intersection of health, health equity and transportation.



Integration area:

- All



Champions:

- Professional organizations for transportation and public health practitioners
- Consulting firms
- Academia
- Non-governmental organizations
- Government agencies



Preliminary actions:

- Identify, develop and conduct frequent webinar sessions, information campaigns and conferences that cover topics regarding the intersection of health, health equity and transportation.



Challenges to recognize:

- Effective education and training across audiences typically requires adequate funding, political support and substantial partnership efforts to provide accurate, consistent, coordinated information.



Resources:

Examples of professional development opportunities:
Webinars

- Canadian Public Health Association - A Day in the Life of an Urban Planner with a Public Health Impact. <https://www.cpha.ca/day-life-urban-planner-public-health-impact>
- Healthy Canada by Design CLASP. Bringing Health Considerations into the Transportation Planning Process, and Incubating Active Transportation & Healthy Urban Design - <https://hcbdclasp.blog/members-only-hcbd-webinars-panel-presentations/>
- Safe Routes to School National Partnership. Leading with Health: Complete Streets and Bicycle and Pedestrian Planning - <https://www.saferoutespartnership.org/resources/webinar/complete-streets-bicycle-and-pedestrian-planning>

Conferences

- International Conference on Transport & Health. <https://www.tphlink.com/ict2019--melbourne.html>

Content resources:

- Public Health Agency of Canada (2014). *Mobilizing Knowledge on Active Transportation: Project Briefing and Highlight Sheets*. G. Noxon. Ottawa, Canada, Public Health Agency of Canada. http://publications.gc.ca/collections/collection_2015/aspc-phac/HP35-52-2014-eng.pdf
- Robert Wood Johnson Foundation (2012). *How does Transportation Impact Health? Health Policy Snapshot*, Robert Wood Johnson Foundation. https://www.rwjf.org/content/dam/farm/reports/issue_briefs/2012/rwjf402311
- Canadian Public Health Association (2014). *Healthy Canada by Design Supplement: Canadian Journal of Public Health*. Ottawa, ON, Canadian Public Health Association. <https://journal.cpha.ca/index.php/cjph/article/viewFile/5009/2998>.
- *The Public Health Officer's Report of the State of Public Health in Canada 2017*. https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/chief-public-health-officer-reports-state-public-health-canada/2017-designing-healthy-living/PHAC_CPHO-2017_Report_E.pdf

Recommendation 3

Establish cross-sector funding opportunities, interdisciplinary conferences, coordinated policy and mandates that increase interdisciplinary efforts between transportation and public health organizations and agencies.



Integration area:

- All



Champions:

- Transportation and public health practitioners



Preliminary actions:

- Develop collaborative working agreements, linked project funding and other grant opportunities, organizational partnerships (e.g., the Ontario Public Health Association and the Ontario Professional Planners), sharing of best practices and cross-sector employment.



Challenges to recognize:

- Diversity in professional approaches within the transportation field as a result of location of practice, professional experience and generational differences [33].



Resources:

Guidelines, Strategy and Action Plans

- Craig, K. and J. van Hemert (2012). *Healthy Communities Practice Guide*, Canadian Institute of Planners. https://www.cip-icu.ca/Files/Healthy-Communities/CIP-Healthy-Communities-Practice-Guide_FINAL_lowre.aspx.
- BC Healthy Communities Society, Ministry of Health (2018). Plan H. Active Communities. https://planh.ca/sites/default/files/tools-resources/2018_09_17_activecommunities_ag_v01_2018_web.pdf

*Funding Mechanisms*³⁵

- Alberta's Basic Municipal Transportation Grant program. <https://open.alberta.ca/dataset/basic-municipal-transportation-grant-program-guidelines>
- The Cycling Infrastructure Partnerships Program in British Columbia (a cost-sharing program making these changes and adding in the local governments to improve commuter cycling facilities). www.th.gov.bc.ca/bikebc/cipp.html
- Manitoba's Small Communities Transit Fund. https://www.gov.mb.ca/mr/bldgcomm/pubs/sctf_pg.pdf
- The Nova Scotia Moves program. www.novascotia.ca/sustainabletransportation
- Alberta Transportation's GreenTIP funding program.³⁶ <http://www.transportation.alberta.ca/5409.htm>

³⁵ Examples from Public Health Agency of Canada (2014). *Mobilizing Knowledge on Active Transportation: Project Briefing and Highlight Sheets*. G. Noxon. Ottawa, Canada, Public Health Agency of Canada.

³⁶ Note - this program funded new and expanded public transit until 2016 and will cease to exist once existing projects are paid in full.

Recommendation 3

Examples of interdisciplinary efforts:

- Kestens, Y., Winters, M., Fuller, D., Bell, S., Berscheid, J., et al. (2019). *INTERACT: A comprehensive approach to assess urban form interventions through natural experiments*. *BMC Public Health*, 19(51).
<https://bmcpublikealth.biomedcentral.com/articles/10.1186/s12889-018-6339-z>
- The University of British Columbia Health & Community Design Lab. <http://health-design.spph.ubc.ca/publications/>
- Arterial Roadways Research Needs and Concern. *Informing the Planning, Design, and Operation of Arterial Roadways Considering Public Health*.
<http://onlinepubs.trb.org/onlinepubs/circulars/ec239.pdf>

Papers, Reports and Other Sources of Information

- Kent, J. & Thompson, S. (2012). *Health and the Built Environment: Exploring Foundations for a New Interdisciplinary Profession*. *Journal of Environmental and Public Health*. <https://www.hindawi.com/journals/jeph/2012/958175/>

Recommendation 4

Integrate existing public health evidence into the development, implementation, and evaluation of government policies that guide the transportation planning process.



Integration area:

- All



Champions:

- Professional organizations for transportation and public health practitioners
- Consulting firms
- Academia
- Non-governmental organizations
- Government agencies



Preliminary actions:

- Identify the level of government to focus on.
- Prioritize specific relevant public health needs that can be impacted through transportation planning policies.
- Develop policy language, and a process to implement.



Challenges to recognize:

- Government legislation and regulations have typically focused on motorized vehicles.
- Differences between jurisdictions add a degree of complexity to cohesive policy strategy.
- Achieving balance between provincial leadership and local autonomy is critical to obtaining political support from elected officials and residents [33].



Resources:

Guides, Strategies and Action Plans

- Lukes, J., et al. (2011). *Greater Strides: Taking Action on Active Transportation, Manitoba's Active Transportation Advisory Group*. http://www.gov.mb.ca/sd/pdf/atag_report6.pdf
- Ontario Government. #CycleON: ACTION PLAN 2.0 (2018) <http://www.mto.gov.on.ca/english/publications/pdfs/cycle-action-plan.pdf>
- Government of Ontario. Guidelines for Municipal Official Plan Preparation and Review. Sections 2.2.4 Bicycle Policy (under review) and 2.2.5 Ontario Bikeways Planning and Design Guidelines. http://www.mto.gov.on.ca/english/engineering/management/corridor/municipal-guideline/planning.shtml#section_two_two_four
- Transport Canada (2011). *Active Transportation in Canada: A Resource and Planning Guide*. EcoPlan International. Ottawa, ON, Transport Canada, Environmental Initiatives Group. http://publications.gc.ca/collections/collection_2011/tc/T22-201-2011-eng.pdf

Examples of transportation policy strategies that integrates health evidence

- Government of Alberta. *Active Alberta: 2011-2021*. www.tpr.alberta.ca/activealberta
- Quebec's Sustainable Mobility Policy: Action Plan 2018-2030. <https://www.transports.gouv.qc.ca/en/Documents/action-plan-pmd.pdf>

Recommendation 5

Standardize a Canadian cost-benefit analysis model that considers the impacts of investments in walking and bicycling infrastructure (construction/maintenance) at a variety of scales.

	Integration area:	<ul style="list-style-type: none"> • Monetizing Health Outcomes Related to Travel Behaviour
	Champions:	<ul style="list-style-type: none"> • Professional organizations for transportation and public health practitioners • Government agencies
	Preliminary actions:	<ul style="list-style-type: none"> • Review existing cost-benefit analysis models, and applicability to the Canadian context. • Develop a standardized cost-benefit analysis model for investments in walking and bicycling infrastructure, including such outcomes as job creation, health care costs and job productivity. • Create a portfolio of case studies for Canadian applications of the cost-benefit analysis model across both micro- and macroscale projects and across various regions.
	Challenges to recognize:	<ul style="list-style-type: none"> • Requires substantial financial investment and time for comprehensive data collection (i.e., rural areas, contextual differences across regions, local economy, etc.). • Multiple cost-benefit analysis models may be necessary to address various scales (e.g., large community, neighbourhood, project-level, etc.). • Interpreting the model for practical applications to policy and practice may require professional consultation.
	Resources:	<p><i>Case studies</i></p> <ul style="list-style-type: none"> • Toronto Centre for Active Transportation (2012). <i>The Economic Impacts of Active Transportation</i>. (http://www.tcat.ca/wp-content/uploads/2014/10/Economic-Impacts-of-Active-Transportation-Backgrounder.pdf) • The Alberta Centre for Active Living. <i>Infographic with economic benefits for shifting more trips to active modes, including costs associated with infrastructure and roadway maintenance, health care, productivity, and other indirect costs</i>. (https://www.centre4activeliving.ca/media/filer_public/07/77/077713ef-e097-4bc5-8278-1fb455d26630/2017-active-transportation-factsheet.pdf) • Canadian Urban Transit Association's (2010), <i>The Economic Impact of Transit Investment: A National Survey</i>. (http://cutaactu.ca/sites/default/files/final_cuta-economicbenefitsoftransit-finalreportsept2010.pdf) • U.S. Transportation Research Board (2014). <i>Benefit-Cost Analysis of Public Health Outcomes in Long-Range Transportation Planning in the San Francisco Bay Area to help evaluate the region's most recent long-range transportation plan</i>. (https://trid.trb.org/view.aspx?id=1288720) <p><i>Guides, Strategies and Action Plans</i></p> <ul style="list-style-type: none"> • Transport Canada's (2011). <i>Active Transportation in Canada: A resource and planning guide</i>. See section on "Economic Development and Financial." (http://publications.gc.ca/collections/collection_2011/tc/T22-201-2011-eng.pdf) • The Victoria Transport Policy Institute. <i>Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications</i>. http://www.vtpi.org/tca/ • Metro Vancouver (2015). <i>The Metro Vancouver Housing and Transportation Cost Burden Study – a New Way of Looking at Affordability</i>. http://www.metrovancouver.org/services/regional-planning/PlanningPublications/HousingAndTransportCostBurdenReport2015.pdf

Recommendation 6

Develop or improve guidelines for transportation professionals that include evidence-based strategies to address safety concerns related to active travel through transportation planning and design.



Integration area:

- Safe Multimodal Systems



Champions:

- Professional organizations for transportation and public health practitioners



Preliminary actions:

- Review current best practices guidelines for transportation planning and project design.
- Work with public health professionals to develop specific, evidence-based strategies to reduce injuries and fatalities among active mode users.



Challenges to recognize:

- Guidelines need to be regularly updated.
- Guidelines need to be specific but also need to allow for innovation and creativity in order for implementation to occur [33].



Resources:

Guides, Strategies and Action Plans

- BC Centre for Disease Control. *Healthy Built Environment Linkages Toolkit: making the links between design, planning and health, Version 2.0*. Vancouver, B.C. Provincial Health Services Authority, 2018. http://www.bccdc.ca/pop-public-health/Documents/HBE_linkages_toolkit_2018.pdf
- Toronto Public Health, et al. (2014). *Active City: Designing for Health (Principle 5)*, City of Toronto.
- Transportation Association of Canada. *Geometric Design Guide for Canadian Roads*. <https://www.tac-atc.ca/en/publications-and-resources/geometric-design-guide-canadian-roads>
- CCMTA (2016). *Towards Zero: The Safest Roads in the World*, Canadian Council of Motor Transportation Administrators. <http://roadsafetystrategy.ca/en/>
- NACTO (2017, March). *Creating Safe, Sustainable, Multi-Modal Urban Transportation*.
 - *NACTO Policy*. New York, NACTO. from <https://nacto.org/wp-content/uploads/2017/03/NACTO-Policy-2017.pdf>
- World Resources Institute, R. C. (2018, January). *Sustainable & Safe: A Vision and Guidance for Zero Road Deaths*. Washington, D.C. from <https://www.wri.org/publication/sustainable-and-safe-vision-and-guidance-zero-road-deaths>
- National Center for Safe Routes to School (2015). *Safe Routes to School Online Guide*. <http://guide.saferoutesinfo>

Training

- *Webinars*. The Pedestrian and Bicycle Information Center (PBIC) <http://www.pedbikeinfo.org/training/webinars.cfm>
- *Complete Streets in Canada: Designing for Change Webinar*. <https://smartgrowthamerica.org/complete-streets-in-canada-designing-for-change-webinar-recap/>

Recommendation 7

Develop or improve guidelines for transportation professionals that include evidence-based strategies to increase equal access to health promoting and community resources (e.g., health care facilities, food outlets, parks, work, and school settings).



Integration area:

- Transportation Access to Health Promoting Resources



Champions:

- Professional organizations for transportation and public health practitioners



Preliminary actions:

- Review current best practices guidelines for transportation planning and project design.
- Work with public health professionals to develop specific, evidence-based strategies that have demonstrated a positive impact on health, health equity, and healthcare.



Challenges to recognize:

- In order for transportation to facilitate access to health promoting resources, supportive land use policies and practices also need to be in place.
- Guidelines and standards need to be regularly updated.
- Guidelines need to be specific but also need to allow for innovation and creativity in order for implementation to occur [33].



Resources:

Guides, Strategies and Action Plans

- BC Centre for Disease Control. *Healthy Built Environment Linkages Toolkit: making the links between design, planning and health, Version 2.0*. Vancouver, B.C. Provincial Health Services Authority, 2018. http://www.bccdc.ca/pop-public-health/Documents/HBE_linkages_toolkit_2018.pdf
- Craig, K. and J. van Hemert (2012). *Healthy Communities Practice Guide, Canadian Institute of Planners*. https://www.cip-icu.ca/Files/Healthy-Communities/CIP-Healthy-Communities-Practice-Guide_FINAL_lowre.aspx
- Toronto Public Health, et al. (2014). *Active City: Designing for Health*. Toronto, City of Toronto. <https://www.toronto.ca/legdocs/mmis/2014/hl/bgrd/backgroundfile-69334.pdf>
- Transport Canada (2011). *Active Transportation in Canada: A Resource and Planning Guide*. EcoPlan International. Ottawa, ON, Transport Canada, Environmental Initiatives Group. http://publications.gc.ca/collections/collection_2011/tc/T22-201-2011-eng.pdf
- Ontario Ministry of Municipal Affairs and Housing and Ontario Professional Planners Institute (2009). *Planning by Design: A Healthy Communities Handbook*. Toronto, ON, Ontario Ministry of Municipal Affairs and Housing: Provincial Planning Policy Branch. <http://www.mah.gov.on.ca/Page6737.aspx>.
- Ontario Ministry of Transportation (2012). *Transit Supportive Guidelines*. <http://www.mto.gov.on.ca/english/transit/pdfs/transit-supportive-guidelines.pdf>
- *The City of North Vancouver's Active Design Guidelines*. <https://www.cnv.org/city-services/planning-and-policies/active-design>

Papers, Reports and Other Sources of Information

- Boisjoly, G., Deboosere, R., Wasfi, R., Orpana, H., Manaugh, K., Buliung, R. & El-Geneidy, A. (2019). *Accessibility to healthcare via public transport across Canada*. Paper presented at the 98th Annual Meeting of the Transportation Research Board, Washington D.C., USA. http://tram.mcgill.ca/Research/Publications/Access_To_Healthcare_Canada.pdf

Recommendation 8

Improve community engagement and involvement in the transportation planning process to better meet community health needs and promote health equity.



Integration area:

- Health Equity



Champions:

- Government agencies



Preliminary actions:

- Establish partnerships, policy and funding to support community-based participatory research and involvement.



Challenges to recognize:

- Innovative engagement, recruitment and data collection methods must consider cultural diversity and ensure that there is representation from a variety of developed environments (e.g., urban, suburban and rural).



Resources:

Guides, Strategies and Action Plan

- The World Health Organization. *Engagement and Participation for Health Equity*. <http://www.euro.who.int/en/health-topics/health-determinants/social-determinants/publications/2017/engagement-and-participation-for-health-equity-2017>
- U.S.'s Centers for Disease Control and Prevention. *Meaningful Community Engagement for Health and Equity documents provide rationales, case studies, and high-level guidance on community engagement for health equity*. <https://www.cdc.gov/nccdphp/dnpao/state-local-programs/health-equity-guide/pdf/health-equity-guide/Health-Equity-Guide-sect-1-2.pdf>
- *Active Neighbourhoods Canada: participatory planning approach*. <https://participatoryplanning.ca/participatory-planning>
- *Advancing Equity and Inclusion: A Guide for Municipalities*. City for All Women Initiative. (2015). http://www.cawi-ivtf.org/sites/default/files/publications/advancing-equity-inclusion-web_0.pdf

Case Studies

- *The City of Surrey Parks, Recreation and Culture 10-Year Strategic Plan*. <https://www.surrey.ca/files/PRCStrategicPlan.pdf>
- *Lower Columbia Healthy Communities Plan*.

Recommendation 9

Utilize a checklist to self-assess how well and in what ways organizations and communities are integrating health and transportation (provided in the Annex).



Integration area:

- All



Champions:

- Government leaders
- Transportation practitioners
- Public health practitioners
- Academics
- Community members



Preliminary actions:

- Determine the purpose for assessment.
- Determine the relevant areas in which to assess.
- Develop, modify, or use an existing checklist.



Challenges to recognize:

- Multiple checklists may need to be synthesized to get an authentic assessment for an entire community.



Resources:

- World Health Organization's *Global Age-friendly Cities: A Guide*. https://apps.who.int/iris/bitstream/handle/10665/43755/9789241547307_eng.pdf;jsessionid=1910E18A9A0548E8A2275A20E5D86CE0?sequence=1
- *Active Neighborhood Checklist*. https://activelivingresearch.org/sites/activelivingresearch.org/files/Protocol_ActiveNeighborhoodChecklist.v2.pdf
- Metro Healthy Comprehensive Plan Work Group's *Checklist: Comprehensive Planning for a Health Community*. <http://mnfoodcharter.com/wp-content/uploads/2014/10/COMMUNITY-HEALTH-IN-COMPREHENSIVE-PLANNING-CHECKLIST.pdf>

Recommendation 10

Use a standardized and integrated database that includes injuries, fatalities and health outcomes to develop, monitor, and evaluate policy and practices for all modes of travel and vulnerable populations.


Integration area:

- Safe Multimodal Systems


Champions:

- Public health agencies
- Transportation agencies
- Transportation professional organizations
- Police Departments


Preliminary actions:

- Identify existing sources of data (including potentially crowd-sourced, social media), content, spatial coverage, update frequency.
- Evaluate priorities, phasing options (e.g., with different emphasis, rural, urban)
- Collect data about transportation modes used (counts, travel distance and time, trip purpose), incidence of collision-related and infrastructure-related injuries and fatalities, and health outcomes.
- Create an integrated database of data collected by diverse agencies and disciplines.
- Make the data anonymous and open for the public to access.
- Create use-case examples of the data, for example using it with place-based built, natural and social environmental, including presence/absence of infrastructure measures to identify potential equity concerns about injuries, fatalities, and other health outcomes.


Challenges to recognize:

- Budget constraints and low response rates have limited data collection efforts.
- Privacy concerns must be addressed using ethical research methodology.
- Data will come from multiple agencies, each of which collects it for their own agency needs.
- Data are assembled for different regions, on different parts of the transportation system, using non-consistent data formats, variable names, etc.


Resources:
Existing Data Collection & Sharing Efforts:

- Injury & Fatality data collection
 - Transport Canada's National Collision Database. <http://wwwapps2.tc.gc.ca/Saf-Sec-Sur/7/NCDB-BNDC/p.aspx?l=en>
 - Canadian Motor Vehicle Traffic Collision Statistics: 2016. <https://www.tc.gc.ca/eng/motorvehiclesafety/canadian-motor-vehicle-traffic-collision-statistics-2016.html>
 - Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP). <https://www.canada.ca/en/public-health/services/reports-publications/health-promotion-chronic-disease-prevention-canada-research-policy-practice/vol-36-no-6-2016/status-report-canadian-hospitals-injury-reporting-prevention-program-dynamic-innovative-injur>
 - CIHI Ontario Trauma Registry Metadata, Discharge Abstract Database. <https://www.cihi.ca/en/ontario-trauma-registry-metadata>
- Mode Share data collection
 - Canadian Census of Population: Journey to Work Reference Guide, Census of Population, 2016. <https://www12.statcan.gc.ca/census-recensement/2016/ref/guides/011/98-500-x2016011-eng.cfm>
 - Canadian National Household Survey: Commuting to work. https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/99-012-x2011003_1-eng.cfm

Recommendation 10

- Urban, suburban and rural characteristics.
 - The Canadian Urban Environmental Health Research Consortium (CANUE) sharable data and tools program: <https://canue.ca/data-and-tools-home/>

Paper, Reports and Other Sources of Information:

- ITF, OECD, *International Traffic Safety Data and Analysis Group, Reporting on Serious Road Traffic Casualties*. <https://www.itf-oecd.org/sites/default/files/docs/road-casualties-web.pdf>
- Centre for Surveillance Coordination, Centre for Healthy Human Development Population and Public Health Branch, Health Canada. *2003 Report, Injury Surveillance in Canada: Current Realities and Challenges*. https://www.injuryresearch.bc.ca/docs/3_20090910_100541Report%20HC%20Inj%20Surveillance%20in%20Can%20Aug%202003.pdf
- Mooney, S., Magee, C. Dang, K. et al. (2018). “Complete Streets” and Adult Bicyclist Fatalities: Applying G-Computation to Evaluate an Intervention That Affects the Size of a Population at Risk. *American Journal of Epidemiology*. <https://academic.oup.com/aje/article-abstract/187/9/2038/4995886>

Recommendation 11

Expand the evidence-base and understanding of transportation design and active transportation’s role in promoting mental and emotional health.



Integration area:

- Supporting Mental Health



Champions:

- Academia
- Professional organizations for transportation and public health practitioners
- Government agencies



Preliminary actions:

- Identify gaps in the existing research related to transportation and mental/emotional health.
- Identify funding sources to conduct relevant research.
- Conduct research that addresses significant gaps in the existing research related to transportation and mental/emotional health.
- Develop compelling public health campaign to disseminate innovative finding to diverse audiences.



Challenges to recognize:

- Obtaining funding for research and collaborating across agency and different levels of government.



Resources:

Examples of Research Partners

- Mental Health Research Canada (MHRC) - funds outcomes-based mental health research and builds capacity in mental health research. <http://www.mhrc.ca>
- Institute for Mental Health Policy Research - conducts collaborative research on communities, populations, health systems and global health. <https://www.camh.ca/en/science-and-research/institutes-and-centres/institute-for-mental-health-policy-research#>
- Canadian Mental Health Association - facilitates access to the resources people require to maintain and improve mental health and community integration, build resilience, and support recovery from mental illness. <https://cmha.ca/>
- Mental Health Commission of Canada - leads the development and dissemination of innovative programs and tools to support the mental health and wellness of Canadians. <https://www.mentalhealthcommission.ca/English>

Guides, Strategies and Action Plans

- Tam T. *The Chief Public Health Officer’s Report on the State of Public Health in Canada 2017 – Designing Healthy Living*. City of Ottawa, ON: Public Health Agency of Canada, 2017
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Recommendation 11

Papers, Reports and Other Information Sources

- The *Journal of Urban Design and Mental Health* published *Scoping assessment of transport design targets to improve public mental health* in 2017, a simple assessment listing transport-related factors and potentially relevant design factors that could potentially improve public mental health.
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ANNEX: CHECKLIST TO ASSESS THE LEVEL OF HEALTH & TRANSPORTATION INTEGRATION

A checklist was developed to assess if/how various sectors are achieving the key elements for successful integration of health and transportation, and to allow a community to collectively track changes over time. While the checklist is designed for individual-level use, a comprehensive review of a sector is best achieved when multiple of its members complete the checklist. A comprehensive review allows for each sector to identify strengths and weaknesses regarding the integration of health and transportation, and allows for baseline scores to monitor over time as modifications are made to better meet the key elements identified in this report. A community might use the checklist as a collective examination of efforts to integrate health and transportation across various sectors, holding all sectors accountable for respective roles, and allowing for necessary modifications to be made to ensure successful integration of health and transportation in the community (Figure A1).



Figure A1: Checklist Application and Utility

The checklist content includes examples of items that need to be addressed by various disciplines to achieve better integration of health and transportation in Canada. This checklist provides a template that can be tailored to local needs and interest and used to assess current conditions and track progress toward complete integration of health and transportation. The checklist can be amended to include other ways that various sectors contribute to successful integration of health and transportation which might not be included here.

TAC's Health & Transportation CHECKLIST

How well is your organization integrating health and transportation?

Listed below, by professions, are key elements to integrate transportation and health. In addition, items can be added to the list provided to reflect updated strategies being implemented.

Check each box you agree with, and then sum the number of checked boxes at the end for an indication of level of completeness. Unchecked boxes indicate areas to work on. For resources to use in this work please see the Transportation Association of Canada's *Integrating Health and Transportation in Canada* (2019).

INSTITUTIONAL CAPACITY AND CROSS-DISCIPLINE ENGAGEMENT

Government Leaders: ___ / ___

- Decision-makers in transportation and health organizations regularly convene to discuss and coordinate their activities, such as the development of policies, strategies, initiatives, plans, funding priorities and projects.
- Political decision-makers at the local/regional/federal level of government understand the impact that transportation planning has on human health and healthcare.

Transportation Practitioners: ___ / ___

- Public health professionals' involvement in the transportation planning process is proactively sought and encouraged.
- Professional development opportunities that provide information on the intersection of health, health equity and transportation are promoted and expected to be taken advantage of.
- There are professional organizations that offer continuing education credits that explore the relationships between transportation planning, land use design and health, and incorporates background, approaches, methods and tools to include health equity considerations in transportation system planning, including travel needs, as well as the design, maintenance, and operations of the system.
- Staff with public health training work for my transportation agency/ organization.

Academics: ___ / ___

- The accredited public health and/or transportation-related program that I attended or currently attend/work at requires at least one interdisciplinary course which explores the relationships between transportation planning, land use design and health and includes health equity considerations in transportation system planning, including travel needs.
- At least one faculty member's research in the transportation/public health/psychology department where I obtained my degree or where I work explores the role of transportation in mental & emotional health.

Public Health Practitioners: ____ / ____

- Staff with transportation planning training work for my public health agency/organization.
- Professional development opportunities that provide information on the intersection of health, health equity and transportation are promoted and expected to be taken advantage of.
- There are professional organizations that offer continuing education credits that explore the relationships between transportation planning, land use design and health, and incorporates background, approaches, methods and tools to include health equity considerations in transportation system planning, including travel needs, as well as the design, maintenance, and operations of the system.
- There is an educational campaign that promotes the interrelated economic, environmental and human health and health equity impacts of design, location and interconnectedness of transportation infrastructure, land uses and buildings.
- Educational and/or training sessions are delivered for political decision-makers, transportation planners and engineers and citizen groups.

POLICY COMMITMENT

Government Leaders: ____ / ____

Transportation policies are in place and guide project prioritization, planning, design and development which support:

- | | |
|---|---|
| <input type="checkbox"/> Complete Streets | <input type="checkbox"/> Addressing Traffic Related Air Pollution (TRAPs) |
| <input type="checkbox"/> Vision Zero | <input type="checkbox"/> Addressing Climate Change Mitigation and |
| <input type="checkbox"/> Traffic Calming | Adaption |
| <input type="checkbox"/> Age Friendly Communities | |

FUNDING

Government Leaders: ____ / ____

Local, regional, provincial, and/or federal levels of government offer:

- Linked grant opportunities for transportation and public health agencies.
- Community-based participatory research grants related to transportation planning and health.
- Grants/incentive for the development and application of a cost-benefit analysis model for investment in walking and bicycling infrastructure which includes outcomes such as job creation, health care costs and job productivity.
- Funding for research that explores the role of transportation in mental & emotional health.

PLANNING

Transportation Practitioners: ____ / ____

- Plans consider existing and emerging evidence regarding planning, designing and maintaining for safety for all modes, all ages and all abilities.
- Plans explicitly consider and calculate the health impacts and cost-benefit analysis of the planned changes, across the study area, and demographic subgroups (e.g., age, income levels).
- Plans promote increased use of active transportation modes (including multimodal trip making).
- Survey behaviour data collection efforts seek information on travel by all modes.

Public Health Practitioners: ____ / ____

- Public health safety surveillance efforts distinguish between collision-related and infrastructure-related injuries and fatalities and incorporates all mode injuries and fatalities, regardless of whether a motor vehicle is involved.
- Public health surveillance tracks utilization of all transportation modes (including multimodal trip making) in relation to chronic disease surveillance.

ATTENDS TO SOCIAL, HEALTH, AND ENVIRONMENTAL EQUITY CONSIDERATIONS

Government Leaders: ____ / ____

- Policies and plans exist to investigate social, health and environmental equity disparities.
- The evaluation and monitoring results from the implementation of policies and plans are inputs to subsequent policy and funding decisions.

Transportation Practitioners: ____ / ____

Analysis and reporting by different socio-demographic groups (e.g., income, age, gender, race, disability), travel modes, and at varying spatial scales are done for:

- The benefits and burdens of the impacts of proposed policies, plans and projects.
- Performance measures used to evaluate progress toward established goals.
- Consideration of health in policy, plan and project development extends beyond safety and accessibility consideration.
- Planning and building efforts prioritized in areas where the most health-disadvantaged populations reside and in areas with the fewest resources to promote active living.
- Consideration of accessibility extends beyond motor vehicle travel time to also include (a) affordability and convenience by all modes and (b) desirability of the destination as a health promoting service (e.g., access to schools, local services and amenities, including retail sources of healthy food options).

IMPLEMENTS HEALTHY DESIGN

Transportation Practitioners: ____ / ____

- Does the project design process include consideration of the needs of a comprehensive range of potential users (e.g., include people who are walking, biking, and using visual aids, wheelchairs, and other mobility aid), including placing more emphasis on vulnerable road users.
- Transportation projects that demonstrate a positive impact on health are highlighted and promoted.

Opportunities/projects are prioritized which:

- Reduce travel speeds (to reduce travel related injuries and fatalities).
- Improve travel conditions for active transportation (e.g., through the addition of crosswalks, sidewalks, trails, and bicycle infrastructure).
- Increase the safety and convenience of active transportation access to public transit.

COMMUNITY SCORECARD

INSTITUTIONAL CAPACITY AND CROSS-DISCIPLINE ENGAGEMENT

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

POLICY COMMITMENT

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

FUNDING

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

PLANNING

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

SOCIAL, HEALTH AND ENVIRONMENTAL EQUITY CONSIDERATIONS

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

ATTENDING TO EQUITY COMPONENTS

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%

IMPLEMENTS HEALTHY DESIGN

Government leaders: ___/___
 Transportation Practitioners: ___/___
 Public Health Practitioners: ___/___
 Academics: ___/___
 Total: ___/___ = ___%



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