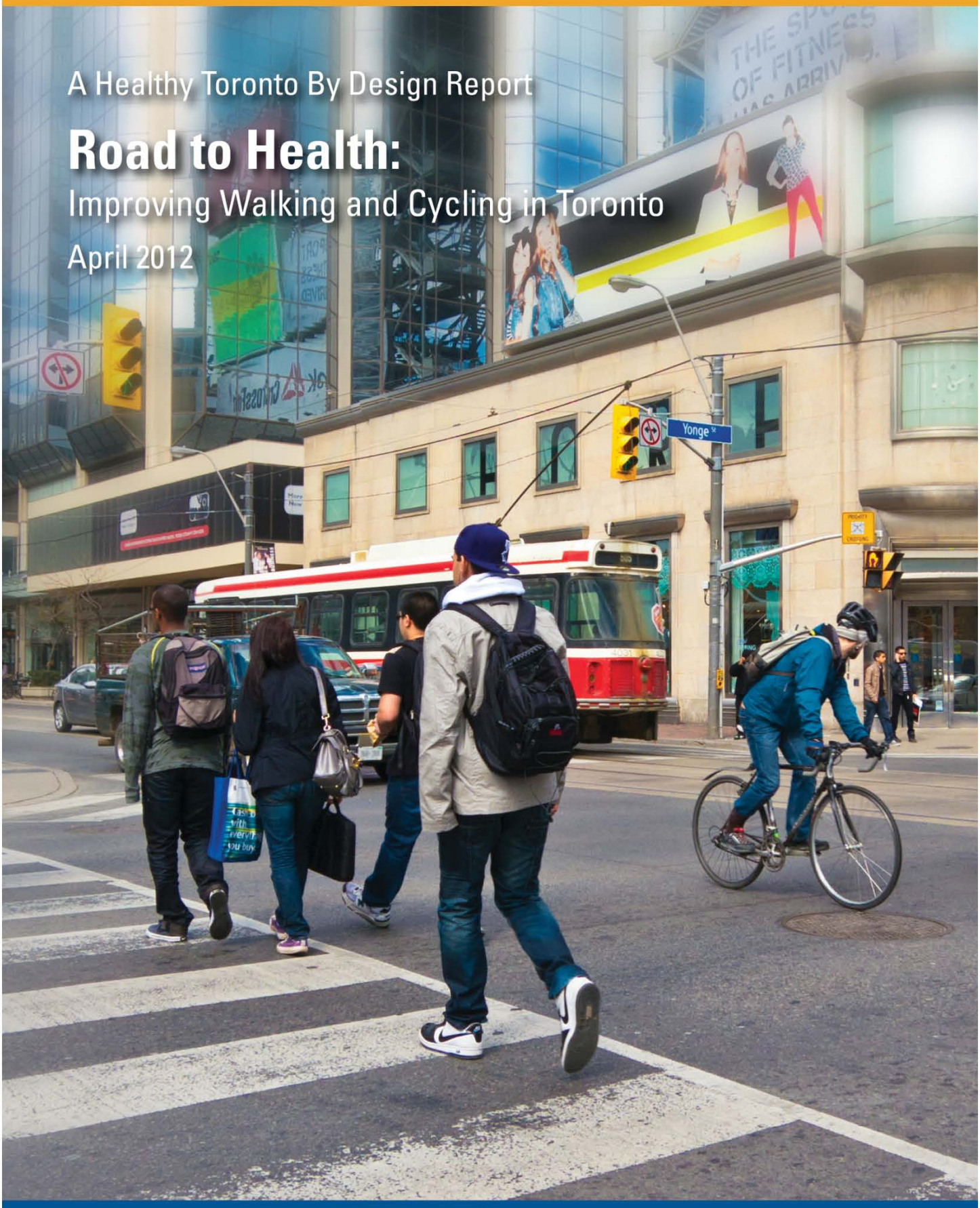

A Healthy Toronto By Design Report

Road to Health:

Improving Walking and Cycling in Toronto

April 2012

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About the Healthy Toronto By Design Report Series

Healthy Toronto By Design was released by Toronto Public Health in October 2011 and was the first in a series of reports on how local communities shape the health of their residents. The report noted that healthy cities are cities that are liveable, prosperous and sustainable. They are cities with high quality built and natural environments, public transit, housing, culture, education, food and health care. Healthy cities don't just happen. They result from creative vision, strategic decision-making and thoughtful implementation that respects the needs and challenges of all residents. They happen by design – through intentional investment and provision of infrastructure, programs and services with health in mind.

This report is one of a series which explore what makes a healthy city. Visit Toronto Public Health's website at http://www.toronto.ca/health for a list of reports in the series. Some of the topic areas in the series include the following:

- Road to Health – this report synthesizes evidence on health benefits and risks associated with walking, cycling and physical activity related to the use of public transit, as well as economic assessments and specific strategies to increase the use and safety of active transportation in Toronto.

- The Walkable City – this report summarizes the findings of a Residential Preferences Survey that gauges public demand for walkable versus more auto-oriented neighbourhoods, and links this information with travel choices, physical activity levels and body weight.

- Creating Healthy Built Environments – Highlights of Best Practices in Toronto – this report showcases examples of innovative practices and policies across city government in Toronto that promote healthy built environments.

- Enabling Healthier Neighbourhoods through Land Use Planning – this report synthesizes zoning barriers and opportunities to promote healthy neighbourhoods, particularly in clusters of residential apartment towers in low income areas and inner suburbs of Toronto.

- Health Impact Assessment Software Tool – a software tool has been developed to assist policy and decision-makers understand how different approaches to neighbourhood design might impact health-related outcomes such as physical activity levels, body weight and greenhouse gas emissions. A technical report synthesizes information on the development of the tool and results of pilot testing.

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Executive Summary

This report focuses on active transportation as a means to improve health and quality of life in Toronto. It reviews the literature on the health impacts of walking and cycling for transportation in urban areas, and also discusses the economic, social, environmental, and transportation system benefits. It presents data on walking and cycling mode shares in the City of Toronto and quantifies the health benefits of active transportation in Toronto. It also analyzes collision data and quantifies the costs of pedestrian and cyclist collisions and injuries in Toronto. Finally, it draws on secondary sources and interviews with municipal staff in other jurisdictions to identify strategies for increasing the safety and use of active transportation across Toronto. The report's conclusions are presented below.

Review of the benefits of active transportation

- Physical activity from active transportation has very important health benefits, including significantly reducing the risk of all-cause mortality, cardiovascular disease, obesity, type II diabetes, and certain types of cancer.
- Increasing the use of active transportation can also generate significant social, environmental, economic and transportation system benefits.
- In North America, users of active transportation generally face greater risks from traffic collisions than users of other modes (such as cars and transit). However, the health benefits experienced by individuals who increase their physical activity through the use of active transportation greatly outweigh the risks.
- Walking and cycling infrastructure investments are extremely cost-effective, even when considering the health benefits alone.
- Better design for active modes, such as walking and cycling, can greatly increase safety for all modes; increasing the proportion of trips made by walking and cycling can also independently lower collision and injury rates (the 'safety in numbers' effect).

The state of active transportation in Toronto

- Toronto's walking and cycling mode shares are increasing, though they continue to lag behind some leading North American cities.
- Surveys suggest that official mode shares understate the number of Torontonians for whom walking and cycling are important modes of transportation. However, it is difficult to determine how many, how often and how far Torontonians walk and cycle based on available data sources.
- Toronto's trip distances suggest that large increases in active transportation mode shares are potentially very feasible. About 55% of all trips in Toronto are less than 7 km, and are therefore very conducive to cycling. Over 20% of all trips are under 2 km and therefore very walkable.
- Of relevance to Toronto, cycling is almost as fast as driving for trips of 7 km in urban areas, and walking is generally as fast as driving for trips of 500 m and less.

Health benefits of active transportation in Toronto

- Higher levels of physical activity through increased cycling and walking can significantly reduce an individual's risk of a number of chronic diseases and prevent deaths. Based on very conservative calculations, 2006 levels of walking and cycling in Toronto are estimated to prevent about 120 deaths each year. Total savings from these prevented deaths range from $130 million to $478 million depending on how deaths are valued. Savings in direct medical costs arising from residents staying active by walking and cycling are estimated to provide a further economic benefit of $110 to $160 million.
- Achieving walking and cycling commuting mode shares of 12% and 6%, respectively, would prevent about 100 additional deaths each year, yielding additional annual benefits of $100 million to $400 million. These increases would bring Toronto to the walking and cycling mode shares in Vancouver and Portland, respectively, and are feasible based on the analysis of trip distances, recognizing that communities in Toronto with higher densities and infrastructure can achieve these increases sooner than others.
- The health benefits of active transportation are not evenly distributed across the city – geographically or socioeconomically. Levels of walking and cycling among residents of Toronto's core are over three times higher than among residents of the suburbs. Toronto's core is also more walkable and bikeable than the suburbs. Since many low-income and high-rise neighbourhoods are located in the suburbs, these patterns result in transportation and health inequality.

Collisions, injuries and fatalities in Toronto

- While collision rates for pedestrians and cyclists have declined over the last decade, Toronto is still less safe for pedestrians and cyclists than other Canadian cities.
- Collisions involving pedestrians and cyclists in Toronto cost over $60 million each year. By continuing to improve the safety of active transportation, Toronto could reduce collisions, injuries and fatalities, and generate significant economic benefits.
- Efforts to make walking and cycling safer can start by using collision analysis to identify specific issues and factors related to the frequency of conflicts, near misses and collisions among modes.
- In Toronto, collisions most frequently occur at intersections and on major arterial roads.
- In Toronto 30% of collisions happen mid-block (primarily related to collisions with car doors) and may be linked to inadequate separation of cyclists from motor vehicles.
- Elderly pedestrians are most likely to be killed in collisions with vehicles; children and residents of low-income neighbourhoods may also be particularly at risk of injury when walking and cycling. Speed increases the numbers of collisions, injuries and fatalities of pedestrians and cyclists.

Improving active transportation in Toronto

- Toronto has successfully implemented diverse initiatives that support active transportation, including the Green Standard and the Walking Strategy – both of

which won recognition from the Federation of Canadian Municipalities. In order to further improve active transportation and health, the City of Toronto must continue to make targeted efforts to increase safety for pedestrians and cyclists. The City must also continue to make walking and cycling more attractive and accessible to residents across the city.

  - Examples of interventions that have been proven to effectively reduce collision and injury rates for pedestrians and cyclists include: Traffic calming: individual physical interventions to reduce motor vehicle speeds, and area-wide speed reduction strategies.
  - Traffic signal phasing: leading pedestrian / bicycle phases, and pedestrian / bicycle-only phases.
  - Intersection improvements for pedestrians: curb bulbs, medians and improved marking and signage.
  - Intersection markings for cyclists: bicycle boxes, solid-line bike lanes approaching intersections, and lanes or markings through intersections.
  - Connected sidewalks and paths that buffer pedestrians from traffic.
  - Connected facilities that separate cyclists from traffic: separated bike lanes, buffered bike lanes, coloured bike lanes, and off-road bike paths.

- In some parts of Toronto, bicycle facilities are poorly connected and less separated from traffic than in other cities, and Torontonians have identified this as a key factor limiting their use of cycling for transportation. However, developing a viable bikeway network will likely require re-allocation of roadway space from motor vehicles to bicycles. Different strategies may also be needed in Toronto's core and in the suburbs, given the dramatically different land use patterns.
- Many options for improving safety require only road surface coatings or signs, and are relatively inexpensive to implement (e.g. new approaches to bike lanes at intersections). Other improvements may be more expensive, but are needed to keep Toronto on par with other leading cities in North America (e.g. separated bike lanes).
- In other cities, a number of other features in the built environment have also contributed to increases in mode share. These include:
  - Improvements to pavement quality and snow clearance
  - Short-cuts and direct walking and cycling routes
  - Showers and secure bicycle parking at trip destinations
  - Improvements to the convenience of active transportation-transit trips through station design, bicycle parking and signage
  - Streetscape and pathway improvements including lighting and pedestrian-friendly urban design.
- Land use patterns play a crucial role in enabling active transportation, since trip distance is often the limiting factor. In Toronto's re-developing areas, walking and cycling can be supported through mixed use, higher density development with high route connectivity.
- Marketing and education programs also play an important role in overcoming barriers to walking and cycling for transportation.

- Making active transportation accessible to residents of all ages, abilities and incomes may require targeted investments in walking and cycling facilities and programs. It also calls for the development of affordable housing in accessible locations.
- In other cities, interventions in the built environment and in marketing and education have most effectively generated rapid increases in active transportation safety and mode shares.

Facilitating effective action

- In cities including Montreal, Chicago and New York, new goals and targets for active transportation safety and/or mode shares have served as important stimuli for action.
- Toronto and other cities have also adopted policies and/or standards that ensure that walking and cycling are considered in land use, roadway and facility planning.
- Cities including Toronto and Vancouver have recognized the importance of improving the quality of data on walking and cycling.
- Cities including Portland have also adopted transportation planning tools that are specifically designed to assess latent demand for active transportation and to evaluate the need for improvements to walking and cycling environments.
- In a number of cities, public health departments are working closely with the transportation, planning and other municipal departments to achieve integrated, coordinated action on active transportation.
- Involving community stakeholders in planning and decision-making may help to generate widespread support for progressive actions.
- Many provincial, state and federal governments have developed programs to fund improvements in walking, cycling and public health, as the economic benefits of active transportation are shared across levels of government.

The City of Toronto has articulated a commitment to supporting safe active transportation and has made progress towards this objective. However, Toronto's walking and cycling safety, infrastructure and mode shares lag behind other leading North American cities. Toronto should continue to use best practices and benchmark other leading cities that have successfully improved quality of life by enabling safe active transportation.

Introduction: The critical nexus of transportation and health

Transportation and public health have historically been addressed separately by planners and policymakers in Canada. However, it is now recognized that current land use planning and automobile-oriented transportation systems are closely linked to Canadians' low levels of daily physical activity (Canadian Institute for Health Information 2006). Physical inactivity and obesity are in turn generating increased levels of chronic disease, rising healthcare costs and reduced quality of life.

These problems are particularly notable in Toronto, where only 42% of adults are physically active in their leisure-time (Toronto Public Health, 2011). Adults in Toronto aged 20 or older have the second lowest levels of physical activity compared to adults surveyed in 35 other health units throughout Ontario (Ontario Ministry of Health and Long-Term Care 2009). Furthermore, 4 in 10 adults and 22% of adolescents aged 12 to 17 are overweight or obese. Inactivity and obesity are also contributing to increasing levels of chronic disease in Toronto. Overall, 29% of Torontonians have been diagnosed with major chronic conditions, up from 23% in 2001 (Toronto Public Health 2010).

In response to these issues, public health practitioners, urban planners and transportation engineers across Canada are working together to design healthier cities and transportation systems. In particular, the City of Toronto has affirmed its commitment to the goal of healthy, sustainable land use and transportation planning in its Official Plan (City of Toronto 2010a). This report, *Active transportation and health in Toronto,* addresses the goal of creating a healthy city, focusing on active transportation as a means to improve health and quality of life in Toronto.

Active transportation refers to any form of human-powered transportation including walking, cycling, using a wheelchair, or skateboarding (Public Health Agency of Canada 2010). Toronto's Official Plan specifically highlights walking and cycling as a key element of the City's vision of creating an attractive and safe city that evokes pride, passion and a sense of belonging. The Official Plan also emphasizes the importance of walking and cycling in all parts of the city, including employment districts, avenues, centres, and regeneration areas.

The objectives of this report, *Active transportation and health in Toronto,* include:

- To present research evidence on the health impacts of walking and cycling for transportation in urban areas.
- To investigate the health benefits and risks of walking and cycling in the City of Toronto.
- To identify strategies for improving public health by increasing the safety and use of active transportation across Toronto.

The report focuses on walking and cycling, including to and from transit. It also addresses the aspects of land use and transportation planning that enables or hinders safe active transportation. It draws on primary data analysis, the review of secondary sources, and interviews with municipal transportation and public health staff in other jurisdictions. The report is structured as follows:

- Chapter 1 reviews the literature on the benefits of walking and cycling for transportation, focusing on health benefits.
- Chapter 2 explores the current state of walking and cycling in Toronto and estimates the economic value of current and potential future levels of walking and cycling in Toronto.
- Chapter 3 investigates collisions, injuries and fatalities involving users of active transportation in Toronto, and estimates the costs of these collisions.
- Chapter 4 explores the distribution of health benefits and risks across the City of Toronto.
- Chapter 5 highlights actions to increase walking and cycling safety and mode shares, in order to improve public health in Toronto.
- Chapter 6 identifies strategies to facilitate implementation of these actions.

Chapter1. Active transportation: A review of the evidence

This chapter reviews the literature on the benefits of walking and cycling for transportation and their relevance to Toronto, with a focus on health benefits. It presents evidence on the significant health benefits experienced by individuals who increase their physical activity through the use of active transportation. It also discusses the population-level benefits of increases in physical activity and potential reductions in motor vehicle traffic. The chapter compares the health risks and benefits of active transportation and explores the cost-effectiveness of investing in active transportation. Finally, it discusses the important social, economic, environmental and transportation system benefits of active transportation.

Active transportation as a source of physical activity

Physical activity is a critical part of staying healthy, and active transportation can help individuals meet the recommended levels of physical activity. The Canadian Physical Activity Guidelines recommend that all adults aged 18 and over obtain 150 minutes of moderate to vigorous physical activity each week, in bouts of at least 10 minutes. This corresponds to 30 minutes of physical activity (a 2 km walking trip or a 7.5 km biking trip), 5 days per week.

The Canadian Physical Activity Guidelines highlight that children aged 5-11 and youth aged 12-17 years need more physical activity than adults. The Guidelines recommend a minimum of 60 minutes of moderate- to vigorous-intensity activity per day. Walking and cycling to and from school can help children reach these levels, and may help to establish active lifestyle habits (Telama *et al.* 2005).

People who commute by active modes (e.g. walking or biking) get more physical activity than those who commute by inactive modes (e.g. driving) (Oja *et al.* 1998). Walking to and from public transit has also been identified as an important source of physical activity. Data from a study in the United States (Edwards 2008) indicates that public transit users walk 8.3 more minutes per day, on average, than non-users.

Research indicates that it is also easier to maintain physical activity levels through activities that are incorporated into daily life – such as walking, cycling or using stairs –than through activities that require a gym or recreation centre. “Lifestyle” physical activity interventions that are not “facility-dependent” are more likely to produce longer-term increases in activity levels (Hillsdon and Thorogood 1996, Dunn *et al.* 1998).

Active transportation may be a particularly important source of physical activity in the City of Toronto, where leisure-time physical activity levels are among the lowest in Ontario (Ontario Ministry of Health and Long-Term Care 2009). In the City of Toronto, only 43% of residents were moderately active or active in their leisure time in 2007[1] – below the Ontario average of 50%. A startling 93% of Toronto youth are not meeting the recommended daily requirements needed to derive health benefits from physical activity (Get Active Toronto 2011). Walking and cycling for transportation may enable Torontonians of all ages to get active and stay active without giving up other aspects of their busy lives.

[1] The Physical Activity Index estimates the age-standardized proportion of the population 12 years and older that is active or moderately active in their leisure time physical activity.

Individual health benefits of physical activity from active transportation

By increasing their use of walking and cycling for transportation, individuals can significantly reduce their risk of a number of chronic diseases. These improvements in health translate to reductions in the risk of all-cause mortality, and to reduced societal costs of illness and disease. The health benefits of physical activity from active transportation are summarized in **Figure 2** at the end of the section.

Increased fitness and reduced obesity

Walking and cycling for transportation are as effective as traditional structured exercise programs in improving physical activity, cardio-respiratory fitness and blood pressure (Dunn *et al.* 1999). Individuals who begin to use active transportation experience improvements in heart rate, lung capacity and metabolic health (Oja *et al.* 1998, Gordon-Larsen *et al.* 2009).

People who use active transportation are also at a reduced risk of being obese, as walking and cycling can improve energy balance and body composition (Murphy *et al*. 2007, McAuley *et al*. 2000). One US study found that men who walk or cycle to work were half as likely to be obese (Gordon-Larsen *et al.* 2009). Another US study found that every additional kilometre walked per day is associated with a 4.8% reduction in obesity. In contrast, every additional hour spent in a car each day is associated with a 6% increase in the likelihood of obesity (Frank *et al.* 2004).

According to Basset *et al.* (2008), at the population level, countries with higher rates of active transportation and transit use have lower obesity rates, as illustrated in **Figure 1**.

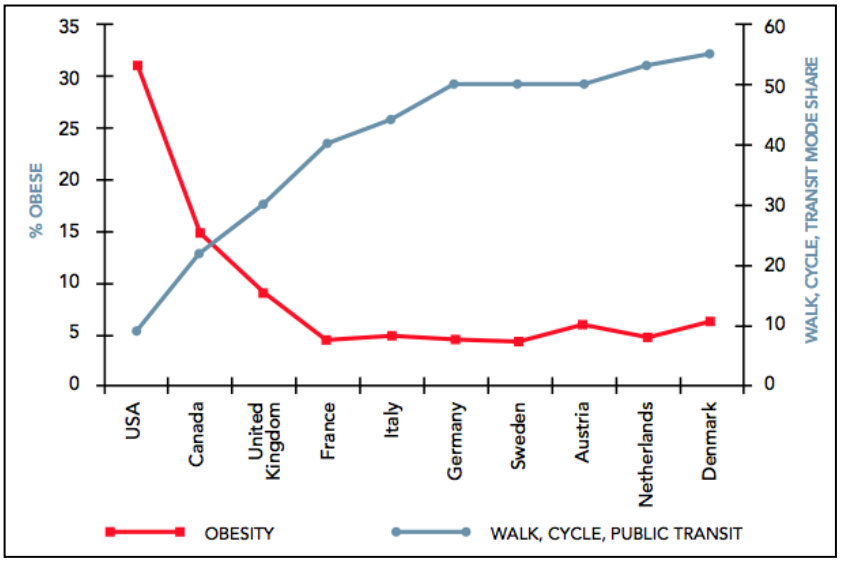


Figure 1: Population-level relationship between obesity and combined walking, cycling, and transit mode share

Source: Transport Canada (2010), data from Basset et al. (2008)

In Toronto, over 40% of adults and 22% of adolescents are overweight or obese (Toronto Public Health 2010). Increasing the active transportation mode share could help to improve physical fitness and reduce the proportion of Torontonians who are overweight or obese.

Reduced risk of cardiovascular disease, diabetes, stroke and cancer

Active transportation reduces the risk of cardiovascular disease, including mortality, incident coronary heart disease, stroke, hypertension and diabetes. A meta-analysis concluded that active commuting is associated with an 11% reduction in cardiovascular risk (Hamer and Chida 2008a). High levels of walking for transportation have been associated with a 31% decrease in the risk of cardiovascular disease (Hamer and Chida 2008b).

There is strong evidence for the role of physical activity and active commuting in the prevention of Type II diabetes (Kesaniemi *et al.* 2001, Hu *et al.* 2003). Evidence from case-control and prospective studies also suggest that physical activity can reduce the incidence of stroke, though the evidence for this association is not as strong as for cardiovascular disease (Cavill *et al.* 2007).

Finally, physical activity has been found to reduce the overall risk of cancer, with particularly strong evidence related to colon cancer and breast cancer (Thune and Furberg 2001). Physical activity has been found to reduce the overall relative risk of colon cancer by 24% (Wolin *et al.* 2009). Active commuting in particular has also been associated with significant reductions in the risk of breast cancer (Hou *et al.* 2004).

Reductions in cardiovascular disease, diabetes, stroke and cancer are important for the City of Toronto, given the increasing rates of chronic disease. Rates of self-reported diabetes doubled from 4% to approximately 8% between 2001 and 2008 among Torontonians 12 and older, while high blood pressure increased from 12% to 15%. Circulatory diseases are responsible for more than 1 in 4 deaths in Toronto each year; breast and colorectal cancers alone are responsible for over 5% of deaths in Toronto (Statistics Canada 2011).

Improved mental health

Physical activity has a demonstrated positive effect on a range of mental illnesses. Physical activity has also been found to reduce the symptoms of depression, anxiety and panic disorders, with beneficial effect equal to meditation or relaxation (Paluska and Schwenk 2000). One study demonstrated that walking in particular can reduce anxiety and depressive symptoms in older women, and that walking was as effective as other forms of physical activity in reducing anxiety and depression (Heesch *et al.* 2010).

Research also suggests that physical activity can improve mental health in people without specific disorders. There is evidence that increasing physical activity can improve multidimensional self-esteem (McAuley *et al.* 2000), improve mood, reduce stress (Fox 1999 and Taylor 2000), and enhance perceptions of happiness and satisfaction (Taylor 2000).

In Toronto, 26.5% of the population aged 15 and over reported that most days in their life were quite stressful or extremely stressful (Statistics Canada 2011). Active transportation's contributions to stress reduction may thus prove valuable to many Torontonians.

Reduced risk of all-cause mortality

Physical activity from active transportation is associated with lower mortality. In a meta-analysis of 80 large cohort studies, people who received 150 minutes of moderate to vigorous activity per week have a 14% reduction in mortality, while people who received 300 minutes of physical activity experienced a 26% reduction in mortality. The highest levels of *active commuting* were associated with a 12% decrease in mortality as compared to the lowest levels (Samitz *et al.* 2011).

The benefits of physical activity are stronger for people moving from no activity to low activity; the incremental benefit is less when an already active person becomes more active (Woodcock *et al.* 2011).

Population health benefits of physical activity from active transportation

Reduced medical costs

There is strong evidence that reducing physical inactivity yields substantial health care cost savings. A US study found that inactive individuals incur over $600 in additional health care costs per year as compared to active individuals (Pratt *et al.* 2000). Another US study concluded that taking public transit is associated with walking 8.3 more minutes per day on average, which could save $5,500 per person in net present value by reducing long-term obesity-related medical costs (Edwards 2008).

A Canadian study calculated that physical inactivity alone is directly associated with $1.6 billion in annual health care costs in Canada, or 1.5% of all Canadian health care costs (Katzmarzyk and Janssen 2004). Each additional 10% increase in physical activity in Canada would translate to annual direct health care savings of up to $150 million (Katzmarzyk *et al.* 2000).

Reduced work absenteeism

Research on the relationship between increased physical activity and reduced work absenteeism is limited but rapidly growing. A study of cycling and absenteeism among over one thousand Dutch employees found that, on average, people who cycled to work were absent 1 day less than non-cyclists over a one-year period (Hendriksen *et al.* 2010). A dose-response relationship was observed, with further reductions in absenteeism among people who cycled at least 5 km more than three times a week (Hendriksen *et al.* 2010). The study controlled for other differences between cyclists and non-cyclists. There is also evidence from workplace intervention programs that increased levels of physical activity will reduce absenteeism (Davis and Jones 2007).

Across Canada, physical inactivity is estimated to cost $3.7 billion in economic productivity loss, due to its role in coronary artery disease, stroke, hypertension, colon cancer, breast cancer, type II diabetes and osteoporosis. Together, inactivity and obesity are estimated to account for $6.4 billion in lost economic output due to short- and long-term disability and premature death (Katzmarzyk and Janssen 2004).

Figure 2: Overview of health benefits of increased physical activity from active transportation

Population health benefits of reduced motor vehicle travel

Increasing the use of active transportation can indirectly improve population-level health by reducing motor vehicle travel and the associated health impacts. These health benefits are summarized in **Figure 3** at the end of the section.

Reduced air and noise pollution

Replacing car trips with walking and cycling trips can reduce air pollution and generate significant health benefits. One study modeled the air quality effects of eliminating automobile round trips of 8 km and shorter and replacing 50% of them with bicycle trips in 11 metropolitan areas in the Upper Midwestern US. They estimated net health benefits from reduced urban particulate matter (PM 2.5) and ozone to be $3.5 billion per year **(**Grabow *et al.* 2011).

Exposure to air pollution from vehicles increases the risk of all-cause mortality at the population level (Hoek *et al.* 2002, Pope *et al.* 2002). Traffic-related air pollution is also associated with chronic respiratory conditions (e.g. chronic obstructive pulmonary disease) and acute respiratory effects. Finally, there is evidence that traffic-related pollutants are linked to cardiovascular disease, lung cancer, and increased risk of adverse pregnancy outcomes (Toronto Public Health 2007).

Noise pollution from traffic may also have negative health impacts that can be reduced through a shift to active transportation. These impacts include hearing impairment, sleep disturbance, impaired task performance, and impaired childhood development (Berglund *et al.* 1999, Stansfeld and Matheson 2003).

Air pollution from traffic is a major public health concern in Canada's urban centres, including Toronto. The Ontario Medical Association (2005) estimated that provincial costs associated with air pollution exposure were $7.8 billion in 2005. In the City of Toronto, traffic-related pollution was estimated to cause 440 premature deaths, 200,000 restricted activity person-days and 1,700 hospitalizations per year in 2007. Mortality costs alone were valued at $2.2 billion (Toronto Public Health 2007).

Increasing the mode share of active transportation may help Toronto to reduce these health costs of motor vehicle travel. It may also help the City to achieve its goal of reducing locally generated smog causing pollutants by 20% below 2004 levels (City of Toronto 2007).

Reduced traffic accident rates

Reducing the total automobile travel could also reduce motor-vehicle collisions, and the associated health costs. Automobile accidents take a heavy toll on human life and health in Canada. In 2009, they resulted in over 2,000 deaths and 172,000 injuries, 11,000 of them serious injuries (Transport Canada 2009). Motor vehicle collisions are a leading cause of death for young people, accounting for 70% of all accidental deaths in the 15 to 24 age group.

In Toronto, motor vehicle collisions resulted in over 18,000 injuries and over 40 fatalities in 2010. Toronto's injury rates as a result of motor vehicle collisions are significantly higher than in most other major Canadian cities. They are more than double those of Montreal, Calgary and Vancouver (City of Toronto Traffic Safety Unit 2012). Toronto has much to gain from reducing motor vehicle use and the associated burden of collisions, injuries and fatalities.

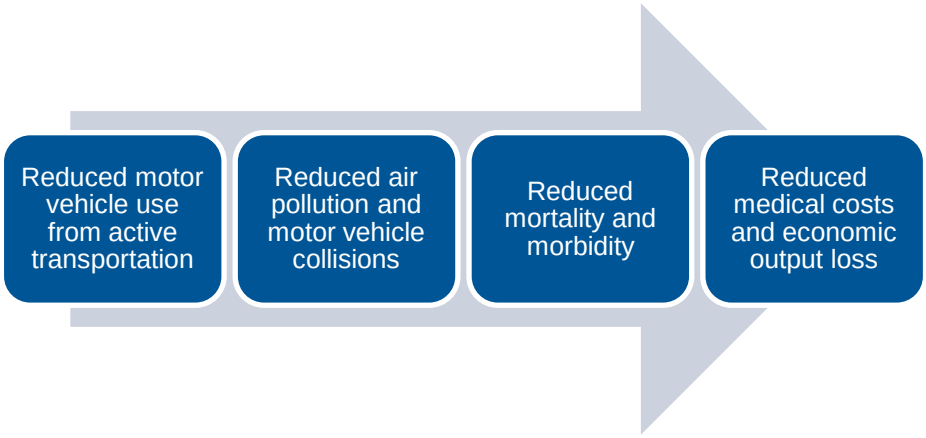


Figure 3: Overview of health benefits of reduced motor vehicle use from active transportation

Comparing health benefits, risks and costs

Research consistently concludes that the health benefits of active transportation dramatically outweigh the health risks, and that investments in walking and cycling infrastructure are extremely cost-effective.

Health risks of active transportation

In North America, individuals who walk and cycle face a higher risk of traffic injuries. Pedestrians and cyclists are more likely to be killed or injured than car and public transit users, by either per trip or per kilometre measures, in proportion to the number of pedestrians and cyclists on the road (Pucher and Dijikstra 2003; Elvik 2009).

However, these high injury and fatality rates are closely tied to walking and cycling conditions in North America. For example, cyclists in North America are twice as likely to be killed and eight times more likely to be seriously injured than cyclists in Germany, North American cyclists are three times as likely to be killed and 30 times as likely to suffer serious injuries than cyclists in the Netherlands (Pucher and Dijkstra 2003).

Air pollution exposure may also be higher for active commuters, though this remains a subject of debate (Thai *et al.* 2008, de Nazelle *et al.* 2009, Hertel *et al.* 2008). Several studies have found that air pollution exposure levels are lower for active transportation users as compared to inside motor vehicles or buses (e.g. Zuurbier *et al.*, 2010; Kaur *et al.* 2007). Other studies have found that active transportation users have higher air pollution exposure due to longer travel times and higher breathing rates (e.g. Briggs *et al.* 2008).

Health benefits versus risks

Studies conclude that the health benefits of shifting to active transportation outweigh the health risks – by at least a 15:1 ratio. For example, de Hartog (2010) estimated that individuals who shift from cars to bicycles gain 3-14 months of life thanks to the beneficial effects of increased physical activity. They may lose 0.8 to 40 days due to the mortality effect of increased inhaled air pollution doses, and 5 to 9 days due to the increased risk of traffic accidents. This corresponds to more than a 15:1 health benefit to risk ratio.

Rojas-Rueda *et al.* (2011) calculated the net reductions in all-cause mortality that results from participating in Bicing (a bicycle sharing initiative) in Barcelona, Spain. Overall, the 181,982 users resulted in 12.3 avoided deaths per year. Increased physical activity was associated with 12.5 deaths avoided, while increased traffic accidents and air pollution exposure were associated with 0.03 and 0.13 additional deaths, respectively. This leads to more than a 60:1 benefit-risk ratio.

Health benefits versus infrastructure costs

Walking and cycling infrastructure investments are extremely cost-effective – even when only considering the health benefits. In a review of 16 economic analyses of the health-related impact of interventions to increase walking and cycling, the median health benefit to cost ratio was 5:1 (Cavill *et al.* 2009). The five studies deemed highest quality by the authors yielded cost-benefit ratios from ~3:1 to ~14:1, as they included different benefits, costs, timeframes and methodologies to assess benefits and risks.

These ratios increase further when also considering benefits that are not health-related. An analysis by the Sustainable Development Commission (2011) highlights benefit-cost ratios of 18:1 to 38:1 for small-scale cycling schemes using the UK NATA framework for benefit-cost analysis. Major cycling infrastructure projects are pegged at 11:1, while local highway road schemes have benefit-cost ratios of 4:1 or 5:1. The NATA framework monetizes costs and benefits related to: changes in journey time, travel costs, accidents, noise and greenhouse gas emissions (UK Department for Transport 2011).

The high benefits to cost ratios enable the achievement of high mode shares without excessive costs. In Portland where the cycling mode share is between 3% and 7%, bike facilities comprised less than one percent of Portland's capital expenditures for transportation from 2001 to 2007 (Wallasper 2010).

Transportation system benefits

Many people walk and cycle because it makes practical sense from a traditional transportation point of view. For example, in Copenhagen where the mode share for walking, cycling and transit is 74%, 83% of cyclists say it is faster or more convenient than alternative modes (New York City Global Partners 2011). In Europe, walking is faster than driving for urban trips up to 0.5 km in length. **Figure 4** illustrates the time required for trips of different

lengths, using different modes of travel. This data is based on travel in urban areas in Europe. It demonstrates that walking and cycling are very fast modes of transportation for short trips in urban areas. This is in part due to the time required before beginning trips by car, bus or train. For example, **Figure 4** suggests that it takes about 4 minutes to unlock, turn on a car and leave a parking spot, even for a trip of only 0.1 km.

Figure 4 indicates that cycling is the fastest mode of transportation for urban trips of 5 km or less. Even for trips of 7 km in urban areas, cycling is almost as fast as driving, and is faster than other modes of transportation. Walking is generally as fast as driving for trips of about 500 m and less, and is faster than travel by bus for trips of up to 1.5 km.

Trip times using different modes undoubtedly vary by city and by time of day. Given Toronto's increasing levels of congestion, the general trends illustrated in**Figure 4** are highly relevant to Toronto – particularly during peak hours.

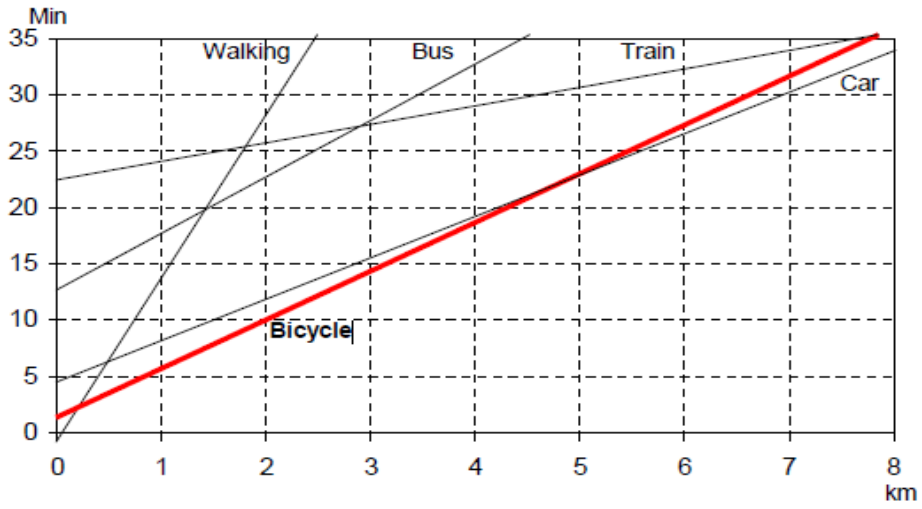


Figure 4: Comparing the speed of different travel modes for different trip distances*

***Source**: Dekoster and Schollaert (1999)*

*The modes depicted in the figure do not all start at 0 minutes because of the time required at the "start-up" of some of the modes. For example, train trips require ~22 minutes to arrive at the station, purchase a ticket and board the train. Alternatively, there is no "start-up time" for walking, which starts at 0.

Investing in active transportation and public transport can also help to reduce congestion, reduce delays from collisions, reduce the unreliability of travel time, reduce fuel and transport costs and improve residents' ability to access facilities and services (Mohan 2010).

The benefits to individual travelers and to the transportation system as a whole are particularly relevant to Toronto. Seventy percent of Toronto commuters use cars, fuelling consistent traffic congestion in and around the city and metro area (Statistics Canada 2011). An Organization for Economic Co-operation and Development report estimated that traffic jams cost Toronto $3.3 billion per year (OECD 2010). Recent reports by the Toronto Board of Trade also highlight transportation as a major factor limiting prosperity in Toronto. In the Board's *Scorecard on Prosperity,* Toronto was ranked last for commute times and 19th of 23 global cities on transportation (Toronto Board of Trade 2011a, 2011b).

The strain on Toronto's transportation systems will only increase, as population and employment in the Greater Toronto and Hamilton Area are expected to grow by 50% between 2001 and 2031 (Ontario Ministry of Public Infrastructure Renewal 2006). As a growth centre, the City of Toronto will be home to more people, more jobs, and more trips of all kinds. Models from the University of Toronto Cities Centre show that travel times for all trips will nearly double by 2031, while speeds on highways and arterial roads will drop by about 20 per cent (Kalinowski 2011a). According to Metrolinx, the regional transportation agency for the Greater Toronto Area, active transportation has an important role to play in the transition to a more effective, sustainable transportation system (Metrolinx 2008).

Social, economic, and environmental benefits

Active transportation also yields benefits not directly related to health or transportation.

Increased neighbourhood safety, social benefits and real estate value

Active transportation as an alternative to car travel is associated with a number of social benefits, including increased social interaction, social networks and social capital (Leyden 2003). Residents of neighbourhoods that are pedestrian-oriented are more likely to feel a stronger sense of community than residents of automobile-oriented neighbourhoods (Lund 2002). Research shows a strong association between the sense of belonging to a community and physical and mental health (Statistics Canada 2011).

Increasing the mode share of walking and cycling may also contribute to reduced crime. Liggett *et al.*'s (2001) analysis of bus stop crime in Los Angeles found that bus stops with more pedestrians and higher visibility had reduced crime rates. Neighbourhoods with strong social networks have also been associated with lower crime rates (Bellair 1997).

Finally, improving the walking environment can increase economic value of local properties. Homes within walking distance of schools, parks and shopping sell for more in the United States (Cortright 2009). Improvements to the walking environment in the UK have been associated with increases in sale and rental prices of both residential and commercial properties (University of the West of England and Cavill Associates 2008).

In Toronto, only 66% of adults report a strong sense of belonging to their local community (Statistics Canada 2011). Developing walkable and bikeable neighbourhoods and communities may help to fulfill Toronto's vision of "creating an attractive and safe city that evokes pride, passion and a sense of belonging", stated in the Official Plan (City of Toronto 2010a).

Local economic activity and job creation

A number of reports demonstrate that cycling generates significant economic activity. In Portland, bicycling now accounts for $100 million in local economic activity each year, and is directly responsible for almost 1000 jobs in the region (Cortright 2007). A similar study in Wisconsin found that cycling generates $1.5 billion for the state economy (Wallasper 2010). In the UK, the "gross cycling product" is estimated at $4.6 billion CAD, with 23,000 people directly employed in the cycling economy (Grous 2011).

There are also ways in which active transportation generates "net" economic benefits – economic activity that would not have otherwise occurred. For example, cycling expenditures are more likely to remain within the local economy rather than going almost directly to companies out of the city or province (as do expenditures on gasoline). Cortright (2007)

concludes that Portland keeps $800 million that would drain out-of-town if local residents drove cars at the same rate as an average U.S. city. By spending less money on gasoline, a higher proportion of Portlanders' expenditures on goods and services are likely to remain in the local economy (Cortright 2007).

Walking and cycling investments that generate new tourism also generate a net economic benefit for the local economy. North Carolina's Outer Banks draw an estimated 680,000 visiting bicyclists each year and support 1,400 jobs in the area (Lawrie *et al.* 2004). Finally, research indicates that investments in cycling infrastructure generate more jobs per dollar spent than investments in road-only infrastructure. Cycling projects create a total of 11.4 local jobs for each $1 million spent. Pedestrian-only projects create about 10 jobs per $1 million and road-only projects create 9.6 jobs per $1 million (Garrett-Peltier 2011).

Supporting active transportation is clearly well-aligned with Toronto's Official Plan vision of a city with a "a strong and competitive economy with a vital downtown that creates and sustains well-paid, stable, safe and fulfilling employment opportunities for all Torontonians" (City of Toronto 2010a). Promoting active transportation is also aligned with the 2007 "green" economic development strategy that encourages the retention, growth and attraction of companies or organizations whose products and/or services directly or indirectly reduce the impact on the environment (City of Toronto Economic Development, Culture and Tourism 2007).

Reduced greenhouse gas emissions

Investing in active transportation may be a particularly cost-effective way of reducing greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) suggests that packages of walkways, bikeways and bus/rapid transit could reduce greenhouse gas emissions from light-duty vehicles by 25% at a cost of only US$33 per tonne of CO_2 equivalent (WHO 2011a). By comparison, the IPCC estimates that reductions from high-efficiency vehicles would cost less than US$110 per tonne of CO_2 equivalent (WHO 2011a).

One review of measures to promote active transportation found that between 17 and 57 kg of CO_2 equivalent could be saved per person walking to work and school; and 183 kg could be saved through personalized travel plans (Mohan 2010). The Bicing scheme in Barcelona is estimated to have reduced greenhouse gas emissions by 9 million kg of CO_2 equivalent, or just less than 1% of the annual emissions from motor vehicles (Rojas Rueda *et al.* 2011).

Toronto has an ambitious greenhouse gas reduction target within its 2007 *Climate Change, Clean Air and Sustainable Energy Action Plan*. The City is aiming to reduce greenhouse gas emissions to 80% below 1990 levels of 22 million tonnes per year, by 2050. The plan reported that approximately one-third of the locally generated greenhouse gases and a significant portion of smog causing pollutants come from the operation of motor vehicles and recommended creation of a long-term vision of a sustainable transportation system to decrease emissions.

Chapter 1 Findings

- **Increasing the use of walking and cycling for transportation generates significant health benefits for individual users, and at the population level.**
- **The health benefits of walking and cycling significantly outweigh the risks.**
- **Better design for active modes can greatly increase safety; increasing the proportion of trips made**
- **by walking and cycling can also independently lower collision and injury rates.**
- **Increasing the use of active transportation can also generate important social, economic and environmental benefits.**
- **Investments in walking and cycling tend to be extremely cost-effective.**

Chapter 2. Active transportation in Toronto

This chapter discusses recent increases in city-wide levels of walking and cycling in Toronto. It also quantifies the health benefits of current levels of walking and cycling. Despite the assumptions and estimations required, this economic assessment clearly demonstrates that active transportation generates important health benefits – benefits that are rarely considered in transportation planning and decision-making. Finally, it identifies the opportunity to significantly increase walking and cycling mode shares[2], and quantifies the potential benefits of these increases in active transportation.

Walking and cycling in the City of Toronto

Based on the 2006 census, 7.1% of Torontonians walk to work, and 1.7% cycle to work, leading to a combined active commuting mode share of 8.8%[3]. The 2006 Transportation Tomorrow Survey (TTS) indicates that 7.1% of trips for all purposes are made by walking, and 1.1% is made by cycling, leading to a combined mode share of 8.2%. The overall TTS mode shares for all trips made by City of Toronto residents are illustrated below (**Figure 5**).

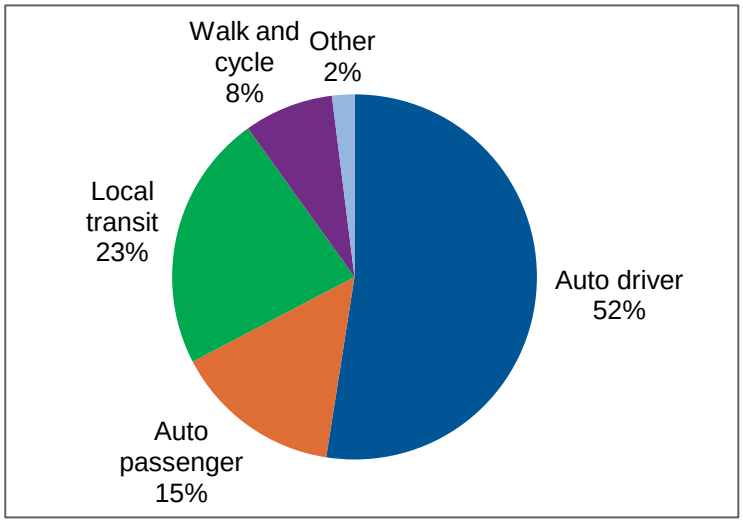


Figure 5: Mode shares for all trips made by Toronto residents
Data: TTS 2006 from University of Toronto Data Management Group (DMG 2008)

These census and TTS mode shares under-represent the importance of walking and cycling to Torontonians. First, walking and cycling trips for shopping and leisure activities are not included in the TTS, while trips for these purposes using other modes are counted. Furthermore, many Torontonians walk or cycle only in good weather, only to destinations other than to work or school, or only in combination with transit.

- **31% of Torontonians** report walking to work, school, shopping or leisure activities, as their main mode of choice (Harris-Decima 2008).

[2] Mode share describes the percentage of travelers using a particular type (mode) of transportation.

- **92% of Toronto public transit users** report walking to their transit stop, on average a 5 minute walk (Harris-Decima 2008).
- **29% of Torontonians** report cycling to work, school, shopping or other destinations in good weather – an increase from 20% in 1999 (Ipsos-Reid 2009).
- The 2010 downtown bicycle screenline count suggests that **approximately 48,000 Torontonians** cycle for transportation each weekday in the summer – more than twice the number of cycle commuters in the 2006 census.[4]

City-wide statistics also disguise dramatic differences in levels of walking and cycling among residents of different neighbourhoods. As discussed in Chapter 4, among residents of some neighbourhoods in the Toronto core, over 25% of all trips are made using active transportation (DMG 2008).

Overall, increasing numbers of Torontonians of all ages are walking and cycling for transportation. Between 2001 and 2006, there was an 11% increase in the mode share for walking to work, and a 31% increase in the cycle commuting mode share based on census data (**Figure 6**). Between 1999 and 2009, there was a 20% increase in the number of Torontonians who reported cycling for transportation in the Toronto Bicycle Survey (Ipsos-Reid 2009).

Finally, increasing numbers of older adults are cycling for transportation, demonstrating the viability of this mode for Torontonians of all ages. Between 2001 and 2006, there was a 69% increase in cyclists aged 45-54, a 110% increase in cyclists aged 55-64, and a 55% increase in cyclists aged 65+ (City of Toronto Transportation Services 2011a).

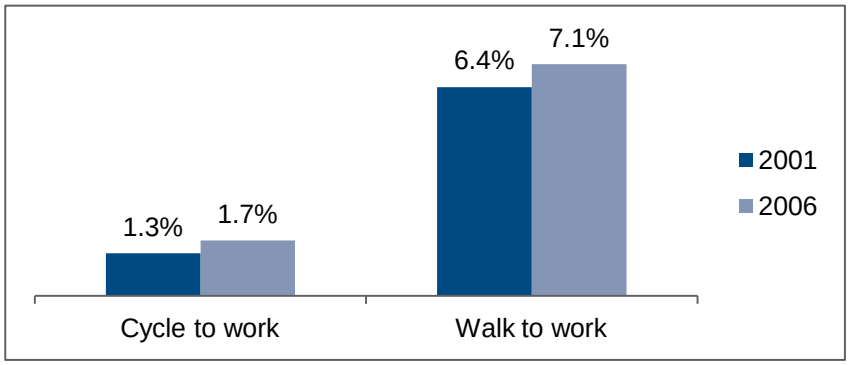


Figure 6: Active transportation mode shares, 2001 & 2006
Data: City of Toronto Transportation Services 2011a

Despite these increases, Toronto's active commuting mode shares lag behind those of many other leading North American cities (**Figure 7**). Of these cities, Portland has the highest mode

[4] In the downtown bicycle screenline count in September 2010, 19,162 cyclists entered the downtown area between 7am and 7pm. The TTS suggests that trips in the downtown area account for just fewer than 40% of all trips across the City of Toronto. One would therefore expect that in September 2010, 48,600 cyclists were cycling across the City. Note this estimation may under-represent the numbers of trips as the count does not include trips started and ended within the downtown area.

share for cycling (5.8%) while Vancouver has the highest mode share for walking (12.3%) and for combined walking and cycling (16.0%).

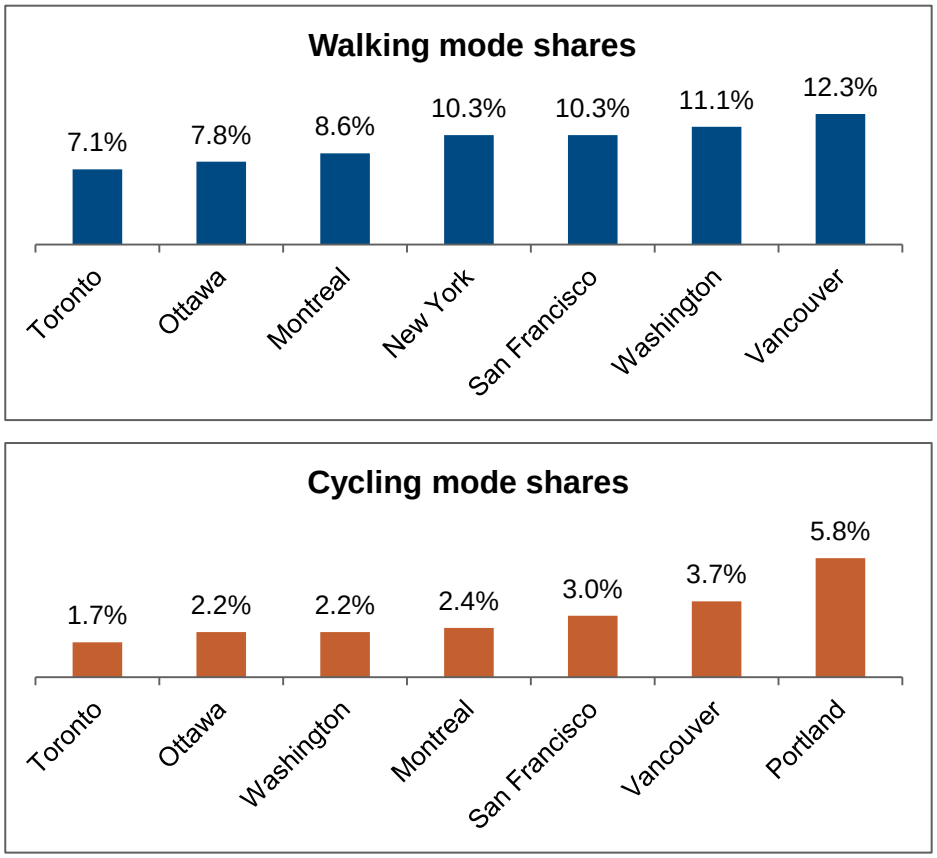


Figure 7: Active commuting mode shares of North American cities
Data: Pucher and Buehler 2011, TransportPolitic 2011

Toronto's trip distances suggest that there is significant potential to increase the active transportation mode shares to the levels observed in other North American cities. 21% of all trips made by City of Toronto residents are under 2 km and therefore very walkable. An additional 34% of all trips are 7 km or under, and therefore very bikeable (**Figure 8**). These data include one-way trips made by Toronto residents using all modes of travel, for all purposes. Therefore, at least 55% of all trips could be made using active transportation, recognizing that communities in Toronto with higher densities and infrastructure can achieve these higher modal shares for active transportation sooner than others.

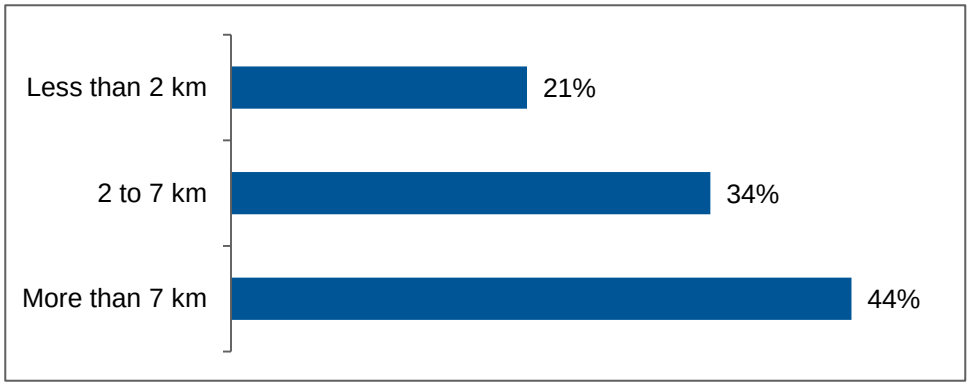


Figure 8: Distances of all trips made by City of Toronto residents
Data: 2006 TTS from DMG 2008

Quantifying the health benefits of active transportation in Toronto

In this report, we generate conservative estimates of the health benefits of walking and cycling in Toronto. We quantify only the benefits of reductions in mortality in the Toronto population due to increased physical activity from walking and cycling, using the World Health Organization's (WHO) Health Economic Assessment Tools (HEAT).

Estimating reduced mortality

The WHO tools (*HEAT for Walking* and *HEAT for Cycling*) evaluate the reduction in population-level mortality from a given level of walking and cycling. The HEAT uses data from published studies on the relative risk of death from all causes among regular pedestrians or cyclists, compared to people who do not cycle or walk regularly. Based on these "relative risk estimates", the tool calculates the reduction in expected deaths in the population that cycle or walk at this level. HEAT for cycling is designed for adult populations aged 20-64. HEAT for walking is designed for adult populations aged approximately 20-74 years.

The HEAT requires an estimate of how many people are walking or cycling and an estimate of the average annual duration or distance of walking or cycling. They also require the mortality rate for Canadians aged 20-74 to estimate the number of deaths that would have occurred in the absence of walking or cycling. We calculate this mortality rate at 383 deaths per 100,000, using Statistics Canada (2008) data.

Valuing prevented deaths

We use two different methods to estimate the economic value of the deaths prevented thanks to active transportation in Toronto: the more common "willingness to pay" method, and the more restrictive "discounted future earnings methods".

The value of a statistical life using "willingness to pay" (WTP) reflects how much a representative sample of the population (potential victims) would be willing to pay (in monetary terms) to avoid the risk of sudden death (WHO 2011b). We use the Value of a Statistical Life of $4.05 million from a report for Transport Canada to monetize the benefits of these prevented deaths using willingness to pay (Sawyer *et al.* 2007).

The economic value of a prevented death can also be quantified based on the avoided loss of economic productivity from premature mortality. This economic productivity loss, called

"Discounted Future Earnings" (DFE), is calculated based on the average number of lost work days and daily earnings. We use the DFE value calculated by Vodden *et al.* (2007) in a report for Transport Canada. Vodden *et al.* (2007) calculate that the average DFE for Ontarians killed in motor vehicle collisions is $1.1 million.

Estimating current levels of walking and cycling

No single data source provides a clear picture of the number of Torontonians who walk and cycle for transportation, the frequency with which they walk and cycle, or the distances walked and cycled. To estimate current levels of walking and cycling in Toronto, we combine data from multiple sources: the 2006 Transportation Tomorrow Survey (TTS), the 2006 Census, the 2010 Downtown Bicycle Screenline Count report (City of Toronto Transportation Services 2010), the 2008 Walking Survey report (Harris-Decima 2008), and the 2009 Bicycle Survey report (Ipsos-Reid 2009).

We also make conservative assumptions where none of these sources provide appropriate data. For example, none of the data sources provide information on the total number of Torontonians who regularly cycle for transportation in the summer months. They also do not provide adequate information on the use of active transportation for trips to shopping and to leisure destinations. Appendix A further explains the methods, the data sources and their limitations.

Methodologies and assumptions

The 2006 census provides information on the number of people walking and cycling to work, while the 2006 TTS provides data on the number of people walking and cycling to school. The number of people who walk and cycle to shopping and other destinations is estimated based on the TTS and walking survey ratios of people who walk and cycle to shopping versus to work.

Data on trip distances and the number of trips per week are based on the more conservative of two sources: the TTS and the walking and cycling surveys. We assume that walking is used year-round except for on vacations. We estimate the number of weeks of cycling to work per year based on the City of Calgary's survey of cycle commuters (City of Calgary 2007). We estimate seasonal cycling based on the Downtown Bicycle Screenline Count in combination with TTS data on relative cycling downtown and in other areas. We assume a walking speed of 4.8 km/h and a cycling speed of 15 km/h.

Appendix A describes the full methodology used to estimate current levels of walking and cycling. **Table 10** in Appendix A presents the resultant levels of walking and cycling for Torontonians who walk and cycle for different purposes, including: number of people, average trip distance, number of trips per week, and average annual distance. It also presents the associated reductions in mortality from the HEAT tools. The overall results of this analysis are presented below.

Deaths prevented through active transportation in Toronto

Current levels of active transportation are estimated to prevent about 120 deaths per year in the Toronto population. This mortality reduction alone can be associated with over $475 million in economic benefits.

As indicated in Table 1, we estimate that about 180,000 Torontonians walk regularly for transportation, and about 80,000 cycle for transportation. Torontonians use active transportation for over 136 million kilometres of travel. Current levels of walking are estimated to prevent 69 deaths each year, while cycling prevents 49 deaths per year. Walking prevents more deaths than cycling as there are many more pedestrians than cyclists in Toronto. However, cycling leads to higher levels of physical activity and protection against mortality, resulting in higher benefits per cyclist.

Overall, these are very significant benefits, particularly considering the conservative estimate that under 15% of Torontonians walk or cycle for transportation.

Table 1: Reductions in all-cause mortality from regular walking and cycling in Toronto

	All walking for transportation	All cycling for transportation	Total
Number of people	180,000	80,000	260,000
Total distance per year	68.3 million km	68.1 million km	136.4 million km
Number of deaths prevented each year	**69**	**49**	**118**
Willingness to pay value[1]	$278 million	$200 million	478 million
Discounted future earnings value[2]	$76 million	$54 million	$130 million

1. Based on Sawyer *et al.*'s (2007) Value of a Statistical Life ($4.05 million CAD)
2. Based on Vodden *et al.*'s (2007) average Discounted Future Earnings of Ontarians who are killed in motor-vehicle collisions ($1.1 million CAD)

The value of active transportation in Toronto

The reductions in mortality from current levels of walking and cycling in the Toronto population are worth between $130 million and $478 million each year. These benefits – which accrue from about 120 prevented deaths – are rarely considered in transportation planning and decision-making. How do these values compare to Toronto's expenditures on walking and cycling?

Approximately $14 million of the City's annual capital transportation budget is dedicated to improvements in walking and cycling infrastructure – or, 5% of the total capital expenditures for Transportation Services. Over the next five years, $9 million of the City's capital transportation budget will be allocated to cycling infrastructure and projects each year. At the same time, cycling is expected to prevent 49 deaths each year, for an annual value of $54 million to $200 million.

The City's Pedestrian Projects unit has an annual capital budget of approximately $3 million for new sidewalks, pedestrian safety and other pedestrian projects. Other units of the City pay for signal improvements, signs and markings, multi-use trails, curb cuts and ramps at TTC stops, traffic calming/safety and new or widening of sidewalks as part of roadway reconstruction. Nonetheless, the total expenditures on pedestrian infrastructure are undoubtedly well below the $76 to 278 million in benefits from prevented deaths each year.

These calculations consider only the economic benefits of prevented deaths through active transportation. Active transportation yields many other health benefits (**Figure 9**).

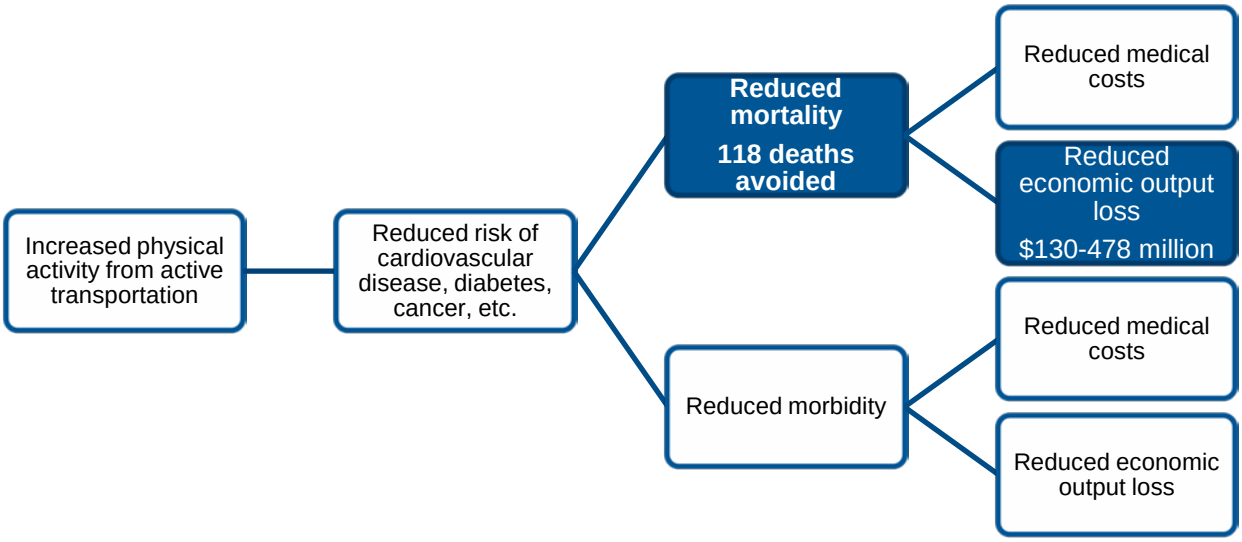


Figure 9: The $130 to $478 million in health benefits are only a fraction of total health benefits of walking and cycling in Toronto.

Many of the health benefits that are excluded in the above analysis have been quantified in other studies (**Table 2**). For example, increases in physical activity from active transportation improve health and reduce illness (or "morbidity") due to a number of diseases. The value of improved health and reduced morbidity is estimated at $427 per newly active person using "willingness to pay" methods (Genter *et al.* 2008).

Increases in physical activity from active transportation also reduce health care costs. Pratt *et al.* (2000) estimate that active people in the United States incur $622 less in annual medical costs than inactive people, on average. Increases in physical activity are associated with decreases in short- and long-term absences from work that have been valued at over $400 per active person per year (Saelensminde 2004).

Using published estimates of the health benefits of physical activity from avoided chronic diseases, it is possible to estimate the direct savings in medical costs for Toronto residents who walk or cycle to work. From Table 1 it is seen that 260,000 residents use active transportation(based on 2006 data). Applying the per capita benefit estimates from New Zealand and the United States (see Table 2), it is calculated that the savings in direct medical costs range from $110 to $160 million.

Finally, active transportation has significant additional environmental, social, economic and transportation system benefits, as discussed in Chapter 1.

Table 2: Value of other types of health benefits associated with active transportation

Annual value of benefits	Type of benefits	Source
$427 per active person	Reductions in morbidity	Genter *et al.* (2008), New Zealand
$622 per active person	Direct medical cost savings	Pratt *et al.* (2000), United States
$449 per active person	Reductions in short-term absence from work	Saelensminde (2004), Norway

The value of increasing active transportation in Toronto

As discussed earlier in the chapter, there is significant potential to increase the active transportation mode shares. At least 21% of all trips could be made using walking, and 55% of all trips in Toronto could be made by cycling. Toronto's median commute distance of 7.5 km further indicates that half of all trips to work could be made using active transportation. Increasing the active mode shares would undoubtedly yield important health benefits – benefits that may not be considered in decision-making.

We estimate the economic value of three scenarios of increased walking and cycling to work in Toronto (**Figure 10**):

- Scenario 1: a 25% increase in walking to work and a 50% increase in cycling. This would bring Toronto just above Montreal's mode shares of 8.6% and 2.4%.
- Scenario 2: a 50% increase in walking to work and a 100% increase in cycling. This would bring Toronto to just above New York City's walking mode share (10.3%) and just below Vancouver's cycling mode share (3.7%).
- Scenario 3: a 75% increase in walking to work and a 250% increase in cycling. This would bring Toronto to have the highest levels of active commuting in North America – just above Vancouver's 12.3% walking mode share, and just above Portland's 5.8% cycling mode share.

All three scenarios are feasible for Toronto given current land use and trip patterns.

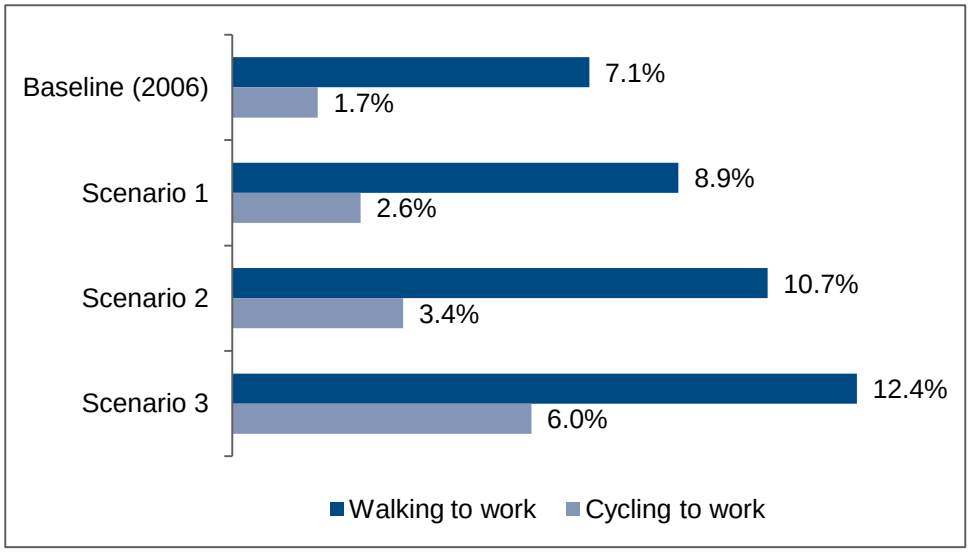


Figure 10: Increased active commuting mode share scenarios

We quantify the health benefits of these scenarios using the same trip distances and frequencies from Table 1. As in the analysis above, we assume that people walk and cycle to work 4-5 times per week, and walk and cycle to shopping or other destinations 1-2 times per week, leading to an average of 12 one-way trips per week. In order to present a conservative estimate of health benefits, we limit our analysis to people who walk and cycle to work. The levels of walking and cycling associated with Scenario 1,2 and 3 are presented in **Table 3**. The associated reductions in morality and values of prevented deaths are also presented in **Table 3**. As in the analysis of Toronto's current levels of walking and cycling, we use both "willingness to pay" (WTP) and "discounted future earnings" (DFE) values to estimate the economic values of the prevented deaths.

Table 3: Health benefits of scenarios for increased active transportation

	Scenario 1		**Scenario 2**		**Scenario 3**	
	Montreal's walking levels	Montreal's cycling levels	New York's walking levels	Vancouver's cycling levels	Vancouver's walking levels	Portland's cycling levels
Number of active commuters	101,956	29,670	122,348	49,450	142,739	69,230
Annual deaths prevented	61	37	73	62	85	87
Economic value – WTP	$246 million	$151 million	$295 million	$252 million	$344 million	$353 million
Economic value –DFE	$10 million	$2.9 million	$12 million	$4.9 million	$14 million	$6.9 million

As illustrated in **Table 4,** the three scenarios of increases in the number of active commuters in Toronto would prevent 25, 62, and 99 additional deaths each year, as compared to the 2006 baseline. These additional health benefits of scenarios 1, 2 and 3 can be valued at $27 million, $68 million, and $109 million using Discounted Future Earnings valuations. Using willingness to pay values, these additional reductions in mortality can be valued at $100 million, $250 million, and $400 million. As the City of Toronto prioritizes its investments in transportation infrastructure, the tremendous potential health benefits of walking and cycling should be adequately considered.

Table 4: Total and additional deaths prevented (compared to 2006)

Results	Scenario 1	Scenario 2	Scenario 3
Total deaths prevented through active commuting	98	135	172
Additional deaths prevents (compared to 2006)	25	62	99
Economic value - WTP	**$100 million**	**$250 million**	**$400 million**
Economic value - DFE	**$27 million**	**$68 million**	**$109 million**

Chapter 2 Findings

- **Large and increasing numbers of Torontonians are walking and cycling for transportation.**
- **Toronto's active transportation mode shares lag behind those of other leading North American cities.**
- **Toronto's trip distances indicate that there is tremendous potential to increase the use of active transportation.**
- **Existing data sources do not provide a clear picture of the number of Torontonians who walk and cycle, their trip distances, and their trip frequencies.**
- **Using conservative methods, we estimate that 2006 levels of walking and cycling prevent about 120 deaths in the Toronto population. We estimate that 180,000 Torontonians walk for transportation and 80,000 cycle for transportation, traveling combined annual distances of over 136 million kilometres.**
- **The economic value of this reduction in mortality is estimated at $130 million to $478 million, depending on how deaths are valued.**
- **In comparison, annual capital expenditures on cycling and pedestrian projects are only about $14 million, or 5% of total capital expenditures for City of Toronto Transportation Services.**
- **Increasing Toronto's active commuting mode shares to 12% for walking and 6% for cycling to become the "best in North America" would prevent about 100 additional deaths using conservative estimates, with an associated economic value of $109 million to $400 million.**

Chapter 3. Health risks of walking and cycling in Toronto

This chapter discusses the health impacts of collisions, injuries and fatalities involving users of active transportation in Toronto[5]. It analyses the relative risk to pedestrians and cyclists, the changes in risk over time, and the types of collisions that are most common. It also estimates the costs of pedestrian and cyclist collisions with motor vehicles – costs that could be avoided through improvements to safety for pedestrians and cyclists.

Collisions, injuries and fatalities

In an average year in Toronto, over 1,000 cyclists and over 2,000 pedestrians are injured in collisions with motor vehicles. In 2009, collisions involving users of active transportation resulted in 31 pedestrian fatalities and one cyclist fatality (City of Toronto Traffic Safety Unit 2010a, 2010b). Due to under-reporting, the actual number of collisions is likely much higher than the number of reported collisions (2,189 for pedestrian-vehicle collisions, and 1,266 for cyclist-vehicle collisions).

Relative risks for pedestrians and cyclists in Toronto

Pedestrians account for 52% of all fatalities from collisions involving motor vehicles in Toronto, despite their mode share of only 7%. They also account for 11% of all injuries from collisions in Toronto. This reinforces that collisions with motor vehicles have very serious consequences for pedestrians-they very frequently lead to injury or death.

Similar trends are observed for collisions involving cyclists, though the discrepancy between mode share and fatalities is not quite as extreme. Cyclists account for 4% of all fatalities and 6% of all injuries from collisions, despite a cycling mode share of less than 2%.

Collisions involving pedestrians are particularly likely to lead to fatality or hospitalization. In 2009, 1.4% of collisions involving pedestrians led to pedestrian fatalities, 8.8% led to hospitalization, and 39% led to hospital trips for pedestrians. In 2010, 39% of collisions involving cyclists led to visits to hospital and 3.3% led to hospitalization for injuries.

[5] We do not discuss exposure to air pollution since the relative risks or benefits for users of active transportation are highly uncertain (as discussed in Chapter 1).

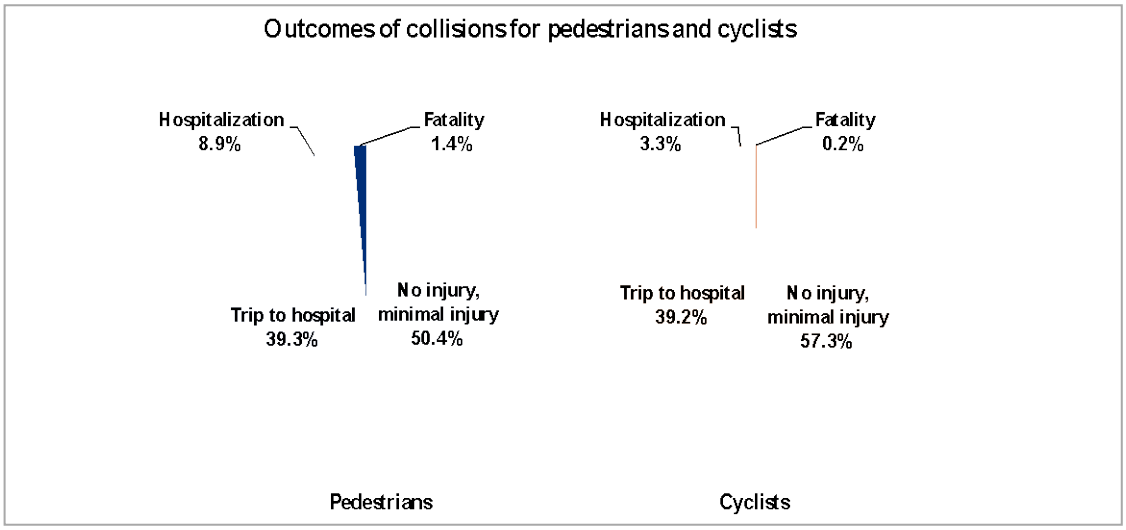


Figure 11: Outcomes of collisions with vehicles for cyclists and pedestrians
Data: City of Toronto Traffic Safety Unit 2010a, 2010b

Toronto has higher rates of walking and cycling collisions than other large Canadian cities, including Ottawa, Montreal and Vancouver when comparing pedestrian and cyclist collisions relative to the commuting mode share[6]. The City of Toronto (2011a, 2011b) compares Toronto's pedestrian and cyclist collision rates relative to the total population. In both analyses, Toronto's collision rates are higher than those of comparison cities including Montreal, Ottawa and Vancouver.

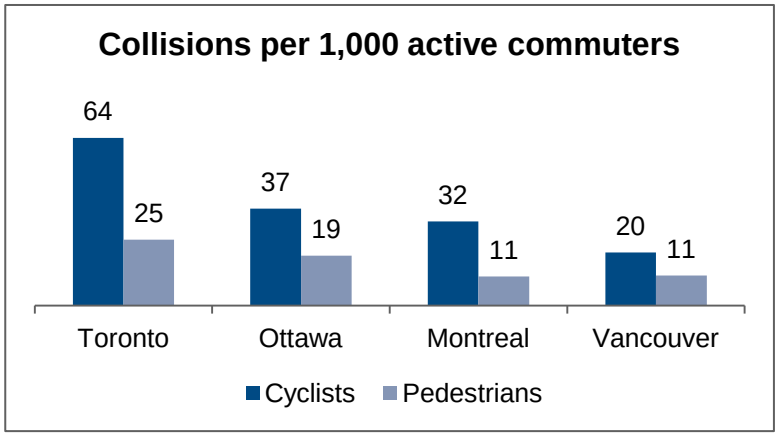


Figure 12: Active commuting collision rates in Canadian cities (per 1,000 commuters)
Data: 2006 Statistics Canada census data, City of Toronto Traffic Safety Unit 2011a, 2011b

Signs of progress

Over the past ten years, collision rates have decreased substantially for both pedestrians and cyclists (**Table 5**). Collision rates have decreased relative to total population, and relative to the number of active commuters. The total number of pedestrian and cyclist collisions and fatalities also decreased between 2000 and 2009. This is particularly impressive given the significant increases in active commuting over this time period.

[6] We use 2006 census data on population and active commuting mode shares to estimate

However, the relative fatality rates for pedestrians have not improved. In the five years leading up to 2000, pedestrians accounted for 49% of all fatalities from collisions in Toronto. In the five years leading up to 2009, pedestrians accounted for 52% of all fatalities form collisions.

Table 5: Changes in collisions, collision rates and fatalities for pedestrians and cyclists
Data: City of Toronto Traffic Safety Unit 2011a, 2011b

	Pedestrians: % change 2000-2009	Cyclists: % change 2000-2009*
Number of collisions	-8%	-10%
Collisions / 100,000 population	-24%	-12%
Collisions / 1,000 commuters*	-18%	-33%
Number of fatalities (5-yr average)	-29%	-43%
% of fatalities (5-yr average)	+6%	-15%

*Number of commuters for 2000 and 2009 are based on the 2001 and 2006 census, respectively

Types of collisions

Collisions involving users of active transportation in Toronto most commonly occur on major arterial roads[7] and at intersections. Pedestrians are often hit when crossing with the right of way, while cyclist-vehicle collisions are often due to inadequate separation of cyclists from vehicles. According to City of Toronto Traffic Safety Unit data (2010a, 2010b), in an average year:

- Over half (58%) of pedestrian-vehicle collisions and 69% of cyclist-vehicle collisions occur on major arterials (City of Toronto 2010a, 2010b).
- 47% of pedestrian-vehicle collisions occur at intersections, and in over 75% of these collisions pedestrians have the right-of-way.
- 37% of cyclist-vehicle collisions occur at intersections, where one party is turning.
- 675 collisions involved pedestrians crossing with the right of way who are hit by turning vehicles. These collisions accounted for 30% of total pedestrian-vehicle collisions, and led to 10 pedestrian fatalities in 2009.
- 30% of cyclist-vehicle collisions involve sideswiping collisions, collisions with car doors, and rear-ending collisions. Table 11 and 14 in Appendix B form the basis of this analysis, and provide a more complete list of the types of collisions and number of each type of collision in Toronto.

[7] Arterial roads provide the major corridors for surface travel. Major arterial roads are defined by the City of Toronto Transportation Services (2000) as those with counts of greater than 20,000 vehicles per day; greater than 5,000 transit passengers per day, up to 4 lanes for vehicles, sidewalks on both sides, and high priority for winter maintenance. For a list of arterial roads in Toronto, visit: http://www.toronto.ca/transportation/road_class/pdf/city-wide_index.pdf

Costs of collisions, injuries, and fatalities

Pedestrian-vehicle and cyclist-vehicle collisions lead to injuries and fatalities with serious consequences for the people involved and for society as a whole. In this section, we quantify the costs of pedestrian-vehicle and cyclist-vehicle collisions in Toronto based on Vodden *et al.*'s (2007) report for Transport Canada, *The Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario.* We use Vodden *et al.*'s (2007) analysis of the average cost per collision, distinguishing between those that lead to minimal injury, minor injury, major injury, and fatality. The analysis includes three types of costs:

- Human consequences: costs of fatalities and injuries to those affected
- Direct medical costs: costs of ambulances, emergency room visits, hospital stays, and medical professionals
- Other attributable costs: costs of police, fire services and time in traffic delays.

Average costs of collisions

The human consequences of injuries and fatalities are evaluated using two methods, as in Chapter 2: willingness to pay (WTP) and discounted future earnings (DFE). We use the same mortality values as in Chapter 2, from Sawyer *et al.* (2007) and Vodden *et al.* (2007). We use Vodden *et al.*'s (2007) WTP and DFE values for the human consequences of non-fatal collisions leading to major, minor and minimal injuries. The evaluation of human consequences accounts for the likelihood of a major or minor injury leading to permanent disability. **Table 6** presents Vodden *et al.'s* (2007) average costs for different types of collisions using both types of valuations. **Table 6** also presents the average direct medical costs of collisions, divided according to the severity of injury and fatality, as calculated by Vodden *et al.* (2007).

The "other indirect costs" in **Table 6** are specifically attributable to pedestrian-vehicle collisions, again calculated by Vodden *et al.* (2007). For the costs associated with police response, fire service response, and time costs of traffic delays, Vodden *et al.* (2007) present average costs for only two types of collisions: collisions leading to fatality, and collisions leading to injuries of all kinds. We assume that cyclist-vehicle collisions would have similar costs. To maintain a conservative estimate, we exclude the costs of court services, out of pocket expenses, and the costs of extra fuel and pollution associated with traffic delays that are estimated by Vodden *et al.* (2007).

Table 6: Average human, direct and indirect costs per collision
Data: Vodden et al. 2007

Outcome of collision	Minimal injury	Minor injury	Major injury	Fatality
All human costs: willingness to pay	**$1,384**	**$33,945**	**$238,844**	**$4,050,000**
All human costs: future earnings	**$36**	**$3,297**	**$52,483**	**$1,100,000**
Ambulance trip	-	$313	$783	$392
ER visit	-	$95	$95	$48
Hospital stay	-	-	$2,211	$583
Health care professionals	$405	$920	$4,600	$1,887
All direct medical costs	**$405**	**$1,328**	**$7,689**	**$2,909**
Police	$744	$744	$744	$8,491
Fire	$1,318	$1,318	$1,318	$2,548
Traffic delays (time)	$383	$383	$383	$22,642
All other indirect costs	**$2,445**	**$2,445**	**$2,445**	**$33,680**

Costs of pedestrian-vehicle and cyclist-vehicle collisions in Toronto

To calculate the total costs of collisions involving users of active transportation in Toronto, we apply the average costs in **Table 6** to the annual number of collisions in Toronto. Even using the more restrictive "discounted future earnings" values to quantify the human costs of collisions and injuries, our analysis reveals that pedestrian-vehicle collisions yield costs of over $53 million. (**Table 7)** Cyclist-vehicle collisions generate costs of over $9 million (**Table 8).** When using "willingness to pay" values for human consequences, the total costs of pedestrian-vehicle and cyclist-vehicle collisions increase to over $200 million and $36 million, respectively.

All City of Toronto residents stand to gain from improvements in safety that reduces the economic burden of traffic collisions. Improving safety for pedestrians and cyclists in Toronto could avoid over $60 million in direct and indirect economic costs.

Across Ontario, the 2% of collisions that involve pedestrians lead to 11% of the social costs of all collisions in Ontario (Vodden *et al.* 2007). Investing in safety for users of active transportation has the potential to yield disproportionate economic benefits.

Table 7: Annual costs of pedestrian-vehicle collisions in Toronto based on 2005-2009 average collisions
Data: City of Toronto Traffic Safety Unit 2011a, 2011b

	Number of collisions	Discounted future earnings	Direct medical costs	Other indirect costs	Total costs
Minimal injury	1014	$36,504	$410,163	$2,478,954	$2,925,621
Minor injury	878	$2,895,089	$1,166,160	$2,146,471	$6,207,719
Major injury	202	$10,601,557	$1,553,239	$493,835	$12,648,630
Fatality	28	$30,800,000	$81,452	$943,042	$31,824,494
Total	**2,122**	**$44,333,149**	**$3,211,013**	**$6,062,302**	**$53,606,465**

Table 8: Annual costs of cyclist-vehicle collisions in Toronto based on 2005-2009 average collisions
Data: City of Toronto Traffic Safety Unit 2011a, 2011b

	Number of collisions	Discounted future earnings	Direct medical costs	Other attributable costs	Total costs
Minimal injury	531	$19,116	$214,790	$1,298,151	$1,532,056
Minor injury	417	$1,375,002	$553,859	$1,019,452	$2,948,313
Major injury	40	$2,099,318	$307,572	$97,789	$2,504,679
Fatality	2	$2,200,000	$5,818	$67,360	$2,273,178
Total	**990**	**$5,693,436**	**$1,082,039**	**$2,482,751**	**$9,258,227**

Chapter 3 Findings

- **Collision rates have decreased for both pedestrians and cyclists over the past ten years, even with increases in active commuting over this time period. Further improvements are needed as the relative fatality rates for pedestrians have not improved.**
- **Collisions involving pedestrians are particularly likely to lead to fatality or hospitalization.**
- **Toronto is also less safe for pedestrians and cyclists than other Canadian cities.**
- **Collisions involving users of active transportation in Toronto most commonly occur at intersections and on major arterial roads. Many also appear linked to inadequate separation of cyclists from motor vehicles.**
- **Collisions involving users of active transportation lead to direct and indirect economic costs of over $60 million each year, using conservative estimates. Reducing these collisions and injuries would generate significant economic benefits.**

Chapter 4. Distribution of health benefits and risks

This chapter discusses the distribution of the health benefits and risks of walking and cycling across the City of Toronto. It identifies dramatically higher levels of walking and cycling in the Toronto's core neighbourhoods (former City of Toronto and East York) – with a corresponding concentration of health benefits among residents of this area. It identifies lower levels of active transportation, walkability, and bikeability in Toronto's suburbs, and discusses how these patterns connect to income and health equity in Toronto. Finally, it discusses how active transportation collisions and injuries appear to be disproportionately borne by vulnerable users in Toronto: children, elderly adults, and residents of low-income neighbourhoods.

Walking and cycling in Toronto's core versus suburbs

The suburbs of the City of Toronto were primarily constructed after the Second World War. Unlike the narrow streets and density of Toronto's core, most of this post-war development is car-oriented, low density and uninviting to pedestrians (OPPI 2011). These differences in urban form are closely connected to current differences in transportation patterns – and the associated health benefits and risks.

The health benefits of active transportation in Toronto appear concentrated in the city's core, where levels of walking and cycling are dramatically higher, and where land use patterns enable safe walking and cycling. In the former City of Toronto, the combined active transportation mode share is three times higher than in North York, Scarborough and Etobicoke (**Figure 13**). In the wards closest to downtown (Wards 20 and 27), walking and cycling account for at least 26% of all trips over a 24-hour period (DMG 2006).

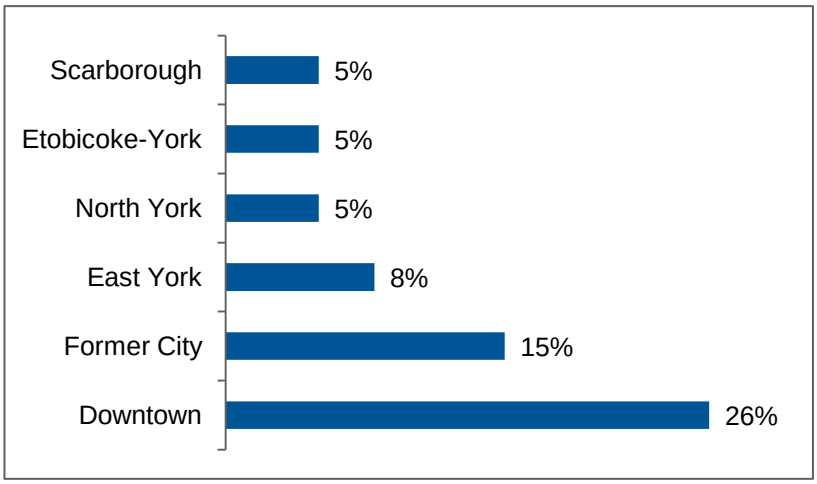


Figure 13: Walking and cycling trips as percentage of all trips over a 24-hour period
Data: TTS 2006 from University of Toronto Data Management Group (DMG) 2008

In Toronto's core neighbourhoods with the highest levels of active transportation, residents make over five times more walking trips and over fifteen times more cycling trips, on average, than residents of many neighbourhoods in the suburbs (Figure 14 and Figure 15).

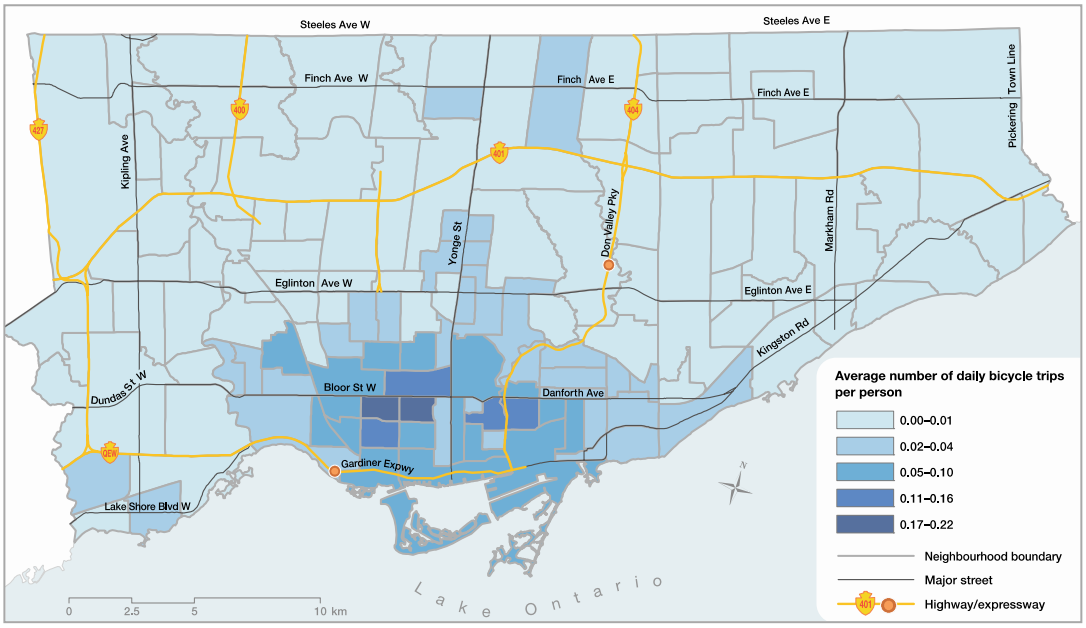


Figure 14: Daily cycling trips per person
Source: Glazier et al. 2007

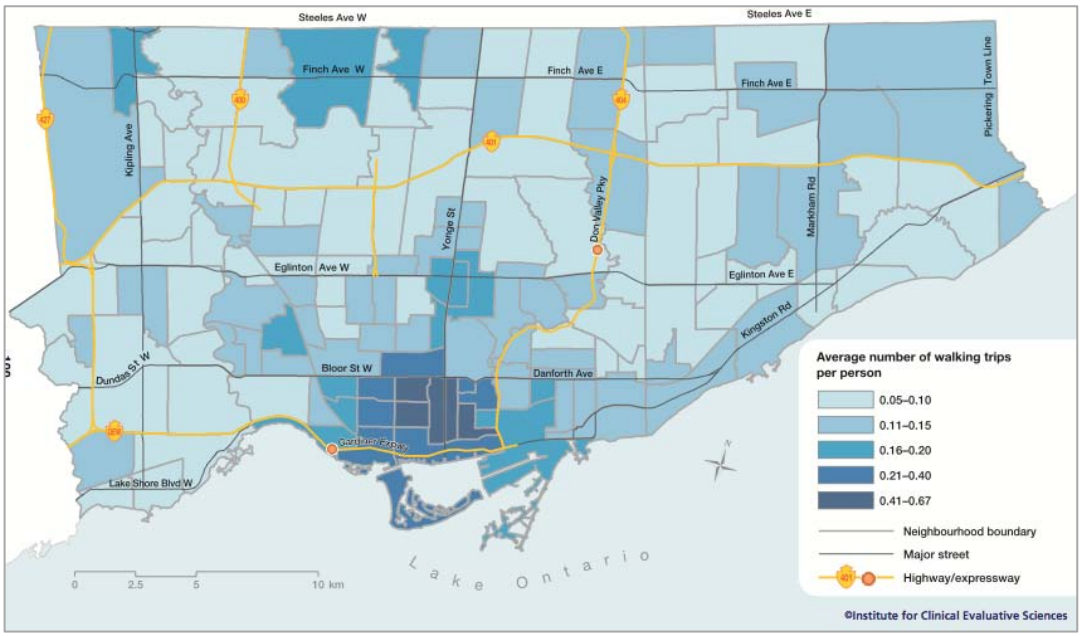


Figure 15: Daily walking trips per person
Source: Glazier et al. 2007

Walking and cycling in Toronto's core is facilitated by the proximity to destinations. The Toronto –East York district has a high active transportation mode share of 15%, which is comparable to other leading North American cities (City of Toronto). In Toronto-East York, all types of destinations are significantly closer than in other parts of the city (**Figure 16**). For example, in the former City of Toronto-East York, the mean walking time to reach a convenience store is 3.2 minutes, and the mean walking time to a library is 10 minutes. In Scarborough, the mean walking times to reach a convenience store and library are 7.4 minutes and 18.2 minutes, respectively. As discussed in Chapter 5, the proximity to

destinations in the former City of Toronto reflects land use patterns: land use mix, residential and commercial density, and route connectivity.

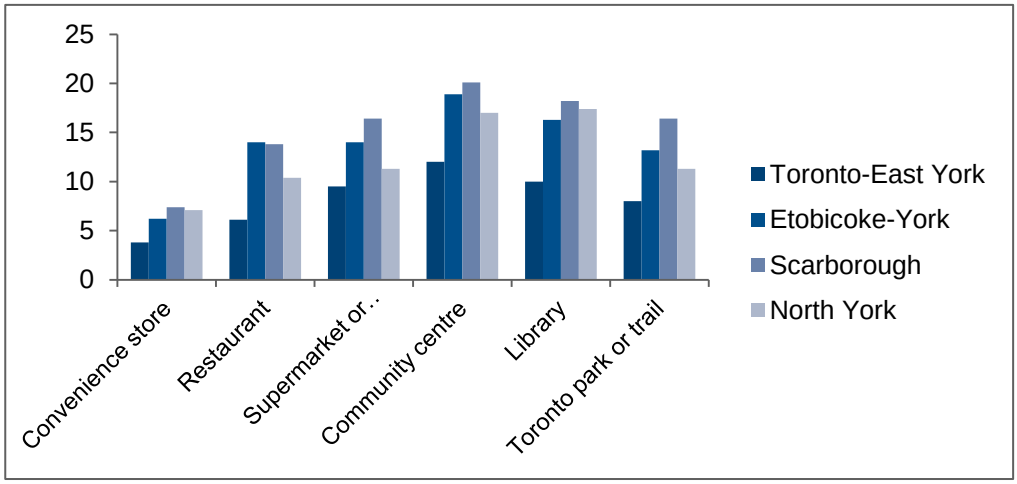


Figure 16: Mean walk time to destinations in minutes
Data: Harris-Decima 2008

Cycling in Toronto's core is also facilitated by the presence of bicycle facilities. Bicycle lanes and paths are concentrated in south-central Toronto (Toronto –East York District), while bicycle facilities in the northern and eastern parts of the city are notably lacking (**Figure 17**).

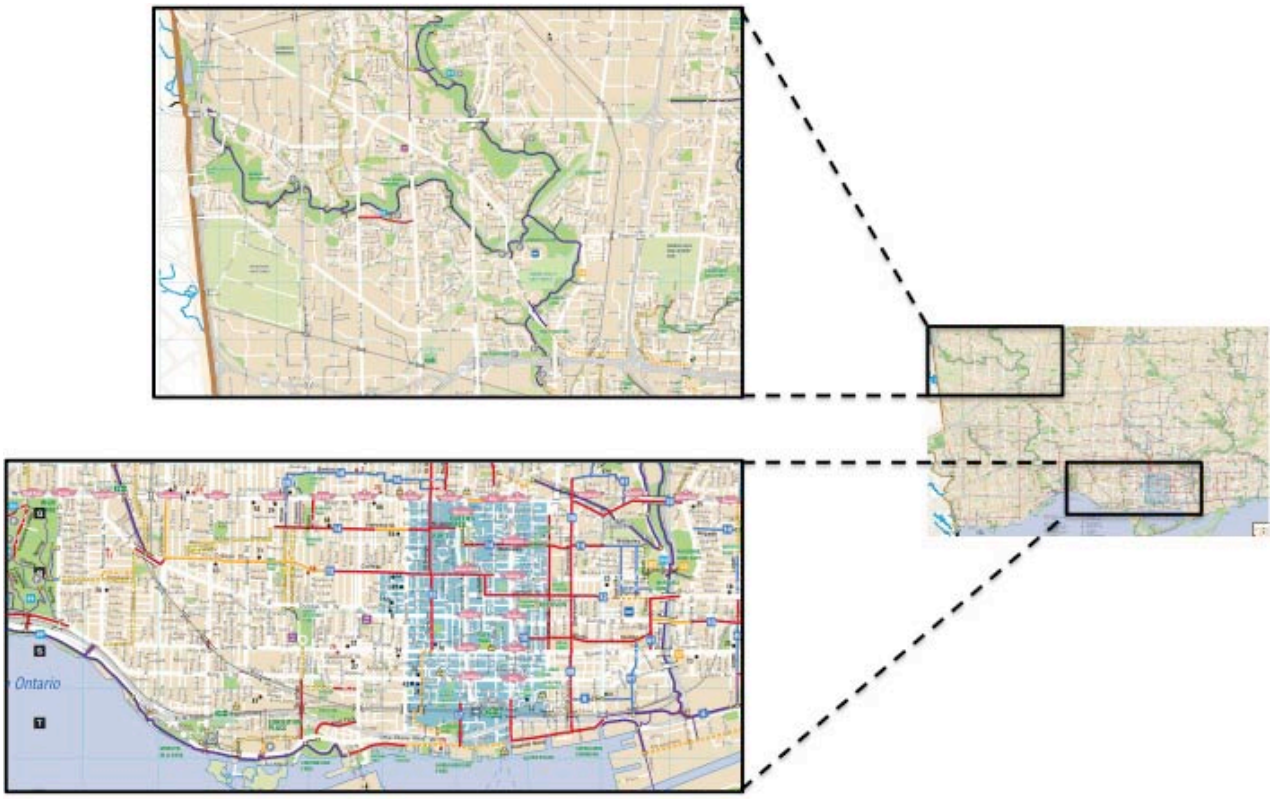


Figure 17: Bikeway network – downtown versus suburbs
Source: Created from City of Toronto Transportation Services (2010) cycling map

The health risks of active transportation may also be higher in Toronto's suburbs where levels of walking and cycling are lower. Intersections in Toronto that have the highest volumes of pedestrians also appear to have the lowest pedestrian collision rates, as illustrated in Reid's 2011 maps (**Figure 18**). These intersections are predominantly located in the downtown core and along subway lines. In contrast, intersections in Toronto's suburbs have lower pedestrian volumes and higher collision rates (red points, bottom right map). The finding that walking is less safe in Toronto's suburbs is aligned with the general "safety in numbers" trend, described in Chapter 1.

Figure 18: Left: volume of pedestrians (red = more pedestrians). Right: collision rates (red=higher rates)

Source: Reid 2011, adapted from Shaw Media / Global News 2011

Active transportation and equity in Toronto

Safe walking and cycling opportunities can reduce inequality by enabling individuals without motor vehicles to more easily access goods and services. In Canada, older adults, children, and low-income families are less likely to own cars, and are therefore most likely to benefit from improvements to alternative modes of transportation (Federation of Canadian Municipalities 2010). Active transportation can also reduce health inequality by improving access to health services and increasing physical activity.

Unfortunately, active transportation does not appear to effectively reduce inequalities in Toronto. This is in large part due to the dramatic differences between walking and cycling in the former City of Toronto and the suburbs, discussed above. In Toronto, low housing affordability in the core, land use patterns in high-rise neighbourhoods, and collision patterns may create health and transportation inequalities.

First, walkable and bikeable neighbourhoods in the former City of Toronto tend to be the least affordable for those with low incomes. Neighbourhoods in Toronto's core with the highest levels of walking and cycling have high land values, and are increasingly home to higher income households. As illustrated in **Figure 19**, average incomes in many parts of Toronto's core have increased over the past 35 years (blue, "City 1"), while incomes in Scarborough and in northwest Toronto have consistently decreased by 20% or more (dark red, "City 3").

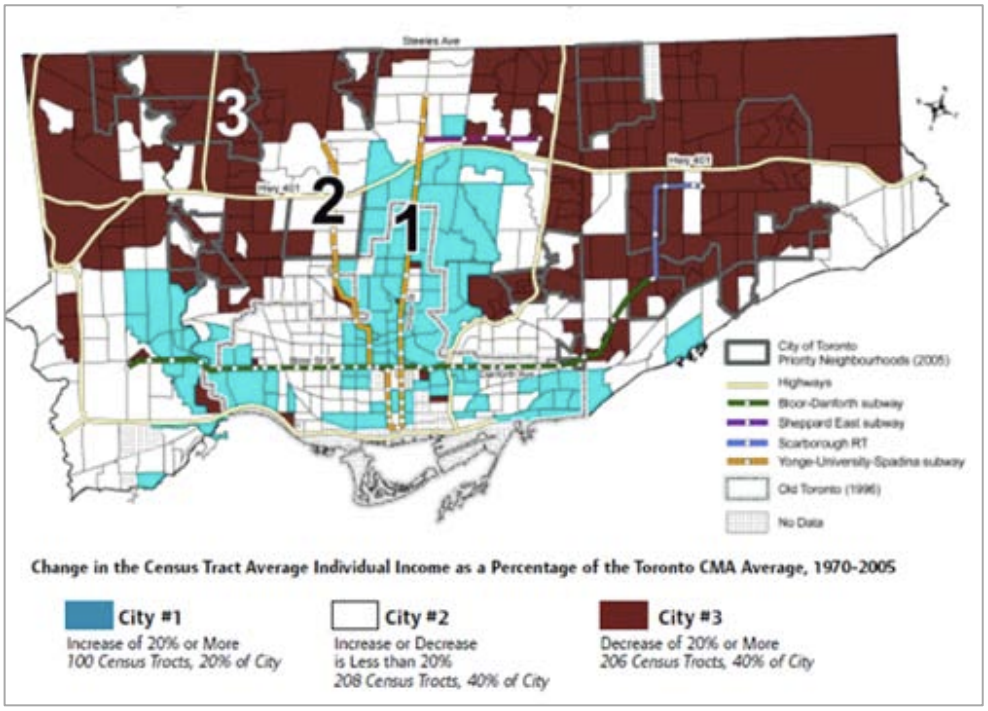


Figure 19: Changes in income in Toronto, 1970-2005
Source: Hulchanski 2007

Second, low-income families often live in high-rise neighbourhoods in Toronto's suburbs. These neighbourhoods are characterized by wide roads, long city blocks, segregated land uses, and clusters of high rise apartment buildings (City of Toronto 2009a). They frequently feature limited pedestrian and bicycle infrastructure and few public gathering places (City of Toronto 2009b). Many residents feel uncomfortable walking in their neighbourhood at night (Harris-Decima 2008, Hess and Farrow 2010).

In a recent survey of residents of Toronto high-rise neighbourhoods, 28% of respondents disagreed or strongly disagreed that they feel safe from traffic when walking, and 29% disagreed that there are enough places to safely cross the large streets. Only 24% of parents reported feeling comfortable letting their children walk unaccompanied in their neighbourhood (Hess and Farrow 2010).

Additional physical barriers may also limit the use of active transportation in high-rise neighbourhoods. For example, two highways cross the Lawrence-Allen neighbourhood: the Allen Road Corridor and Provincial Highway 401. There are few connections across these highways, and those that exist are characterized by high traffic volumes and speeds, wide roadways, narrow sidewalks, nonexistent bicycle lanes, and highway on- and off-ramps. Only 38% of residents of the Lawrence-Allen neighbourhood described their neighbourhood as "very walkable", as compared to 76% for the city as a whole (City of Toronto, 2009a). In addition, other 400 series highways, rail corridors, and natural features such as ravines can similarly create barriers to persons wishing to walk or cycle.

Figure 20 identifies low-income areas in Toronto that also feature low or medium-low walkability, based on an index that considers land use mix, street connectivity, and density. These areas are primarily located in Scarborough and in the northwest corner of the City. This walkability index is further discussed in Chapter 5.

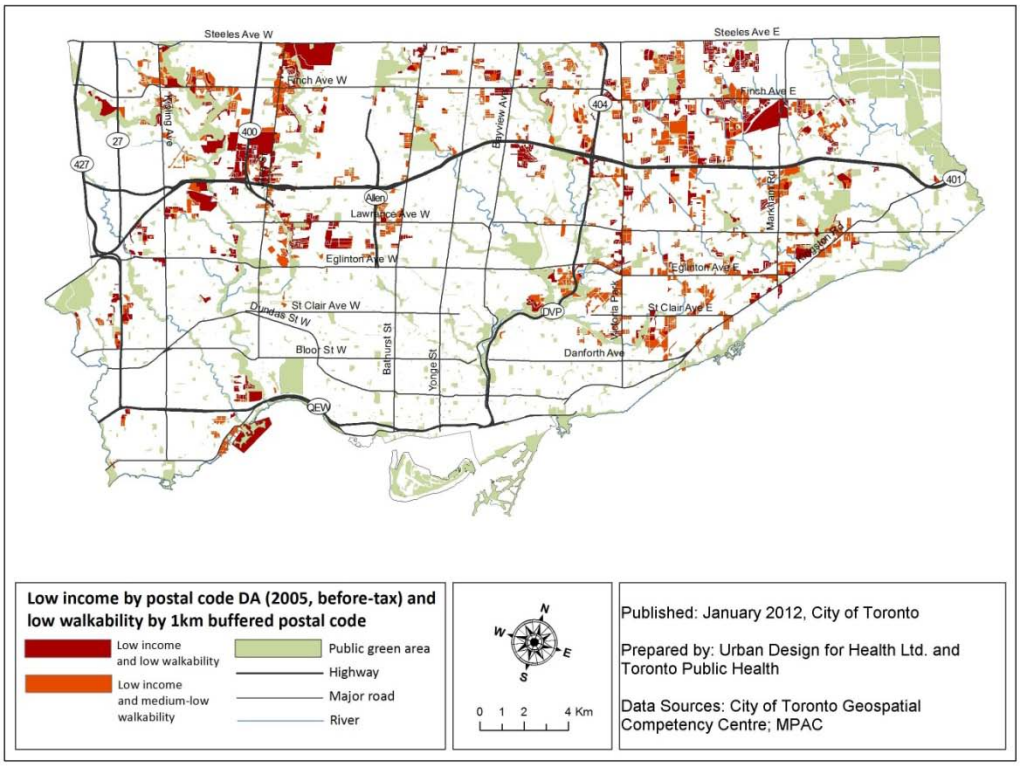


Figure 20: Low-income areas with low and medium-low walkability based on the UD4H walkability index

Source: Urban Design 4 Health (UD4H) 2012

Finally, children, older adults and residents of low-income neighbourhoods in Toronto may be most vulnerable to the risks of collision while walking and cycling.

As discussed above, pedestrian collision rates appear to be higher in the suburbs of Toronto, where pedestrian volumes are lower. Though studies have not quantified the risks to pedestrians in Toronto's low-income versus high-income neighbourhoods, the positive association between income and pedestrian safety has been recorded in many American cities (Active Living Research 2011). In Montreal, twice as many young cyclists and almost four times as many young pedestrians require medical interventions in the poorest areas than in the wealthiest areas (Agence de la Santé et des Services Sociaux de Montréal 2006).

Young and elderly people using active transportation also appear more vulnerable to collisions and fatalities in Toronto.

- Older people (over 65) account for 50% of pedestrian fatalities, though they account for only 13% of the population and 13% of pedestrians involved in collisions (City of Toronto Traffic Safety Unit 2007). The high fatality rates may be linked to the physical vulnerability of older adults, and to pedestrian infrastructure that ignores their needs (Ernst 2011).
- Boys aged 5-14 and Torontonians aged 15-24 are over-represented in pedestrian-vehicle collisions (City of Toronto Traffic Safety Unit 2007). Cyclists aged 15-24 are also more likely to be involved in collisions than older cyclists; they represent only 12% of cyclists based on TTS data but are involved in 22% of collisions based on City of Toronto data (DMG 2008, City of Toronto Transportation Services 2011b).

However, there is also evidence that high levels of walking and cycling in low-income neighbourhoods may help to address health disparities. In Toronto, lower incomes are associated with higher premature mortality, higher cardiovascular disease, higher rates of diabetes, lower self-rated health and lower levels of physical activity (Toronto Public Health 2011, Creatore *et al.* 2007).

Figure 21 illustrates where low rates of diabetes coincide with low incomes in south-central Toronto (light blue), defying the dominant trend of high diabetes rates in low-income neighbourhoods (red). These neighbourhoods have higher levels of walking and cycling and are "activity-friendly" (Glazier and Booth 2007). Though dietary, genetic and other lifestyle factors also influence diabetes rates, these findings illustrate that increasing access to safe active transportation may help to improve health equity.

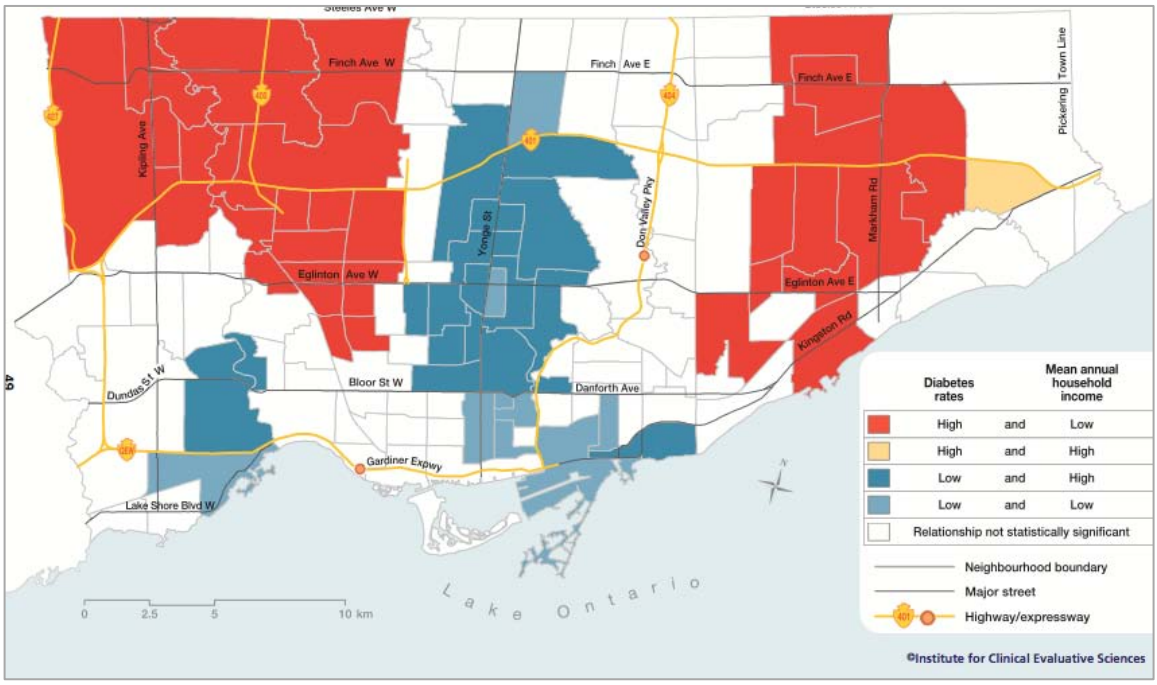


Figure 21: Significant relationships between diabetes rates and household income

Source: Creatore et al. 2007

Overall, the links between health, equity and active transportation in Toronto have not been well studied. Future research should continue to explore how collision rates, access to safe walking and cycling, physical activity, and transportation choices vary for different groups across Toronto, with a particular focus on vulnerable users.

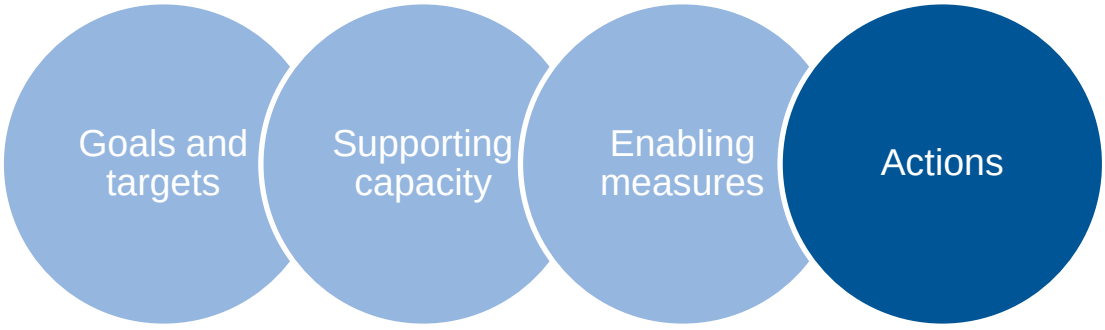
Chapter 4 Findings

- **Levels of walking and cycling among residents of the Toronto's central areas are over three times higher than among residents of the suburbs. The city core (Toronto- East York District) is also more walkable and bikeable than the suburbs. The health benefits of walking and cycling are, therefore, concentrated in the central areas of Toronto.**
- **Pedestrian-vehicle collision rates appear higher in the suburbs. The health risks of walking are thus concentrated among residents of the suburbs.**
- **The suburbs of Toronto – where walkability and bikeability are lower, and collision rates are higher – are predominantly low-income areas. Active transportation thus appears to further aggravate health and transportation inequality.**
- **However, there is evidence that high levels of walking and cycling in low-income and high-risk neighbourhoods may help to address health disparities.**

Chapter 5. Strategies for improving active transportation in Toronto

This chapter highlights actions to increase walking and cycling safety and mode shares, in order to improve public health in Toronto. It presents infrastructure-based solutions that have been effectively implemented in other cities, and that appear likely to dramatically improve safety in Toronto. It also presents actions to improve the attractiveness of walking and cycling, and to ensure that active modes are safe and accessible for all Torontonians.

In this chapter we focus only on actions. However, we recognize that effective action is underpinned by enabling measures, goals and supporting capacity. In Chapter 6, we briefly review the enabling measures – plans, policies, and standards – that support these actions. We discuss the development of visions, goals and targets to provide the impetus for actions and measures. We also discuss the capacity that is needed to support the development and implementation of goals, policies and actions.



Toronto's actions on active transportation

The City of Toronto's efforts to promote walking and cycling demonstrate the City's commitment to active transportation. The Official Plan highlights the importance of walking and cycling as a core component of an effective transportation system. The 2001 Bike Plan's groundbreaking wheel and spoke model emphasized that hard infrastructure must be supplemented by education and softer measures; this model was used by many jurisdictions that developed bicycle plans subsequently. The City of Toronto's 2009 Walking Strategy received national recognition from the Federation of Canadian Municipalities in 2011 for "excellence, leadership and innovation" in transportation.

Many of Toronto's recent actions to promote active transportation have demonstrated leadership and innovation, and have been extremely successful. For example, the City's Green Standard is an exciting approach to sustainable new development that includes both mandatory requirements and incentives for going beyond the minimum requirements. The PATH underground walkway system in Toronto's downtown facilitates pedestrian linkages to

public transit, and accommodates more than 100,000 daily commuters, providing shelter in the winter cold and in the summer heat. Other capital-related initiatives to improve walking in Toronto include pedestrian countdown signals, longer walk times for signalized crossings, zebra crossing pavement markings, and an Essential Links program to address missing sidewalks. Initiatives to improve cycling in Toronto include the' installation of over 17,000 post and ring bicycle parking stands, the introduction of BIXI bike sharing program, bike racks on all TTC buses, and the bike parking zoning bylaw The Active and Safe Routes to School program, the Bicycle-Friendly Business Awards and the guidelines for bicycle parking are examples of other exciting City of Toronto initiatives related to marketing and education, and policy tools.

The City is also experimenting with bicycle boxes and pedestrian scramble intersections. The Metrolinx regional transportation plan that emphasizes walking, cycling and integration will complement municipal efforts with transit at mobility hubs. Finally, Toronto features an active network of profit and non-profit organizations that work to improve walking and cycling for city residents. There are over 100 bicycle specialty shops, clubs and teams in Toronto. These efforts are further described in Appendix C, and in the relevant sections of this chapter.

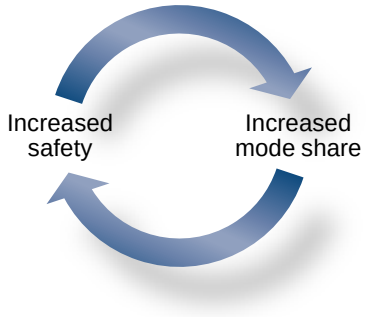
Nonetheless, Toronto lags behind other leading North American jurisdictions. Toronto's walking and cycling mode shares of 7.1% and 1.7% respectively, are well behind those of other North American jurisdictions including Vancouver and Montreal (Chapter 2). Toronto's pedestrian and cycling collision and injury rates are above those of Vancouver and Montreal (Chapter 3).

Improving active transportation in Toronto

Improving active transportation in Toronto would bring significant public health benefits. The City of Toronto can reduce the health burden of transportation by reducing the number of pedestrian-vehicle and cyclist-vehicle collisions and fatalities. The City of Toronto can also generate millions of dollars in health benefits by increasing the number of pedestrians and cyclists – both due to reductions in mortality, reduced health care costs and reduced costs of lost economic output from physical inactivity (Chapter 2).

There are a number of dimensions to improving active transportation in Toronto. First and foremost, Toronto should continue to target safety improvements for pedestrians and cyclists. Walking and cycling is currently less safe than other modes, as pedestrians and cyclists are more likely to be injured in collisions. Pedestrians are particularly at risk, accounting for 50% of all fatalities from collisions in Toronto (Chapter 3).

Addressing concerns about safety is also essential to increasing active transportation mode shares – particularly cycling mode shares. According to the Ontario Bike Plan, the number one reason that people do not cycle is because they are afraid of cycling on the road amidst traffic (Stantec and Vandermark Consulting 2008). Surveys in North American cities suggest that up to 70% of residents would cycle if they felt safe doing so. In Calgary, only 2% are "fearless" riders who will cycle in all conditions, and only 28% are not interested in cycling (City of Calgary 2011). This is supported by Toronto survey data, where general safety is the number one concern about cycling in Toronto (Ipsos-Reid 2009).



According to the "safety in numbers" theory, increasing the active transportation mode shares would also help to increase safety. The incidence of collisions and injuries decreases as the mode share of cycling increases (Jacobsen 2003, Robinson 2005, Elvik 2009, Aertsens *et al.* 2010). This is likely due to drivers' increased awareness of cyclists and ability to anticipate their actions. There is a positive feedback between cycling safety and mode share. As cities invest in safe cycling infrastructure, cycling safety and mode shares increase, leading to further increases in safety for all modes.

This chapter presents actions that have been demonstrated to increase active transportation safety and mode shares in other cities, and discusses their relevance to Toronto. The following types of actions are presented:

- Making active transportation safer
    - Reducing vehicle speed limits
    - Traffic calming
    - Separating pedestrians and cyclists from traffic
    - Increasing safety at intersections
- Making active transportation more attractive
    - Route quality and speed
    - Transit integration, especially in suburbs where active transportation distances are longer
    - End-of-trip facilities
    - Marketing and education programs
- Enabling active transportation through land use planning
    - Destination accessibility, street connectivity and density
- Making active transportation more accessible
    - Walking and cycling facilities for vulnerable users
    - Affordable housing in vibrant communities
    - Culturally competent community-based programs

The chapter also discusses how cities can maximize results by implementing coordinated packages of actions.

Making active transportation safer

The analysis of Toronto collision data, Toronto survey data, and research from other cities specifically suggests the importance of traffic calming, separating pedestrians and cyclists from traffic, and increasing safety at intersections. These efforts are particularly important on major arterials where 69% of cyclist-vehicle collisions and 58% of pedestrian-vehicle collisions occur. Major arterials provide direct, connected walking and cycling routes, feature a wide variety of destinations, and are designated as priority areas for re-urbanization in the Official Plan (City of Toronto 2010).

Reducing Vehicle Speed Limits

The speed of a vehicle is an important factor in both the occurrence of a collision and the severity of injuries that result (WHO 2004). A number of studies have looked at the relationship between vehicle speed and pedestrian or cyclist injuries when a collision occurs. A pedestrian is 8 times more likely to die as a result of a collision when a vehicle is going 50 km/hr than when it is going 30 km/hr (WHO 2004). Based on work by Anderson et al, 1997, Figure 22 shows that less than 5% of pedestrians are likely to die as a result of a collision when it occurs at speeds below 30 km/hr; this rate rises to about 25 percent at 40 km/hr and about 85 percent at speeds of 50 km/hr. The greatly increased probability of death or serious injury when hit by a vehicle travelling 50 km/hr compared with 40 km/hr provides compelling evidence to reduce the typical city-wide speed limit in Toronto from 50 to 40. A pedestrian hit while a vehicle is going at 60 km/hr or more is unlikely to survive.

In another study, the UK Department of Transport found that the risk of pedestrian death in crashes rises from 5% at about 30 km/h, to 45% at about 50 km/h, and 85% at about 65 km/h (Pucher and Dijkstra 2003),findings that again demonstrate the greatly increased risk with traffic speeds of 50 km/hr or higher.

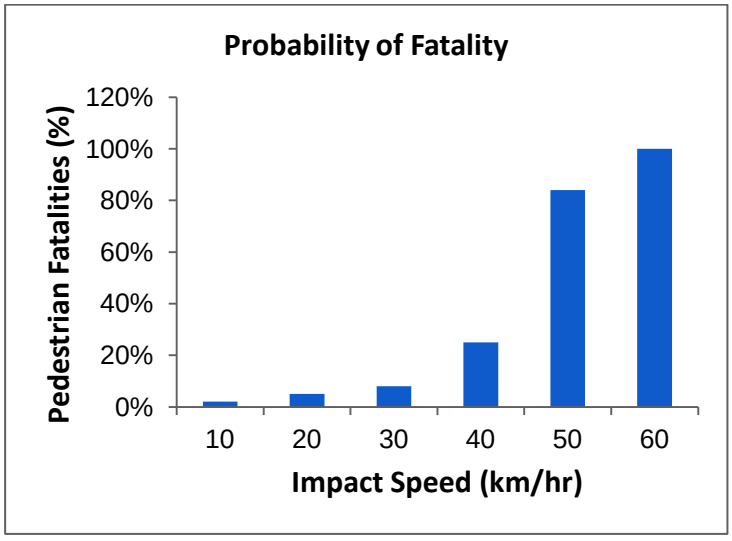


Figure 22: Probability of Pedestrian Fatality by Impact Speed
Source: Derived from Anderson et al. 1997

Some pedestrians are at greater risks than others. For example, pedestrians over 65 are about five times more likely to die as a result of a collision than children under 14 (WHO 2004).

A review of 19 traffic-calming initiatives in four European countries found that injuries caused by collisions for all road users fell by 41-83%, while fatalities dropped by 14-85% (Preston 1995). After 30 km/h zones were introduced in London, these zones experienced a 42% reduction in fatalities (Grundy et al. 2009). In 1988 the Town of Baden, Austria restricted speeds to 30 km/hr to about 75 percent of its road network. This and other measures reduced the rate of casualties by 60 percent (WHO 2004). New York City is now piloting reduced neighbourhood speed zones, with speed limits of about 30 km/hr.

Traffic calming

Traffic calming strategies generally feature physical treatments that reduce vehicle speeds, as noted in the City of Toronto's 2010 Traffic Calming policy. Physical treatments such as road narrowing, curb bulges, traffic islands and medians have been demonstrated to effectively reduce vehicle speeds (Transport Association of Canada and Canadian Institute of Transportation Engineers 1998). Innovative uses of landscaping, signage, and pavement markings can also narrow roads and reduce vehicle speeds at low cost. Traffic calming strategies may also include reduction of speed limits and increased enforcement of existing speed limits.

Figure 22: Traffic calming using curb extensions, pavement markings, speed bumps and signage
Source: Wikipedia 2012 (left), stock.xchng 2007 (right)

Traffic calming can significantly reduce the total number of collisions, injuries, and fatalities. Traffic calming can also help to promote increased levels of walking and cycling. Traffic calming increases the speed of walking and bicycling relative to the speed of driving, and also increases the safety of walking and bicycling (Pucher *et al.* 2010). In Hilden, Germany, widespread automobile speed restrictions led to a significant increase in bicycling (Pucher *et al.* 2010). Area-wide traffic calming has been extensively used in France, the United Kingdom, and Switzerland as part of overall strategies to increase the use of walking and cycling for transportation (Gagnon and Bellefleur 2011).

In Toronto, speed humps are frequently used to reduce vehicle speeds on residential streets. However, there are a number of ways in which traffic calming can be further used to improve safety for cyclists and pedestrians in Toronto. Options can be evaluated and implemented based on the specific needs of roadway users. For example:

- Toronto can reduce speed limits on streets with high pedestrian collision and injury rates (e.g. major arterial roads), and increase enforcement of existing speed limits.
- Toronto can reduce speed limits on streets that form part of the bicycle network (either on major arterials with bike lanes, or on local streets without bike lanes intended for bicycle traffic).
- Toronto can develop additional bicycle routes on local streets where traffic calming is already implemented (see *Bicycle boulevards* section below*).*

- Toronto can implement physical measures such as curb extensions, traffic islands and landscaping at intersections (see *Safer intersections* section below*).*

Separation from traffic

Cycling and walking are safer and more enjoyable if cyclists and pedestrians are well separated from traffic for the entire length of their journey. The extent and continuity of sidewalks are associated with increased walking and reduced pedestrian-vehicle collisions (Hess *et al.* 1999). In residential and mixed residential neighbourhoods in the US, pedestrian crashes were more than twice as likely to occur at locations without sidewalks as would be expected on the basis of exposure (Knoblauch *et al.* 1988).

Well-connected and high quality bicycle facilities are also essential to improving safety and attracting new people to bicycling (Dill 2009, Titze *et al.* 2008). Bicycle facilities that separate cyclists from motor vehicle traffic are strongly associated with increased levels of cycling (Pucher *et al.* 2010), and reduced crashes and injuries (Reynolds *et al.* 2010). In the City of Portland, the 210% increase in cycling from 1991 to 2004 is linked to two key factors: the quality of cycling facilities; and the completeness of the bikeway network, including clear connections and near-continuous service. Where the bikeway network was not well connected and not of the highest quality, bicycle use essentially remained at the levels that existed prior to network expansion (Birk and Geller 2005).

For pedestrians, Toronto has a fairly complete sidewalk network and a large number of off-road paths. Toronto has also developed the PATH network, the largest underground shopping complex in the world. The PATH network provides a climate-controlled environment for year-round use by 100,000 daily commuters, and thousands of additional tourists and residents (City of Toronto 2012).

While the City maintains an extensive network of approximately 7,900 kilometres of sidewalks, there is still a lack of sidewalk continuity in many areas. Over 1,600 km of sidewalks are missing from Toronto's local roads, and over 450 km of local roads are missing sidewalks on both sides of the road. These roads are almost exclusively located in North York, Scarborough and Etobicoke-York (City of Toronto 2011). In locations where sidewalks are missing, pedestrians often have no alternative but to walk on unimproved shoulders that may be inaccessible in the winter, or on the roadway (City of Toronto 2011). The City's Missing Sidewalk Program is working to gradually fill in these gaps.

Toronto is also making progress towards a full, connected set of bike paths and lanes. However, Toronto lags behind other cities in providing cyclists with connected facilities that separate them from traffic. Toronto has fewer kilometres of bike lanes per resident than other Canadian cities. As of 2010, Toronto had 17 km of bicycle lanes per 100,000 residents. Montreal and Vancouver had 28 and 38, respectively.

Toronto's bike lanes were described as "poor" by 54% of Torontonians and 64% of Toronto cyclists. Over 70% of Torontonians – those who already cycle for transportation and those who do not – reported that separating bike lanes from traffic would most improve cycling in Toronto (Ipsos-Reid 2009). Toronto's on-street bicycle lanes and routes are also commonly critiqued for being neither continuous nor connected (City of Toronto 2011). Improvements to cycling facilities are also needed to reduce the 30% of Toronto collisions that involve sideswiping, car doors, and rear-ending.

As demonstrated in **Table 9**, Montreal and Vancouver have used different strategies to create connected bicycle facilities that separate cyclists from traffic. Montreal has invested heavily

in separated bike lanes on major arterials, while Vancouver has developed a connected network of traffic-calmed, bicycle-oriented local street bikeways (bicycle boulevards). Toronto has 14 km of separated facilities in development but does not yet have any separated bike lanes built at this time (City of Toronto 2012).

Table 9: Kilometers of roadway/pathways with cycling infrastructure in Toronto, Montreal and Vancouver as of 2010*****

Data: City of Toronto Transportation staff (2012), Ville de Montreal (2010), City of Vancouver Bicycle Program Coordinator (2012)

City	Separated bike lanes	On-street bike lanes	Off-road paths	Marked shared lanes (sharrows)	Local street bikeways	Total	Kilometers per 100,000
Montreal	249 km	94 km	84 km	0[1] km	0 km	528 km	28
Toronto	0	113 km	191 km	9 km	147 km	460km	17
Vancouver[2]	6 km	30 km	41 km	10 km	134 km	221 km	38

*The values in Table 9 represent approximate kilometers of roadways and pathways with bicycle lanes. A one kilometer path or road with two-way cycling infra-structure is counted as 1 km.

1. Montreal primarily uses sharrow markings in intersections
2. Estimates based on data on one-way lane-kilometers

Toronto's 2011 bikeway strategy includes the construction of an additional 100 km of off-street trails along rail, hydro corridors, ravines and valleys to serve as the backbone for bicycle transportation across Toronto, particularly in the suburbs. It also includes the completion of "critical on-street bike lane connections where the community supports them and where they do not impede traffic flow, including a separated bike lane network downtown" (City of Toronto Transportation Services 2011b).

A complete bikeway network that combines off-street trails, separated bike lanes and on-street connections would have the potential to dramatically improve cycling in Toronto. However, this strategy disregards the importance of major arterials to cyclists, and the large number of collisions on these streets. In addition, the "critical on-street bike lane connections" that link trip origins, off-street trails, and destinations are essential to the network's connectivity – and to the viability of cycling in Toronto (Birk and Geller 2005). This is particularly important in the suburbs, where cycling is rare and high-speed vehicle traffic dominates.

To develop these links, Toronto can use a variety of innovative options that consider cyclists' needs and local roadway conditions. Cyclists' needs are primarily affected by vehicle speeds and volumes; they may also be affected by roadway and lane widths, pavement quality, on-street parking, construction, and other roadway obstructions. The different roadway conditions in Toronto's core versus in the suburbs will create different opportunities and constraints.

Several on-road options to link trip origins, trails and destinations are presented below.

Separated bike lanes (cycle tracks). "Separated bike lanes" are lanes on major roads that are exclusively for bicycle use and are separated from motor vehicles by a curb or other physical barrier. They provide riders with greater confidence and significantly reduce collisions. Based on surveys, separated bike lanes are viewed as being equally desirable as off-street paths, a testament to their perceived safety (Winters *et al.* 2011).

In New York City, the installation of cycle tracks decreased injuries to cyclists and pedestrians by 57% and 29%, respectively (District Department of Transportation 2011). Studies in London found that new cycle tracks decreased the rate of bicycling crashes and increased the number of cyclists on the roadway by 58% over 3.5 years (Pucher *et al.* 2010).

Bicycle lanes that are separated from cars by concrete curbs are estimated to cost $470,000 per kilometre on existing roads, or $320,000 when as part of a road reconstruction project (Toronto Coalition for Active Transportation 2011). However, less expensive options for separating cars from bicycles have been used in other cities. In Washington D.C., bike lanes are separated from parked cars and moving traffic by yellow posts. **Figure 23** (right) illustrates the use of posts to separate bike lanes from traffic.

Buffered bicycle lanes. Buffered bike lanes can also improve on-street separation of cyclists from traffic at low cost. With buffered bike lanes, conventional on-street bike lanes are paired with painted, designated buffer spaces separating the bike lane from the adjacent motor vehicle travel lane and/or parking lane (National Association of City Transportation Officials - NACTO 2011) (**Figure 23**, left).

Coloured on-street bike lanes. In cities including New York and Vancouver, on-street bike lanes are brightly painted to visually reinforce the separation of areas for motorists and cyclists. Though few studies have evaluated the impact of coloured lanes, it is consistent with the research by Retting et al. (2003) that increasing the visibility of bike lanes would also increase safety for cyclists. Anecdotally, most cyclists believe4that the green paint is more effective at keeping cars from parking in bike lanes than regular striping (NYC Department of Transportation 2011). Coloured bike lanes can also be used in combination with buffered or separated bike lanes (**Figure 23**).

Figure 23: Buffered bike lane (left) and separated, coloured bike lane (right)
Source: NACTO 2011

Bicycle boulevards. Bicycle boulevards (also known as “greenways” or local street bikeways) are low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming, signage and pavement markings, and intersection crossing treatments (IBPI 2009). Bicycle boulevards may also include contra-flow bicycle lanes that allow cyclists to ride in the opposite direction of motor vehicle traffic. They convert a one-way traffic street into a two-way street: one direction for motor vehicles and bikes, and the other for bikes only (NACTO 2011). Studies have found that some cyclists go out of their way to use bicycle boulevards, particularly women and less-experienced cyclists (Winters and Teschke 2010, Dill and Gliebe 2008). They may also encourage new cyclists. In a survey, 42%

of residents reported that living on a bicycle boulevard makes them more likely to bicycle (VanZerr 2010).

Re-allocating space from motor vehicles to active transportation

Separating pedestrians and cyclists from traffic often requires reallocating space from motorized vehicles to pedestrians and cyclists. This is particularly relevant to the City of Toronto. According to City of Toronto Transportation Services (2011b), there are few remaining opportunities to accommodate bicycle lanes on Toronto roadways without reducing traffic capacity or on-street parking. Consequently, in both the downtown and the suburbs, safe cycling facilities will likely require the reallocation of roadway space from on-street parking or motor-vehicle traffic to cyclists.

Re-allocating space from motor vehicles to pedestrians and cyclists need not mean increased traffic (or congestion) for motorists. In a study of 62 roadway reallocation projects in eleven countries, 51 of the 62 cases showed a traffic decrease as the overall result, with 11% reductions on average (Cairns *et al.* 2002). There may be reports of short-term problems and problems on particular streets. However, most transportation staff reported, "a lot of the traffic seems to have disappeared, and we don't know where it has gone" (Cairns *et al.* 2002, p.14). These results indicate that people have a wide range of behavioural responses: some may simply change their route or their time of travel, while others may change their means of travel, the frequency of travel, or their destination.

In Vancouver, the installation of separated bicycle lanes on Hornby Street had little effect on vehicle travel times along the street. Only the northernmost block of Hornby Street had increased delays, averaging 30 seconds in peak periods (City of Vancouver 2011).

In New York City, a bold program to reallocate space has transformed Times Square and Herald Square into pedestrian plazas. The change has increased the number of pedestrians by 11% in Times Square and has decreased injuries to motorists and passengers by 63% in the project area. It has also reduced traffic congestion in the area and increased travel speed along most routes. Finally, the scheme has broad public support; 74% of New York residents agreed that Times Square has improved dramatically as a result of the change (New York City DOT 2010).

The Toronto Centre for Active Transportation reports that many Toronto residents are in favour of roadway re-allocations that favour pedestrians and cyclists. In Bloor West Village, nearly half (48%) of those who usually drive to the neighbourhood reported that they would prefer a more pedestrian- or cyclist-oriented street, even if it meant removing on-street parking (TCAT, Forkes and Smith Lea 2010). In a survey of visitors to Toronto's Annex neighbourhood, 62% of people were most in favour replacing on-street parking with bike lanes on Bloor Street compared to other alternatives including the status quo, and an additional 16% were most in favour of widening sidewalks at the expense of on-street parking. Almost 75% of business owners and managers thought that their business would improve or stay the same with these changes (Sztabinski 2009).

Safer intersections

Improvements to intersections can reduce collisions and injuries for pedestrians and cyclists alike (Retting *et al.* 2003). Interventions to improve safety at intersections generally fall into three categories:

- Traffic signal phases
- Physical interventions
- Roadway and intersection markings.

As presented in Appendix B, 47% of collisions between pedestrians and motor-vehicles could be prevented through improved safety at intersections in Toronto. 37% of collisions between cyclists and motor vehicles could be prevented through improved safety at intersections. The City of Toronto is already making efforts to improve intersection safety:

- Since 2006, the City has installed pedestrian countdown signals at over 2,100 intersections (TCAT 2010).
- Beginning in 2007, signalized intersections were being converted to permit longer pedestrian crossing time based on a reduction in presumed pedestrian walking speed from 1.2 m/second to 1.0m/second.
- Red light cameras have proven to reduce injury collisions attributed to red light running by more than 60 percent. There are currently approximately 87 red light cameras operating at Toronto signalized intersections.
- Three busy downtown intersections in use at Yonge/Dundas, Bloor/Yonge and Bloor/Bay intersections currently have a Pedestrian Priority Phase, or "pedestrian scramble".
- Pedestrians also now receive a head start at the intersection of University Avenue and Adelaide Street West (thanks to a "leading pedestrian interval" signal phase).
- "Bicycle boxes" were implemented at five intersections in 2010 and 2011 in Toronto's downtown-west end area.

To improve safety at intersections, Toronto can continue to experiment with different treatments of intersections for pedestrians and cyclists, monitor outcomes, and roll-out effective options in a systematic way. The City could consider a wide range of promising options that have been demonstrated to improve safety. These options are discussed below. Some of these options require only surface coatings, and are therefore available at relatively little cost.

Traffic signal phases

Pedestrian scrambles. Pedestrian scrambles–already in use at the Yonge-Dundas, Bloor-Yonge, and Bloor-Bay intersections-provide an all way stop for motor vehicle traffic to allow pedestrians to cross in all directions. Pedestrian scrambles were found to cut the risk of pedestrian-vehicle collisions in half (Zegeer *et al.* 1982).

Leading pedestrian signal intervals. With a leading pedestrian signal interval (LPI), the WALK sign is turned on 3-5 seconds before the green light, so that the first vehicle intending to turn right or left has improved visibility and yielding response time for pedestrians that have already started to cross. In a US study, LPIs reduced the odds of conflict with turning vehicles by 95% at the beginning of the walk phase (Van Houten *et al.* 2000).

In Cambridge, Massachusetts, pedestrians receive a head start at almost all intersections where vehicles and pedestrians move at the same time. The WALK signal comes on a few seconds in advance of the green light.

Bicycle phases. Separate traffic signal phases can provide time for cyclists to cross an intersection without motor vehicle traffic. A study in Davis, California, found that bicycle phases dramatically reduced automobile bicycle collisions. There were 10 collisions near a focus intersection in the 35 months before the installations of a bicycle phase; in the 35 months following installation there were no collisions at this same intersection (Korve and Niemeier 2002).

Leading bicycle signal intervals can also provide a "head start" strategy for cyclists and can be expected to yield a similar reduction in collisions at signalled intersections.

Physical interventions

Curb extensions. Curb extensions (curb bulbs) reduce crossing distances, provide more pedestrian storage space, slow vehicles and allow pedestrians and approaching vehicles to see each other (Retting *et al.* 2003).

Medians and refuge islands. Refuge islands and raised medians can lower pedestrian-car collision rates on multilane roads (e.g. Zegeer *et al.* 2001).

Crosswalk lighting and signage. Clear lighting of crosswalks can improve safety for pedestrians. In two studies, in-pavement flashing lights that were automatically activated by the presence of pedestrians reduced vehicle speeds and conflicts at crosswalks (Retting *et al.* 2003). Simple advance warning signs for drivers to "Yield to Pedestrians" have been shown to reduce pedestrian crashes by 10% (Lynott *et al.* 2009).

Roadway and intersection markings

Crosswalk markings. Modifications to pavement markings around crosswalks may improve safety for pedestrians. For example, simply repositioning stop lines further from crosswalks has also been show to increase the distance between pedestrians and halted cars in the US (Retting and Van Houten 2000). Textured and coloured markings can also improve safety at crosswalks, as recognized by Toronto's 2006 zebra crossing policy. As of 2010, 300 intersections had zebra crosswalk markings installed in the City of Toronto.

Intersection markings for cyclists. Pavement markings through intersections indicate the intended path of bicyclists through an intersection and raise awareness of potential conflict zones. The appropriate markings vary based on the intersection, but may include dashed lines, coloured boxes, chevrons and/or shared roadway markings. Blue cycle crossings in Portland, Oregon were estimated to reduce accidents by 10% and injuries by 19% (Jensen 2008). They also increased cyclists' confidence and increased the number of motorists that yielded to cyclists from 72% to 92% (Hunter et al, 2000).

Through bike lanes or combined bicycle lane/turn lanes. Different types of lane markings can be used to delineate the space for bicyclists and motorists as they approach an intersection. Combined bicycle/turn lines use dotted lines within the shared lane to indicate the intended path for through bicyclists (**Figure** , left). "Through bike lanes" provide cyclists with a dedicated lane to enter intersections to the left of right turning vehicles, and are generally the preferred option (**Figure** , right). In Toronto, many bicycle lanes simply disappear before intersections. Terminating bike lanes in advance of intersections is discouraged (NACTO 2011). City of Toronto recognizes the benefits and has installed some markings of this type. The concept has been incorporated into Toronto's the bikeway design and could be expanded and improved so that designs are more consistent City-wide.

Figure 25: Combined bicycle / turn lanes (left) and "through" bicycle lanes (right)
Source: NACTO 2011

Bicycle boxes (a.k.a. advanced stop lines) accompanied by educational marketing. Bicycle boxes are painted pavement markings that give cyclists a dedicated space to wait at a signalized intersection, in front of cars. Cyclists in bike boxes get a head start at signals, are more visible and are less likely to be cut off or hit by vehicles. In New York City, the 204 bicycle boxes are also painted bright green to increase visibility.

In Portland, observations revealed an improvement in motorists yielding to cyclists at bike box locations (Dill *et al.* 2012). Most cyclists report feeling safer with bike boxes (Pucher *et al.* 2010, Dill *et al.* 2012). The majority of motorists in Portland also reported that bike boxes made driving safer (Dill *et al.* 2012).

However, without education and marketing, cyclists will not understand the purpose of the bike box and will not feel confident using them (Hunter 2000). NACTO (2011) also recommends that bike boxes be accompanied by signs that reinforce that bicyclists have the right-of-way going through the intersection.

Making active transportation more attractive

In order to increase active transportation mode shares, the City of Toronto could take additional action to make walking and cycling more attractive. Toronto could seek to improve the speed and comfort of walking and cycling routes, and improve access to transit and to end-of trip facilities. The City could also use media, marketing and education programs to overcome social barriers to the use of active transportation (Titze *et al.* 2008, Edwards and Tsouros 2006).

Route quality and speed

Walking and cycling are generally the fastest modes of travel for short trips in urban areas (up to 5 km in length). Toronto can further increase the relative speed of active transportation by developing shortcuts and routes with minimal stops. Pedestrian and cyclist-only shortcuts can shorten trips significantly, particularly in areas where streets have low connectivity, long blocks and/or dead ends (Walker 2009). Bikeway routes may also seek to follow roads with fewer traffic signals. A decrease in the number of stops along a route increases bicycling along the route (Rietveld and Daniel 2004).

However, people's decisions about mode of travel are not just about speed – they are also about comfort and enjoyment of travel. People will not walk unless the experience is

positive. In Toronto, additional effort is needed to ensure that walking and cycling routes are safe, comfortable and enjoyable year-round. The walking and cycling surveys indicate the importance of pavement quality, snow clearance and lighting:

- Repairing potholes and bad pavement ranked second on Torontonians' wish list for improving cycling in Toronto, right behind separating bike lanes from car traffic.
- 39% of Torontonians who do not ride in the winter reported that they would ride more often with safer, cleared bike lanes and paths.
- 38% of Torontonians reported being very unsatisfied or somewhat unsatisfied with the Toronto's sidewalk snow clearance. Satisfaction with Toronto's sidewalk snow removal is significantly lower among older adults (Harris-Decima 2008)
- 17% of Torontonians report being very unsatisfied or somewhat unsatisfied with lighting on Toronto's walkways and paths, and 16% report dissatisfaction with sidewalk maintenance and repair.

In other cities, pavement quality and snow clearance have been identified as important predictors of the use of active transportation. Street lighting can increase pedestrian street use after dark, reduce crime and reduce fear of crime (Painter 1996).

Quality walking and cycling surfaces. Pavement quality is very important to cyclists' rating of road segments (Landis *et al.* 1997). The number of cyclists on a path in London doubled after the path was resurfaced Pucher *et al.* 2010). Paved routes are preferred over unpaved routes, especially by people who cycle frequently (Winters and Teschke 2010).

Sidewalk quality is also important to pedestrians, particularly to those with limited mobility. Paths that are sufficiently smooth, sufficiently wide and have turning radii adequate for a wheelchair or walker are needed to support walking among elderly and disabled people (City of New York 2010).

Snow clearance. Clearance of snow and ice from sidewalks and roads is a key enabler of safe, enjoyable walking in winter. Elderly people and people with impaired mobility are particularly vulnerable in snowy or icy conditions; elderly pedestrians are overrepresented in winter collisions and in winter injuries from falls (Zegeer *et al.* 1993, Merrild and Bak 1983).

Snow clearance is also an important enabler of cycling in winter. Winter reductions in cycling may be countered by snow clearing and sanding or salting of ice along cycling routes, dedicated bike lanes, bike-friendly transit, and education about how to ride safely in inclement weather (Winters *et al.* 2007). For example, Minneapolis has a policy of clearing snow from off-street trails soon after the end of a snowfall – generally, in less than 24 hours. The off-road bicycle paths that form the backbone of their bikeway network can thus be used all year long. Minneapolis has very high rates of winter cycling.

Transit integration

All aspects of the Greater Toronto Area's transportation system will face increasing stress as 100,000 people move to the area each year. Avoiding doomsday predictions of total gridlock in the City of Toronto will require significant investments in regional transit, active transportation, and modal integration (Kalinowski 2011a).

The integration of transit and active transportation is particularly important given the increasing number of trips that start or end outside the City of Toronto. Between 1985 and 2006, the number of inbound vehicle trips between 6:30 and 9:30am increased by 75%, and outbound vehicle trips increased by 79% (City of Toronto Planning 2007). Many of these

vehicle trips are too long to be made by walking or cycling alone, but could effectively be replaced by active transportation in combination with transit.

Replacing segments of transit trips with walking and cycling trips can also help to ease the increasing strain on Toronto's struggling public transit system. According to Metrolinx predictions, transit trips through Union Station — already the country's busiest transit hub — could nearly triple by 2031 (Kalinowski 2011b).

Research supports the possibility of increasing walking-transit trips through targeted investment in the comfort and convenience of these integrated trips. Creating safe, visible and comfortable transit facilities can support increases in transit use - and therefore in walking to transit (Sutherland and Carlisle 2007, Wener and Evans 2007). Almost all transit users in Toronto walk to and from transit (92%), so it is critical that Toronto ensure safe and convenient pedestrian access to transit.

There is also substantial evidence that better integration of bicycling with public transport leads to more "bike and ride" trips, and probably to more bicycling overall (Pucher *et al.* 2010). Toronto surveys suggest that improving the convenience of bike-and-ride trips could dramatically increase bike-and-ride trips in Toronto. For example, almost three quarters of Toronto cyclists (74%) and more than half of recreational cyclists (66%) report that they would combine cycling and transit more often if stations featured secure bicycle parking (Ipsos-Reid 2009).

The City of Toronto is already taking action to support active transportation in and around transit, particularly in the downtown area:

- The PATH underground walkway system integrates walking, local transit and regional transit.
- The new bicycle station at Union Station provides secure bicycle parking and other cycling-related services to Toronto residents and commuters.
- Streetcars and subways allow bikes during off-peak hours, and the TTC Rack It Rocket program is aiming to install bike racks on all buses by the end of 2012.

Toronto can build on these exciting efforts with additional investments in transit station areas, in bus stops and in secure bicycle parking. Of course, these efforts must be accompanied by investments in the public transit system itself.

Secure bicycle parking. A study of pilot projects in the Netherlands in the 1990s found that bicycle parking significantly increased bicycle trips between homes and rail stations (Martens 2007). In the Washington D.C. area, bike-and-ride trips increased by 60% between 2002 and 2007 after the Washington Metropolitan Area Transit Authority invested in bicycle parking at Metrorail stations (DDOT 2011). All stations in the Area now have bicycle racks and almost 50 stations have bicycle lockers available for rent.

Transit station areas. The Ministry of Transportation of Ontario's (2012)Transit-Supportive Guidelines provides detailed recommendations for enhancing pedestrian and cyclist access in station areas, including:

- Treating the sidewalks in and immediately adjacent to a station as a pedestrian priority area, with appropriate snow clearance, lighting, seating, waste receptacles and landscaping.
- Avoiding cycling barriers such as curbs or stairs where possible.
- Keeping pedestrian and cyclist access routes separate to minimize conflicts.

Bus stops. The City of New York (2010) recommends bus bulbs and wider sidewalks at bus stops to better accommodate pedestrian traffic and transit use. Bus shelters with seating or places to lean are important for accommodating the elderly and other users who have trouble standing for extended periods.

End-of trip facilities

Secure bicycle parking and showers are important enablers of cycling, particularly to work and to school. An analysis of UK National Travel Survey concluded that universal outdoor bicycle parking would raise the bicycle commuting mode share from 5.8% to 6.3%, secure indoor parking would raise the mode share to 6.6%, and indoor parking plus showers would increase it to 7.1% (Wardman *et al.* 2007). In Calgary, 88% of commuter cyclists use some type of change room or shower facility (City of Calgary 2007).

In Toronto, 68% of work/school cyclists report having access to convenient and secure bicycle parking, as compared to only 46% of recreational cyclists. 57% of cyclists report that secure indoor bicycle parking would improve cycling in Toronto a great deal, and 39% said the same about shower / change facilities. 45% of non-cyclists and 43% of recreational cyclists stressed the importance of secure indoor bicycle parking (Ipsos-Reid 2009).

The Toronto Green Standard will dramatically improve the availability of end-of-trip facilities in new developments. In place since 2010, it requires that new developments meet requirements including:

- Cycling infrastructure—provision of short-term bicycle parking, long-term bicycle storage, and shower and change facilities
- Pedestrian infrastructure—provision of sun and weather protection for pedestrians, building integration with walking routes, grading and surface treatment, signage, lighting, and separation from vehicular routes and air intake or exhaust systems
- Transit accessibility—provision of building integration with transit facilities, proximity to transit service, and direct pedestrian linkage to transit

The City can continue to require, encourage and promote the provision of secure bicycle parking and access to shower facilities in public spaces and in existing private developments.

Marketing and education programs

While interventions in the built environment generally receive greatest attention, it is also critical to understand barriers to physical activities that are rooted in people's attitudes and habits (Lavizzo *et al.* 2003). Marketing and education programs to promote walking and cycling play an important role in overcoming barriers to cycling and walking that go beyond the physical environment (Pooley *et al.* 2010, Pucher *et al.* 2010).

Toronto has developed a number of marketing programs for cycling including: Bike Month, Cycling Ambassadors, Bicycle-Friendly Business Awards, and the Kids CAN-BIKE camp. Toronto also launched a public bike system (BIXI) in May, 2011, that has resulted in over 420,000 cycling trips to date. Toronto's programs to promote walking include numerous promotions during bike month, pedestrian newsletters, pedestrian pilot projects, walking tours and street festivals, promotion of Explore Toronto's parks and Trails and Discovery Walks maps, Toronto Public Health's Walk into Health Program and the pedometer lending program at Toronto Public Library.

However, Toronto can do more to develop marketing programs that cost-effectively increase walking and cycling, improve safety and reduce car use. Toronto could also consider the role of the primary and secondary school system in promoting safe, healthy and sustainable transportation.

Marketing programs

Media campaigns, special events, trip reduction programs, individualized marketing programs, incentive programs, bicycle access programs and travel awareness programs can all be used to shift car trips to transit, walking, and bicycling. For example:

- Bike-to-Work days have been associated with long-term increases in cycling. In San Francisco, bicycle counts remained 25.4% higher for one month after a Bike-to-Work event; in Victoria, Australia, over one quarter of first-time cyclists were still bicycling five months later (Pucher *et al.* 2010).
- Marketing programs in South Perth, Australia, increased public transportation by 17%, cycling by 61% and walking by 35% among area residents - changes that were sustained two years after the program ended (Thogersen 2007).
- Community-level marketing programs in Portland and in Washington State have contributed to long-term increases in the share of trips made by walking, bicycle and transit (Cooper 2007, Pucher *et al.* 2010).
- Signage for pedestrians and cyclists can provide directions, distances and times to various destinations. They can also encourage people to walk an extra transit stop or two (City of New York 2010).
- In the BikeBusters bicycle access pilot program in Arhus, Denmark, participants were given a new bicycle and bus tickets free for a year, in exchange for signing a contract promising to reduce driving. Bicycling for everyday trips increased from 8% to 40%, while bicycling to work increased from 15% to 60% (Pucher *et al.* 2010).

Because of their relatively minimal cost, marketing programs are extremely cost-effective, particularly at the city- or community-level (UWE and Cavill and Associates 2007). One study found benefit-cost ratios exceeding 20:1 (Buchan 2009). The UK reported that walking information packs and the Sustainable Travel Towns marketing programs reduced car use at a cost of $63 to $69 CAD per 1,000 car kilometres (Ashcroft *et al.* 2011).

Mass-media marketing is being effectively and creatively used in a number of Canadian cities. For example, in Ottawa, the iWalk iBike social marketing campaign challenges residents to leave their cars at home and try active forms of transportation. The campaign includes widespread advertisements that underscore the advantages of walking and cycling instead of driving. The campaign also features an interactive website where residents can register and track their distance travelled, calories burned, reduction in greenhouse gas emissions, and money saved by using less fuel. Residents can earn badges for their active trips, and can monitor citywide reductions in car trips. The total cost of Ottawa's iWalk iBike campaign is only $90,000, $40,000 of which is covered by a grant from Ontario's Transportation Demand Management Municipal Grant Program.

Education programs

Safe, healthy transportation habits can start at a young age. In both Germany and the Netherlands, curriculum-based education on safe walking and cycling encourages habitual and safe active transportation in the next generation of citizens. All schoolchildren have received extensive instruction on safe walking and cycling by age 10. In addition to learning traffic regulations, they learn how to walk and bike defensively, and how to anticipate and react to dangerous situations (Pucher and Dijkstra 2003).

Other Canadian cities are looking to Europe's educational programs for inspiration. In Montreal, curriculum-based cycling education is now reaching a small (but growing) percentage of elementary school children. In Vancouver, the Cycling Training for the School Community (CTSC) program promotes active transportation by offering bicycle commuting training to Vancouver teachers, support staff and school administrators.

In the Netherlands and Germany, rigorous driver education also contributes to safe walking and cycling conditions. Car drivers must assume that pedestrians and cyclists will make unsafe (and illegal) moves in traffic, and are required to anticipate such unsafe moves. The ability to anticipate potentially unsafe moves by pedestrians and cyclists is included in the driver's license exam (Pucher and Dijkstra 2000).

Enabling active transportation through land-use planning

The City of Toronto can increase the feasibility of walking and cycling for all Torontonians by promoting higher density, mixed-use neighbourhoods with high street connectivity and pedestrian-friendly urban design in Toronto's high-growth areas – as envisioned in the city's Official Plan and supported by tools such as the Streetscape Manual.

Destination accessibility, street connectivity, density, and urban design

Land use patterns play an important role in enabling active transportation, since trip distance is often the most significant limiting factor. This is particularly relevant for walking trips. Trip origins and destinations are more likely to be sufficiently close together in neighbourhoods with more destinations and a greater mix of land uses, in neighbourhoods with connected, grid-like street layouts, and in higher density neighbourhoods.

There is substantial evidence to support these trends. For example, in Montreal, women aged 45 and older living in neighbourhoods with higher "destination density" were 53% more likely to walk at least 30 minutes per day, 5 days per week (Gauvin *et al.* 2008). In the United States, increasing the number of business types in a neighbourhood from three to four increases the number of walking trips by 24% (Boer *et al.* 2007). One study found that urban sites with small blocks and extensive sidewalk systems had, on average, three times the pedestrian volumes of suburban sites with long blocks and short, incomplete sidewalk systems (Hess *et al.* 1999). The Transportation Research Board (2009) concluded that doubling residential density reduces household vehicle miles traveled (VMT) by 5-12% in the US. When combined with mixed-use developments and improvements to public transit and employment concentration, VMT reductions reach 25%[8].

There is also evidence that street-level urban design significantly increases levels of walking and cycling (Forsyth *et al.* 2008, Larsen *et al.* 2009, Ewing and Handy 2009). Pedestrian-

[8] Though reductions in VMT are not directly associated with increases in walking and cycling, they are linked.

friendly streetscapes often include public spaces, benches, fountains, restrooms, art installations, vegetation and effective exterior lighting. The City of Toronto's Streetscape Manual and Vibrant Streets Guidelines (for street furniture) help guide the quality of design and experience of the city's streets and built environment for pedestrians. Trees and vegetation can provide shade and separate pedestrians from traffic. Benches, drinking fountains and restrooms are particularly important for seniors (Lockett *et al.* 2005).

In Toronto, the different land use patterns in the core and in the suburbs lead to dramatic differences in walkability **Figure 26** illustrates the "walkability" of different areas in Toronto based on a land use index that considers: land use mix (destination accessibility), intersection density (route connectivity), residential density, and floor-to-area ratios for retail land (residential and retail density). The former City of Toronto features more mixed use neighbourhoods with high connectivity, high residential density, and high retail density – factors that increase "walkability".

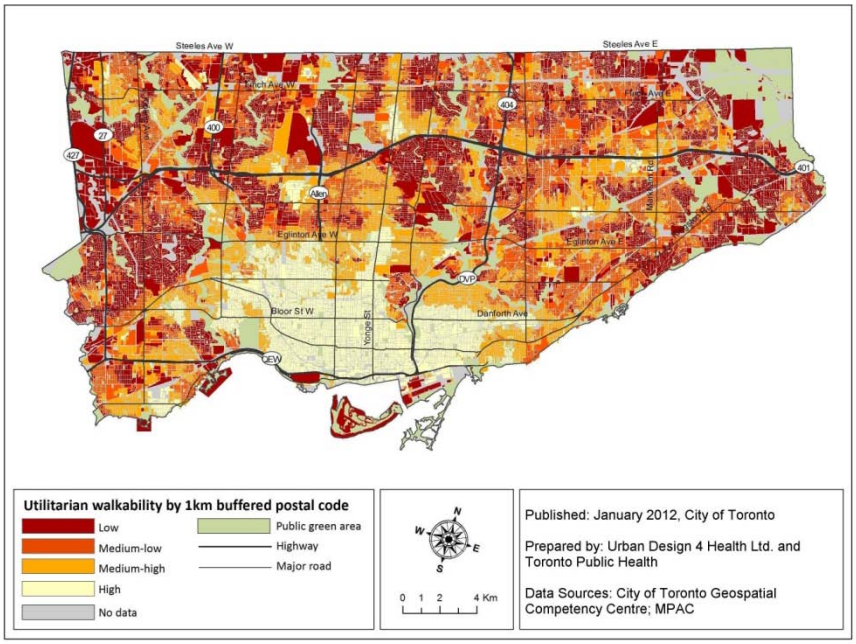


Figure 26 Walkability in Toronto based on the UD4H walkability index
Source: Urban Design 4 Health (UD4H) and Toronto Public Health (2012)

Neighbourhoods in the former City of Toronto also tend to feature highly engaging streetscapes and pedestrian-friendly urban design. In contrast, many neighbourhoods in the suburbs are characterized by wide streets, long city blocks with little visual richness, and few engaging public spaces (Chapter 3).

Efforts to enable long-term increases in active transportation will be most effective if they also focus on land use. In Toronto, the greatest opportunities exist in the 25% of the City where the most growth will occur over the next 30 years: Toronto's five "Centres" (Downtown/Waterfront, Scarborough Centre, North York Centre, Etobicoke Centre and Yonge-Eglinton Centre), Avenues, Employment Districts and Port Lands. The Official Plan's (2010) goal of focusing growth into a pattern of compact mixed use communities and corridors is well aligned with increases in active transportation mode shares.

Toronto can build off of the City's Green Standard and ensure that walking and cycling are enabled by land use and roadway design in all of the areas targeted for growth. Toronto can

also invest in gradual revitalization and redevelopment in the low-walkability neighbourhoods that are home to large numbers of low-income households (Chapter 4). "Mainstreet" programs, business improvement areas, grants, and incentives can increase jobs and destinations in Toronto's least walkable neighbourhoods. For example, in Washington D.C., the Great Streets Initiative is a multi-agency effort to transform nine under-invested corridors into thriving neighbourhood centers through investment in mixed use development projects, storefront improvements, transportation, streetscape, and transit improvements (District of Columbia 2012).

These types of efforts are supported – and required – under the Government of Ontario's Growth Plan for the Greater Golden Horseshoe Area**.** The 2006 Growth Plan is a regulatory regional planning framework that requires the development of vibrant, compact, mixed use, transit-supportive communities with pedestrian-friendly urban environments and high quality open spaces. Planners must offer multi-modal access to destinations, and provide connectivity among modes (Government of Ontario 2006).

Making active transportation more accessible

The City could make special efforts to ensure that safe walking and cycling is accessible to all Torontonians by developing affordable housing in central areas, improving walking and cycling infrastructure in areas with vulnerable users, and developing programs to promote walking and cycling at the community level.

Walking and cycling facilities for vulnerable users

Interventions that increase the year-round safety and convenience of walking, cycling and transit use tend to support non-drivers and economically disadvantaged people (Martens 2006). Unfortunately, as discussed in Chapter 4, Toronto's current active transportation patterns and facilities appear to create transportation and health inequalities. Young pedestrians in Toronto appear particularly likely to be hit by motor vehicles, while elderly pedestrians are particularly at risk of being killed. Toronto's low-income neighbourhoods may also have lower levels of walkability and bikeability.

To improve health and transportation equity, Toronto could prioritize the development of safe walking and cycling facilities for vulnerable users: young people, older adults, and residents of low-income neighbourhoods. Traffic calming strategies are particularly valuable for the elderly, for children and for other vulnerable users (City of New York 2010, Preston 1995). Traffic calming in the UK was associated with an increase in the proportion of children walking to school (UK Department for Transport 2010).

In areas around schools and with large numbers of senior citizens, it is also important to provide continuous sidewalks cleared of snow, generous crossing times, and appropriate pedestrian-scale lighting and signage (City of New York 2010, OPPI 2009a, 2009b). In Toronto, older adults are significantly less likely to be satisfied with intersection crossing times and snow clearance (Harris-Decima 2008).

In New York City, the Age-Friendly City initiative will lead to a wide variety of physical transformations to improve city life for older adults. Initiatives will include: more seating in bus shelters, more public restrooms, more elevators and escalators, "age-friendly" parks, and improved safety at intersections. Three neighbourhoods have been named Aging Improvement Districts as part of a pilot program to implement changes requested by seniors.

The initiative has also won eager cooperation from local businesses, institutions and elected officials (Herndon 2012).

Toronto may also seek to address equity concerns by improving walking and cycling environments in and around low-income neighbourhoods. Safe walking and cycling routes could be developed to connect residents to destinations in their neighbourhood and in adjacent areas of the city. Additional crosswalks may also be needed in the outer areas of Toronto where long city blocks lead to higher rates of jaywalking, and pedestrian-vehicle collisions at mid-block locations (Hess et al. 1999, Hess and Farrow 2010). Unsafe intersections and crossings could be identified and enhanced, and streetscape improvements could be prioritized in communities where benches, trees, and human-scale design are particularly lacking. Finally, the City can address safety concerns at night by improving lighting on paths and around transit.

In Montreal, the "Quartier 21" programme provides funding to community groups to improve safe and active transportation in low-income neighbourhoods. Each year, four projects are awarded grants totalling $130,000 over a three-year period (Ville de Montreal 2012).

Affordable housing in vibrant communities

Residents of multi-modal communities with high destination accessibility tend to spend less time and money on transportation. However, high demand may reduce housing affordability in these same communities unless special efforts are made to ensure a supply of lower-priced housing (Malefkalazi 2010).

These trends are apparent in Toronto, where many low-income families often live in the outer areas where active transportation is least feasible. Toronto's housing market is among the least affordable in Canada, second only to Vancouver. High prices and low rental vacancy rates are particularly problematic in the (walkable and bikeable) former City of Toronto (Toronto Community Foundation 2011). Toronto could make a special effort to increase the supply of affordable housing in neighbourhoods with high destination accessibility. Increasing the supply of affordable housing in walkable and bikeable locations may help to address health disparities (Chapter 4).

Different types of strategies could be used. For example, inclusionary zoning requires or encourages developers of market residential projects to construct some proportion – generally 10 to 25% – for affordable housing. Inclusionary zoning is used by 200 or so municipalities in the United States.

In Minneapolis, the Corridor Housing Strategy aims to foster affordable housing growth along the city's transit corridors, using three innovations:

- Planning – giving neighbourhood organizations an early and comprehensive role in planning affordable housing development.
- Site acquisition – acquiring critical sites on transit corridors.
- Funding – awarding priority housing funding to development that is tied to jobs and transit (City of Minneapolis 2011).

Culturally competent community-based programs

Well-designed programs to increase physical activity in low-income communities have successfully increased walking, and had associated social benefits. For example, a walking

promotion program in a low-income housing complex in Seattle sponsored walking groups, improved walking routes, advocated for pedestrian safety, and provided information about walking options. Walking group participants increased their walking levels from 65 to 109 minutes per day and also reported an increase in the number of neighbours they knew (University of West of England and Cavill and Associates 2011).

However, planners must focus on "culturally competent" planning – planning that begins by understanding active transportation from the perspectives of these communities (Day 2006). For example, do people travel to shopping and other destinations in groups? Are safety concerns a limiting factor? For efforts that focus on specific minority populations, there is a need for a delicate balance between embracing group customs and values, and recognizing the non-monolithic nature of any group (Yancey 2006). Communities themselves should be centrally engaged in developing strategies to support active living, and planners should provide a menu of program choices to fit different needs (Day 2006).

In Toronto, CultureLink, a settlement organization, is among the organizations seeking to promote healthy lifestyles in immigrant neighbourhoods. The City could do more to promote and enable active transportation in low-income and immigrant communities. In a survey conducted by the Community Cycling Centre in Portland, 60% of respondents expressed concern about the cost of a bicycle, indicating that such an expense would be outside their means (Ersoz 2011). In Toronto, programs that connect low-income families to free or low-cost bicycles or Bixi memberships may significantly reduce this first and most formidable barrier to cycling for transportation.

Implementing coordinated packages of actions

The City can maximize results by ensuring that its actions are integrated and coordinated. Multi-level interventions that target individuals, social environments, physical environments and policies can best achieve population-level changes (Sallis *et al.* 2004). A coordinated package of complementary infrastructure measures, programs, and policies may enhance the impact of any intervention that is a component of that package (Pucher *et al.* 2010).

For example, in the City of Paris, there was a 150% increase in the bicycle share of trips in only six years – the bicycle share of trips increased from 1% in 2001 to 2.5% in 2007. This dramatic increase can be linked to a number of coordinated actions:

- The bike lane network more than tripled from 122 km to 399 km from 1998 to 2007. Bicycling parking also tripled between 2000 to 2007.
- The City implemented extensive traffic-calmed areas, car-free zones, narrowed roadways and widened sidewalks, and "civilized travel corridors" of restricted motor vehicle access.
- The Velib bicycle sharing program started in 2007, and is now the world's largest bicycle sharing program (Pucher *et al.* 2010).

In the UK, the Sustainable Travel Towns Initiative led to a 9% decrease in the number of car driver trips, a 10-13% increase in walking trips, and a 26-20% increase in cycling trips by residents of the Sustainable Travel Towns. Walking and cycling to school increased by up to 7%, and average distances walked by residents increased by 18-27% (Sloman *et al.* 2010). The Initiative included a suite of programs including improvements to pedestrian infrastructure and the public realm; personalized, school and workplace travel planning programs; and cycling and walking media promotion and brand identity.

The City of Whitehorse's 2006-2007 Wheel 2 Work program included a four-month marketing campaign and a $2 million municipal infrastructure investment. Interventions in the built environment included: improved trail linkages between downtown and residential areas, a new pedestrian and bicycle bridge, improved lighting and staircases, on-street bike lanes, and new artisan-designed bicycle racks in the downtown area. Marketing and education included: incentive prizes for cycling to work, online bicycle route maps and safety information, bicycle maintenance and repair workshops, and improved safety signage for bicycles along major arterials. In 2006, 40,000 km of bicycle travel were logged, offsetting 4.5 tonnes of GHG-eq. (Ministry of Municipal Affairs and Housing and Ontario Professional Planners Institute 2009).

Prioritizing Transportation Infrastructure Funding in Toronto

Finally, the City can maximize the tremendous potential health benefits of walking and cycling by prioritizing its investments in transportation infrastructure. As discussed in Chapter 2, only 5% of the total capital expenditures for Transportation Services are dedicated to improvements in walking and cycling infrastructure.

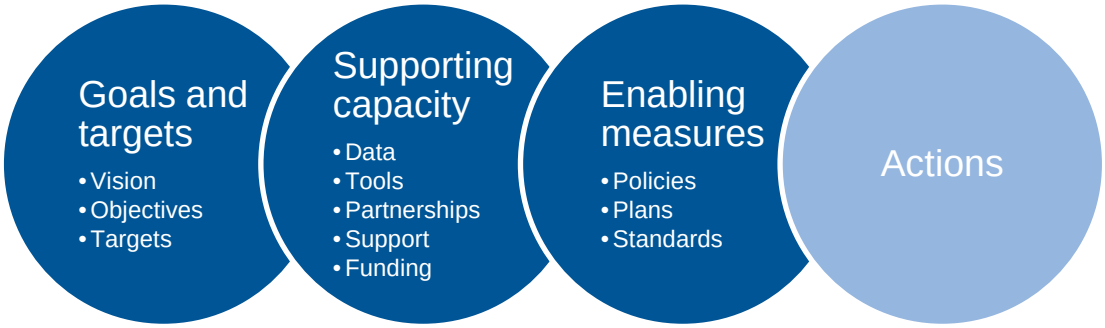
Other cities who have invested in infrastructure are outpacing Toronto. For instance, the City of Montreal has made significant investments to improve conditions for cycling, and this has yielded impressive results. The combined mode split in Montreal is 11%, about 3.2% higher than in the City of Toronto.

Chapter 5 Findings

- **In order to improve public health, Toronto should make targeted efforts to increase safety for pedestrians and cyclists. Toronto could also work to make walking and cycling more attractive, more feasible, and more accessible to residents across the city; increases in safety and in mode share tend to go hand-in-hand.**
- **Safety for Toronto users of active transportation can be improved through targeted action to reduce vehicle speeds, separate cyclists from vehicles, improve intersections for pedestrians and cyclists, and increase safety on major arterials.**
- **Many of these options require only pavement markings or signs, and are relatively inexpensive to implement (e.g. new approaches to bike lanes at intersections, new speed limit signs). Others are more expensive but important for Toronto to keep pace with other cities (e.g. separated bike lanes).**
- **The City can also increase the attractiveness of active transportation by improving snow clearance, pavement quality, short-cuts, and lighting; by improving access to transit and end-of-trip facilities; and by developing marketing and education programs.**
- **In order to make active transportation feasible for all Torontonians, the City can invest in mixed use, compact communities in high-growth areas and gradual redevelopment of neighbourhoods with low walkability and bikeability.**
- **Making active transportation accessible to residents of all ages, abilities and incomes will require targeted investments in walking and cycling facilities, in affordable housing in accessible locations, and in community-based programs.**
- **Coordinated packages of interventions in the built environment and in the social environment can produce the greatest results.**
- **The City can also maximize the tremendous potential health benefits of walking and cycling by prioritizing its investments in transportation infrastructure.**

6. Facilitating effective action in Toronto

This chapter draws on interviews with municipal staff in other jurisdictions to identify strategies and capacities that underpin effective action on active transportation. It discusses the role of visions, goals and targets, and enabling policies, plans and standards. It also discusses the role of data, evaluation tools, partnerships, community support and funding in enabling effective implementation.



Setting goals

Toronto's 2009 Walking Strategy articulates a well-developed vision of a city with a culture of walking, where streets, parks, public spaces and neighbourhoods are accessible, secure, vibrant and enjoyable so that people choose to walk more often, including in combination with other sustainable modes of travel. The 2001 Bike Plan identifies the vision of a "safe, comfortable and bicycle friendly environment in Toronto, which encourages people of all ages to use bicycles for everyday transportation and enjoyment". Toronto needs to continue to set goals to guide and expand its actions on walking and cycling from 2012 onwards.

Developing quantitative goals that are supported by Council, by City staff, and by community stakeholders have helped other cities increase their effectiveness in promoting safe walking and cycling. For example:

- Chicago's goals are to increase bicycle use so that 5% of all trips less than 8 km are by bicycle; to reduce the number of bicycle injuries by 20% from current levels, and to increase the number of bike-transit trips by 19% each year (City of Chicago 2006).
- New York City's goal is to reduce traffic fatalities by 50% by 2030 (New York City DOT 2012).
- Calgary's goal is to increase the downtown walking mode share to 11% and the downtown cycling mode share to 4% by 2020 (City of Calgary 2009).

Developing plans, policies and standards

In many other cities, policies and standards ensure that the needs of pedestrians and cyclists are consistently considered in planning and decision-making at all scales – from the city- and community-scale, down to the street- and site-level.

For example, the City of Toronto could proactively identify opportunities for pedestrian and cyclist facilities as part of every road reconstruction or resurfacing project. Every "secondary land use plan" is an opportunity to specifically address the needs of pedestrians, cyclists, and users of all ages and abilities. As of 2006, few Toronto secondary plans addressed active transportation (Hess and Milroy 2006). Zoning bylaws, site plan controls, and development permit systems are tools that can be used to ensure that active transportation is routinely considered in decision-making (MMAH and OPPI 2009).

Policies and standards can also be designed for adaptability to different areas of a city. For example, New York City is developing different "complete streets" design templates for different streets, ranging from walking-only streets to major bus and truck routes (NYC DOT 2008). This approach may be particularly relevant to Toronto. As described in Chapter 4, land use patterns, roadway design, and current levels of walking and cycling are dramatically different in the former City of Toronto and in the suburbs. In downtown Toronto as in New York City, not all roads can feature a bike lane, dedicated transit lane and lanes for motor vehicles; considering the needs of all roadway users may thus involve eliminating car travel from some streets and improving conditions for car travel on others.

Priorities for improving pedestrian and cyclist safety may also be dramatically different in the central and outer areas. For example, in outer areas, safe, visible crosswalks may be needed to reduce collisions along long city blocks. In inner areas, leading pedestrian phases may be needed to reduce conflicts with returning vehicles. The City can consider these differences in developing policies, plans and standards.

Collecting better information

Existing Toronto data sources do not provide a clear picture of the number of people who walk and cycle, the frequency with which they walk and cycle, or the distances walked and cycled. This is not a unique situation. In many North American cities, professionals doubt that available data can produce reliable estimates of current levels of walking and cycling (Fenton and Junot 2010). According to City of Portland staff, "one of the greatest challenges facing the bicycle and pedestrian field is the lack of documentation on usage and demand" (Birk and Geller 2005).

Without accurate and consistent data, it is very difficult to measure the benefits of investments in walking and cycling, including public health benefits. Better information on walking and cycling travel patterns can also improve infrastructure and program planning, help to prioritize walking and cycling routes, and enhance a city's ability to track changes over time. Finally, data on walking and cycling demand and use can help in evaluating the adequacy of funding of these modes.

Bicycle facility planning and evaluation in Toronto could be significantly enhanced through regular data collection on cycling across the city. The downtown screenline bicycle count conducted in September 2010 provided a valuable baseline of cycling in the downtown core. However, it was not repeated in 2011, nor was it accompanied by counts of cyclists outside the downtown core. Toronto's annual downtown bicycle count could be supplemented with additional data:

- Manual or automated bicycle counts in locations across the city
- Regular counts for all bike lanes and paths, including "before" and "after" counts for new lanes and paths.

For example, in Vancouver, manual bicycle counts are regularly conducted at more than 100 key intersections throughout the city, and eight permanent bike counters supplement this manual data. The City is further seeking to develop a comprehensive cycling monitoring program to provide baseline data to define the next 10-year Cycling Program Master Plan, to enable timely reporting of cycling statistics, and to allow successful evaluation of the new Cycling Plan (City of Vancouver 2010).

Data on walking and cycling in Toronto is severely limited by the Transportation Tomorrow Survey's exclusion of walking trips other than to work or to school. New types of data and uses of data could also enhance pedestrian project planning including:

- Discretionary walking trips in the Transportation Tomorrow Survey could help to address the deficit of data on walking in Toronto.
- Mid-block counts on streets across Toronto could provide a useful supplement to current counts of pedestrians at intersections.

Finally, Toronto has very few data on walking, cycling, collisions and injuries among low-income, immigrant and minority groups. Toronto also has limited qualitative information on barriers and perceptions of active transportation in different parts of the city. Both qualitative and quantitative data can help planners develop infrastructure and programmatic measures to support transportation and health equity. The improved understanding of travel patterns and barriers can also help planners engage with communities on priority issues and partner with appropriate community organizations.

Tools to improve decision-making

The use of walking and cycling-specific modeling tools can increase the likelihood that infrastructure investments deliver the maximum benefits (Moudon and Lee 2002). The general scarcity of walking and cycling evaluation tools is particularly notable when compared to the decades of experience modeling demand, usage and benefits of other modes (Birk and Geller 2005).

Different types of new and modified tools are needed. For example:

- Cost-benefit and cost-effectiveness evaluation tools that consider a broader range of costs and benefits, including those related to health.
- Tools that evaluate the quality of walking and cycling routes and identify intersections and road segments for safety audits.
- Transportation models that assess latent demand for walking and cycling, and forecast increases in demand.
- Models that consider a wide range of behavioural responses in assessing the impacts of interventions (e.g. roadway re-allocation projects), based on evidence from other cities.
- Tools that evaluate the impacts of land use and development on opportunities for active living.

Like other types of decision support tools, these tools alone are a starting point. They can identify problem areas, and point towards the type of infrastructure that is appropriate in a given location. They can more accurately assess the importance of investment in active transportation. Finally, they can provide a shared starting point for conversations about problems, priorities and solutions.

For example, Copenhagen developed a simple tool to evaluate the need for separated bike lanes (cycle tracks) and on-street bike lanes based on daily motor vehicle traffic and posted speed limits (F**igure 27**). The model states that below speed limits of 40 km/h and vehicle traffic of 2,000 vehicles per day, cyclists ride in mixed traffic. Cycle tracks are developed on high speed roads with relatively low traffic (e.g. 55 km/h and 6,000 vehicles per day), and on lower speed roads with very high traffic flows (e.g. 35 km/h and 12,000 vehicles per day).

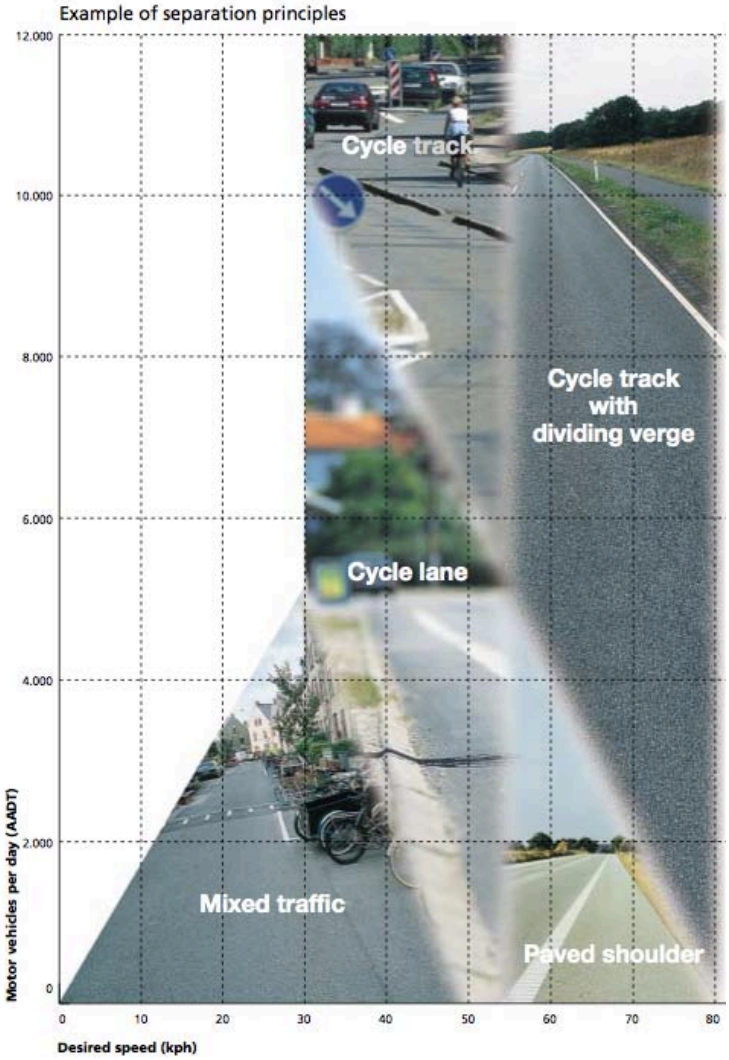


Figure 27 Tool to plan cycling facilities in Copenhagen based on vehicle speed and volume
Source: Jensen 2000

In many cities including Portland and Washington D.C., evaluation tools also link collision analyses to project prioritization for improvements to intersections, crosswalks, and sidewalks:

- The City of Portland developed the "*Pedestrian Potential Index*" and the '*Pedestrian Deficiency Index*" to highlight priority areas for improvements in the walking environment. The *Pedestrian Potential Index* on a given roadway segment is determined using proximity to pedestrian "attractors/generators", anticipated growth in population and employment density near the location, and scheduled transportation improvements. The *Pedestrian Deficiency Index* identifies problematic roadway segments based on sidewalk characteristics, traffic, crossing conditions and historical collisions.
- Washington D.C.'s 2009 Pedestrian Plan identified eight high priority corridors (one in each ward) using modified versions of the *Pedestrian Potential Index* and the *Pedestrian Deficiency Index*. Recommendations for improvements included sidewalk repair and construction, relocation of bus stops, signalization changes, and reduced crossing distances at intersections. The use of the two indices helped the transportation department identify and prioritize projects with the maximum potential benefit (Washington transportation staff 2011).

Finally, several municipalities have adopted tools that specifically consider how planning and development decisions affect opportunities for active living and active transportation. For example, San Francisco's Healthy Development Measurement Tool assesses how urban planning affects community health. The Tool includes a checklist of over 100 community health indicators, and a menu of policies and design strategies.

Enhancing partnerships

Collaboration across municipal government increases the likelihood of developing a common vision, securing solutions that address this vision and implementing actions needed to implement that vision (MMAH and OPPI 2009). Efforts to enable active transportation are thus enhanced through cooperation between municipal planning, transportation, public health, housing, social services, and parks departments (Edwards and Tsouros 2006).

The health sector is well positioned to lead collaborative initiatives to promote active transportation. In New York City, the public health department played a key role in coordinating and advancing the Active Design Guidelines, developed in partnership with Design + Construction, City Planning, and the Office of Management and Budget. All departments were able to rally around the goals of reducing congestion, improving health and/or improving environmental sustainability, and provided diverse technical knowledge that was important for success (New York City public health staff 2011).

Public health departments can also develop and implement their own initiatives that are complementary to the work of other departments. In Minneapolis, the public health department's community active living programs is coordinated with planning and transportation programs but are run separately (Minneapolis transportation staff 2011).

Finally, public health departments can recommend that health benefits and risks be considered in transportation and land use decisions. Public health practitioners can work with transportation engineers and city planners to develop tools that evaluate health benefits and risks, and can facilitate conversations about the factors that promote safe walking and cycling.

Building community support

The private and voluntary sectors are important potential partners in promoting active transportation (Edwards and Tsouros 2006). Cities including Calgary and Seattle have effectively used community engagement, outreach to local businesses and the energy of the non-profit sector to generate support and resources for active transportation projects (Calgary transportation staff 2012, Seattle Department of Transportation 2011).

In Toronto, residents and business owners are generally supportive of investments in walking, cycling and the public realm. For example, two studies conducted in Bloor Street West neighbourhoods indicate that visitors, residents, business owners and managers recognize the value of walking and cycling for the local economy and quality of life (Sztabinski 2009, Forkes and Smith Lea 2010). Toronto's non-profit organizations dedicated to walking and cycling are also valuable potential partners.

Finally, municipal experience indicates that engaging community stakeholders can reduce time wasted on conflict (MMAH and OPPI 2009). For example, the success of traffic calming projects often relies on the involvement of community members in decision-making (City of Calgary 2006). Engaging stakeholders in the earliest stages of active transportation project planning reduces the likelihood of opposition from local groups (NIMBY-ism) and increases the likelihood that the project parameters will meet the needs of all stakeholder groups.

Seeking funding from other levels of government

The Ontario Ministry of Transportation is increasingly recognizing the value of active transportation. Last year, the Government of Ontario's Transportation Demand Management (TDM) Municipal Grant Program awarded grants of up to $50,000 to 21 municipalities for TDM, including active transportation (for a total investment up to $1 million). Nonetheless, the City of Toronto remains primarily responsible for planning and funding improvements to active transportation infrastructure.

The City of Toronto's investments undoubtedly pay off as walking and cycling projects improve quality of life, enhance the city's competiveness, and reduce the strain on the transportation system. However, the health benefits and avoided costs of increased physical activity from walking and cycling are primarily accrued at the provincial and federal levels through reduced health care costs.

The City of Toronto could seek funding from the provincial government for investments in walking and cycling that reduce mortality, chronic disease, and health care costs. The City could also use its influence to push for changes to provincial health and transportation legislation, funding, and programs to support cost-effective investments in active transportation. Finally, the City could work with provincial and federal government agencies to develop new programs that enable municipal innovation and leadership in healthy community planning, transportation equity and active transportation infrastructure.

A number of federal, provincial and state programs in Canada and the United States aim to promote active transportation by providing funding for municipal action. Some focus on land use and street-level planning while others support investment in infrastructure and programs. Examples are highlighted below.

Quebec Route Verte. The Government of Quebec collaborated with Velo Quebec to invest $88.5 million over ten years to create a 4,000 km bikeway all throughout the province, making it the most extensive bicycle route in all of North America. The Ministry of Transportation administers the Route Verte construction assistance program that provides funding for up to 25% of the eligible costs of the project.

British Columbia BikeBC. Bike BC is a $31 million program with the objective of improving cycling infrastructure across British Columbia. It includes the Cycling Infrastructure Partnerships Program (CIPP), a cost-shared program for the construction of new transportation cycling infrastructure. All British Columbia municipalities and regional districts are eligible to apply for up to $100,000 in CIPP funding.

U.S. Partnership for Sustainable Communities. The US Partnership for Sustainable Communities is collaboration between the U.S. Departments of Housing and Urban Development, Transportation and the Environmental Protection Agency. The Partnership offers grants for integrated sustainable community planning, emphasizing the importance of investing in healthy, safe and walkable neighbourhoods; allowing people to live closer to jobs and school; and increasing regional sustainability.

Minnesota Statewide Health Improvement Program. Minnesota's Statewide Health Improvement Program (SHIP) awards grants to fund projects that promote physical activity and health at the community- or population-level. Examples include: interventions to offer more time in physical education, community design to promote biking and walking, and policy changes to provide time off during working hours for physical activity.

U.S. Safe Routes to School. In 2005, the US federal government established a grant program to support projects that improve the safety of walking and biking routes and encourage children and parents to walk and bike between home and school. As of 2011, 11,371 schools in 50 states have participated. Though few studies have measured the program's effects, in a California study, a parental estimate suggested 10% increases in walking and bicycling for participating schools, and also decreases in injury rates (Orenstein *et al.* 2007).

Benchmarking other jurisdictions

The City of Toronto's Official Plan (2010) describes a successful city as "one with a competitive advantage over others locally, nationally and internationally. It has a quality of life that will attract and retain people who have capital, skills, knowledge, ingenuity and creativity." Benchmarking the active transportation plans, policies and standards in other jurisdictions in Canada, the United States and Europe could help to enhance Toronto's competitive advantage.

Toronto may be inspired and challenged by the aggressive plans of other cities – for example, New York City plans to redesign almost 100 km of streets for greater pedestrian safety as part of their goal of reducing fatalities by 50% (NYC DOT 2012). Through benchmarking and review of best practices in other jurisdictions, Toronto may also be able to implement the actions and measures that have proven most effective in other cities – both those that are relevant to Toronto's downtown and those that relevant to the suburbs. Toronto may improve its ability to monitor the health and transportation impacts of actions using methods pioneered in other cities. Finally, Toronto may be able to build the case for investment in active transportation based on the outcomes of action in other cities.

Chapter 6 Findings

- **In cities including Montreal, Chicago and New York, goals and targets for active transportation safety and/or mode shares have served as important stimuli for action. Toronto could set new targets for active transportation safety and mode share.**
- **New policies and standards could enable action by requiring that walking and cycling are considered in planning and decision-making at a variety of scales.**
- **Cities including Vancouver have recognized the importance of high-quality data for effective investment in walking and cycling. Toronto could enhance planning, monitoring and evaluation by improving the quality of data on walking and cycling.**
- **Cities including Portland have also adopted transportation planning tools that are specifically designed to assess latent demand for active transportation and to evaluate the need for improvements to walking and cycling environments.**
- **A number of public health departments are now working closely with the transportation, planning and other municipal departments to achieve integrated, coordinated action on active transportation.**
- **Involving community stakeholders in planning and decision-making also has the potential to generate widespread support for progressive actions.**
- **Many provincial, state and federal governments have developed programs to fund improvements in walking, cycling and public health, as the economic benefits of active transportation are shared across levels of government.**
- **Reviewing active transportation policies, plans, and actions in other cities may help Toronto to enhance its competitive advantage.**

Conclusions

This report concludes that increased City of Toronto investment in the safety, attractiveness and feasibility of walking and cycling can be expected to improve public health in Toronto. The major research findings are as follows:

There is clear evidence that physical activity from active transportation generates very important health benefits. Physical activity from active transportation reduces the risk of cardiovascular disease, diabetes, cancer, and numerous other diseases, leading to significant reductions in the risk of all-cause mortality. Increasing walking and cycling mode shares and safety can also improve quality of life, reduce travel times, and improve the sustainability of Toronto's struggling transportation system.

Walking and cycling prevent an estimated 120 premature deaths each year, yielding annual benefits of over $100 million. Large increases in mode share – and in the associated health benefits – are very feasible given Toronto trip distances. Toronto lags behind other leading North American cities in active transportation mode share, despite the fact that 55% of all trips are conducive to active transportation. By achieving Vancouver and Portland's walking and cycling commuting mode shares (12% and 6%, respectively), Toronto could prevent an estimated 100 additional deaths each year.

The health benefits of active transportation are not evenly distributed across Toronto. In the former City of Toronto, destinations are closer together, street blocks are shorter, and levels of walking and cycling are over three times higher than in the suburbs, where many of Toronto's high-rise and low-income neighbourhoods are located.

Walking and cycling in Toronto is more dangerous than in other Canadian cities. Though Toronto has made progress in reducing collision rates, pedestrians and cyclists are still disproportionately at risk of injury and fatality due to collisions; pedestrians are particularly

vulnerable. We estimate that Toronto could save dozens of lives and avoid over $60 million in costs by improving the active transportation safety.

Many interventions have the proven potential to increase walking and cycling safety and mode shares, and yield associated public health benefits. Actions related to traffic calming, intersection improvements, and separated walking and cycling facilities have the demonstrated ability to reduce collision and injury rates. They also contribute to mode share increases. Some of these actions can be implemented at minimal cost; for example, intersection markings for pedestrians and cyclists require only surface coatings. Marketing and education programs are also important, cost-effective enablers of safe active transportation, and are particularly successful in combination with action in the built environment. Targeted actions to address the needs of vulnerable users can improve transportation and health inequalities.

Effective goals, standards, data, evaluation tools, and collaboration can facilitate action to improve walking and cycling. Many cities have adopted ambitious safety and mode share goals, and have developed supporting policies and standards that require consideration of the needs of walkers and cyclists in decision-making. Many cities have also enhanced their capacity to promote active transportation by improving the quality of walking and cycling data and evaluation tools. Many cities have received funding from provincial and federal governments, who share in the economic benefits of improved public health. Finally, many cities have enhanced collaboration across municipal departments, and have generated widespread support for progressive actions by involving community stakeholders in planning.

Going forward, Toronto planners and policymakers should consider the health impacts of transportation decisions. This report provides a starting point for valuing the health benefits of walking and cycling, and for investing in interventions that cost-effectively improve public health. Toronto planners can also learn from other North American cities that have successfully improved health and quality of life by enabling safe walking and cycling for transportation.

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Appendix A. Methodology for quantifying health benefits

A.1. Overview of health benefits and quantification tools

Calculating mortality reduction: WHO Health Economic Assessment Tools

HEAT for cycling is designed for adult populations age 20-64. The relative risk estimate was derived from three combined cohort studies that controlled for leisure time physical activity as well as for socioeconomic variables (age, sex, smoking, etc.) The studies yielded a relative risk of all-cause mortality of 0.72 for cycling 3 hours per week, 36 weeks per year, at 14 km/h. This means that, in any given year, regular cyclists were 28% less likely to die from any cause than non-cyclists with similar characteristics and levels of leisure time activity.

HEAT for walking is designed for adult populations aged approximately 20-74 years. This is the age range for which the relative risk estimate used by the tool is applicable. The tool applies to walking at a pace that achieves health benefits (of at least 4.8 km/hour) and is designed for habitual behaviour rather than for one-time walking events. The relative risk estimate was derived from fifteen studies that reported associations between walking and reduction in all-cause mortality. For a walking exposure of 29 minutes seven days per week, aggregated relative risk for all cause mortality was 0.78 (0.64-0.98 with a 95% confidence interval).

Both tools use a linear dose-response relationship between walking/cycling and mortality across the range of likely behaviours. For example, people who cycle 1.5 rather than 3 hours per week are 14% less likely to die from any cause, rather than 28%. To avoid inflated estimates at high levels of walking and cycling, risk reduction reaches a maximum of 50% in HEAT. This is based on currently available studies that conclude that regular physical activity usually does not reduce all-cause mortality by more than 50%.

The HEAT tools for walking and cycling use the following input data on walking and cycling:

- An estimate of how many people are walking or cycling. We include only walking and cycling by residents 20-74 years of age for walking, and 20-64 years of age for cycling.
- An estimate of the average annual duration or distance spent walking or cycling. Distances are converted to durations based on assumed paces of 4.8 km / hour (walking) and 14 km / hour (cycling). Again, we include only walking and cycling by residents 20-74 years of age for walking, and 20-64 years of age for cycling.

The HEAT tools also require the mortality rate, value of a statistical life, and time period of benefits. We use the following inputs:

- Mortality rate (age 20-74). We were unable to find Canada- or Toronto-specific mortality rates for age 20-74. However, we did find World Health Organization data for all countries on mortality for adults age 15-60. For this age range, Norway's mortality rate is very close to Canada's (WHOSIS 2011). We thus use Norway's mortality rate of 224.98 per 100,000 adults age 20-74 (provided within the HEAT tools).
- Time period of benefits and discount rate. We calculate benefits over a single year. The discount rate is therefore not relevant.

A.2. Toronto data sources

2006 Transportation Tomorrow Survey. The Transportation Tomorrow Survey uses telephone interviews that cover 5% of the population to gather data regarding weekday travel patterns of Torontonians. The Survey uses interviews with one members of a household to record trips made by all members of a household over the previous 24 hours. The Transportation Tomorrow Survey uses telephone interviews that cover 5% of the population to gather data regarding weekday travel patterns of Torontonians. The Survey uses interviews with one members of a household to record trips made by all members of a household over the previous 24 hours. The survey covered 129,273 people age 12 and over, and these results were expanded to represent all 2,445,937 Toronto residents age 12+. The 2006 survey was conducted for weekdays in the months of September, October, November, December and January, excluding the holiday season, plus one week in May. The four major reasons that walking and cycling are underestimated in the 2006 TTS are as follows:

- TTS data aims to exclude walking trips other than to work and to school. Thus, TTS severely underestimates both the number of trips and the number of people making trips. However, some trips are captured by interviewers and included in the database.
- The survey is conducted in the fall and winter season and thus fails to capture the large number of Torontonians who only cycle in the summer and / or in good weather.
- “Discretionary” trips and walking and cycling trips are generally under-reported in oral surveys such as the TTS. A comparison of trip diaries and TTS oral surveys in Toronto indicated that oral surveys exclude almost half of “non home-based” trips, and 12% of “other” home-based trips (Halcrow 2008). Modes with smaller mode shares are also generally are under-counted by oral surveys such as the TTS (Halcrow 2008). These issues are further aggravated by the TTS’ reliance on a single household member to report on the trip making of all household members (Halcrow 2008).
- The sample lists used for the 2006 TTS include only persons living in households with listed telephone numbers. Residents age 18-24 have been consistently under-represented since 1996 as they substitute cell phones for landlines and do not appear on sample lists (Halcrow Consulting 2008).

2010 City of Toronto Downtown Bicycle Count. In 2010, the City conducted its first downtown bicycle count. This Count provides the first data on how many cyclists are riding on downtown streets, when and where they are riding, and other characteristics about cyclists such as helmet use, gender, sidewalk riding, and whether the cyclist is transporting a passenger. The Bicycle Count used screenlines that were selected to capture the large number of bike trips that begin and end within the central area of Toronto (Figure 1). The four screenlines that were used for the Bicycle Count are Bloor Street in the north, Spadina Avenue in the west, Queen's Quay Boulevard in the south, and Jarvis Street in the east (City of Toronto Transportation Services 2010). A map of the screenlines is included below.

Manual bicycle counts were collected by Ontario Traffic Inc. contract staff along the inside of the cordon at 34 locations (Figure 4), from September 13th to October 1st, 2010. The number of people riding a bicycle was counted at each location for one 12-hour period (7:00 AM to 7:00 PM) in 15-minute intervals, on one day when there was no precipitation. People on e-bikes were included in the count (City of Toronto Transportation Services 2010).

2008 Toronto Walking Survey and 2009 Toronto Bicycle Survey. The 2008 Walking Survey conducted by Harris-Decima (2008) included 1,000 Torontonians age 16 and over, fairly evenly divided between Toronto’s districts (Central Toronto-East York, Etobicoke-York, North York and Scarborough). The 2009 Bicycle Survey conducted by Ipsos-Reid included 1,000 Torontonians age 15 and over, equally divided between Toronto’s four districts.

A.3. Methodology used to estimate walking and cycling

We include three types of trips in our estimation of current levels of walking: trips to work, trips to school and trips to shopping and other destinations. Though trips to shopping and other destinations are not included in the TTS, the Walking Survey suggests that they are very important. We thus estimate walking patterns for three groups: people who walk to work and to other destinations, people who walk to school and to other destinations, and people who walk only to other destinations.

We include two types of trips in our estimation of current levels of walking: trips to work, and all other trips. We assume that only commuter cyclists travel close to year-round; for cyclists making other trips (including trips to school and occasional trips to work) we estimate a shorter cycling season. We thus estimate cycling patterns for two groups: people who cycle to work and to other destinations for a significant part of the year, and "seasonal cyclist" who cycle to a variety of destinations but only in the summer months.

We assume conservative average walking speeds of 4.8 km/h and cycling speeds of 15 km/h.

Walking and cycling to work

Number of people walking and cycling to work: The 2006 census provides information on the number of Torontonians who usually walk and cycle to work: 81,565 and 19,780, respectively.

Distance walked and cycled to work: Both the 2006 TTS and the 2008 / 2009 Walking / Bicycle surveys provide information on the average distance of walking and cycling trips to work. We take the more conservative of these two estimates. For walking, the survey-based average walking time of 12 minutes (1 km) is used rather than the TTS value of 1.3 km. For cycling, the TTS-based average cycling distance to work of 5.2 km is used rather than the survey-based average of 26 minutes (6.5 km).

Travel days per week: We assume that people who report "usually" walking and cycling to work (in the 2006 census) do so 4 days per week. This is a conservative estimate: on average, Torontonians travel to work 4.7 days per week (Harris-Decima 2008). In the City of Calgary, commuter cyclists report cycling to work 4.1 days per week, on average. We also assume that this group of commuters walks or cycles to shopping or to another destination once each week. This is further described under *Other walking trips* below.

Weeks per year of walking and cycling to work: We estimate that Torontonians who walk to work do so year-round except for two weeks of vacation (50 weeks per year). We estimate that Torontonians who cycle to work do so 36 weeks per year, based on the City of Calgary's 2006 survey of downtown cycle commuters. They report commuting 145 days per year on average, which equates to 4 days per week, 36 weeks per year.

Walking to school

Number of people walking to school and travel days per week: The 2006 TTS provides data on the number of people who walked to school on a given weekday. For the calculation of mortality reduction, we count only the Torontonians aged 20-74 who walked to school. We estimate that the students in this age group travel to school 3 days each week – less than the average of 3.9 times per week reported for all ages, as they often attend university or college (Harris-Decima 2008).

Combining this travel frequency with the 10,184 Torontonians who walk to school in a single-day based on the TTS, we calculate that 16,973 Torontonians aged 20-74 walk to school in a given week.

We also assume that this group of mature students walks to shopping or to another destination once each week. This is further described under *Other walking trips* below.

Distance walked to school: We use the average walking time of 8.9 min (0.7 km) from the walking survey rather than the TTS average distance of 1.1 km.

Weeks per year of walking to school: We estimate that all students walk to school 32 weeks per year.

Other walking trips

Number of people who walk to shopping and other destinations: The 2008 walking survey indicates that more than twice as many Torontonians use walking as the main mode of transportation to shopping as compared to work. 17% of survey respondents reported walking to shopping as their main mode of transportation, while only 7.3% reported walking to work as a main mode. Using this greater than 2:1 ratio, we estimate that 180,100 Torontonians regularly walk to shopping.

However, some of these people also walk to work and to school. We make the very conservative assumption that all of the people who walk to work and to school also walk to shopping. This still leaves over 80,000 people who only walk to shopping.

Travel frequency: We estimate that the people who walk only to shopping and for other discretionary trips travel twice each week. This is a very conservative estimate; in the Walking Survey, Torontonians report traveling to shopping 2.5 times per week on average, and to leisure activities 2.3 times per week.

We estimate that people who walk to school or to work make only one additional walking journey to shopping or leisure activities. (The second trip may be combined with a trip to or from work or school.)

Seasonal cycling (all other cycling trips)

Number of seasonal cyclists. We estimate seasonal cycling based on the Downtown Bicycle Count in combination with TTS data on relative cycling in the downtown vs. other areas.

The City of Toronto's 2010 bicycle screenline count recorded 19,162 cyclists entering the downtown core area depicted in Figure 28 below. We estimate that 40% of all City of Toronto cyclists that would be entering the downtown core using TTS data on the distribution of trips between residents of different planning districts. This is undoubtedly a conservative estimate as we assume that ALL trips made by residents of former Planning Districts 1 and 6 (map below) are to the downtown core. As seen in Figure 1, the boundaries of Planning Districts 1 and 6 extend far beyond the boundaries of the bicycle screenline count. According to the TTS, residents of Planning Districts 1 and 6 made roughly 38% of all cycling trips over a 24-hour period. (We assume that the relative number of cyclists in these planning districts is proportional to the number of trips.)

We subtract the number of regular cyclists from the citywide total to estimate the number of seasonal cyclists, and use data from the TTS to estimate that number of these seasonal cyclists that are 20-64 years of age. The bicycle count indicates that weekend cycling is about 45% lower than weekday cycling, so we estimate that the weekly volume is 6 times the single day weekday volume of 19,602. Number of "seasonal" cyclists = Total cyclists – commuter cyclists

Total cyclists on a single day = 19,162 inbound downtown / 38% = 50,426

Total seasonal cyclists on a single day = 50,426 – 19,780 = 30,646

Weekly volume = 28,582 * 6 = 183,878

Total seasonal cyclists if cyclists ride 3 days per week = approx. 61,292

We recognize that many assumptions underlie this estimate of occasional cycling. However, given the 2009 survey that suggests that 29% of all Torontonians age 16+ are utilitarian cyclists, we nonetheless feel that this is a conservative estimate of cycling in Toronto.

Travel days per week, and weeks per year. We use responses from the 2009 bicycle survey to estimate that these occasional cyclists not captured by the TTS only ride 3 days per week. This is a very conservative estimate, as Toronto cyclists report cycling to shopping alone an average of 2.6 days per week. In addition, 11% of all respondents reported cycling to work and to school and most of these cyclists are not captured by the census data on cycling to work (Ipsos-Reid 2009).

Distance cycled. We use the TTS average cycling trip distance of 3.9 km for seasonal cycling. This is a shorter distance than the average travel times suggested the 2009 Bicycle Survey.

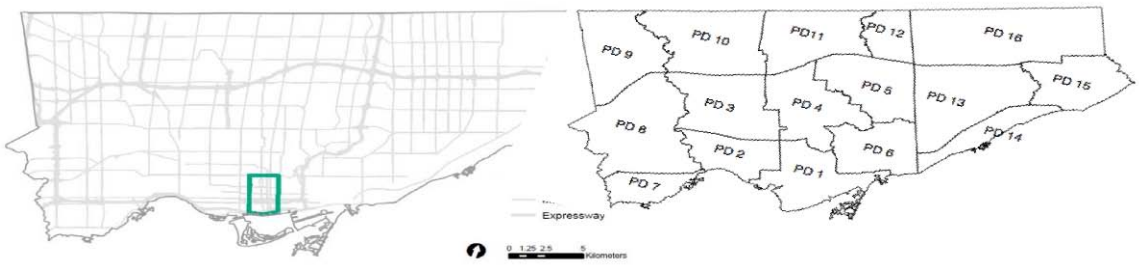

Figure 28: Downtown bicycle screenline count (left) and Planning district 1 (right) used to estimate seasonal cycling

Table 10: Reductions in all-cause mortality from regular walking and cycling in Toronto

	Walking to work and shopping	Walking to school and shopping	Walking to shopping only	Cycling to work and shopping	Seasonal cycling	*Total*
Number of people	81,565	16,973	81,565	19,780	61,292	*260,167*
Distance per trip	1.0 km	0.7 km	1.0 km	5.2 km	3.9 km	
One-way trips per week	12	8	4	10	6	
Weeks per year	50	32	50	36	22	
Distance per year	600 km	179 km	200 km	1872 km	515 km	
Percent reduction in risk of all-cause mortality	16%	5%	5%	33%	11%	
Number of deaths prevented each year	**48.5**	**3.2**	**17.1**	**24.9**	**24.4**	***118***
Willingness to pay value[1]	**$196 million**	**$13 million**	**$69 million**	**$101 million**	**$99 million**	***$478 million***
Discounted future earnings value[2]	**$53 million**	**$4 million**	**$19 million**	**$27 million**	**$27 million**	***$130 million***

1. Based on Sawyer *et al.*'s (2007) Value of a Statistical Life ($4.05 million CAD)
2. Based on Vodden *et al.*'s (2007) average Discounted Future Earnings of Ontarians who are killed in motor-vehicle collisions ($1.1 million CAD)

Appendix B. Analysis of types of collisions

Table 11: Analysis of cyclist-vehicle collisions in Toronto (5-year average, 2005-2009)
Source: City of Toronto 2011b

Type of cyclist-vehicle collision	Number of collisions	% of collisions
Sideswiping collisions	169	15%
Collisions with car doors	136	12%
Rear-ending collisions	45	4%
Sub-total: Separation of cyclists and vehicles	**350**	**31%**
Motorists turning left	**151**	**13%**
Motorists turning right at signalized intersections	**145**	**13%**
Motorists turning right at un-signalized intersections	**100**	**9%**
Cyclists turning left	**31**	**3%**
Sub-total: Turns at intersections	**427**	**37%**
Total collisions	**1145**	**100%**

Table 12: Analysis of pedestrian-vehicle collisions in Toronto (5-year average, 2005-2009)
Source: City of Toronto 2011a

Type of pedestrian-vehicle collision	Number of collisions	Fatalities (2009)	% of collisions
Vehicle turning left, pedestrian ROW	444	8	20%
Vehicle turning right, pedestrian ROW	231	2	10%
Vehicle going straight, pedestrian ROW	129	2	6%
Vehicle going straight, pedestrian without ROW	239	9	11%
Sub-total: Safety at intersections	**1043**	**21**	**47%**
Pedestrian hit mid-block	347	3	16%
Pedestrian hit at PXO	52	1	2%
Sub-total: Crosswalks	**399**	**4**	**18%**
Pedestrian on shoulder or sidewalk	114	1	5%
Total collisions	**2,222**	**31**	**100%**

Appendix C. Toronto policies and programs

Active transportation in the City of Toronto Official Plan

The City of Toronto's Official Plan highlights walking and cycling as a key element of the campaign for next generation transportation. The overall aim of the section entitled *A Progressive Agenda for Transportation Change* is to "provide the widest range of sustainable transportation options that are seamlessly linked, safe, convenient, affordable and economically competitive". Corresponding principles include:

- Promoting land use development and urban form that lead to fewer and shorter trips, and
- Instituting planning, traffic engineering and street design practices that encourage walking and cycling.

The Official Plan also highlights the role of walking and cycling in the vision of creating an attractive and safe city that evokes pride, passion and a sense of belonging. The Plan emphasizes the importance of walking and cycling in all parts of the City, including employment districts, avenues, centres, regeneration areas and priority neighbourhoods.

City of Toronto Walking Strategy and Pedestrian Charter

The Walking Strategy aims to build a physical and cultural environment that supports and encourages walking, including vibrant streets, parks, public squares and neighbourhoods where people will choose to walk more often:

- Encourages seamless integration with public transit and cycling
- Keep sidewalks clear, accessible and easy to navigate
- High-quality walking environment will be a consideration in public and private building projects
- Signage and maps designed to make walking easy and enjoyable
- Transforming neighbourhoods in places where people want to walk where needed
- Pedestrian-focused projects and initiatives

http://www.toronto.ca/transportation/walking/walking_strategy.htm

The Toronto Pedestrian Charter sets out six principles to ensure that walking is a safe and convenient mode of urban travel:

- accessibility
- equity
- health and well-being
- environmental sustainability
- personal and community safety
- community cohesion and vitality

http://www.toronto.ca/transportation/walking/charter.htm

City of Toronto Bike Plan

The Toronto Bike Plan sets out integrated principles, objectives and recommendations regarding safety, education and promotional programs as well as cycling related infrastructure, including a comprehensive bikeway network. “The vision for the Toronto Bike Plan is to create a safe, comfortable and bicycle friendly environment in Toronto, which encourages people of all ages to use bicycles for everyday transportation and enjoyment. The primary goals of the TBP are:

- to double the number of bicycle trips made in the City of Toronto, as a percentage of total trips by 2011; and
- to reduce the number of bicycle collisions and injuries.

The “six spokes” model used by the Toronto Bike Plan has inspired the planning efforts of numerous other cities (Interview). The six areas of focus are as follows:

- Bicycle friendly streets
- Bikeway network
- Safety and education
- Promotion
- Cycling and transit
- Implementation and evaluation

http://www.toronto.ca/cycling/bikeplan/

Active transportation in “The Big Move”

“The Big Move” is the Draft Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) that provides a vision, goals and objectives for seamless, coordinated, efficient, equitable and user-centred transportation within the region. Eight of the fifteen strategic directions relate to active transportation:

- SD#1 Build a Comprehensive Regional Rapid Transit Network
- SD#2 Promote Active Transportation
- SD#4 Consider all Modes of Transportation
- SD#7 Implement an Integrated Transit Fare System
- SD#8 Build Communities That are Pedestrian, Cycling and Transit-Supportive
- SD#9 Develop a System of Mobility Hubs
- SD#10 Focus Growth and Development Along Transportation Corridors
- SD#12 Plan For Universal Access

http://www.metrolinx.com/thebigmove/en/

Bikeway network status

The Bikeway Network is a part of the City of Toronto Bike Plan. Table 13 below presents the status update available on the city's webpage.

Table 13: Status of the Bikeway Network

Bikeway type	Planned*	Existing**	Percentage of goal reached
Bike lanes	495	111	~24%
Shared roadways (local street bikeways and sharrows)	260	150	56%
Off-road paths	249	168	68%
Total	**1,004**	**429**	**43%**

* City of Toronto Bike Plan, 2001
** Updated November 30, 2010

Bicycle parking and storage infrastructure status

With currently over 16,000 parking spots, the City of Toronto's Post and Ring bike parking program is a leader in North America and new bike parking stands are installed every year.

The City of Toronto currently has 202 bicycle lockers in fifteen locations. They provide excellent, secure bicycle parking by offering protection from theft, vandalism and inclement weather. The lockers can be rented for a monthly fee and are designed to hold one bicycle plus gear such as panniers, locks, lights, etc.

Toronto's first bicycle parking station is in operation at Union Station. It offers secure, indoor bicycle parking to protect the bicycles of registered participants from theft and vandalism. The location at Union Station maximizes the opportunity for cyclists to use their bikes in combination with transit, as it is a hub for GTA transit. Two future bicycle parking stations are planned for Victoria Park Subway Station and Toronto City Hall.

http://www.toronto.ca/cycling/parking/index.htm

Toronto Green Standard

The Toronto Green Standard (TGS) establishes mandatory requirements related to sustainable site and building design for new development (Tier 1 performance measures). Developers can also receive incentives for achieving the optional (Tier 2) performance measures. Measures related to active transportation include:

- Cycling infrastructure—provision of short-term bicycle parking, long-term bicycle storage, and shower and change facilities
- Pedestrian infrastructure—provision of sun and weather protection for pedestrians, building integration with walking routes, grading and surface treatment, signage, lighting, and separation from vehicular routes and air intake or exhaust systems

- Transit accessibility—provision of building integration with transit facilities, proximity to transit service, and direct pedestrian linkage to transit

http://www.toronto.ca/planning/environment/greendevelopment.htm

Guidelines for the Design and Management of Bicycle Parking Facilities

The City of Toronto has developed these guidelines to provide specific information for planners, developers and property managers to use to improve the quality of bicycle parking that is secured through the City's development approval process. These guidelines will help new developments meet Official Plan policies and environmental targets of the Toronto Green Development Standard.

http://www.toronto.ca/planning/bicycle_parking_guide.htm

Bike boxes

The City of Toronto has recently started installing bike boxes at intersections to designate a space for cyclists to wait in front of cars at the red light, and to proceed first when the light turns green. Bike boxes increase the visibility and safety of cyclists and make left hand turns safer for cyclists.

http://www.toronto.ca/cycling/network/bikebox_faq.htm

Cycling Ambassadors

“The Cycling Ambassadors are a team of cycling experts who reach out to communities across Toronto with programs and campaigns to deliver safety messages and to encourage cycling.” The Ambassadors are involved with the delivery of many cycling related initiatives, like the Bicycle Friendly Business Awards, Bike Month, the Bicycle User Group Network, and CAN-BIKE as well as providing information on cycling safety at community events and through giving safety seminars. Ambassadors participate in the evaluation process for the Toronto Bike Plan by collecting data from surveys and bicycle counts.

http://www.toronto.ca/cycling/ratsa/index.htm

Bicycle Friendly Business Awards

The Bicycle Friendly Business Awards recognize businesses and organizations that demonstrate leadership in encouraging cycling by employees and/or customers. The following are the award categories:

- Bike Parking
- Suburban Business
- Small Business
- Large Business
- Best Skills Development
- Best Overall

http://www.toronto.ca/cycling/bfba/index.htm

Toronto Bike Month

Toronto Bike Month involves dozens of events in June each year that strive to raise awareness of the benefits of cycling and encourage people to ride their bikes more. Events are hosted by the City of Toronto and other partners and include the Toronto Group Commute and pancake breakfast.

http://www.toronto.ca/cycling/bikemonth/index.htm

CAN-BIKE

CAN-BIKE courses teach cycling skills such as anticipating traffic dynamics, recognizing road hazards, and collision-avoidance techniques. Courses are offered for kids, novice cyclists, casual / recreational cyclists, and advanced / commuter cyclists. Employers are responsible for providing this safety training for all employees that are required to ride a bike to perform work duties.

http://www.toronto.ca/cycling/canbike/

BIXI Toronto

BIXI Toronto provides a network of bikes for public use throughout the downtown core. The BIXI bikes are intended to be used for one-way trips of less than 30 minutes and can be picked up or dropped off at any of the 80 bicycle docking terminals 24 hours a day, seven days a week. Users can choose to pay for single day, monthly, or annual use passes that allow free use of a bike for up to 30 minutes at a time, with fees charged for longer trips. BIXI Toronto was launched May 3, 2011 and logged over 325,000 trips, on 1,000 bikes by over 3,500 monthly or annual subscribers and over 35,000 single day 'casual users' within the first six months.

http://www.toronto.ca/cycling/bixi/

Ride the City Toronto

Ride the City Toronto is an online bike route planning tool that uses bikeway network information and user feedback to recommend safe cycling routes. It also illustrates the location of bike sharing pick-up locations and bicycle repair shops.

http://www.ridethecity.com/toronto

Green Communities Canada Active and Safe Routes to School

Green Communities Canada Active & Safe Routes to School promotes the use of active and efficient transportation for the daily trip to school, including walking and cycling by providing resources for participating schools.

Active & Safe Routes to School is a collaborative initiative between families, schools and community. This community approach helps to ensure children's safety when actively traveling to and from school.

Walk into Health Library Pedometer Lending Program

Toronto Public Health, Toronto Public Library and the City of Toronto Transportation Services offer the Walk into Health Pedometer Lending Program at 40 Toronto Public Library Branches across the City of Toronto. Residents can borrow a pedometer and receive a goal-oriented resource package to help them begin and maintain their walking behaviours. To date, approximately 12,000 pedometers have been borrowed. Plans are underway to expand the program to all library branches across the city.

Toronto Public Health's Walk into Health Program

Toronto Public Health provides agency training and support to community agencies and workplaces interested in starting a walking program or initiative within their organization. The training incorporates the health benefits of walking, training of walking leaders/guides and the provision of educational resources to help participants begin and maintain their walking behaviours. Pedometer kits are also available on loan from Toronto Public Health for organizations implementing a walking program. In addition, the program promotes both the Explore Toronto's Parks & Trails and Discovery Walks maps.

Appendix D. 2008 Toronto Road Classification System Street Name Index

http://www.toronto.ca/transportation/road_class/pdf/city-wide_index.pdf