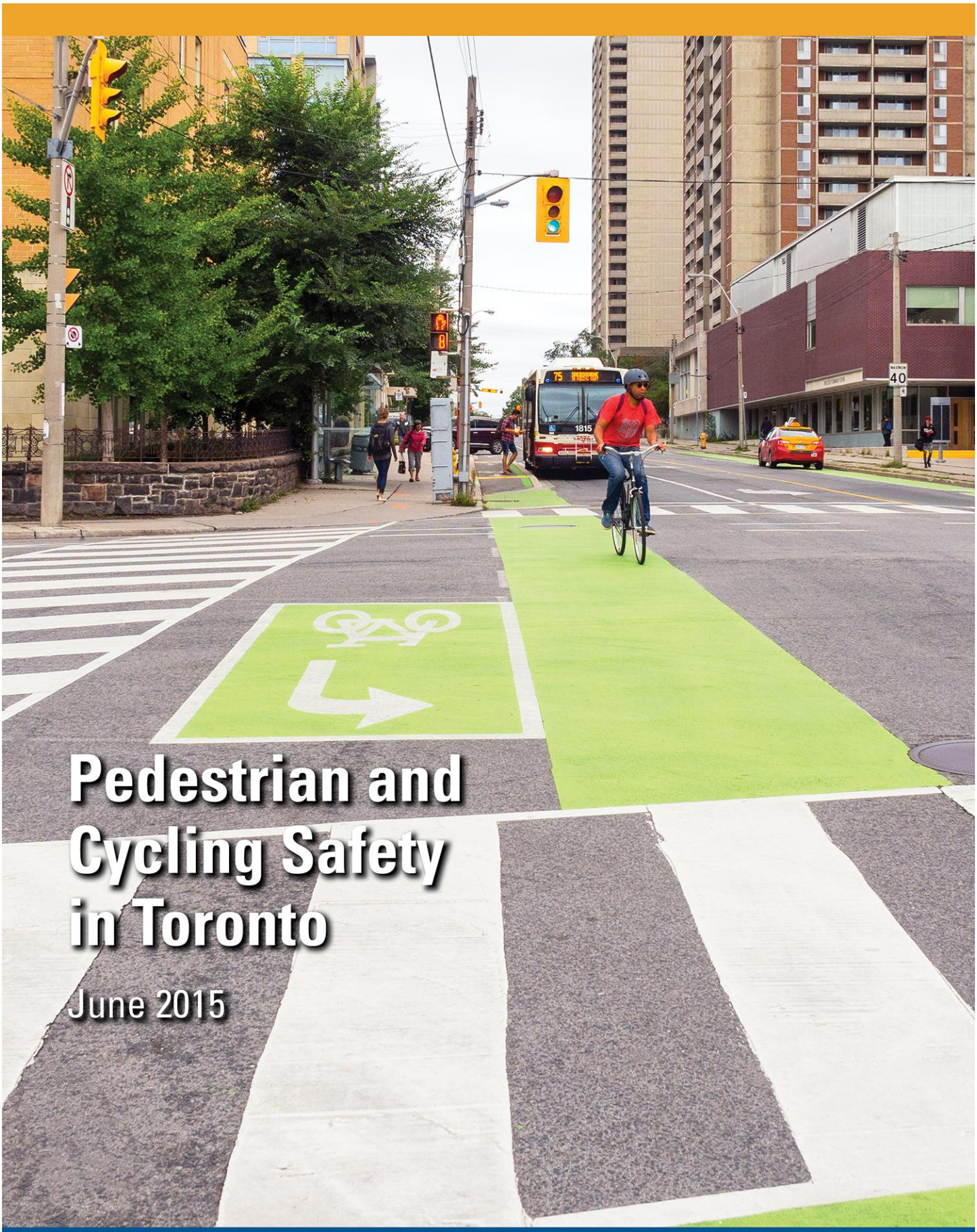
Attachment 1



Pedestrian and Cycling Safety in Toronto

June 2015

416.338.7600 toronto.ca/health | TORONTO Public Health

Reference:

Toronto Public Health. Pedestrian and Cyclist Safety in Toronto. June 2015.

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Acknowledgements:

We gratefully acknowledge the contributions made by a wide variety of people who helped shape the contents and key ideas presented in this report, including:

Andi Stover, Donna Ansara, Kelly Drew, Carol Mee, Sherry Biscope, Ronald Macfarlane (Toronto Public Health)

Mike Brady, Saikat Basat, Nazzareno Capano, Christina Bouchard, Vesna Stevanovic-Briatico, Lukasz Pawlowski (Transportation Services)

Anne Harris, Jessica Miki (Ryerson University)

We thank the Chronic Disease and Injury Prevention (CDIP) staff at Toronto Public Health for their review and comments on the report.

Distribution:

Copies of this document are available on the Toronto Public Health website at: www.toronto.ca/health/reports

Executive Summary

Walking and cycling are two important types of active transportation that have many health benefits including lower all-cause mortality as well as reductions in chronic illnesses such as diabetes, cardiovascular disease, and some types of cancer. However, people who walk and cycle are also at increased risk of injury or death as a result of collisions with motor vehicles when compared to people travelling in cars or using public transit.

This report describes the health impacts of collisions involving pedestrians and cyclists in Toronto. From the analysis it is clear that many factors contribute to the likelihood of a collision occurring. Youth, young adults, and older adults (65 years and older) are especially vulnerable. Road type and speed also play a role in the occurrence of a collision. For example, collisions that result in pedestrian and cyclist injury or death most frequently occur on roads with higher posted speed limits like major and minor arterial roads. As well, the majority of collisions occur at an intersection as compared to midblock locations. Inattentiveness and alcohol use also contribute to the occurrence of a collision and the severity of injury that may result.

A renewed focus on strategies to reduce vehicle collisions that result in pedestrian and cyclist injury is needed in order to enable safe active transportation in the City. Enhancing measures to slow driver speeds is one essential way to improve safety. These measures include lowering posted speed limits and designing streets that include narrower and fewer travel lanes, medians, and other traffic calming measures. Increased education for motorists, cyclists, and pedestrians will also help to improve safety for all.

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Introduction

Toronto Public Health (TPH) has published previous reports that highlight the importance of road safety and active transportation. In April 2012, TPH released the report, *Road to Health: Improving Walking and Cycling in Toronto*. This report presented a comprehensive examination of the health benefits and risks of active transportation and identified specific strategies for improving health by increasing the safety of active transportation in the City. One of the concerns that was highlighted in the report was the risk of pedestrian and cyclist injury and death as a result of collisions with motor vehicles. A number of recommendations were made directed to enhancing and expanding pedestrian and cycling infrastructure as well as lowering speed limits. Specifically, it was recommended to reduce vehicle speed limits to 30 km/hr on residential streets and to adopt a city-wide speed limit of 40 km/hr on all streets, unless otherwise posted.

This report builds on the previous work presented in *Road to Health*. This study provides Toronto-specific data that aligns well with studies elsewhere to identify risk factors for collisions that result in pedestrian and cyclist injury. Ensuring a safe walking and cycling environment in the City requires an understanding of these risk factors in order to develop effective programs and policies to mitigate the risks.

Health Benefits of Walking and Cycling

Walking and cycling are two important types of active transportation that have a number of health benefits. People who use active transportation have, on average, a lower risk of obesity and chronic illnesses like diabetes, heart disease, stroke, and some types of cancer.[1-4] Walking and cycling also have positive impacts on a range of mental health conditions including anxiety and depression.[5]

As well, walking and cycling indirectly improves the health of the population by reducing motor vehicle trips. This lowers levels of air pollution, greenhouse gases, noise and traffic congestion. Traffic-related air pollution has been associated with many harmful health impacts including respiratory conditions, lung cancer, and cardiovascular mortality.[6] In the City of Toronto, traffic-related pollution contributes to about 280 premature deaths and 1090 hospitalizations each year.[7]

Weighing the Benefits and Risks of Walking and Cycling

While walking and cycling are linked with many health benefits, pedestrians and cyclists do face higher risks of traffic injuries and fatalities from collisions when compared to people travelling in cars or using public transit, per trip or per distance travelled.[8-10] For example, a Toronto Public Health (TPH) report found that pedestrians account for 52% of all fatalities and 11% of all injuries from collisions with motor vehicles in Toronto despite having a mode share of only 7%.[11]

Motor vehicle collisions involving pedestrians are also particularly likely to lead to a fatality or hospitalization. Pedestrians have been found to be 1.5 times more likely than

passenger vehicle occupants to be killed in a collision with a motor vehicle per trip.[12] In a collision, pedestrians do not have the physical protection that motor vehicle users do to shield themselves against the impact. As well, the size of a typical motor vehicle is much greater than a pedestrian, and a vehicle travels at much higher speeds. This combination of large size and high speed of a vehicle make a pedestrian especially vulnerable to severe injury or fatality.

Overall, the health benefits of walking and cycling have been shown to outweigh the safety risks. Several studies have shown the large health benefit for walking and cycling since the risk of fatal injury is greatly outweighed by the reductions in mortality that result from the increase in physical activity.[10,13,14] Increased strategies to promote active transportation will increase this number of positive health outcomes.

Increased Walking and Cycling Can Lead to "Safety in Numbers"

Concerns about safety can impact the choice to use cycling and walking to travel around the City. These concerns often relate to a perception of reduced safety when sharing road space with heavier vehicles that are moving at higher speeds on busy roads.

However, as levels of cycling and walking increase, injury and fatalities have been shown to decrease.[15] This effect is known as "safety in numbers" and is seen when comparing pedestrian and cyclist fatalities in countries that have high overall rates of walking and cycling with countries with lower rates. For example, in the Netherlands where almost 30% of all trips are made by bicycle, the fatality risk for cyclists is 1.1 per 100 million km cycled. In the UK and US where only about 1% of all trips are made by bicycle, the risk is 3.6 and 5.8 cyclists injured per 100 million km cycled.[16] Motorists are more likely to drive more slowly and with greater caution when there are more pedestrians and cyclists.[17] This safety in numbers effect is also likely to be influenced by the fact that countries with more pedestrians and cyclists often have a transportation infrastructure that has been designed with pedestrian and cyclist safety in mind.

Identifying Risk Factors for Pedestrian and Cyclist Collisions

In order to identify the factors that are of particular risk for pedestrian and cyclist collisions with motor vehicles, TPH conducted an analysis to address the following questions:

- What are the environmental and individual-level risk factors for traffic collisions involving a pedestrian or cyclist in Toronto?
- Among these collisions, what are the environmental and individual-level risk factors associated with severe injuries and fatalities?

Approach – Data Sources

Data were combined from multiple sources to address the research questions listed above. Table 1 provides an overview of the data sources used for the analysis.

Table 1: Data Sources Used in the Collisions Analysis

Description of data	Source, year
Pedestrian and cyclist motor vehicle collisions	City of Toronto Police Motor Vehicle Collision Reports, obtained from City of Toronto Transportation Services Division, 2008-2012
Number of trips made with walking or cycling as the primary mode of travel	Transportation Tomorrow Survey, 2001, 2006 and 2011
Posted speed	City of Toronto Transportation Services
Bikeway network	City of Toronto Transportation Services

Collision Data

The collision and injury/fatality data were obtained from the Toronto Police Services' collisions reports for the time period 2008-2012. This electronic database contains information on all police-reported motor vehicle collisions that occur in the City. For every collision it lists the date, time, location, age of the person involved, and the severity of any injuries that resulted. The dataset was provided to TPH by Transportation Services. As the focus of this report is on the health impact of collisions, only those collisions that resulted in an injury or fatality were included in the analysis; collisions resulting in property damage only were excluded. In addition, collisions were only included if they involved at least one cyclist or pedestrian and a motor vehicle (i.e. collisions where a cyclist hit another cyclist or pedestrian were not included).

Location coordinates for each collision are provided in the database and the Geographic Information Systems (GIS) software ArcGIS was used to identify the location of each collision for the spatial analysis.

Table 2 provides an explanation of how pedestrians, cyclists, injuries and fatalities were defined in the analysis using the Toronto Police Services collisions reports.

Table 2: Definitions of Pedestrian, Cyclist, and Injury Types

Category	Definition
Individual	
Pedestrian	A person travelling on foot, wheelchair, or a small wheeled device that provides personal mobility (e.g. skateboard, skates, segways, strollers, or scooter).
Cyclist	A person riding a road vehicle propelled by human power (i.e. pedalling) through a belt, chain or gear at the time of the collision event. This includes E-bikes, unicycles and tricycles.
Injury type	
Minimal injury	A non-fatal injury at the time of the collision, including minor abrasions, bruises, and complaints of pain which does not require the injured person to go to the hospital.
Minor injury	A non-fatal injury requiring medical treatment at a hospital emergency room, but not requiring hospitalization of the involved person at the time of the collision.
Major injury	A non-fatal injury that is severe enough to result in the person involved being hospitalized.
Fatality	Person sustains bodily injuries resulting in death (within 366 days of the date of the motor vehicle collision).

Source: Ontario Ministry of Transportation

For the purpose of this analysis, these categories were collapsed into two definitions of injury severity: minimal/minor injury and major injury/fatality.

Pedestrian and Cyclist Denominator Data

The 2001, 2006 and 2011 Transportation Tomorrow Surveys (TTS) were used to identify the typical number of trips made by walking and cycling in Toronto. The TTS is a retrospective survey of the number and mode of all travel trips made by each member of a household 11 years of age and older. For non-survey years, the total number of trips made was estimated by calculating the difference in walking or cycling trips between each survey year, and then estimating the change in trips for each year based on the assumption of a constant increase between survey years.

In TTS, all cycling trips are included irrespective of the trip purpose. For walking trips, only trips made to and from school and work are included. As a result, for the age-specific pedestrian rates that were calculated, population estimates were used as the denominator. This was done because the TTS likely underestimates walking trips in people ages 65 years and older. These values were based on the 2006 and 2011 Census and obtained from Intellihealth.

Posted Speed

The posted speed analysis was conducted by Transportation Services and presented in a recent report (Transportation Services, *Supplemental Report to Proposed 30 km/h Speed Limit Policy*, May 2 2015 (PW3.3)).The posted speed data were extracted using linear referencing from by-laws and observations using street view. The assumption of 50 km/hr was applied to road segments with no speed information.

Road Classification

Every street in the City of Toronto is categorized into one of five road classifications (Table 3). The road classification system assigns roads to a group or class according to the type of service that road is designed to provide. These road classifications were used in the analysis to determine any differences in the frequency of collisions or severity of injuries according to road type.

Table 3: Road Classifications

Road Classification	Description
Local	• Provide access to property • Less than 2,500 vehicles per day • Low traffic speed • Sidewalks on at least one side of the road
Collector	• Provide access to property and traffic movement • 2,500 to 8,000 vehicles per day • Sidewalks on both sides of the road • Signalized intersections at arterial roads
Minor Arterial	• Traffic movement is a primary function • 8,000 to 20,000 vehicles per day • Speed limits 40 to 60 km/h • Sidewalks on both sides • Main intersections controlled by traffic signals
Major Arterial	• Traffic movement is a primary function • Greater than 20,000 vehicles per day • Speed limits 50 to 60 km/h • Sidewalks on both sides
Expressway	• Traffic movement is a primary function • No property access • Greater than 40,000 vehicles per day • Speed limits 80 to 100 km/h • Pedestrians and cyclists prohibited

Source: Transportation Services

Bikeway Network

There is a network of cycling routes throughout the City that includes many different types of infrastructure such as cycle tracks, bicycle lanes, shared roadway routes, and multi-use pathways. In order to consider cyclist collisions and their location in more detail, an analysis was conducted that considered different bikeway types, using data available from Transportation Services. A selection method was used to identify cyclist collisions within 10 metres of each type of bikeway. Table 4 provides a description of the different bikeway types that were considered in the analysis.

Table 4: Bikeway Types

Bikeway Category	Type of Lane in the Bikeway Network	Definition
Fast, Busy Streets		
Bike Lanes	White Bike Lanes	Solid white lines, bicycle symbol and white diamond painted on the roadways that designate lanes for bicycles only. Vehicles are not permitted to stop in these lanes.
	Contra-Flow Bike Lanes	Also known as, “Yellow Bike Ways”. Bicycle lanes painted with a yellow line allow cyclists to travel two ways on a street that are one-way for all other vehicles.
Cycle Tracks	Cycle Tracks	Bike Ways that have physical barriers to separate motor vehicles from cyclists NOTE: Cycle tracks were not used in this analysis since the only one in the city was constructed after the time of the available data.
Quiet Streets		
Sharrows	Sharrows	Shared lane pavement marking. Sharrows are used to mark cycling routes, which are not dedicated, but mixed with motor vehicle traffic.
Signed Routes	Signed Routes Suggested on-street connections Suggested on-street routes Park Roads Cycling Connections	Also known as, “Bicycle Boulevards” Pre-determined routes that are suggested for cyclist travel. Some have signage to help cyclists navigate the city. May be linked to specific destinations or scenic areas of Toronto (e.g. Pan Am Path).
Other		
Off Road Pathway	Informal Dirt Footpath Major Multi-use Pathway Minor Multi-use Pathway	Both city-maintained and informal off road trails designated for cyclists, pedestrians and other non-vehicle traffic (e.g. joggers, inline skaters).

Source: Transportation Services

Approach – Methodology and Assumptions

One of the challenges in studying pedestrian and cyclist injuries is identifying the number of people who are actually at risk of being in a collision. This means identifying how many people are cycling or walking on a given day. One approach that has been used in some studies is to use the underlying population as a whole to calculate the risk. However, we cannot assume that all of the underlying population cycle and are therefore all at potential risk of being involved in a motor vehicle collision while cycling. To most accurately capture the underlying population at risk requires knowledge of the total number of the population who regularly cycle or walk. For this analysis we used the 2001, 2006 and 2011 years of the Transportation Tomorrow Survey (TTS). One component of the TTS asks individuals to identify the number of trips taken by each member of their household ages 11 and over on the previous weekday, and the mode of travel used for each trip. These totals are then weighted to population level using the Canadian Census.

An important part of the analysis was to explore whether pedestrians and cyclists involved in a collision were more likely to be severely injured or killed if certain individual (e.g. alcohol or drug use) or environmental (e.g. road type) risk factors were present. To do this, proportions were calculated and statistical tests (odds ratios with 95% confidence intervals) were conducted to help identify the significance of the associations (i.e. whether the findings were likely to be real or to be due to random chance).

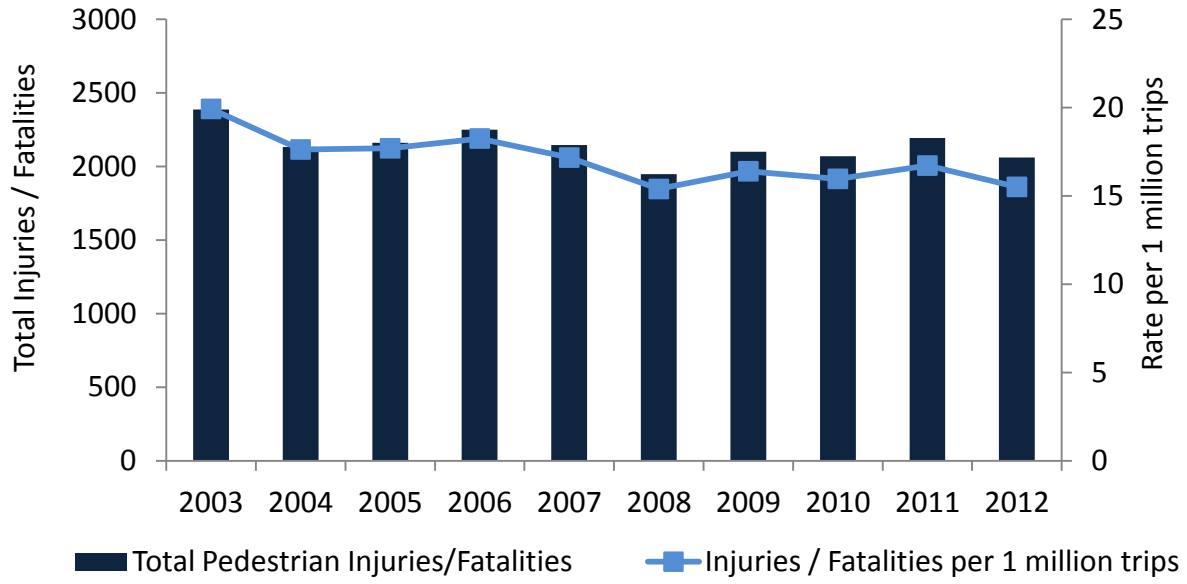
Key Findings

Current Collision Trends – Declining Over Time

Pedestrian and cyclist injuries and fatalities can change from year to year due to many factors including the environment, motorist and pedestrian and cyclist behaviour, and changes in legislation. Over the past 10 years, rates of both pedestrian and cyclist injuries and fatalities due to collisions with motor vehicles have decreased in Toronto (Figures 1 and 2). For pedestrians, the annual number of injuries and fatalities decreased from approximately 20 to 16 per 1 million walking trips between 2003 and 2012. For cyclists the decline has happened at a slightly faster rate over the same time period. In 2003 there were 51 cyclist injuries and fatalities per 1 million trips, as compared to 33 per 1 million trips in 2012.

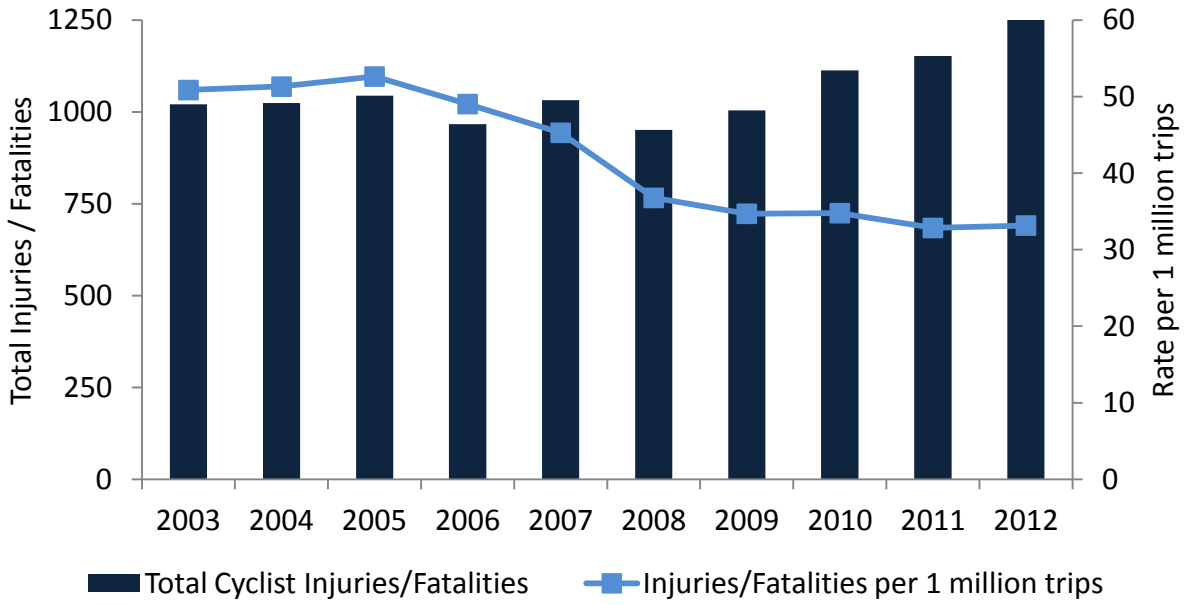
This decline in pedestrian and cyclist injuries in this time period is encouraging, particularly as the Toronto population has grown over the same time period so it can be expected that there are more pedestrians now than in the past. In addition, the total number of cyclists has also increased in the City. Between 2001 and 2006, the number of people riding a bike to work in Toronto increased by over 30%. This can explain why the total number of cyclist injuries in Toronto has increased. However, when considered as a proportion of the population known to cycle the rates actually decrease, as shown in Figure 2. Numerous traffic safety initiatives have also been implemented throughout the City during this time and have had a positive impact on this downward trend.

Figure 1: Pedestrian Collision Injuries and Fatalities, 2003-2012 (Per 1 Million Trips Travelled)



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2003-2012, Transportation Tomorrow Survey (2001, 2006 and 2011).

Figure 2: Cyclist Collision Injuries and Fatalities, 2003-2012 (Per 1 Million Trips Travelled)

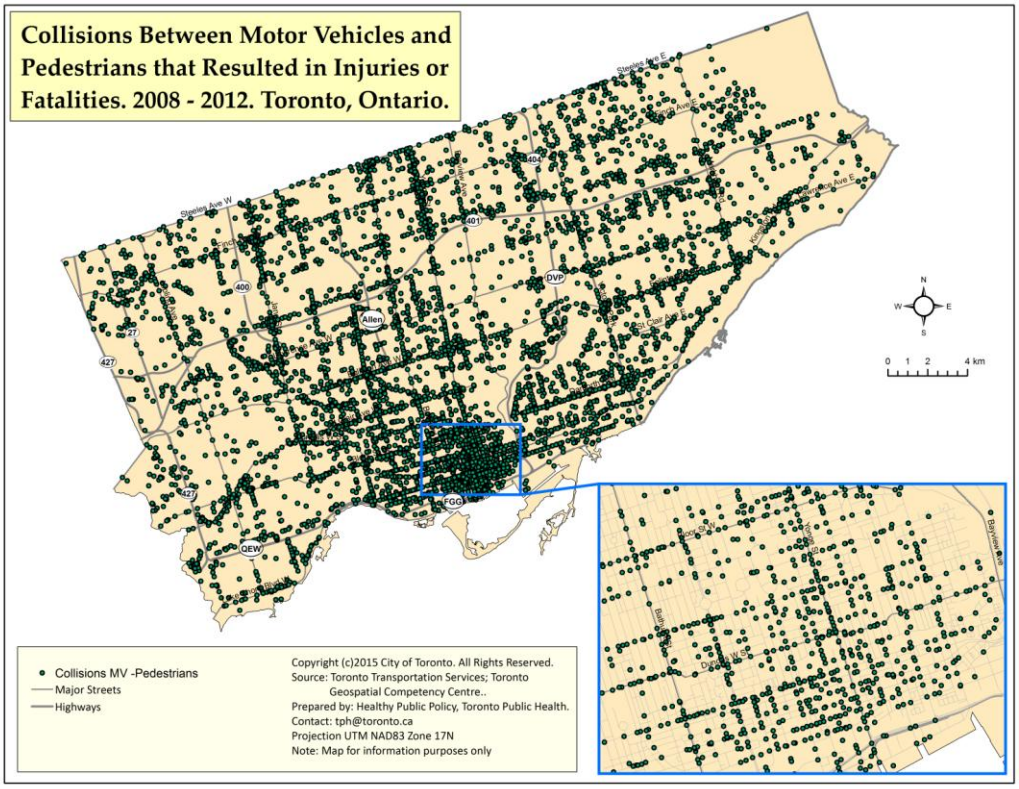


Data Source: City of Toronto Police Motor Vehicle Collision Reports 2003-2012, Transportation Tomorrow Survey (2001, 2006 and 2011)

Collisions, Injuries, and Fatalities

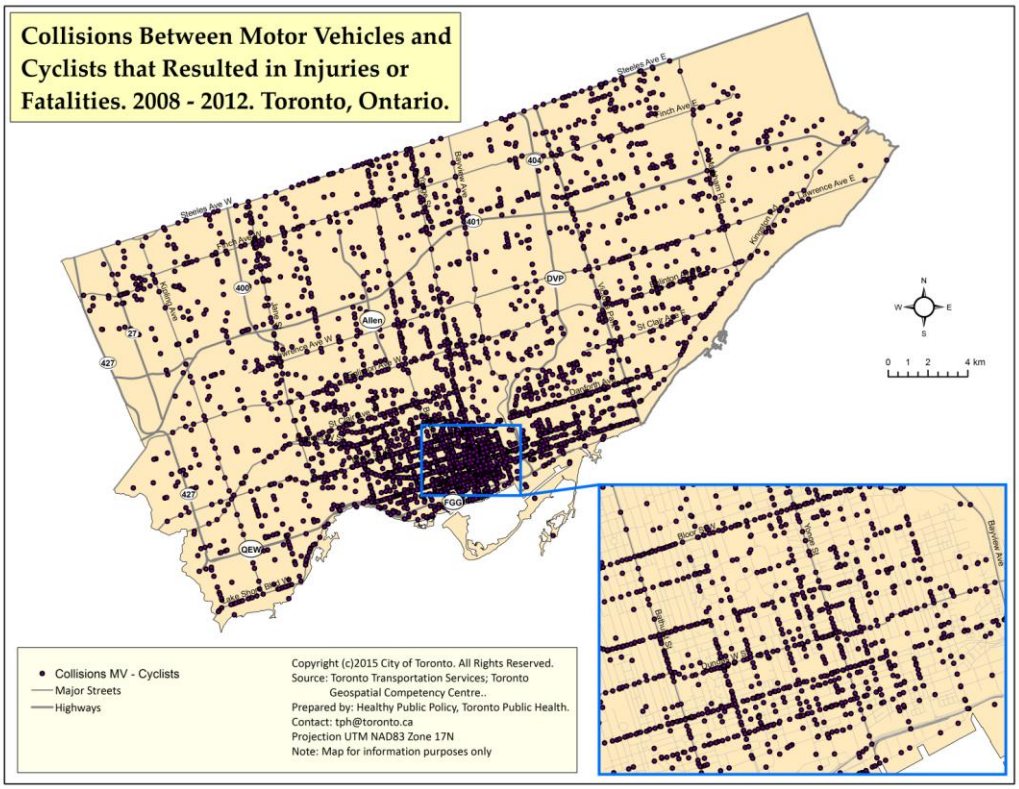
Over the five-year period from 2008 to 2012, there were over 10,000 pedestrians and 5,000 cyclists who were injured or died as a result of a collision with a motor vehicle in Toronto. About 87% of pedestrian and 99% of cyclist injuries occurred on roadways, and about 13% of pedestrian and 1% of cyclist injuries occurred off-road in parks, private property, or public lanes. As shown in Figures 3 and 4, collisions occur across the City with a higher density in the urban core, which corresponds with the location of the highest number of pedestrians and cyclists.

Figure 3: Collisions Involving Pedestrians That Resulted in Injuries or Fatalities, Toronto 2008-2012



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Figure 4: Collisions Involving Cyclists That Resulted In Injuries or Fatalities, Toronto 2008-2012



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

On average, there were 2074 pedestrians and 1097 cyclists who were injured or died as a result of a collision with a motor vehicle per year in Toronto between 2008 and 2012. Among these injuries, an average of 265 pedestrians and 14 cyclists were injured off-road in parks, private property, or public lanes. Tables 5 and 6 provide a description of the number of collisions that occurred in each injury category for both pedestrian and cyclists between 2008 and 2012.

Compared with cyclists, motor vehicle collisions involving pedestrians are more likely to result in hospitalization or a fatality. For example, 9% of pedestrian injuries resulted in hospitalization and 1.2% of pedestrian injuries resulted in a fatality between 2008 and 2012. This is greater than what is seen for cyclist injuries, where 4% of cyclists involved in a collision were hospitalized and less than 1% were fatal.

Table 5: Total Pedestrian Injuries and Fatalities by Injury Category, 2008-2012

Injury Category	Total	Percent (Col)	Rate (per 1 million trips)
Minimal	4146	40	6
Minor	5101	50	8
Major	921	9	1
Fatal	120	1	0.2
Total	10,288	100	16

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012, TTS (2001, 2006 and 2011)

Table 6: Total Cyclist Injuries and Fatalities by Injury Category, 2008-2012

Injury Category	Total	Percent (Col)	Rate (per 1 million trips)
Minimal	2710	50	17
Minor	2442	45	15
Major	222	4	1
Fatal	10	0.2	0.1
Total	5384	100	34

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012, Transportation Tomorrow Survey (2001, 2006 and 2011)

Collisions, Injuries and Fatalities Differ by Age Groups

Young adults have the highest number of collision-related injuries, but older adults have a higher rate of severe injury or fatality.

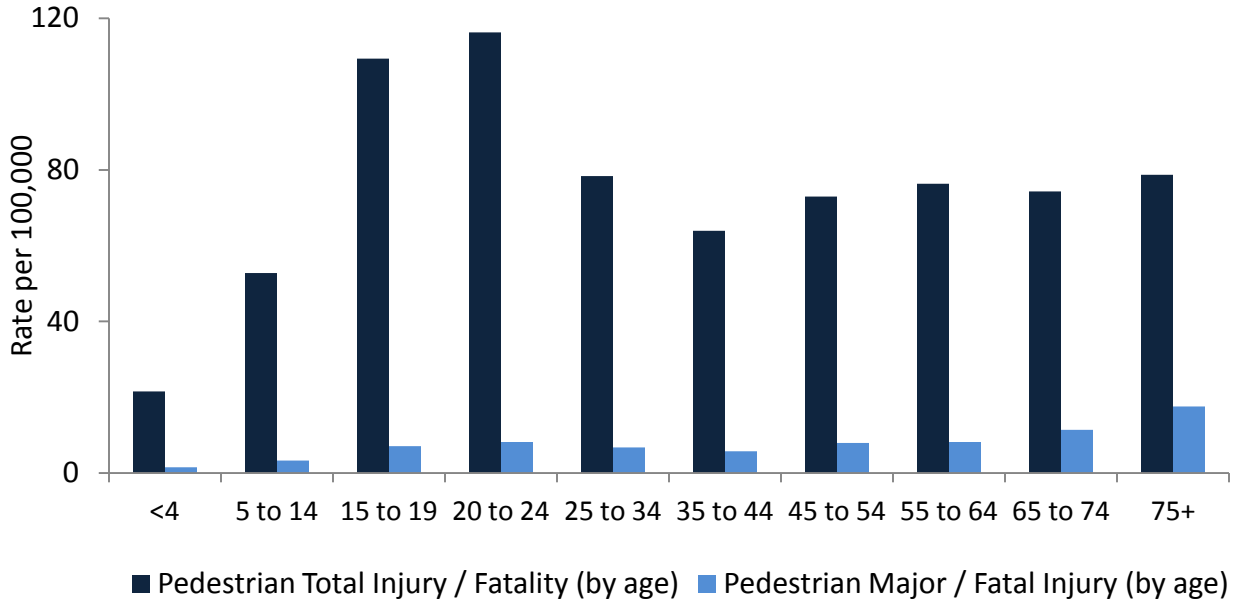
Young adults and seniors are especially vulnerable to collisions with motor vehicles that result in an injury or fatality, as shown in Figures 5 and 6. The highest proportion of pedestrian injuries and fatalities is among young adults age 20-24, followed by youth age 15-19. However, older adults ages 75 and over, followed by older adults ages 65-74, have the highest rate of major injuries and fatalities. Older pedestrians are at greater risk of severe injury when struck by a motor vehicle than other age groups due to their increased physical vulnerability as well as age-related changes that may impact road-crossing behaviour like changes in perceptual and cognitive functions.[18] For example, older people may walk more slowly when crossing a road, have visual or hearing problems that make it more difficult to anticipate an approaching vehicle, and have a slower reaction to a situation that may result in a collision.

For cyclists, the highest proportion of injuries and fatalities is among young adults between the ages of 20 and 24. This age group is also at highest risk of experiencing

the most severe injuries/fatalities as a result of a collision with a motor vehicle, closely followed by the 75+ age group. While the reasons for this increased risk in the 20-24 year age group are not clear, there are a few possible explanations. There may be differences in risk-taking behaviour in different age groups, where younger age groups are more likely to take greater risks while cycling, which could increase the likelihood of a collision.[19] It is also possible that on average, younger cyclists have less cycling experience and skill which may impact their ability to accurately perceive and respond to hazards that could put them at an increased risk of collision with a motor vehicle. It is also noted that the Transportation Tomorrow Survey, which is used to estimate the total number of cycling trips, under represents post-secondary students in their sample. Thus, the increased rate in this age group could be partly due to the underreporting of cycling trips in post-secondary students, which makes the risk of injury per trip appear higher.

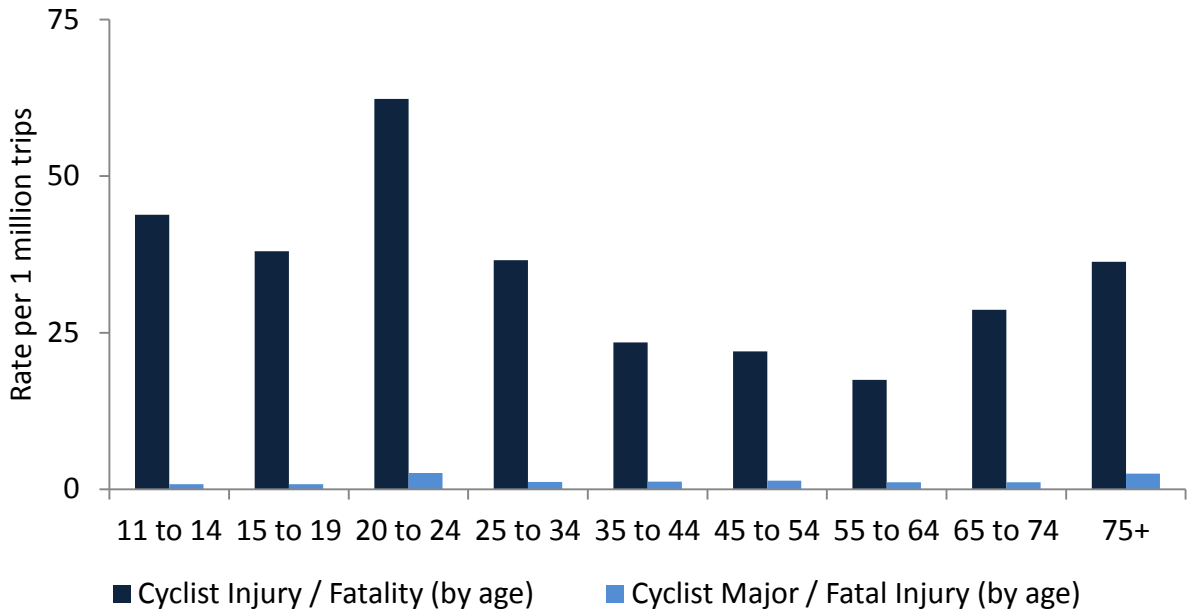
For cyclists, the youngest age groups of 11-19 years are also at particular risk of injury or fatality, although not for the greatest severity of injuries or fatalities as seen in the 20-24 year age category. Other studies have also shown this age group is at a higher risk. Children and teenagers often ride bicycles both for recreation as well as a way to travel back and forth to school. While most bicycle-related injuries in children have been shown to be caused by other factors like falling or colliding with another bicycle or pedestrian, collisions with vehicles are the next most common type of incident.[20]

Figure 5: Pedestrian Injuries and Fatalities, by Age Category, 2008-2012 (Per 100,000 population)



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012, Population Estimates, IntelliHEALTH Ontario

Figure 6: Cyclist Injuries and Fatalities by Age Category, 2008-2012 (Per 1 Million Trips)



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012, Transportation Tomorrow Survey (2011)

Collision Location – Intersections and Midblock

In Toronto, of the pedestrians and cyclists involved in a collision with a motor vehicle, about 69% were struck in an intersection, and about 22% at a midblock location. For pedestrians, about 13% were involved in a collision in a park, private driveway or parking lot, and for cyclists, only 1.3% were involved in a collision in a park, private driveway or parking lot. As compared to midblock locations, intersections have a high potential for motor vehicle collisions with pedestrians or cyclists for many reasons. There are more pedestrians and cyclists in close proximity to motor vehicles at intersections. As well, vehicle turns happen at intersections, which can create a situation where the pedestrian/cyclist and vehicle are very close together and are more likely to collide than when the pedestrian is walking along a sidewalk.

While substantially more collisions happen at intersections, crossing at midblock locations has a greater risk of more severe injury or death for pedestrians. If a pedestrian is hit while crossing at a midblock location the odds of them suffering a major or fatal injury is 1.42 times that of pedestrians involved in collisions at intersections (95% CI 1.22-1.66). This is likely due to the fact that motor vehicles typically travel at higher speeds in midblock locations as compared to intersections, and higher speeds are known to be associated with a greater risk of severe injury or death. A number of studies have developed pedestrian fatality risk curves as a function of impact speed and show an increased risk of pedestrian injury or death as impact speed increases.[21, 22] One study estimated the risk of a pedestrian fatality at 50 km/hr being twice as high as the risk at 40 km/hr and more than five times higher than the risk at 30 km/hr.[22]

Road Classification

Most collisions in Toronto that occur on roadways and involve pedestrians and cyclists occur on major and minor arterial roads. As shown in Tables 7 and 8 below, about 84% of pedestrian injuries and fatalities (7,476) and 87% of cyclist injuries and fatalities (4,646) occur on these roads. This is much higher than collector and local roads where approximately 16% of pedestrian and 12% of cyclist injuries and fatalities occur.

In Toronto, over 80% of pedestrian and cyclist injuries and fatalities from roadway collisions occur on arterial roads.

Compared to local streets, arterial roads are usually wider, have higher volumes of both vehicles and pedestrians, and accommodate faster speeds. These higher speeds likely explain why the highest frequency of major injuries occurs in pedestrians who are hit on a major arterial road. Other features such as the width of arterial roads, the increased crossing distance, and higher pedestrian and cyclist volume are also contributing factors.

Table 7: Pedestrian Injuries and Fatalities by Road Classification and Injury Severity, 2008-2012

Road Class	Major Injury or Fatality (%)	Minimal or Minor Injury (%)	Total
Expressway*	5 (0.5)	21 (0.3)	26
Major Arterial**	663 (70)	5,325 (66)	5,988
Minor Arterial	146 (16)	1,342 (17)	1,488
Collector	59 (6)	665 (8)	724
Local	68 (7)	654 (8)	722
Total	941 (100)	8,007 (100)	8,948

* includes 7 minimal or minor injuries that occurred on an expressway ramp
** includes 2 minimal or minor injuries that occurred on a major arterial road ramp
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Table 8: Cyclist Injuries and Fatalities by Road Classification and Injury Severity, 2008-2012

Road Class	Major Injury or Fatality (%)	Minimal or Minor Injury (%)	Total
Expressway*	0 (0)	13 (0.3)	13
Major Arterial**	146 (64)	3,401 (67)	3,547
Minor Arterial	47 (21)	1,052 (21)	1,099
Collector	19 (8)	308 (6)	327
Local	16 (7)	311 (6)	327
Total	228 (100)	5,085 (100)	5,313

* includes 11 minimal or minor injuries that occurred on an expressway ramp
** includes 5 minimal or minor injuries that occurred on a major arterial road ramp
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

In order to provide some context to the numbers of collisions and their location, Tables 9 and 10 show the proportion of collisions according to the current road network lengths, by road classification. From these tables we note that that 67% of pedestrian and cyclist collisions occur on major arterial roads, despite the fact that these roads comprise only about 14% of the km of road network. However, it is also important to note that major arterial roads have the heaviest pedestrian, cyclist and vehicle volumes, which we were unable to estimate with the data sources available.

Table 9: Pedestrian Collisions per Kilometre of Road Type (5 year average)

Road Class	Length in km	Average Number of Collisions	Collisions per km
Major Arterial	757	1197	1.6
Minor Arterial	411	298	0.7
Collector	771	145	0.2
Local	3291	144	0.04

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Table 10: Cyclist Collisions per Kilometre of Road Type (5 year average)

Road Class	Length in km	Average Number of Collisions	Collisions per km
Major arterial	757	708	0.9
Minor arterial	411	220	0.5
Collector	771	65	0.1
Local	3291	65	0.02

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Posted Speed Limit

It is widely known that the speed of a vehicle has an impact on both the occurrence of a collision and the severity of injuries to those involved. Driving at lower speeds decreases the stopping distance between a car and a pedestrian or cyclist, allowing for more time to avoid a potential collision and/or reduce the severity of impact. In particular, studies have demonstrated that there is a greatly increased risk of pedestrian fatalities at traffic speeds of 50 km/hr or higher.[22,23] Transportation Services recently conducted an analysis of the frequency of collisions according to posted speed in the City from 2009 to 2013 (*Supplemental Report to Proposed 30 km/h Speed Limit Policy*, May 2 2015 (PW3.3)). Tables 11 and 12 show the findings from this analysis and that in Toronto, the roads with a higher posted speed, particularly 50 and 60 km/hr have a higher number of collisions that result in injury or death. There are also collisions occurring on 40 km/hr, although fewer than those happening on roads with higher posted speeds.

Table 11: Pedestrian Collisions by Posted Speed Limit, 2009-2013*

Posted Speed Limit	Fatal (%)	Non-fatal Injury (%)	Total (%)
30 km/hr	0 (0)	43 (0.5)	43 (0.5)
40 km/hr	12 (9)	907 (11)	919 (11)
50 km/hr	44 (33)	2,781 (34)	2,825 (34)
60 km/hr	77 (57)	4,498 (54)	4,575 (54)
70 km/hr	0 (0)	10 (0.1)	10 (0.1)
80 km/hr	0 (0)	16 (0.2)	16 (0.2)
90 km/hr	2 (1.5)	29 (0.4)	31 (0.4)
Total	135 (100)	8,284 (100)	8419 (100)

*Note: Data from Transportation Services, *Supplemental Report to Proposed 30 km/h Speed Limit Policy*, May 2 2015 (PW3.3)

Table 12: Cyclist Collisions by Posted Speed Limit, 2009-2013*

Posted Speed Limit	Fatal (%)	Non-fatal Injury (%)	Total (%)
30 km/hr	0 (0)	27 (0.5)	27 (0.5)
40 km/hr	1 (8)	759 (14)	760 (14)
50 km/hr	5 (42)	2,215 (41)	2,220 (41)
60 km/hr	6 (50)	2,438 (45)	2,444 (45)
70 km/hr	0 (0)	1 (0)	1 (0)
80 km/hr	0 (0)	9 (0.2)	9 (0.2)
90 km/hr	0 (0)	16 (0.3)	16 (0.3)
Total	12 (100)	5,465 (100)	5,477 (100)

*Note: Data from Transportation Services, *Supplemental Report to Proposed 30 km/h Speed Limit Policy*, May 2 2015 (PW3.3)

A recent review of the evidence of the health impact of lowering speed limits to 30 km/hr found a reduction in traffic accidents, injuries, traffic speed and volume, as well as improving perceptions of safety.[24] This supports other previous studies that have demonstrated the effectiveness of lower speed limits on reducing pedestrian and cyclist injury and fatalities.[23,25] As a result, several European and North American cities have implemented changes to lower urban speed limits. A recent example of this is “Vision Zero” that was introduced in New York City in 2014. One of the key components of this initiative is a reduction in default citywide speed limits from 50 km/hr to 40 km/hr. The findings from the literature, in addition to the City-wide data presented above, are compelling evidence for Toronto to take a similar approach to identify measures to reduce speeds.

Type of Traffic Control

Tables 13 and 14 show the frequency of collisions resulting in cyclist and pedestrian injuries and fatalities based on the type of traffic control present for collector and local

roads. For both pedestrian and cyclist collisions that occurred on collector or local roads, most happened where there was no traffic control present. Pedestrian crossovers had the lowest number of collisions, followed by traffic signals. For cyclists the lowest frequency of collisions occurred at traffic signals. It's important to note that these tables do not consider factors such as right of way, which can be found in more detail later in this report.

Table 13: Pedestrian Injuries on Collector and Local Roads by Traffic Control Type

Road Class	Traffic Signal	Stop Sign	Pedestrian Crossover	No Control
Collector (%)	73 (10)	261 (36)	44 (6)	338 (47)
Local (%)	10 (1)	167 (23)	4 (0.6)	531 (74)

Note: 1.2% of pedestrian collisions on collector roads and 1.4% of pedestrian collisions on local roads occurred at a traffic control type other than those listed.
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Table 14: Cyclist Injuries on Collector and Local Roads, by Traffic Control Type

Road Class	Traffic Signal	Stop Sign	No Control
Collector (%)	21 (6)	151 (46)	150 (46)
Local (%)	4 (1)	107 (33)	216 (66)

Note: 1.6% of cyclist collisions on collector roads and 0.1% of cyclist collisions on local roads occurred at a traffic control type other than those listed.
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Cyclist Collisions in Bikeways

Separating cyclists from traffic lowers the risk of collisions and results in a much safer journey for both the cyclist and the motorist. Toronto has a network of cycling paths across the City, and is currently developing a 10-year plan to add and connect to this network. For this project, the number of cyclist collisions was calculated for different types of bikeways, as shown in Table 15.

Of the cyclist collisions that occurred in Toronto between 2008 and 2012, approximately two-thirds happened on roads with no cycling infrastructure at all (i.e. no bike lanes, sharrows, off-road pathways or signed routes). One third of cyclist collisions happened on a road with a bikeway that was either shared with vehicles (a sharrow) or with designated bike lanes that were not physically separated from traffic. While the sample sizes are smaller when the specific types of bikeways are considered, some patterns do emerge. Of these, the highest number of collisions as a proportion of the total km of bikeway type in the network occurred in sharrows. Sharrows are shared bike-car lanes that consist of a painted bike with arrows along the road, however they do not separate cyclists from vehicles. A higher risk for cyclist collisions in sharrows has also been suggested in other research.[26] The authors compared several different types of bikeway infrastructure and found that the only bike infrastructure that significantly reduced the

risk of collisions involving cyclists was a cycle track. Cycle tracks were found to be about one ninth the risk of other bikeway types.[26]

Table 15: Cyclist Collisions per Length of Bikeway Lanes (5 year average)

Type of Bikeway	Average Number of Collisions	Length in km (lane)	Collisions per km
Bike Lanes	161	215	0.7
Sharrows	51	26	1.9
Signed Routes	117	302	0.4
Off Road Pathways*	9	297	0.03
Total	338	840	0.4

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012; Toronto Geospatial Competency Centre; Transportation Services (bikeway lane length)
* denotes trail length

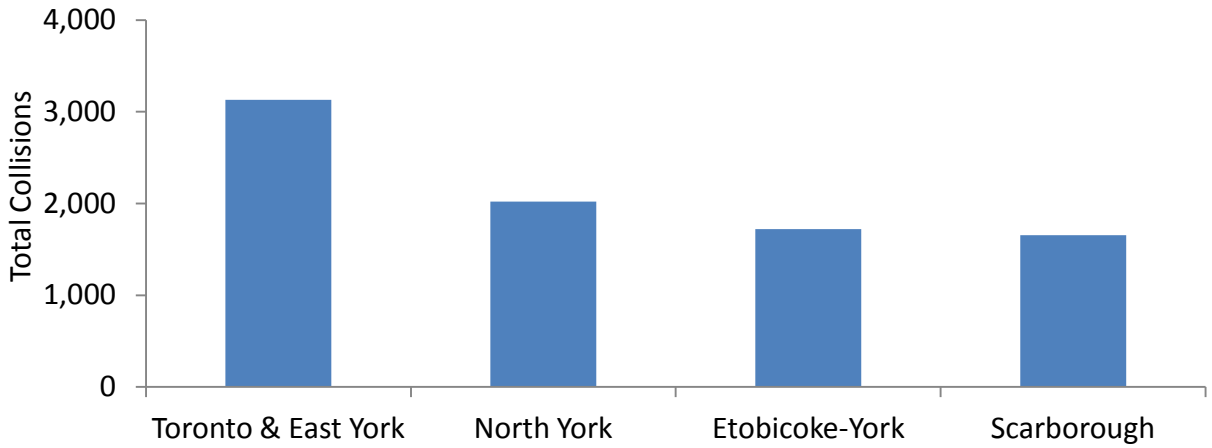
Comparison of Collisions by Toronto's Community Council Areas

Toronto is made up of four Community Council areas, as shown in Figure 7. Community councils focus on local planning issues, including those related to traffic.

Figure 7: Toronto Community Council Areas

Figure 8 shows the number of motor vehicle collisions resulting in pedestrian injury or fatality for each of the four Community Council areas. Of the four, the Toronto and East York Community Council area had the highest number of pedestrian collisions resulting in injury or death between 2008 and 2012.

Figure 8: Pedestrian Collisions Resulting in Injury or Fatality by Community Council Area, 2008-2012



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

For the Community Council areas, slightly different patterns are seen when examining the frequency of collisions according to different road class (Tables 16 and 17). Most of the pedestrian collisions that occur in Toronto on major or minor arterial roads are located in Toronto and East York (52% of Toronto's pedestrian collisions on minor arterial roads are in this Community Council area). This is also where there are likely to be a high concentration of cyclists and pedestrians. Most of Toronto's pedestrian collisions on collector roads are located in North York (36%). For collisions on local roads there is not a large difference between the Community Council areas, with the exception of Scarborough that only has about 15% of Toronto's collisions in this road class as compared with close to 30% for each of the other areas.

Table 16: Pedestrian Collisions by Road Classification for the City of Toronto & Community Council Areas, 2008-2012

Road Class	Etobicoke -York	Toronto & East York	North York	Scarborough	City of Toronto (% of total)
Expressway (%)	5 (20)	12 (48)	7 (28)	1 (4)	25 (0.3)
Major Arterial (%)	1,125 (20)	1,978 (35)	1,461 (26)	1,146 (20)	5,710 (67)
Minor Arterial (%)	293 (21)	739 (52)	121 (9)	269 (19)	1,422 (17)
Collector (%)	118 (17)	180 (27)	244 (36)	137 (20)	679 (8)
Local (%)	180 (26)	220 (32)	188 (27)	102 (15)	690 (8)
Total (%)	1,721 (20)	3,129 (37)	2,021 (24)	1,655 (19)	8,526

Note: Road classification excludes private roads, lanes (public or private), access road, other or pending; expressway includes provincial and city owned highway and ramps; collisions counts which occur on private property are excluded
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

For cyclists, most of Toronto's collisions on major and minor arterial roads occur in Toronto and East York (62% and 71% respectively). Toronto and East York also has the highest proportion of cyclist collisions that occur on collector and local roads (40% and 50% of the City's total, respectively).

Table 17: Cyclist Collisions by Road Classification for the City of Toronto & Community Council Areas, 2008-2012

Road Class	Etobicoke -York	Toronto & East York	North York	Scarborough	City of Toronto (% of total)
Expressway (%)	4 (31)	3 (23)	4 (31)	2 (15)	13 (0.2)
Major Arterial (%)	478 (14)	2,175 (62)	496 (14)	384 (11)	3,533 (67)
Minor Arterial (%)	147 (13)	778 (71)	51 (5)	123 (11)	1,099 (21)
Collector (%)	61 (19)	128 (40)	94 (29)	40 (12)	323 (6)
Local (%)	75 (23)	163 (50)	58 (18)	33 (10)	329 (6)
Total (%)	765 (14)	3,247 (61)	703 (13)	582 (11)	5,297

Note: Road classification excludes private roads, lanes (public or private), access road, other or pending; expressway includes provincial and city owned highway and ramps; collisions counts which occur on private property are excluded
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Individual-Level Risk Factors - Who is at Fault?

In Toronto, about 67% of pedestrian injuries can be attributed to driver error.

Human behaviour is an important factor that can contribute to the occurrence of a collision. Fault in a collision can be due to the pedestrian, cyclist, motorist, or a combination. Common violations include unsafe actions taken by the motorist like speeding, disobeying traffic signals and signs, and failure to yield when a pedestrian or cyclist has the right of way.[27] Collisions can also result from unsafe pedestrian or cyclist actions such as jaywalking and failure to yield to a motorist when they have the right of way. Misjudgement, inattention due to texting and cell phone use, and use of alcohol or drugs can also increase the chance of a collision for the pedestrian, cyclist, or motorist.[28]

One way to understand who is primarily at fault in a collision is to consider which person had the right of way when the collision occurred. In Toronto between 2008 and 2012, about 67% of pedestrians had the right of way when they were involved in a collision, as shown in Table 18. A more detailed breakdown of the types of pedestrian collisions is shown in Table 19 as well as the breakdown by different age groups (Table 20).

Table 18: Summary of Pedestrian Injuries and Fatalities, by Pedestrian Right of Way

Right of way	Total Injuries / Fatalities	Percent
Pedestrian had the right of way	6844	67
Pedestrian did not have the right of way	1987	19
Right of way unknown	1457	14

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Table 19: Pedestrian Collision Type, 2008-2012

Type of Collision	Total Injuries/ Fatalities	Major Injuries / Fatalities	% of Injuries / Fatalities
Vehicle turns left in intersection	**2,682**	**218**	**26**
Vehicle turns left, pedestrian crosses with ROW	2,419	199	24
Vehicle turns left, pedestrian crosses without ROW	263	19	3
Vehicle turns right in intersection	**1,360**	**59**	**13**
Vehicle turns right, pedestrian crosses with ROW	1,235	52	12
Vehicle turns right, pedestrian crosses without ROW	125	7	1
Vehicle travelling straight through intersection	**1,560**	**221**	**15**
Vehicle is going straight, pedestrian crosses with ROW	607	49	6
Vehicle is going straight, pedestrian crosses without ROW	953	172	9
Pedestrian hit at midblock	**1,674**	**241**	**16**
Pedestrian hit at midblock	1,399	213	14
Pedestrian hit at a midblock pedestrian crossing	189	19	2
Vehicle hits a pedestrian walking or running out from between parked vehicles at midblock	86	9	1
Pedestrian hit in parking lot or driveway	**1,577**	**111**	**15**
Pedestrian hit at private driveway	278	15	3
Pedestrian hit at parking lot	1,299	96	13
Other types of pedestrian collisions	**1,028**	**142**	**10**
Pedestrian hit on the sidewalk or shoulder	371	54	4
Pedestrian collision with a transit vehicle	326	59	3
Vehicle is reversing and hits pedestrian	331	29	3
Other / Undefined / Unknown / Missing	**407**	**49**	**4**
Total	10,288	1,041	100

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012
Note: ROW - right of way

Table 20: Pedestrian Collision Type by Age Group, 2008-2012

Type of Collision	% of Injuries / Fatalities Age <19	% of Injuries / Fatalities Age 19-64	% of Injuries / Fatalities Age 65+
Vehicle turns left in intersection	**19**	**28**	**26**
Vehicle turns left, pedestrian crosses with ROW	17	26	23
Vehicle turns left, pedestrian crosses without ROW	2	3	3
Vehicle turns right in intersection	**13**	**14**	**12**
Vehicle turns right, pedestrian crosses with ROW	12	13	11
Vehicle turns right, pedestrian crosses without ROW	1	1	2
Vehicle travelling straight through intersection	**24**	**15**	**12**
Vehicle is going straight, pedestrian crosses with ROW	7	6	5
Vehicle is going straight, pedestrian crosses without ROW	16	8	7
Pedestrian hit at midblock	**24**	**16**	**14**
Pedestrian hit at midblock	18	13	12
Pedestrian hit at a midblock pedestrian crossing	4	2	1
Vehicle hits a pedestrian walking or running out from between parked vehicles at midblock	2	0.6	0.6
Pedestrian hit in parking lot or driveway	**11**	**15**	**22**
Pedestrian hit at private driveway	2	3	4
Pedestrian hit at parking lot	9	13	18
Other types of pedestrian collisions	**8**	**10**	**13**
Pedestrian hit on the sidewalk or shoulder	4	4	3
Pedestrian collision with a transit vehicle	3	3	3
Vehicle is reversing and hits pedestrian	1	3	7
Other / Undefined / Unknown / Missing	**2**	**3**	**2**
Total	100	100	100

Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

As shown in Table 20, there are some differences in the types of pedestrian collisions experienced by different age groups. For example, the most common type of collision for age 19-64 and 65+ years occurs when a vehicle is turning left in an intersection. However, for people younger than 19 years of age, one of the most common types of pedestrian collision is when a vehicle is travelling straight through an intersection, and over half of these occur when the pedestrian does not have the right of way.

In older adults, there is a greater proportion of pedestrian injuries and fatalities that happen in private driveways or parking lots as compared with people under the age of 65 (22% of the pedestrian injuries and fatalities in this age group as compared with 11% and 15% in those under 19 and between 19-64 years of age respectively). Parking areas, especially those located near shopping centres often do not have clearly designated and safe pedestrian paths. They may also be more likely to have distracted drivers as they search for parking spaces.

Of the pedestrian injuries and fatalities among seniors, 22% occur in parking lots or private driveways.

Public Transit

Approximately 3% of all pedestrian collision injuries and 1.5% of all cyclist injuries in the City involve a transit vehicle. In these collisions pedestrians are 70% more likely to suffer a severe or fatal injury (OR 1.70, 95% CI 1.30-2.24) than in a collision that involves a car. For a cyclist collision this impact is even greater - if they collide with a transit vehicle they are 2.16 times as likely to suffer a severe or fatal injury (OR 2.16, 95% CI 1.11-4.20).

Table 21: Pedestrian Action in Collisions with Transit Vehicles

Pedestrian Actions – Transit Vehicle	Number of Pedestrian Injuries / Fatalities	Percent of Pedestrian Injuries / Fatalities
Crossing with the right of way	66	20
Crossing with no traffic control	55	17
Crossing without the right of way	49	15
Running onto the roadway	47	14
Person getting on/off transit vehicle	47	14
On sidewalk or shoulder	32	10
Other (e.g. playing/walking/working on roadway, crossing a marked crosswalk without right of way, getting on and off a school bus, and pushing or working on a vehicle)	32	10
Total	328	100

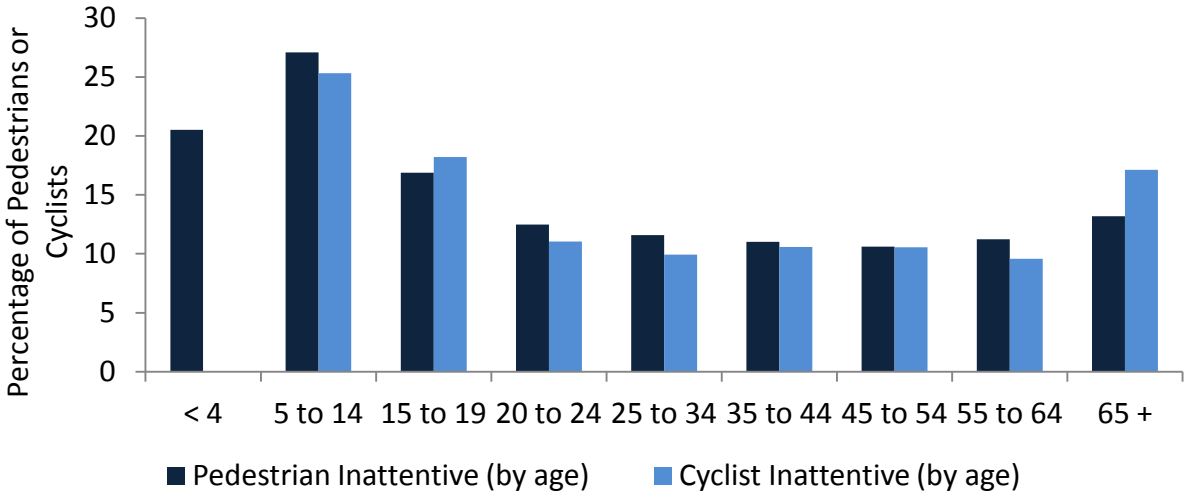
Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Individual Risk Factors - Inattentiveness

About 13% of pedestrians and 12% of cyclists were inattentive at the time of a collision. As well, pedestrians that were inattentive at the time of the collision were about 40% more likely to be severely injured or killed than pedestrians that were not inattentive. Figure 9 shows the differences in inattentiveness by age group for both pedestrian and

cyclist collisions. Children between the ages of 5 to 14 years age have the highest frequency of inattentiveness in collisions as compared with other age groups.

Figure 9: Pedestrian and Cyclist Inattentiveness, by Age Group, 2008-2012

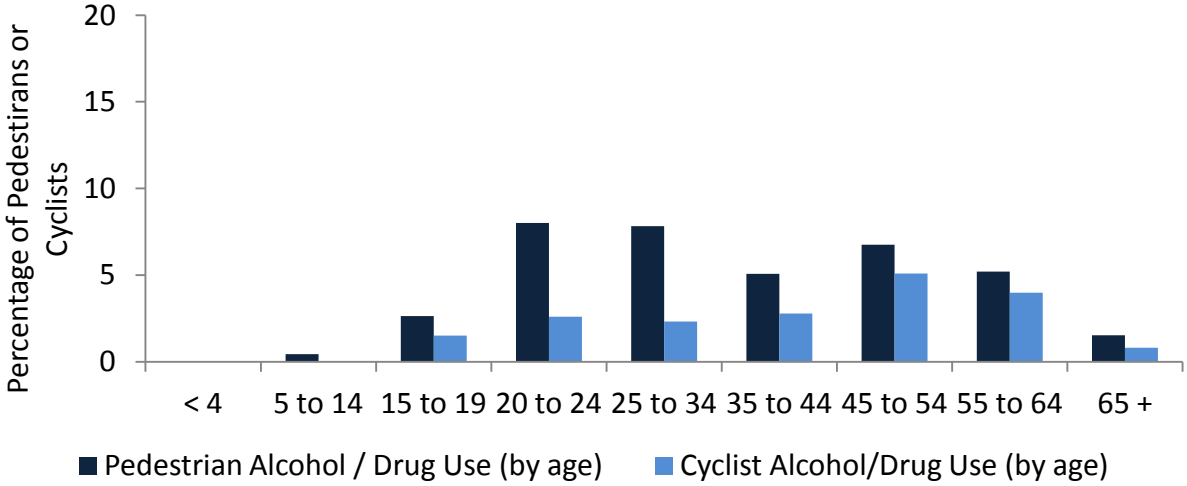


Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Individual Risk Factors – Alcohol or Drug Use

About 5% of pedestrians and 3% of cyclists involved in a collision had used alcohol or drugs at the time of the collision. If a pedestrian or cyclist involved in a collision consumed drugs or alcohol, they had a greater likelihood of being severely injured or killed than a pedestrian or cyclist who hadn't consumed drugs or alcohol (pedestrians were about 2.5 times as likely to be severely injured or killed, and cyclists were more than 2 times as likely to be severely injured or killed).

Figure 10: Pedestrian and Cyclist Alcohol Use, by Age Group, 2008-2012



Data Source: City of Toronto Police Motor Vehicle Collision Reports 2008-2012

Conclusion

This report has identified several risk factors for vehicle collisions that resulted in pedestrian and cyclist injury and death between 2008 and 2012. This Toronto-specific data builds on previous work by Toronto Public Health as well as analysis conducted by Transportation Services that has also highlighted road safety as a key concern for people walking and cycling in the City. The findings of this study can be used to inform the development of policies and procedures to improve pedestrian and cyclist safety, which will result in improved health and quality of life for those people living in and visiting the City of Toronto.

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