Evidence from Safety Research to Update Cycling Training Materials in Canada

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September 2012

Summary

Aim of the project – To improve cycling safety training by comparing cycling education materials to research evidence on cycling safety.

Methods – The scientific literature was searched and reviewed for evidence about cycling injury risk, injury severity, and other safety data. Cycling education materials were compiled from drivers' licensing agencies and cyclist education programs. The scientific evidence was summarized then compared to messages in education materials to determine where there were agreements, disagreements or gaps.

Results – We identified 56 scientific articles focused on crash or injury risk, injury severity, or other safety outcomes that met our inclusion criteria. The evidence covered bicycle-motor vehicle interactions, route characteristics & conditions, route types, bicycling operations, and safety equipment. Two meta-analyses of helmet research were also reviewed.

We gathered 48 education materials for cyclists and/or drivers from 12 provincial and territorial driver's licensing jurisdictions, 5 municipalities, and 7 non-governmental organizations. Materials covered bicycle-motor vehicle interactions, route characteristics & conditions, route types, bicycling operations, safety equipment, bicycle fit and maintenance, and rules of the road.

Overall, we found that many of the principles covered in cycling education materials were supported by scientific evidence. A gap in the educational materials was information to help cyclists plan their routes, including scientific evidence about the relative safety of different route types, and route characteristics and conditions. In addition, evidence on motor vehicle passing distances was not included with education messages about where to cycle on the road.

Many education messages were not addressed in the scientific literature at all, but still provided useful information about potential hazards (e.g., gravel, cars pulling out of driveways), bicycle fit and maintenance (e.g., brake condition), and rules of the road (e.g., hand signals). Some important information on cycling-related traffic rules was rarely explained, e.g., how to behave where there are bike boxes, sharrows or traffic circles. A problem in some education materials was uncited, ambiguous "facts" that may be misinterpreted as suggesting causes of crashes or injuries.

Conclusions – This report provides a summary of and citations for scientific evidence on safety issues related to cycling. It suggests areas where education materials could be modified to better align with the evidence.

Table of Contents

1. Introduction

The goal of this project was to improve cycling safety training by comparing cycling education materials to research evidence on cycling safety.

A literature search was conducted to determine the scientific evidence relating to cycling safety.

Cycling education materials from organizations and individuals across Canada were gathered and evaluated to determine what topics were addressed by education about cycling.

Then the research evidence was compared to safety-related messaging in the training materials to determine areas where the literature and the education materials agreed, disagreed, or were simply mismatched.

Cycling along a painted bike lane on a major city street.

2. Scientific Literature Selection Criteria

We examined research on cycling safety by searching the scientific literature. We searched for articles published up to January 2012 and archived in PubMed, Medline, or the Transportation Research Information Service. We performed searches using the key words "bicycle," "safety," "injury," "accident," "crash," "conflict," "infrastructure," "road," and "intersection." Reference lists of all relevant papers (including review papers) were searched as a source of additional citations. This search identified over 400 scientific articles potentially related to cycling safety.

To be included in our review, research articles had to represent peer-reviewed original research, use a measure of **relative risk** to determine the effect, and be in English. They also had to investigate the relationship between a clearly-defined metric of bicyclist safety (injury, injury severity, crash/collision/fall, conflict) and

- a riding practice (e.g., use of visible clothing, bicycling operations, or route choice), or
- an environmental factor (e.g., road grade, weather conditions).

We did not search the primary research literature on helmets, but instead considered two recent literature reviews on this issue.

Why denominators are important . . .

It is common for reports on cycling injuries to indicate the proportions of injuries with certain characteristics, for example, 75% of injured cyclists were male or 60% of crashes took place in the daytime.

This kind of data does not infer anything about whether men or riding in the daytime have increased risk of injuries, because we are not given any information about what proportion of cyclists are male or what proportion of trips are in the daytime.

To understand the risk of injury with respect to a characteristic, you need a denominator representing the "exposure."

On the next page, we describe "relative risk" and provide an example with denominators for two characteristics.

Studies were excluded if they fell into one of the following categories:

- studies examining gross numbers or types of injuries, without either calculating risks (i.e., no **denominator**) or considering factors influencing risk of those injuries;
- studies only examining personal characteristics of the bicyclists or motor vehicle drivers (e.g., age, sex, experience);
- studies that reported only subjective perceptions of safety or risk, whether by the public or experts;
- studies of injuries or crashes that occurred when the bicycle was being used for bicycle racing, mountain-biking, trick/trials riding, or play; and
- studies of injuries not related to a crash event (e.g., chronic injuries related to riding position).

Most of the over 400 articles identified in our search were excluded based on the above criteria (especially lack of a denominator), leaving 56 articles for our review. They represent studies conducted all over the world, including North America (26 articles), Western Europe (11 articles), Australia/New Zealand (6 articles), Britain (5 articles), Asia (3 articles), South America (1 article), and Eastern Europe (1 article). Two of the articles are from our own research. [18, 47]

All 56 articles (and 2 helmet review articles)[1-58] are listed in **Appendix A. List of Scientific Literature**. A summary of the results on each topic is presented in the next section **3. Scientific Evidence**. Details are included in **Appendix C. Details from the Scientific Literature, by Topic**.

Why relative risk is important . . .

Relative risk (RR) is the ratio of the probability of an event (e.g., injury) occurring in one group (e.g., those riding on a sidewalk) to the probability of the event occurring in a comparison group (e.g., those riding on the road).

The concept of relative risk includes two important features:

- a comparison of risk between two "exposures" therefore putting risks in context, and
- controlling for "exposure" by ensuring there are proper "denominators" for each injured group, as in the formula below:

$$RR = \frac{\dfrac{\#\text{ cyclists injured on sidewalk}}{\#\text{ cyclists riding on sidewalk}}}{\dfrac{\#\text{ cyclists injured on road}}{\#\text{ cyclists riding on road}}}$$

More detail on relative risk is included in Appendix B.

3. Scientific Evidence

We found consistent evidence from multiple studies relating to cycling safety in five themes:

3.1 Bicycle – Motor Vehicle Interactions

3.2 Route Characteristics & Conditions

3.3 Route Types

3.4 Bicycling Operations

3.5 Safety Equipment

The evidence within these themes is summarized in sections 3.1 to 3.5, in text and in summary tables. We evaluated the evidence by considering whether there were multiple studies with consistent results, and by considering whether there was conflicting evidence from other studies. The summary tables in each section indicate the "Weight of Evidence".

There were several topics where evidence was from a single study or from multiple studies with conflicting results. It is difficult to draw conclusions about these topics, so they are outlined separately (section **3.6**).

Most evidence fell into two types: injury or crash risk; and injury severity. Some papers examined other safety-related data. For certain topics, there was evidence about both injury risk and severity, and for others, only one was addressed.

Types of Evidence

Injury or Crash Risk

Addresses the question: "What is the risk of a crash or injury occurring?"

Compares circumstances of injury or crash events to those when no event occurred.

Injury Severity

Addresses the question: "Given that an injury has occurred, how severe is the injury?"

Compares circumstances of severe injuries (e.g., death) to those of less severe injuries, or compares one type of injury to another (e.g., head injuries to injuries of the extremities).

Other Safety Data

Studies examining circumstances of conflicts, passing distances, visibility, speeds, reaction times.

3.1 Bicycle – Motor Vehicle Interactions

Crashes with motor vehicles & heavy vehicles

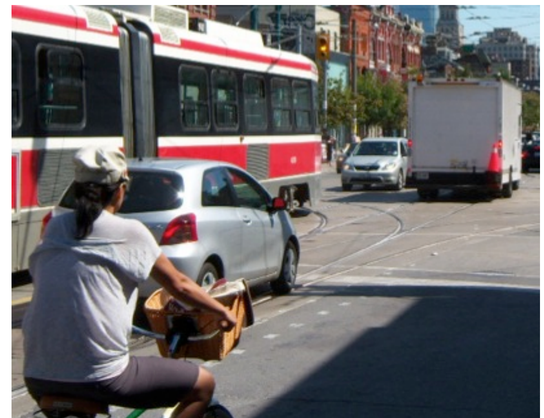
Four studies found that the involvement of a motor vehicle in a cyclist crash was associated with increased injury severity, including hospitalization, disability and death (compared to crashes not involving motor vehicles).[17, 25, 39, 46]

Many studies found that involvement of a heavy vehicle (i.e., truck or bus) in a cyclist crash was associated with increased injury severity, including incapacitating and fatal injuries.[15, 22, 29, 30, 36, 53, 56] Other evidence included a study that found increased injury severity when riding on truck routes compared to other routes, and another that found increased intersection crash risk where there was a bus stop within 50 m.[1,28]

Motor vehicle speed

Numerous studies found that higher motor vehicle speeds or speed limits were associated with increased injury severity for cyclists, including serious head injuries and death. [1, 5, 22, 23, 29, 45, 53, 56]

One study found that the risk of a cyclist injury at an intersection was lower when motor vehicles speeds were below 30 km/h and another found that lower speeds in roundabouts were associated with lower crash risk.[18, 19]



Injuries resulting from crashes with any type of motor vehicle were more severe than those not involving motor vehicles.

Injury severity was especially high for crashes with heavy vehicles.

Motor vehicle traffic volume

Reduced motor vehicle traffic volumes were associated with reduced cyclist injury risk in two studies. [18, 28]

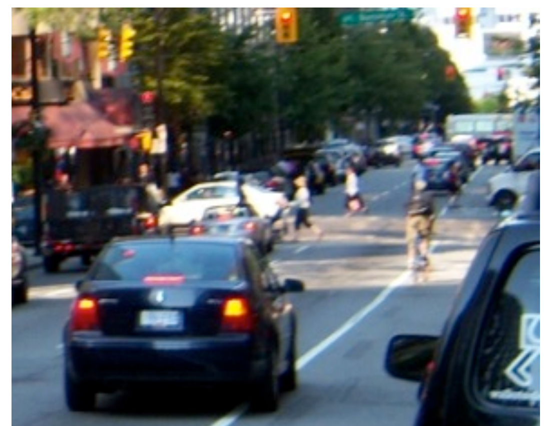
On the other hand, increased motor vehicle traffic volumes were associated with reduced injury severity, potentially because of reduced speeds with congestion.[1, 23]

Motor vehicle passing distances

Several studies looked at the position of cyclists and motor vehicles on the road and resulting motor vehicle passing distances.[14, 20, 37, 52] Motorists passed closer to cyclists on higher speed and traffic roads, and when there was traffic in the opposing direction. [14, 37] Heavy vehicles such as trucks and buses passed closer to bikes than other motor vehicles. [52]

Passing distances were smaller the further cyclists rode from the curb, including when a bike lane was present.[14, 37, 52] Cyclists rode further from the door zone of vehicles and from curbs where a bike lane was available (cyclists rode even further away with increased bike lane width).[14, 20]

Crash risk and injury severity were indirectly studied with respect to passing distances. [5, 23, 50] After installation of wide bike lanes, one study found that "dooring" crashes were almost eliminated. [50] Injury severity was increased in crashes where motor vehicles were passing cyclists (versus denying the



Passing distances depended on traffic speed, presence of opposing traffic, vehicle size, the distance of the cyclist from the curb, and width of bike lanes.

right of way) and decreased with the presence of a shoulder on high speed roads. [5, 23]

Table 3.1 Summary of Evidence on Bicycle – Motor Vehicle Interactions

Topic	References	Injury or Crash Risk	Injury Severity	Other Safety Info	Weight of Evidence
Motor vehicle collisions	17, 25, 39, 46		↑		All studies agree
Heavy vehicle (trucks & buses) collisions	1, 15, 22, 28, 29, 30, 36, 52, 53, 56	↑	↑		All studies agree
High motor vehicle speeds and speed limits	1, 5, 18, 19, 22, 23, 29, 45, 53, 56	↑	↑		All studies agree
High motor vehicle traffic volume	1, 18, 23, 28	↑	↓		All studies agree
Decreased passing distance	5, 14, 20, 23, 37, 50, 52	↑	↑	• Motorists pass closer to cyclists on higher speed and traffic roads, and when there is traffic in the opposite direction. • Large vehicles like trucks and buses pass closer to cyclists. • The farther bicyclists ride from the curb the less space they are given when passed, including with bike lanes.	Injury risk & severity evidence was indirect. Studies on passing distances agree.

3.2 Route Characteristics & Conditions

Roundabouts & traffic circles

Five studies found that roundabouts or traffic circles were associated with increased injury risk to cyclists.[8, 9, 10, 18, 19] These two types of intersection infrastructure are similar but differ in the following way: traffic circles are found at the intersection of minor streets, whereas roundabouts are found at major intersections and are often multilane (see photos to the right). One study found increased fatalities among cyclists and pedestrians at roundabouts.[10]

One study compared roundabouts that had a separated cycling lane to those in which cyclists used the same lanes as motor vehicles, and concluded that roundabouts with separated cycling facilities were safer.[41] Another study found that roundabout dimensions that allowed higher vehicle speeds than other designs had higher crash risk.[19]

Roundabout at intersection of major streets

Traffic circle at intersection of residential streets

Divided roadways or medians

Roadways with medians or road dividers were associated with decreased injury risk and severity to cyclists.[22, 28, 56]

Grades

Downhill grades were associated with increased injury risk.[18, 47] Grades (without distinction of direction) were also associated with increased crash severity. [1, 23]

High cycling speeds (as expected on downhill grades) was another variable studied, but evidence was not consistent (see section 3.6). [4, 39, 48]

Downhill grades were associated with increased injury risk.

Cyclist traffic volume

Two studies found that, at intersections, high cyclist traffic volumes were associated with increased injury risks for cyclists. [18, 28]

Weather conditions

Inclement weather conditions such as rain, fog and snow, were associated with increased injury severity.[22, 23]

Poor weather and light conditions increased injury risk.

Light conditions

Poor light was associated with increased injury risk and severity.[5, 22, 23, 40, 42, 49, 54, 56] Dark, unlit conditions such as night-time without streetlights were linked to increased injury or crash risk and increased injury severity.[5, 22, 40, 49] Street lighting was associated with decreased injury risk and severity.[54, 56]

Table 3.2 Summary of Evidence on Route Characteristics & Conditions

Topic	References	Injury or Crash Risk	Injury Severity	Other Safety Info	Weight of Evidence
Roundabouts & traffic circles	8, 9, 10, 18, 19, 41	↑	↑	• Roundabouts with separated cycling facilities are safer than those without • Roundabout dimensions that allow higher vehicle speeds have higher risk	All studies agree
Medians and divided roadways	18, 23		↓		Both studies agree
Grades	1, 18, 23, 47	↑	↑		All studies agree
High cyclist traffic volumes at intersections	18, 28	↑			Both studies agree
Inclement (rain, snow, fog) weather conditions	22, 23		↑		Both studies agree
Dark, unlit conditions	5, 22, 23, 40, 42, 49, 54, 56	↑	↑	• Single bicycle crashes in the dark are more likely to be related to the visual design of the site	All studies agree

3.3 Route Types

Route designs of various types have been examined by a large number of studies, though each usually studied only a few different designs and sometimes the route types were poorly described. There were patterns of evidence that allowed conclusions to be drawn about which are safer and which more dangerous – thus providing the basis for route planning.

Descriptions and photos of the route types can be seen in Table 3.3.

Decreased risk route types

Route types that were associated with reduced risk for cyclists were cycle tracks (physically separated bike lanes alongside major streets), painted bike lanes, signed bike routes, minor streets, and bike paths.[18, 25, 26, 27, 31, 32, 40, 47, 49] All of the safer route types were associated with decreased injury or crash risk, usually as compared to major streets without bike infrastructure.

Two route types, cycle tracks and minor streets, also had evidence of decreased injury severity.[25, 27, 33, 56] The other safer route types were not included in injury severity studies.

Increased risk route types

Route types that were associated with increased injury risk included major streets without bike facilities, sidewalks and multiuse paths.[2, 3, 6, 18, 31, 32, 47, 49, 51]

Highways and major streets were associated with increased injury severity.[1, 27, 33]

Table 3.3 Summary of Evidence on Route Types

Topic	References	Injury or Crash Risk	Injury Severity	Photo	Weight of Evidence
Cycle Tracks (A lane for cyclists only, alongside a major city street, but separated by a curb or other barrier)	18, 25, 26, 47, 56	↓	↓		All studies agree
Bike Lanes (A painted lane on a city street designated for cyclists only)	18, 31, 32, 47	↓			All studies agree
Signed Bike Route (A route for cyclists, usually on a residential street – may include traffic diversion or calming)	18, 31, 47	↓			All studies agree

Table 3.3 (con't) Summary of Evidence on Route Types

Topic	References	Injury or Crash Risk	Injury Severity	Photo	Weight of Evidence
Minor Streets without Bike Facilities (Minor streets, e.g., residential streets, not specifically designated as a bike route)	18, 27, 31, 32, 33, 47	↓	↓		All studies agree
Bike Paths (An off-street path designated for cyclists only)	18, 32, 40, 47, 49	↓			All studies agree
Multi-use Paths (An off street path shared with pedestrians and other road users)	2, 3, 18, 31, 47	↑			4 of 5 analyses found increased risk compared to streets. One found lower risk compared to major streets with parked cars, but higher risk than bike-specific routes.

Table 3.3 (con't) Summary of Evidence on Route Types

Topic	References	Injury or Crash Risk	Injury Severity	Photo	Weight of Evidence
Sidewalks (An off-street path designated for pedestrians only)	2, 3, 6, 18, 31, 32, 47, 51	↑			All studies agree
Major Streets without Bike Facilities (A street with two or more lanes designated for moving car traffic)	6, 18, 27, 31, 32, 33, 47, 49	↑	↑		All studies agree
Highways (A street for high speed car traffic)	1, 27		↑		Both studies agree

3.4 Bicycling Operations

Cycling when intoxicated

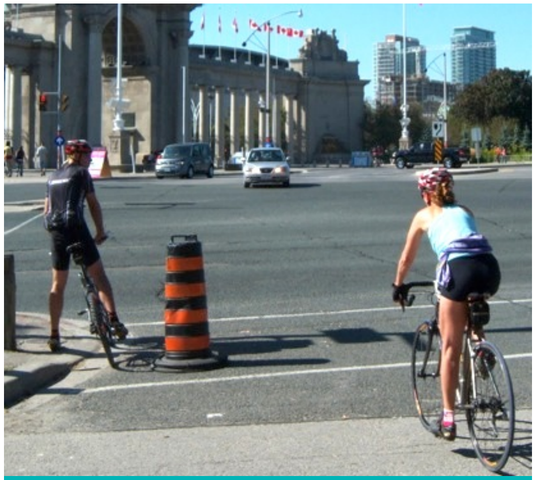
Alcohol intoxication was one of the most common topics investigated. Two studies found an increase in injury or crash risk[24, 35] and five found increased injury severity (including brain injury and death) in cyclists riding while intoxicated. [5, 7, 22, 29, 44]

Cycling using mobile devices

Two studies looked at the effect of using a mobile device while cycling. These did not examine injury risk or severity but other safety issues. Talking or texting on a mobile phone and listening to music resulted in reduced visual and auditory perception and reduced speed (the authors suggested this may reduce cyclist stability).[11, 12]

Cycling in the direction opposite to traffic

Riding in the direction opposite to traffic was associated with increased injury or crash risk and increased injury severity. [5, 18, 22, 38, 41, 51, 56] Two studies found increased injury risk for cyclists riding on the road in the opposite direction of traffic and one found increased injury severity on one-way streets.[1, 18, 51] Two studies found an increased risk among cyclists riding on



Example of cyclists travelling in the direction opposite to traffic an off-street facility who approached an intersection opposite to the direction of traffic.[38, 41]

Three studies found that head-on collisions were the type of car-bicycle crash most likely to be fatal. [5, 22, 56]

Table 3.4 Summary of Evidence on Bicycling Operations

Topic	References	Injury or Crash Risk	Injury Severity	Other Safety Info	Weight of Evidence
Alcohol intoxication	5, 7, 22, 24, 29, 35, 44	↑	↑		All studies agree
Talking or texting on mobile phone (hands free or not), listening to music while cycling	11, 12			• Reduces visual and auditory perception • Reduces speeds	Both studies agree (both by the same research team)
Riding in the direction opposite to motor vehicle traffic	1, 5, 18, 22, 38, 41, 51, 56	↑	↑		All studies agree except one. It did not find increased severity when riding in the opposite direction of traffic, but did find head-on collisions to be the most severe.

3.5 Safety Equipment

Visibility aids

Wearing bright clothing (e.g., fluorescent colours, yellow, orange, red, white) was associated with decreased injury risk. [48] Not having reflectors on the bicycle was associated with increased severe head injury. [53]

In the daytime, bright (yellow, orange, red, white) clothing increased visibility of cyclists. [16] At night, reflective clothing increased visibility, but fluorescent colours did not. [55]

Example of colours shown to be visible in daylight (yellow, orange, red, white, and fluorescent colours).

At dawn, dusk and night, reflective materials and lights increase visibility.

Helmets

Helmets have been extensively studied and consistently found to reduce head injury severity after a crash. [57,58]

Some studies have also examined face and neck injuries, and found that the effects differ with helmet design. [57,58] Face injuries are usually mitigated, but some designs may be associated with increased face injuries ("no shell"). Most helmet designs used in commuter cycling are not designed to reduce neck injuries and some have been shown to increase neck injuries. The features of the designs associated with injury increases have usually been reported as "soft shell" and "no shell", but it is not clear whether it is the shape or the shell hardness that are important.

On balance, reviewers conclude that helmets reduce injury severity.[57, 58]

Table 3.5 Summary of Evidence on Safety Equipment

Topic	References	Injury or Crash Risk	Injury Severity	Other Safety Info	Weight of Evidence
Wearing bright clothing and using reflectors	16, 48, 53, 55	↓	↓	• Reflective clothing and reflectors increases visibility at night • Bright (yellow, red, and orange, white) clothing increases cyclist visibility in daytime	All studies agree
Wearing a helmet	57, 58		↓		All studies agree

3.6 Conflicting Evidence & Single Studies

For some topics, studies found conflicting results. In addition, several papers focused on topics that were not addressed by any other studies. We did not feel comfortable drawing conclusions about these topics, but they are included here for completeness and to suggest areas where more research is needed.

Conflicting Evidence

Cycling quickly was an area where there was some disagreement. Two studies found increased risk for increased cycling speeds (although one of these studies grouped riding quickly with alcohol intoxication and zigzagging through traffic, so which of these variables had an effect is not clear).[4, 39] One study found reduced risk in cyclists who rode quickly (the authors suggested this could be due to more advanced and experienced cyclists riding faster than less experienced cyclists).[48] Downhill grades (see section 3.2) were associated with increased risk of injury, and this is consistent with speed being a risk factor.

Three studies looked at **curved roads**, but no consensus was found.[5, 22, 29]

There was conflicting evidence about **intersections**. One study looked at the relative risk of crashes at intersections and another at injury severity at intersections; neither found an increased risk.[23, 47] Some studies presented simple percentages of crash locations that seemed to suggest intersections present increased risk to cyclists.[21, 51] These data may reflect risk of cyclist–motor vehicle crashes only or may be unreliable as they did not control for the number of cyclists exposed to intersections.

Another area with no consensus was **children riding on the sidewalk**. One study found decreased risk, but two found increased risk.[6, 43, 49] The authors suggested that this may be due to more experienced child cyclists riding on the road, and newer cyclists riding on the sidewalk.

A number of studies examined **off-road and unpaved paths**. The results were not consistent, perhaps because these routes types were often poorly defined or because they may have different characteristics in different geographic locations. [27, 31, 49]

Single Studies

Several road treatments for cyclists showed improved cyclist safety in a single study:

- **bike boxes** (areas at the front of intersections where cyclists can collect and enter the intersection ahead of cars) [13]
- **coloured cycle lanes** (regular bike lanes painted to increase visibility) [50] and
- **separated left turn lanes**. [50]

Two papers reported evidence from one study and found that both **train or streetcar tracks** and **construction** on the route increased crash risk. [18, 47]

One study found that **recently paved roads** decreased injury severity. [1]

The **night time visibility of cycle crossings** was examined by one study which found motor vehicle drivers noticed cycle crossings earlier if there was a cyclist present at the road side. [34] This study also found that crossings were less visible in wet conditions.

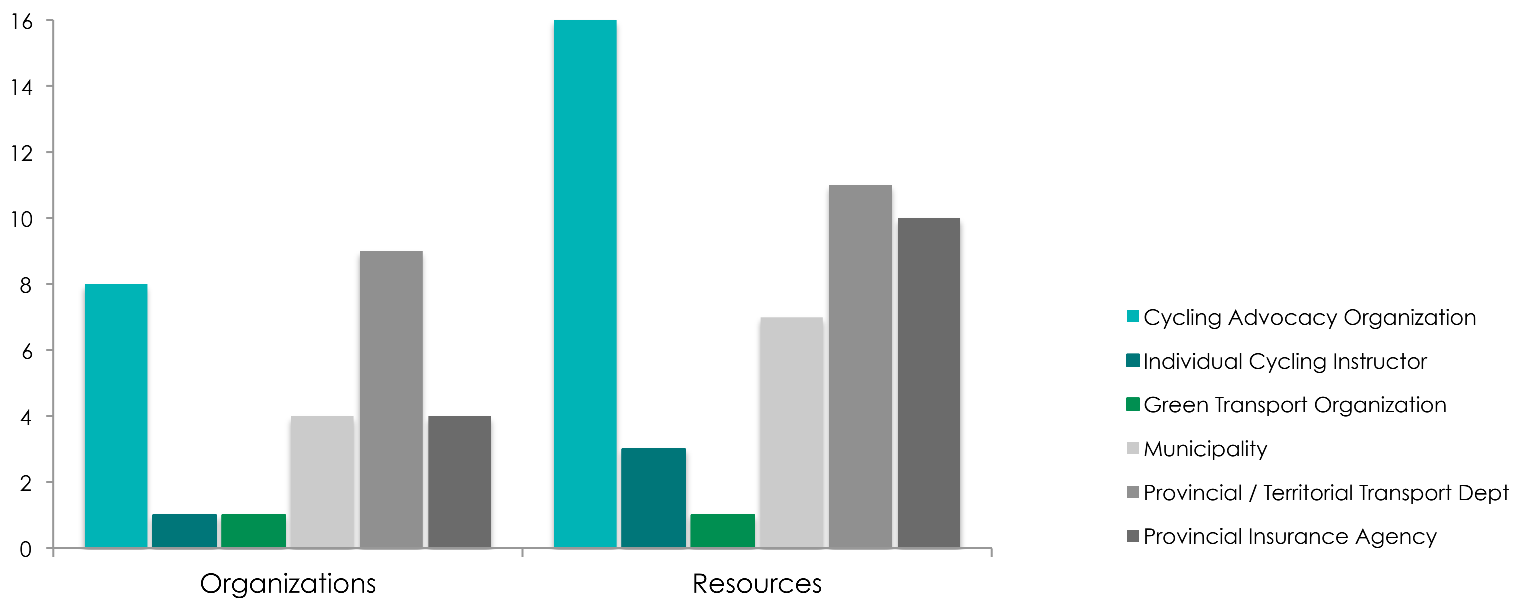
Bicycling operations that were addressed by only one study included

- cyclists **failing to give the right-of-way** to cars (increased injury severity) [5] and
- cyclists **looking away from the route** (increased risk of single bicycle crashes related to visual design of the site, such as hitting the curb or going off the road). [42]

4. Cycling Education Materials

Cycling education materials meant for cyclists and drivers were identified using a systematic search of driver licensing agencies, cycling education and advocacy organizations, the web, and word of mouth.

In total, we acquired and examined 48 resources (see **Appendix D. List of Education Materials**). The figure below shows the types of organizations that provided education resources for the project. The scope of the materials ranged from single-paged information sheets to comprehensive booklets.

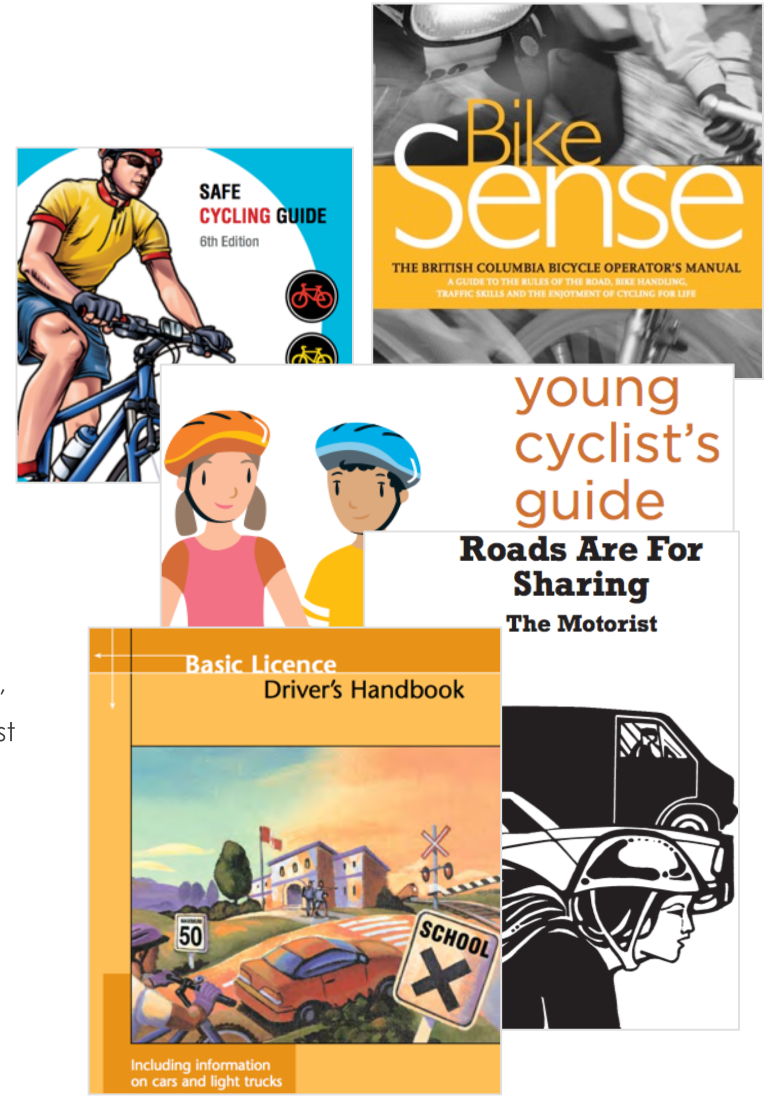


Of the 48 materials gathered, 18 had **messages for drivers**. The following are examples:

- check for cyclists – at intersections, when entering a roadway, pulling out from curb, or opening doors
- slow down & be cautious around cyclists
- make eye contact with cyclists
- be aware of hazards cyclists may face & anticipate their actions
- leave ample room when passing & don't follow too closely
- don't underestimate cyclist speed
- don't drive or park in bike lanes
- always signal turns
- avoid honking at cyclists
- dim your lights when approaching a cyclist.

The materials gathered covered a **broader spectrum of topics for cyclists, with 7 overarching themes**, discussed in the next section. Note that the first five were also themes in the scientific literature:

- bicycle – motor vehicle interactions
- route characteristics & conditions
- route types
- bicycling operations
- safety equipment
- bike fit & maintenance
- rules of the road.



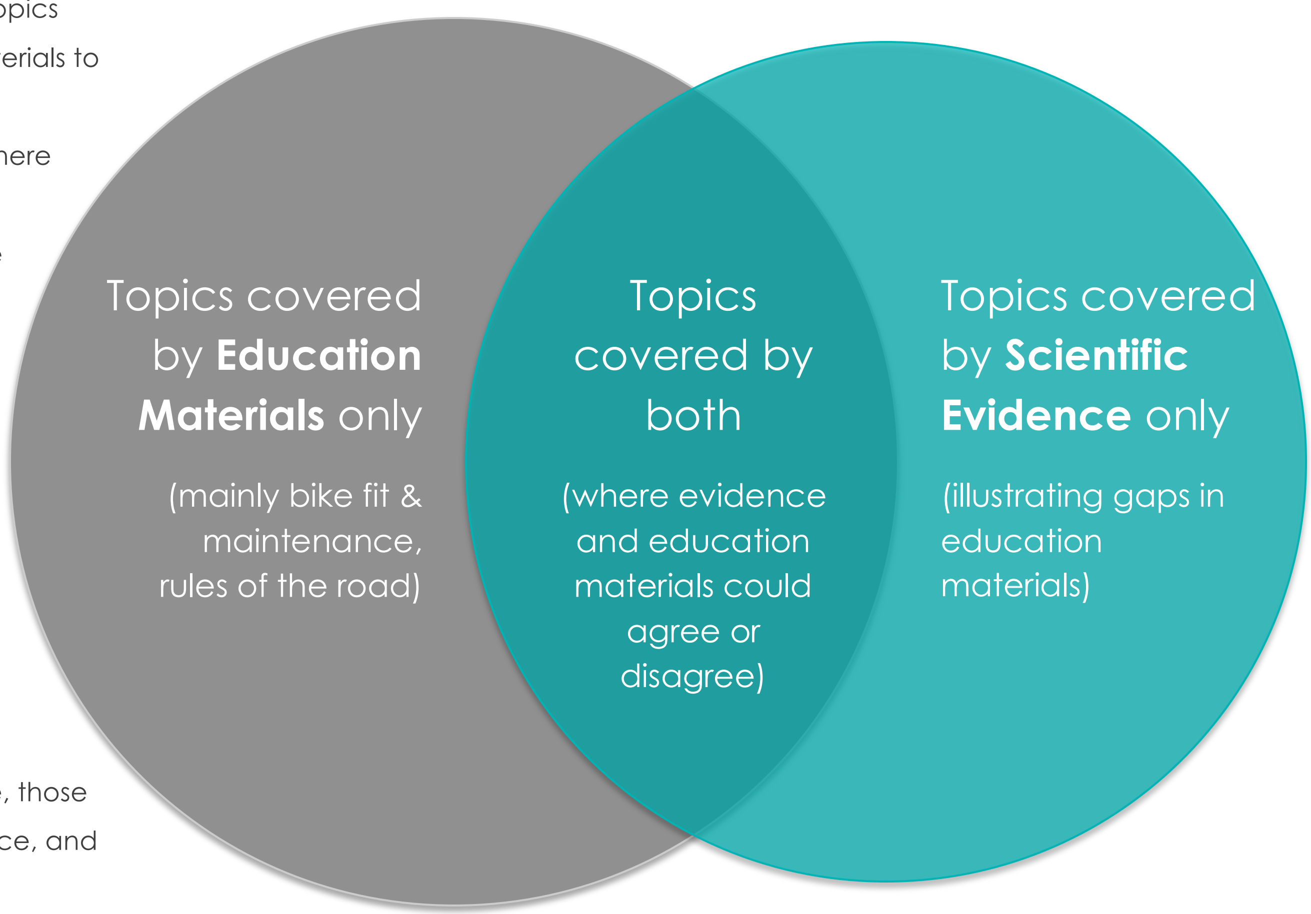
Examples of education resources for cyclists and drivers

5. Education Materials vs. Scientific Literature

We compared the safety topics covered by education materials to those covered by scientific evidence. Not surprisingly there was overlap as well as topics covered by only one or the other.

For some of the topics covered by both, the scientific evidence did not support advice in the education materials.

The following sections provide an overview of the topics, including those supported by the evidence, those not covered by the evidence, and the gaps and conflicts.



Venn diagram not to scale. More topics were covered by the Education Materials than by the Scientific Evidence

5.1 Education Messages Supported by Evidence

Overall, **many of the safety-related messages conveyed by cycling education materials in Canada are supported by scientific evidence**.

Table 5.1 outlines the education messages that are largely supported by the evidence we reviewed. It also indicates how many of the 48 education materials included each message.

It is important to note that the way education messages were written differs from the style of scientific evidence. Education messaging tended to be very definite or prescriptive in style, suggesting a degree of certainty that science does not provide. The circumstances of a scientific study (location, time period, characteristics of cyclists, type of safety evidence, etc.) can make a difference to results, and for that reason conclusions of studies refer to "associations" or "increased risks" rather than providing clear recommendations. For this reason, we indicate that scientific evidence "supports" an educational message or that the same topic is "covered" by both, not that the evidence and message are identical.

Table 5.1 Education Messages Supported by Scientific Evidence

Overarching Theme	Education message supported by scientific evidence	Total number of education materials that included this message
Bicycle – Motor Vehicle Interactions	Stay away from large vehicles	3
	Beware of parked cars pulling out or opening doors	10
	Be extra cautious of heavy vehicles turning right	2
	Ride in the direction of traffic	16
	Yield to cross traffic*	3
Route Characteristics & Conditions	Cross railroad tracks at right angle*	6
	Be aware of weather conditions, brakes work less well when wet	8
	Ride slowly, brake lightly in snow & ice	3
Route Types	Avoid riding on major roads and highways	1
	Don't ride on sidewalks	14
Bicycling Operations	Don't ride while intoxicated	2
	Don't use a mobile device while riding	3
	Pay attention & keep eyes on the road*	3
Safety Equipment	Use lights after dark	29
	Wear reflective or bright clothing	26
	Wear a helmet	25

* one study only to date

5.2 Missing or Incomplete Education Messages

There were a number of topics where scientific evidence exists but it has not been incorporated into education materials (gaps) and one topic where the scientific evidence is not reflected in the education messaging (incomplete and potentially misleading).

Gaps, especially route planning information

Evidence that was not mentioned in education materials included:

- decreased risk associated with bike-specific route types, including cycle tracks, bike lanes, and bike paths [18, 25, 26, 31, 32, 40, 47, 49, 56]
- decreased risk associated with routes with low traffic volumes, including residential street bike routes [18, 27, 31, 32, 33, 47]
- increased risk associated with roundabouts or traffic circles at intersections [8, 9, 10, 18, 19, 41]
- increased risk after dark on routes without streetlights [5, 22, 23, 40, 42, 49, 54, 56]
- increased risk associated with foggy conditions [23]
- decreased stability and perception when listening to music while cycling. [12]

Guidance on the best route types to reduce injury risk would help cyclists plan their routes.

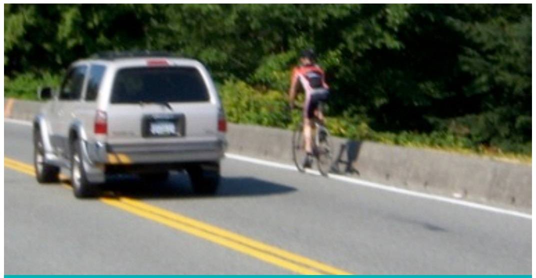
A major focus in the literature was on the relative risks of different route types, yet guidance about route planning was absent from almost all educational materials. Only one explicitly mentioned staying away from busy roads and highways. Yet there is substantial evidence that major streets and highways without bicycle infrastructure are associated with increased injury risk and/or injury severity [1, 6, 18, 27, 31, 32, 33, 47, 49] and that cycling-specific facilities and streets with little vehicle traffic decrease risks. [18, 25, 26, 27, 31, 32, 33, 40, 47, 49, 56] The provision of more explicit direction on the relative safety of different route types can provide guidance to cyclists on how to choose safer routes for cycling.

Position on the Road

Many of the education materials provided guidance about where cyclists should be positioned on the road, in particular the following:

- ride ~1 meter from the curb or parked cars,
- take the entire lane if it is safest.

The scientific literature did not directly examine these, but did examine the distances left by motor vehicles when passing a cyclist. Decreased passing distances were found on higher speed and traffic roads, with motor vehicle traffic in the opposing direction, with heavy vehicles, and where cyclists rode far from the curb (including when cyclists rode in bike lanes, though wider bike lanes increased passing distances and distances from parked cars). [14, 20, 37, 52] Thus the advice given in many education materials is incomplete and may result in reduced motor vehicle passing distances.



Advice on road positioning should indicate situations where motorists are likely to pass closer to cyclists.

It can also include advice about route types that help provide protection from motorists, including cycle tracks, wide bike lanes, traffic diverted residential streets, and off-street bike paths.

Table 5.2 Gaps & Incomplete Education Messages Compared with Scientific Evidence

Overarching Theme	Gap or Incomplete Message	Scientific evidence where there is a gap or an incomplete message in education materials	Total number of education materials that included incomplete message
Route Characteristics & Conditions	Gap	Evidence indicates that roundabouts present an elevated injury risk for cyclists	
	Gap	Evidence indicates that, after dark, routes without streetlights increase injury risk and severity	
	Gap	Evidence indicates that foggy conditions increase injury severity	
Route Types	Gap	Evidence indicates that bike-specific routes (cycle tracks, painted bike lanes, and off-street bike paths) decrease crash risk and injury severity	
	Gap	Evidence indicates that routes separated from traffic (cycle tracks, residential streets with traffic diversion, bike paths) or with low traffic volumes (residential streets) decrease crash risk and injury severity	
Bicycling Operations	Gap	Evidence indicates that listening to music while cycling reduces cyclist stability and perception	
Bicycle – Motor Vehicle Interactions	Incomplete Message	Evidence indicates vehicles pass closer to cyclists riding further from the curb, and that passing distances are smaller on roads with higher vehicle speeds and traffic, vehicles in the opposing direction, and heavy vehicles.	
		Education message recommends cycling 1 m away from curb or parked cars.	17
		Education message recommends taking the lane.	11

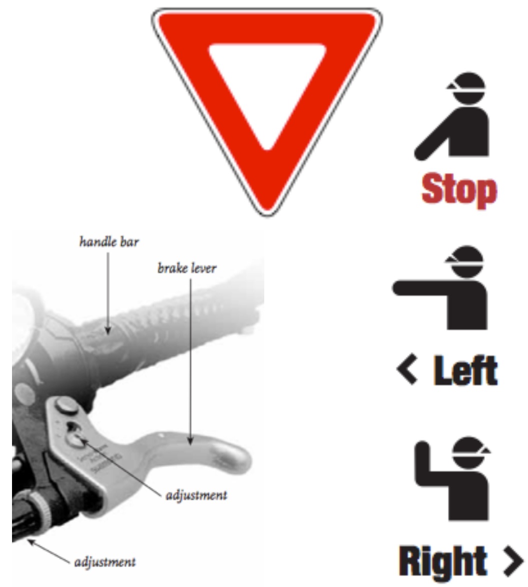
5.3 Education Messages Not Addressed by Evidence

There were many education messages with no applicable scientific evidence (Table 5.3).

The types of items included in education materials were often of a different tenor than those addressed by safety research. Many were on topics that are hard to study (e.g., making eye contact with drivers, being aware of road hazards). Other messages could be studied, but to date had no research evidence (e.g., wearing gloves and safety glasses, flashing lights).

Many of the education messages could be considered "common sense" instructions meant to guide cyclists to avoid certain types of hazards (e.g., look for cars pulling out of driveways and side streets; be aware of road hazards such as gravel, holes, bumps, and objects).

Safety messages within the overarching themes of "bike fit and maintenance" and "rules of the road" were common in education materials but these themes were not addressed in the scientific research. Understanding the rules of the road related to cycling-specific infrastructure is important for both cyclists and drivers, but few education materials explained rules for cycling-related infrastructure such as bike lanes, bike boxes, sharrows or traffic circles.



Education materials included two broad topic areas not addressed in the scientific research:

- bike fit & maintenance
- rules of the road.

Rules about cycling-related infrastructure such as bike lanes, bike boxes, sharrows or traffic circles were rarely explained.

Table 5.3 Education Messages Not Addressed by Scientific Evidence

Overarching Topic	Education message not addressed by scientific evidence	Total number of education materials that included this message
Bicycle – Motor Vehicle Interactions	Ride in a straight line and stay in motorist's field of vision	21
	Take the entire lane if it is safest	14
	Ride far enough behind that the driver can see you in his side mirror	2
	Look for cars pulling out of driveways and side streets	10
	Stay behind right-turning cars at intersections	11
	Look for cars turning left across your path	5
	Make eye contact with drivers	4
Route Characteristics & Conditions	Be aware of road hazards: gravel, holes, bumps, and objects	9
Safety Equipment	Bike should have a bell or horn	17
	Flashing lights are safer	3
	Attach a pennant to bicycle to force vehicles to leave more room	2
	Use a rear view mirror	4
	Wear gloves and safety glasses	2

Table 5.3 (con't) Education Messages Not Addressed by Scientific Evidence

Overarching Topic	Education message not addressed by scientific evidence	Total number of education materials that included this message
Bicycling Operations	Stop and look before entering the street	5
	Keep control of your bike	4
	Shoulder check when changing lanes or turning	18
	Detailed left turning instructions	8
	Move out of right turn lanes if not turning	6
	Anticipate unforeseen events	8
	Don't carry more passengers than bicycle was designed for	11
	Arrange baggage to keep bike stable	3
Bicycle Fit & Maintenance	Bike is correct size	12
	Bike and brakes are in good condition	17
	Tires are fully inflated	10
	Drive train is clean	7
Rules of the Road	Bike is legally considered a vehicle: obey laws, signs, signals	27
	Use hand signals when changing lanes, turning or stopping	20
	Don't pass on the right	5
	Ride single file except when passing	11
	Yield to new lane traffic	3
	Yield to pedestrians	6
	Streetcar and school bus stop distances	1
	Bike lane, bike box, sharrows, or traffic circle riding instructions	1

5.4 Education Materials: Ambiguous "Facts"

Education materials sometimes presented ambiguous and potentially misleading data as "facts". These usually indicated the proportions of crashes or injuries with certain characteristics. Examples are presented in Figure 5.4 on the next page.

Such information has a number of potential problems:

- The source of the data was often not cited, so there was no way to check or update it.
- The context was often not indicated: where, when, all crashes or crashes with motor vehicles only?
- Data were sometimes contradictory, both between resources and within the same resource.
- The implications were usually unclear, since no "denominators" were presented. Without denominators, there was no information about cyclists' "exposure" (see section 2, p. 2-3). Information without denominators does not give scientifically interpretable information about causes of crashes or cycling risk factors. It can confuse or misdirect education about cycling safety.

  For example, information indicating that "40% of crashes occurred in residential areas" may suggest that these areas are dangerous, but if more than half of cycling is in residential areas, it would indicate the opposite: these areas are safer.

Recommendations for presenting data in education materials . . .

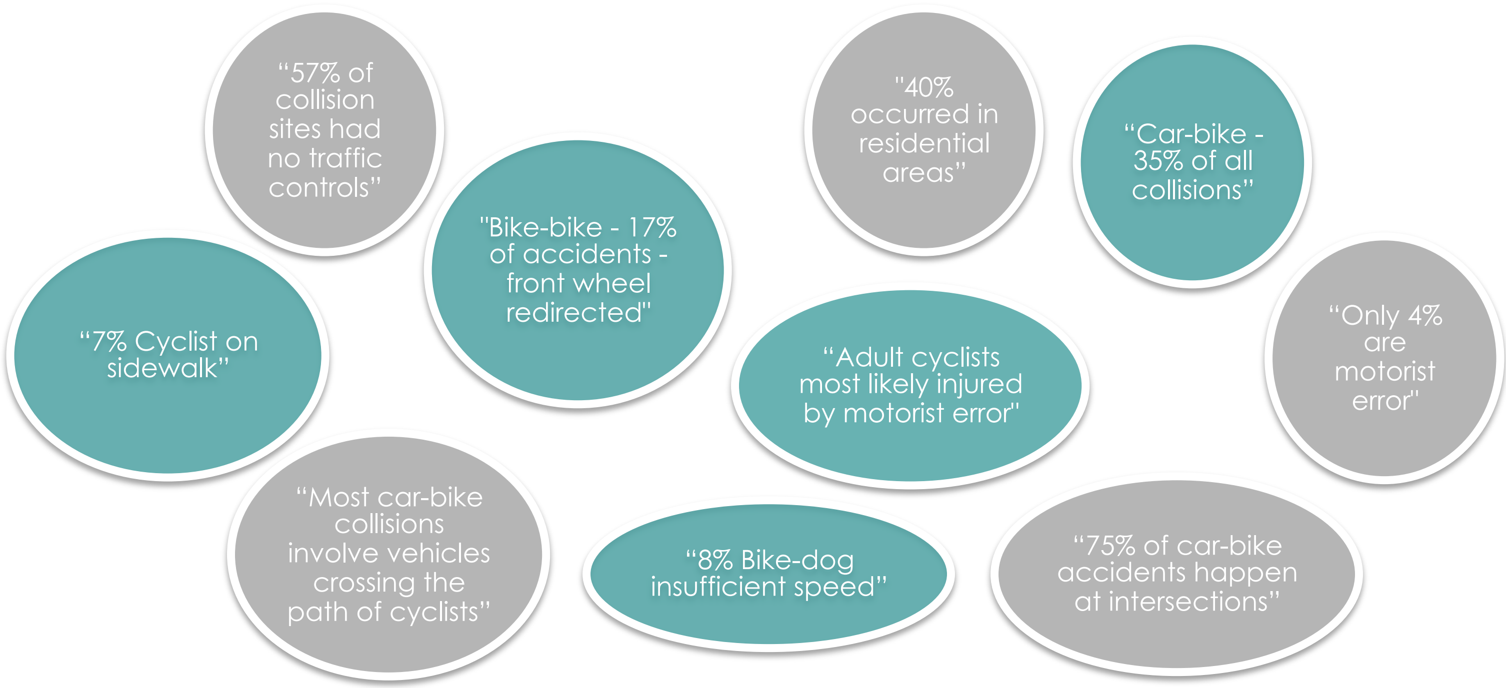
It is best to cite data presented in education materials so trainers and cyclists can refer to the original material and examine the context in which it is presented.

It is best to critically appraise data presented in education materials, to ensure that denominators indicating "exposure" or comparisons based on relative risks are provided (see section 2, p. 2-3). Simple proportions of crashes or injuries may give trainers and cyclists a misleading impression of the causes of crashes or injuries.

If data without denominators indicating "exposure" are presented, it is best to make clear that the data do not imply anything about causes of crashes or injuries.

Similarly, information about fault in crashes is very difficult to interpret. Although there were scientific papers that tallied cyclist or motorist behaviours that occurred in crashes, most did not examine these behaviours using a measure of relative risk.

Figure 5.4 Examples of ambiguous "facts" presented in education materials



6. Recommendations for Updating Education Materials

Based on our review of cycling training materials and scientific evidence to date, we propose the following to improve cycling training materials:

- **Review your organization's education materials** compared to the scientific evidence presented in this report to ensure that all elements your organization wishes to convey are included.
- **Include information about the relative safety of route types and route characteristics** to help cyclists plan their routes, in particular:
    - decreased risk associated with bike-specific route types, including cycle tracks, bike lanes, and bike paths,
    - decreased risk associated with routes with low traffic volumes, including residential street bike routes,
    - increased risk associated with roundabouts or traffic circles at intersections, and
    - increased risk after dark on routes without streetlights.
- **Include information about motor vehicle passing distances**, so cyclists understand circumstances when motor vehicles are likely to pass closer to them, in particular:
    - where motor vehicle speeds and traffic are high,
    - where there is motor vehicle traffic in the opposing direction, and
    - when the passing vehicle is a heavy vehicle such as a truck or bus.
- **Include information** for cyclists and drivers **about the rules of the road for bike-related infrastructure**, e.g., bike lanes, bike boxes, sharrows, traffic circles.
- Remove or carefully explain data that does not provide the basis for drawing conclusions about relative safety.
- **Cite sources of information** used so they can be checked and updated.
- **Update education materials** from time to time with new scientific evidence about factors affecting cycling safety.

7. Acknowledgements

Thank you to all the organizations and individuals who contributed materials to this review.

Alberta Ministry of Transportation
Insurance Corporation of British Columbia
Manitoba Public Insurance
New Brunswick Department of Public Safety
Newfoundland and Labrador Motor Registration Division
Northwest Territories Transportation
Nova Scotia Registry of Motor Vehicles
Ontario Ministry of Transportation
Prince Edward Island Department of Transportation
Société de l'Assurance Automobile du Québec
Saskatchewan General Insurance
Government of Yukon

Abbotsford Cycling Action Group
Bicycle Transportation Alliance
Bike to the Future
Canadian Cycling Association & CAN-BIKE
Elbow Valley Cycling Club
Greater Victoria Cycling Coalition
i-Go
UBC Bike Co-op
Vancouver Area Cycling Coalition
Velo Quebec

City of Calgary
City of Nanaimo
City of Whitehorse
City of Yellowknife

Colleen Cooper
Monica DeLuca
Malcolm Dort
Wade Eide
Chuck Glover
Don Hollingshead
Eric Lorenz
Bruce Mol
Darrell Noakes
Greg Robinson
Alan Salmoni

Project Funder

CIHR IRSC
Canadian Institutes of Health Research

Appendix A. List of Scientific Literature

#	Authors	Article Title	Publication	Study Location	Study Population
1.	Allen-Munley C, Daniel J, Dhar S	Logistic model for rating urban bicycle route safety	Transport Res Rec 2004;1878:107-15	United States	314 bicycle crashes over 3 years,
2.	Aultman-Hall L, Kaltenecker MG	Toronto bicycle commuter safety rates	Accident Anal Prev 1999;31(6):675-86	Canada	1196 bicycle commuters
3.	Aultman-Hall L	Ottawa-Carleton commuter cyclist on- and off-road incident rates	Accident Anal Prev 1998;30(1):29-43	Canada	1604 bicycle commuters
4.	Bacchieri G, Barros AJ, Dos Santos JV, Gigante DP	Cycling to work in Brazil: users profile, risk behaviors, and traffic accident occurrence	Accident Anal Prev 2010;42(4):1025-30	Brazil	1133 male cyclists
5.	Bil M, Bilova M, Muller I	Critical factors in fatal collisions of adult cyclists with automobiles	Accident Anal Prev 2010;42(6):1632-6	Czech Republic	968 fatalities from 1995-2007
6.	Carlin JB, Taylor P, Nolan T	A case-control study of child bicycle injuries: Relationship of risk to exposure	Accident Anal Prev 1995;27(6):839-44	Australia	109 children injured while riding and 118 controls
7.	Crocker P, Zad O, Milling T, Lawson KA	Alcohol, bicycling, and head and brain injury: a study of impaired cyclists' riding patterns	Am J Emerg Med 2010;28(1):68-72	United States	198 injured cyclists
8.	Cumming B	Roundabouts: why they are dangerous for cyclists and what can be done about it	Transport Engineering Austral 2011;13(1):27-40	Australia	Crashes from 2005-2009
9.	Daniels S, Nuyts E, Wets G	The effects of roundabouts on traffic safety for bicyclists: an observational study	Accident Anal Prev 2008;40(2):518-26	Netherlands	411 crashes from 1991-2001 for 91 roundabouts constructed between 1994-2000,

#	Authors	Article Title	Publication	Study Location	Study Population
10.	De Brabander B, Vereeck L	Safety effects of roundabouts in Flanders: signal type, speed limits and vulnerable road users	Accident Anal Prev 2007;39(3):591-9	Belgium	2125 crashes at 95 roundabouts from 1991-2001
11.	de Waard D, Schepers P, Ormel W, Brookhuis K	Mobile phone use while cycling: incidence and effects on behaviour and safety	Ergonomics 2010;53(1):30-42	Netherlands	24 cyclists on a 220m path
12.	de Waard D, Edlinger K, Brookhuis K	Effects of listening to music, and of using a handheld and handsfree telephone on cycling behaviour	Transport Res F-Traf 2011;14(6):626-37	Netherlands	25 cyclists on a 220m path
13.	Dill J, Monsere CM, McNeil N	Evaluation of bike boxes at signalized intersections	Accident Anal Prev 2012;44(1):126-34	United States	Before and after observations at 10 bike boxes and 2 control sites
14.	Duthie J, Brady JF, Mills AF, Machemehl RB	Effects of on-street bicycle facility configuration on bicyclist and motorist behavior	Transport Res Record 2010(2190):37-44	United States	Observations at 48 sites
15.	Gilbert K, McCarthy M	Death of cyclists in London 1985-92: The hazards of road traffic	British Medical Journal 1994;308(6943):1534-7	Britain	178 fatalities from 1985-1992
16.	Hagel BE, Lamyb A, Rizkallah JW, Belton KL, Jhangri GS, Cherry N, Rowe BH	The prevalence and reliability of visibility aid and other risk factor data for uninjured cyclists and pedestrians in Edmonton, Alberta, Canada	Accident Anal Prev 2007;39(2):284-9	Canada	Observations of 273 cyclists
17.	Haileyesus T, Annest JL, Dellinger AM	Cyclists injured while sharing the road with motor vehicles	Injury Prev 2007;13(3):202-6	United States	62,267 cyclist-motor vehicle crashes form 2001-2004
18.	Harris MA, Reynolds CCO, Winters M, Cripton PA, Shen H, Chipman M, Cusimano MD, Babul S, Brubacher J, Friedman SM, Hunte G, Monro M, Vernich L, Teschke K	Bicyclists' Injuries and the Cycling Environment: Comparing the effects of infrastructure on cycling safety at intersections and non-intersections	Injury Prev 2012;submitted	Canada	688 injury events

#	Authors	Article Title	Publication	Study Location	Study Population
19.	Hels T, Orozova-Bekkevold I	The effect of roundabout design features on cyclist accident rate	Accident Anal Prev 2007;39(2):300-7	Denmark	152 crashes at 88 roundabouts from 1999-2003
20.	Hunter W, Feaganes J, Srinivasan R	Conversions of wide curb lanes: the effect on bicycle and motor vehicle interactions	Transport Res Record 2005;1939:37-44	United States	Before and after observations at 7 sites
21.	Johnson M, Charlton J, Oxley J, Newstead S	Naturalistic cycling study: identifying risk factors for on-road commuter cyclists	Annals Advances Automotive Med 2010;54:275-83	Australia	Observations from 127 hr, 38 min of cyclists footage
22.	Kim J-K, Kim S, Ulfarsson GF, Porrello LA	Bicyclist injury severities in bicycle-motor vehicle accidents	Accident Anal Prev 2007;39(2):238-51	United States	2934 crashes from 1997-2002
23.	Klop Jeremy R, Khattak AJ	Factors influencing bicycle crash severity on two-lane, undivided roadways in North Carolina	Transport Res Record 1999;1674:78-85	United States	1025 crashes from 1990-1993
24.	Li G, Baker SP, Smialek JE, Soderstrom CA	Use of alcohol as a risk factor for bicycling injury	JAMA 2001;285(7):893-6	United States	124 seriously or fatal injuries and 324 controls
25.	Loo BPY, Tsui KL	Bicycle crash casualties in a highly motorized city	Accident Anal Prev 2010;42(6):1902-7	Hong Kong	4985 crashes from 2005-2007
26.	Lusk AC, Furth PG, Morency P, Miranda-Moreno LF, Willett WC, Dennerlein JT	Risk of injury for bicycling on cycle tracks versus in the street	Injury Prev 2011;17(2):131-5	Canada	340 injuries from 1999-2008, 24 hour cycle counts for 6 cycle tracks
27.	Meuleners LB, Lee AH, Haworth C	Road environment, crash type and hospitalisation of bicyclists and motorcyclists presented to emergency departments in Western Australia	Accident Anal Prev 2007;39(6):1222-5	Australia	151 crashes over 6 months
28.	Miranda-Moreno LF, Strauss J, Morency P	Disaggregate exposure measures and injury frequency models of cyclist safety at signalized intersections	Transport Res Record 2011;2236:74-82	Canada	Crashes at 753 intersection over 9 years

#	Authors	Article Title	Publication	Study Location	Study Population
29.	Moore DN, Schneider IVWH Savolainen PT, Farzaneh M	Mixed logit analysis of bicyclist injury severity resulting from motor vehicle crashes at intersection and non-intersection locations	Accident Anal Prev 2011;43(3):621-30	United States	10,029 crashes from 2002-2008
30.	Morgan AS, Dale HB, Lee WE, Edwards PJ	Deaths of cyclists in London: trends from 1992 to 2006	BMC Public Health 2010;10:699	Britain	242 fatalities from 1996-2002
31.	Moritz W	Adult bicyclists in the United States: Characteristics and riding experience in 1996	Transport Res Record 1998;1636:1-7	United States	1956 surveys
32.	Moritz W	Survey of North American bicycle commuters: Design and aggregate results	Transport Res Record 1997;1578:91-101	United States	2374 surveys
33.	Nicaj L, Stayton C, Mandel-Ricci J, McCarthy P, Grasso K, Woloch D, Kerker B	Bicyclist fatalities in New York City: 1996-2005	Traffic Injury Prev 2009;10(2):157-61	United States	225 fatalities from 1996 to 2005
34.	Nygardhs S, Fors C, Eriksson L, Nilsson L	Field test on visibility at cycle crossings at night	European Transport Res Rev 2010;2(3):139-45	Sweden	12 participants, 10km route with 9 cycle crossings
35.	Olkkonen S, Honkanen R	The role of alcohol in nonfatal bicycle injuries	Accident Anal Prev 1990;22(1):89-96	Finland	140 non fatally injured cyclists and 700 controls
36.	Ostrom M, Bjornstig U, Naslund K, Eriksson A	Pedal cycling fatalities in northern Sweden	Int J Epidemiol 1993;22(3):483-8	Sweden	146 fatalities in 11 years
37.	Parkin J, Meyers C	The effect of cycle lanes on the proximity between motor traffic and cycle traffic	Accident Anal Prev 2010;42(1):159-65	Britain	
38.	Rasanen M, Summala H	The safety effect of sight obstacles and road-markings at bicycle crossings	Traffic Engineering Control 1998;39(2):101-2	Finland	143 crashes
39.	Rivara FP, Thompson DC, Thompson RS	Epidemiology of bicycle injuries and risk factors for serious injury	Injury Prev 1997;3(2):110-4	United States	3390 injured cyclists over three years

#	Authors	Article Title	Publication	Study Location	Study Population
40.	Rodgers GB	Bicyclist deaths and fatality risk patterns	Accident Anal Prev 1995;27(2):215-23	United States	841 & 917 fatalities (from two databases) over 1 year, 1254 interviews with riders
41.	Sakshaug L, Laureshyn A, Svensson A, Hyden C	Cyclists in roundabouts--Different design solutions	Accident Anal Prev 2010;42(4):1338-51	Sweden	53 hours of observation at 2 roundabouts
42.	Schepers P, den Brinker B	What do cyclists need to see to avoid single-bicycle crashes?	Ergonomics 2011;54(4):315-27	Netherlands	1142 single bicycle crashes
43.	Senturia YD, Morehead T, LeBailly S, Horwitz E, Kharasch M, Fisher J, Chistoffell KK	Bicycle-riding circumstances and injuries in school-aged children: A case control study	Arch Pediat Adol Med 1997;151(5):485-9	United States	47 injured child cyclists and 42 controls
44.	Spaite DW, Criss EA, Weist DJ, Valenzuela TD, Judkins D, Meislin HW	A prospective investigation of the impact of alcohol consumption on helmet use, injury severity, medical resource utilization, and he	J Trauma 1995;38(2):287-90	United States	350 injured cyclists
45.	Stone M, Broughton J	Getting off your bike: Cycling accidents in great Britain in 1990-1999	Accident Anal Prev 2003;35(4):549-56	Britain	30000 fatalities from 1990-1999
46.	Stutts JC, Hunter WW	Motor vehicle and roadway factors in pedestrian and bicyclist injuries: An examination based on emergency department data	Accident Anal Prev 1999;31(5):505-14	United States	1066 injured cyclists
47.	Teschke K, Harris MA, Reynolds CCO, Winters M, Babul S, Chipman M, Cusimano MD, Brubacher J, Friedman SM, Hunte G, Monro M, Shen H, Vernich L, Cripton PA	Route infrastructure and the risk of injuries to bicyclists: A case-crossover study	Am J Public Health 2012;In press	Canada	690 injured cyclists

#	Authors	Article Title	Publication	Study Location	Study Population
48.	Thornley SJ, Woodward A, Langley JD, Ameratunga SN, Rodgers A	Conspicuity and bicycle crashes: preliminary findings of the Taupo Bicycle Study	Injury Prev 2008;14(1):11-8	New Zealand	2469 cyclists
49.	Tinsworth DK, Cassidy SP, Polen C	Bicycle-related injuries: Injury, hazard, and risk patterns	Int J Consumer Product Safety 1994;1(4):207-20	United States	420 cyclists injuries, ~1250 cycling households
50.	Turner S, Wood G, Hughes T, Singh R	Safety performance functions for bicycle crashes in New Zealand and Australia	Transport Res Record 2011;2236:66-73	Australia & New Zealand	102 intersections
51.	Wachtel BYA, Lewiston D	Risk factors for bicycle-motor vehicle collisions at intersections	ITE J. 1994;64(9):30-5	United States	314 bicycle-motor vehicle crashes from 1981-1990
52.	Walker I	Drivers overtaking bicyclists: objective data on the effects of riding position, helmet use, vehicle type and apparent gender	Accident Anal Prev 2007;39(2):417-25	Britain	Video footage from 320km of cycling
53.	Wang JTJ, Li JS, Chiu WT, Chen SH, Tsai SD, Yu WY, Liao CC, Choy CS	Characteristics of bicycle-related head injuries among school-aged children in Taipei area	Surg Neurol 2009;72:36-40	Taiwan	324 bicycle-related head injuries from 2001-2002
54.	Wanvik PO	Effects of road lighting: an analysis based on Dutch accident statistics 1987-2006	Accident Anal Prev 2009;41(1):123-8	Netherlands	762,835 injuries & 3,271,343 property damage only crashes from 1987–2006 (Unknown number of bicycle crashes)
55.	Wood JM, Tyrrell RA, Marszalek R, Lacherez P, Carberry T, Chu BS, & King MJ	Cyclist visibility at night: Perceptions of visibility do not necessarily match reality	J Australasian College Road Safety 2010;21(3):56-60	Australia	24 participants, 1.8km route with 2 cyclist locations
56.	Yan XP, Ma M, Huang HL, Abdel-Aty M, Wu CZ	Motor vehicle-bicycle crashes in Beijing: Irregular maneuvers, crash patterns, and injury severity	Accident Anal Prev 2011;43(5):1751-8	China	1914 crashes from 2004–2007

#	Authors	Article Title	Publication	Study Location	Study Population
57.	Attewell RG, Glase K, McFadden M	Bicycle helmet efficacy: a meta-analysis	Accident Anal Prev 2001;33(3):345-352	n/a	review
58.	Elvik R	Publication bias and time-trend bias in meta-analysis of bicycle helmet efficacy: A re-analysis of Attewell, Glase and McFadden, 2001	Accident Anal Prev 2011;43(3):1245-51	n/a	review

Appendix B. Definitions of Terminology for Relative Risk

Term	Description	Examples using Sidewalks as the "Circumstance of interest"
Relative Risk **(RR)**	Ratio of the probability (risk) of an event (e.g., injury or crash) occurring in a circumstance of interest to the risk of it occurring in a "control" circumstance. RR < 1 indicates lower risk in the circumstance of interest, meaning it is safer. RR > 1 indicates increased risk.	$RR = \frac{\frac{number\ of\ cyclists\ injured\ on\ the\ sidewalk}{number\ of\ cyclists\ riding\ on\ the\ sidewalk}}{\frac{number\ of\ cyclists\ injured\ on\ the\ road}{number\ of\ cyclists\ riding\ on\ the\ road}}$
Odds Ratio **(OR)**	Ratio of the odds of an circumstance of interest occurring in a case (e.g., injured) group to the odds of the same circumstance occurring in a control group. OR < 1 indicates that the odds of the circumstance of interest occurring in the case group are lower than in the control group, meaning it is safer.	$OR = \frac{\frac{number\ of\ injured\ cyclists\ riding\ on\ the\ sidewalk}{number\ of\ injured\ cyclist\ riding\ on\ the\ road}}{\frac{number\ of\ uninjured\ cyclists\ riding\ on\ the\ sidewalk}{number\ of\ uninjured\ cyclists\ riding\ on\ the\ road}}$
Relative Danger Index **(RDI)**	Compares the fraction of events reported for a particular route type to the fraction of kilometers ridden on that route type. RDI < 1 indicates that fewer events occur on this route type than would be expected if events were distributed evenly, meaning this route type is safer.	$RDI = \frac{\frac{number\ of\ cyclists\ injured\ on\ the\ sidewalk}{number\ of\ cyclists\ injured\ on\ all\ facility\ types}}{\frac{number\ kilometers\ ridden\ on\ sidewalks}{number\ of\ kilometeres\ ridden\ on\ all\ facility\ types}}$

Appendix C. Details from Scientific Literature, by Topic

Table C.1 Details of Scientific Literature on Bicycle – Motor Vehicle Interactions

Topic	Type of Evidence, Paper #, Description of Result
Motor vehicle involvement in crashes	**Injury Severity** **17.** Cyclists involved in a crash with a motor vehicle were 2.6 times more likely to need hospitalization than those in other types of injury events. **25.** Crashes involving motor vehicles were more likely to result in disabling injuries than other crashes, OR = 2.75. **39.** Motor vehicle involvement in a cycling crash increased the risk of severe injury (OR = 4.6), neck injury (OR = 4.01) and fatal injury (OR = 14.1). **46.** Cyclists involved in a crash with a motor vehicle more likely to need hospitalization.
Heavy vehicle involvement in crashes	**Injury/Crash Risk** **28.** Increased numbers of bus stops within 50 m increased risk of a crash at signalized intersections. **Injury Severity** **1.** Truck routes were associated with increased injury severity compared to other routes. **15.** Heavy goods vehicles were involved in 75 out of 178 cyclist fatalities despite making up a much smaller proportion of vehicles on the road. **22.** Crashes involving heavy trucks are more likely to cause a fatal (380.9%) or incapacitating (101.8%) injury. **29.** Crashes involving large trucks increase the likelihood of a severe injury 100% at intersection locations and 122% percent at non-intersection locations. **30.** Freight vehicles were involved in 103 of 242 cyclist fatalities despite being a smaller proportion of vehicles. **36.** Trucks were involved 21% of cyclist fatalities despite being 1% of all motor vehicles in the area under study. **53.** Colliding with heavy vehicles and buses resulted in a higher proportion of severe head injuries than collisions with pedestrians (76.9% vs 3.6%). **56.** Heavy vehicles were associated with increased injury severity compared to other types of vehicles. **Other Safety Information** **52.** Buses and heavy-goods vehicles passed closer to cyclists than cars, light-goods vehicles, and SUVs.

Motor Vehicle Speeds	**Injury or Crash Risk** **18.** At intersections, motor vehicle speeds below 30 km/h were associated with lower cycling injury risk, OR: 0.52. **19.** In roundabouts, drive curves that allowed higher vehicle speeds were associated with increased crash risk. **Injury Severity** **1.** Increased road width was associated with increased injury severity. The authors suggested this is because wide roads encourage higher speeds. **5.** Cycling crashes were more likely to be fatal where a motor vehicle driver was at fault and speeding, OR = 8.27, compared to the driver being at fault and denying the right-of-way. **22.** Motor vehicle speeds above 48.3 km/h increase the risk of a fatal crash by 302.7%, and those above 64.4km/h increase the risk of a fatal crash by over 1000%. High speeds also increase the risk of incapacitating injuries. When exceeding the speed limit is involved in a bicycle–motor vehicle collision (regardless of the speed), the probability of fatal injury increases by 300%. **23.** Higher speed limits were associated with increased incapacitating and fatal injuries. **29.** At both intersection and non-intersection locations, increased motor vehicle speed was associated with an increased chance of a bicycle-motor vehicle crash resulting in a non-incapacitating and, especially, severe injuries. **45.** Cyclist fatality rates increased with speed limit, with the rates at 70 km/h 6.5 times higher than that at 30 km/h. **53.** Greater vehicle speed was associated with more severe head injuries. **56.** Speed limits > 50 km/h significantly increased the probability of severe injury.
Motor Vehicle Traffic Volume	**Injury Risk** **18.** Motor vehicle diverters, which reduced traffic volume, were associated with decreased injury risk, OR = 0.04. **28.** Higher motor vehicle traffic volumes at signalized intersections were associated with increased crash risk. Right and left turns of motorists were particularly associated with increased crash rate. **Injury Severity** **1.** Increased traffic volume was associated with decreased injury severity. The authors suggested this is because high traffic volumes are associated with reduced speeds. **23.** Increased average annual daily traffic was associated with a decrease in non-incapacitating, incapacitating, and fatal injuries, due perhaps to decreased speed associated with higher traffic volumes.

Motor Vehicle Passing Distances	**Injury Risk** **50.** Crashes involving car doors were almost eliminated after wide bike lanes were installed. **Injury Severity** **5.** Cycling crashes were more likely to be fatal where a motor vehicle driver was at fault and had faulty overtaking, OR = 3.21, compared to the driver being at fault and denying the right-of-way. **23.** On high speed-limit roads, the presence of a shoulder was associated with decreased injury severity. **Other Safety Information** **14.** Motorists drove closer to cyclists when there was traffic in the opposing direction. Motorists passed further from cyclists where vehicle lanes were wider and in residential areas where traffic was low. Motorists passed closer to cyclists when a bike lane was provided but further from the curb with increased bike lane width (6 feet versus 4 feet wide). Cyclists rode further from the curb in residential areas where motor vehicle traffic was low. They rode closer to the curb or parked cars when a bike lane was provided, but further from the curb or parked cars with increased bike lane width (6 feet versus 4 feet wide). Motorists and cyclists proceeded in a more predictable manner with a bike lane than without. **20.** Motorists drove further from the curb when a bike lane was provided. Cyclists rode further from the curb when a bike lane was provided. Motorists passed closer to cyclists when a bike lane was provided. **37.** Motorists passed closer to cyclists on high speed (40 and 50 mph) streets with bike lanes than without, no significant difference for 30 mph streets. **52.** Buses and heavy goods vehicles provided the least passing distance. The further bicyclists rode from the curb the less space they were given when passed.

Table C.2 Details of Scientific Literature on Route Characteristics & Conditions

Topic	Type of Evidence, Paper #, Description of Result
Roundabouts & Traffic Circles	**Injury/Crash Risk** **8.** Cyclists make up a disproportionate number of roundabout crashes. **9.** Conversion of intersection to roundabouts was associated with an increase in injury-causing crashes involving bicyclists: overall OR 1.27, and 1.41-1.46 for serious injuries. **10.** Overall, roundabouts reduced crashes involving vulnerable road users by 14%, however, when a roundabout replaced a traffic signal, vulnerable road user crashes increased by 28%. **18.** Traffic circles were associated with an increase crash risk on local street intersections, OR = 7.98. **19.** Increased traffic volumes at roundabouts were associated with increased cyclist crash risk. Drive curve of a roundabout that allowed higher vehicle speeds was associated with increased crash risk. **Injury Severity** **10.** Roundabouts increased injury severity for vulnerable road users – the fatality rate increased from 3 to 17 fatalities per 100 injury accidents when a roundabout replaced a traffic signal, and from 12 to 19 on intersections that were not previously signalized. **Other Safety Information** **41.** Roundabouts with separated cycling facilities produced fewer conflicts between cyclists and motorists than roundabouts that integrated cyclists into the traffic flow.
Divided Roadways or Medians	**28.** Presence of a median at signalized intersections was associated with a slight decrease in crash risk. **Injury Severity** **22.** Two-way divided roadways were associated with decreased injury severity (including incapacitating and fatal injuries). **56.** Medians were found to significantly reduce the probability of severe injuries.

Grades	**Injury/Crash Risk** **18.** Downhill grades were associated with increased injury risk, OR = 2 compared to flat routes. **47.** Downhill grades were associated with increased injury risk, OR 2.32 compared to no grade. **Injury Severity** **1.** Grades were associated with increased injury severity. **23.** Both straight and curved grades were associated with a significant increase in injury severity (including incapacitating and fatal injuries), with curved grades having a more significant impact.
Cyclist Traffic Volumes	**Injury Risk** **18.** High cyclist traffic volume at intersections was associated with increased injury risk, OR = 3.04 for > 75 cyclists/h compared to none observed. **28.** Higher cyclist traffic volume at signalized intersections was associated with increased crash risk.
Weather Conditions	**Injury Severity** **22.** Inclement weather conditions (fog, rain, and snow) increased the probability of fatal injury by 129%, as compared to clear and cloudy weather. **23.** Foggy conditions were associated with an increase in non-incapacitating, incapacitating, and fatal injuries.

Light conditions	**Injury/Crash Risk** **40.** Relative risk of a fatal crash for cyclists who ride after dark is 3.8 times the risk of those who do not. **49.** Children who rode at dawn, dusk, or night were more likely to experience an injury than those who rode in daylight, OR = 3.64. **54.** Street lighting at night decreased crash risk for cyclists by 66%. **Injury Severity** **5.** Crashes at night without streetlights were more likely to be fatal, OR=2.16, compared to good visibility daylight conditions. **22.** Crashes in darkness without streetlights increase the probability of fatal injury by 111% and incapacitating injury by 50% compared to crashes in daylight. **23.** Dark, unlit conditions were associated with increased injury severity relative to daylight conditions. **56.** Compared to daylight, riding at night with streetlights and, even more so, riding at night without street lights were associated with increased injury severity. **Other Safety Information** **42.** In the dark or twilight, cyclists are more likely to be involved in a single-bicycle crash related to the visual design of the site (hitting the curb, going off the road, collision with a stationary object, etc.) than all other single bicycle crashes (skidding, bicycle defects, loss of control while mounting or dismounting the bicycle, etc.), OR 1.60. **49.** 46% of all fatalities occurred between 6 pm and 6 am. No denominator was presented, but it is probable that fewer trips occur in these hours than between 6 am and 6 pm.

Table C.3 Details of Scientific Literature on Route Types

Topic	Type of Evidence, Paper #, Description of Results
Cycle Tracks	**Injury/Crash Risk** **18.** Within non-intersection locations, cycle tracks were associated with reduced injury risk, OR = 0.04 compared to no bicycle infrastructure. **26.** Relative risk of injury on cycle tracks significantly lower than nearby reference streets, RR = 0.78. **47.** Cycle tracks provided the least injury risk, OR = 0.11 compared to major streets with no bicycle infrastructure and parked cars. **Injury Severity** **25.** Crashes far away (> 500 m) from cycle tracks were more likely to result in injuries involving disability than crashes on or near cycle tracks, OR = 2.43. **56.** Roadway-bikeway divisions were found to significantly reduce the probability of severe injuries compared to routes with no division.
Bike Lanes	**Injury/Crash Risk** **18.** Within non-intersection locations, painted bike lanes were associated with reduced injury risk, OR = 0.86 compared to no bicycle infrastructure. **31.** Crash risk was lower on streets with bike lanes: RDI = 0.41. **32.** Crash risk was less on streets with bike lanes or bike routes: RDI = 0.50. **40.** Collision or fall risk for those who rode primarily on bike lanes or paths was lower than for those who rode mainly on roadways, OR = 0.60. **47.** Painted bike lanes had lower injury risk, OR = 0.69 (on streets with parked cars) and OR = 0.54 (on streets without parked cars) than major streets with no bicycle infrastructure and parked cars.

Signed Bike Route	**Injury/Crash Risk** **18.** Within non-intersection locations, the injury risk on signed bike routes was lower than on streets without bicycle infrastructure, OR = 0.70. **31.** Crash risk less on signed bike routes: RDI = 0.51 **32.** Crash risk less on streets with bike lanes or bike routes: RDI = 0.50. **47.** Designated bike routes on local streets were associated with lower injury risk, OR = 0.49 compared to major streets without bicycle infrastructure and with parked cars.
Minor Streets without Bike Facilities	**Injury/Crash Risk** **6.** For children, distance travelled on local streets was associated with decreased injury risk, OR = 0.76 for 0-5 km (as compared to none). **18.** Intersections of two local streets had lower injury risk than intersections of two major streets (two or more lanes of traffic), OR = 0.19. Within non-intersection locations, local streets also had lower injury risk, OR = 0.64 compared to major streets. **31.** Crash risk on minor streets was slightly lower than expected based on mode share: RDI = 0.94. **32.** Crash risk on minor streets was not different than expected based on mode share: RDI = 1.04. **47.** Injury risk on local streets without bicycle infrastructure was lower, OR = 0.51 compared to major streets without bicycle infrastructure and with parked cars. **Injury Severity** **27.** Crashes on local roads were less likely to result in admission to a hospital than those on highways or on arterial roads, but more likely than those occurring off-road. OR compared to highways: arterial roads = 0.28, local roads = 0.18, off-road = 0.09. **33.** Less than half (46%) of bicyclists fatalities occurred on local streets, despite the fact that they comprised 80% of the street distances.
Bike Paths	**Injury/Crash Risk** **18.** Within non-intersection locations, the injury risk on bike paths was slightly lower than on streets without bicycle infrastructure, OR = 0.88. **32.** Crash risk on off-road bike paths was lower than expected based on mode share: RDI = 0.67. **40.** Crash risk for those who rode primarily on bike lanes or paths was lower than for those who rode mainly on roadways, OR = 0.60. **47.** The injury risk on bike paths was lower than on major streets with parked cars, OR = 0.59. **49.** The injury risk on bike paths was lower than on neighbourhood streets, OR = 0.14.

Multi-use Paths	**Injury/Crash Risk** **2.** Risks of collisions and injuries were significantly greater on off-road paths (paved or gravel multi-use paths) as compared to on-street (RR of collision = 3.5, of injury = 1.8). **3.** Risks of falls and injuries were significantly greater on off-road paths (paved or gravel multi-use paths) as compared to on-street (RR of falls = 2.1, of injury = 1.6). **18.** Within non-intersection locations, the injury risk on multi-use paths was slightly higher than on streets without bicycle infrastructure, OR = 1.14. **31.** Crash risk greater on multi-use paths: RDI = 1.39. **47.** The injury risk on multi-use paths was somewhat lower than on major streets with parked cars, OR = 0.79 (paved) and 0.73 (unpaved).
Sidewalks	**Injury/Crash Risk** **2.** Risks of collisions and injuries were significantly greater on sidewalks as compared to on-street (RR of collision = 2.0, of injury = 6.4). **3.** Risks of falls and injuries were significantly greater on sidewalks as compared to on-street (RR of fall = 4.0, of injury = 4.0). **6.** For children, distance travelled on sidewalks was associated with increased injury risk, OR = 3.1 for > 5 km (as compared to none). **18.** Within non-intersection locations, the injury risk on sidewalks was not significantly different than on streets without bicycle infrastructure. **31.** Crash risk greater on "Other (most often sidewalks)": RDI =16.3. **32.** Crash risk greater on sidewalks: RDI = 5.3. **47.** The injury risk on sidewalks was not significantly different than on major streets with parked cars. **51.** Risk of injury when riding on the sidewalk 1.8 times the risk when riding on the road.

Major Streets without Bike Facilities	**Injury/Crash Risk** **6.** For children, distance travelled on busy streets was associated with increased injury risk, OR = 1.7 for 0-5 km of travel on busy streets and 1.5 for > 5 km (as compared to none). **18.** Intersections of major streets had higher injury risk than those of local streets. Within non-intersection locations, routes on major streets had a higher injury risk than local streets. **31.** Crash risk was higher on major streets without bike facilities compared to those with bike facilities. **32.** Crash risk was greater on major streets without bike facilities compared to minor streets and streets with bike facilities. **47.** Major streets with parked cars had the highest injury risk on any route type. Major streets without bicycle infrastructure but no parked cars had an OR = 0.63 compared to those with parked cars. **49.** For adults, the relative risk of injury was greater on major thoroughfares, OR = 2.45 as compared to on street. Children riding on streets have a higher risk of injury than those riding on other route types: OR = 1.65 as compared to sidewalks and playgrounds, 8.02 for bike paths, and 3.44 for unpaved surfaces. **Injury Severity** **27.** Crashes on arterial roads were less likely to result in admission to a hospital than those on highways but more likely than those on local roads or off-road. OR compared to highways: arterial roads = 0.28, local roads = 0.18, off-road = 0.09. **33.** More than half (53%) of bicyclists fatalities occurred on multilane roadways, despite the fact that they comprised only 10% of the street distances.
Highways	**Injury Severity** **1.** Highway cycling crashes were associated with increased injury severity compared to local streets. **27.** Crashes on highways were more likely to result in admission to a hospital than those on arterial roads, local roads, or off-road. OR compared to highways: arterial roads = 0.28, local roads = 0.18, off-road = 0.09.

Table C.4 Details of Scientific Literature on Bicycling Operations

Topic	Type of Evidence, Paper #, Description of Result
Alcohol or drug intoxication of cyclists	**Injury or Crash Risk** **24.** Relative to a blood alcohol < 0.02 g/dL, odds ratio for a bicycling injury with a blood alcohol of 0.02 g/dL or higher was 5.6, and for a blood alcohol of 0.08 g/dL or higher was 20.2. **35.** Overall odds ratio for injury risk for an alcohol-intoxicated bicyclist was 7.6. **Injury Severity** **5.** Alcohol intoxication of the at fault party (driver or cyclist) was not associated with increased fatality risk. **7.** Alcohol intoxication was correlated with head and brain injury, odds ratio = 2.53 compared to non-impaired cyclists **22.** Alcohol intoxication of a cyclist was associated with a 174% increase in the risk of a fatality. Alcohol intoxication of motorists was associated with a 265% increase in risk of a cyclist fatality and an 88% increase in risk of cyclist incapacitating injury. **29.** Drug use by cyclists increased the likelihood of severe bicyclist injury by 374% at non-intersections. **44.** Intoxicated cyclists were found to have more severe injuries than sober: average Injury Severity Score of 10.3 vs. 3.3.
Talking or texting on a mobile phone	**Other Safety Information** **11.** Talking or texting on a mobile phone decreased peripheral vision and cyclist speed. **12.** Listening to music, talking on a mobile phone, and using a hands-free mobile phone all decreased auditory perception. Talking on a mobile phone did not reduce visual perception but did reduce ability to name signs. Both hands-free and standard mobile phone use reduced cyclist speed.

Riding in the opposite direction of motor vehicle traffic	**Injury or Crash Risk** **18.** Riding in the opposite direction of motor vehicle traffic was associated with a greater injury risk, OR = 7.8. **38.** At cycle path/vehicle crossings, a greater proportion of crashes involved a cyclist coming from the opposite direction of traffic (coming to an intersection from the right, not cycling on the left side of the road). **41.** In roundabouts with separated cycling facilities, crashes were associated with cyclists riding against the circulating direction. **51.** Risk of bicycle-motor vehicle collisions when riding against traffic was 3.6 times that when riding in the direction of traffic. **Injury Severity** **5.** Head on collisions between cyclists and motor vehicles were more likely to be fatal, OR 1.91 compared to lateral collisions. **22.** Riding in the opposite direction of motor vehicle traffic was associated with a 16% increase in risk of a cyclist fatality. Head-on collisions were associated with 101% increase in risk of a cyclist fatality. **56.** Head-on collisions were associated with increased injury severity and intersection and non-intersection locations. **Other Safety Information** **1.** One-way streets were associated with increased injury severity. The authors suggested this may be because cyclists are more likely to ride on the left side of one-way streets.

Table C.5 Details of Scientific Literature on Safety Equipment

Topic	Type of Evidence, Paper #, Description of Result
Bright or Fluorescent Clothing & Reflectors	**Injury/Crash Risk** **48.** Cyclists who always wore fluorescent clothing were less likely to be involved in a crash than those who did not, RR = 0.73 for crashes rendering the cyclists unable to complete their daily activities for > 24 h, and RR = 0.23 for crashes causing a cyclist to miss one or more days of work. **Injury Severity** **53.** A higher proportion of head injuries were severe among cyclists' whose bicycles were not equipped with reflectors(69%) as compared with those whose bicycles had reflectors (5.7%). **Other Safety Information** **16.** Wearing orange, red, yellow or white on the trunk increased cyclists visibility in the daytime, OR 18.4 for orange/yellow/red and 9.5 for white compared to all other colors. **55.** At night, cyclists wearing a reflective vest plus ankle and knee reflectors were significantly more visible (90%) than those wearing a reflective vest alone (50%), who were in turn significantly more visible than those not wearing a vest. A fluorescent vest (15%) was not significantly more visible than black clothing (2%) at night.
Helmet	**Injury Severity** **57.** This article considered evidence from 16 studies and found consistent evidence that helmets were associated with a reduced risk of head, brain, face, and fatal injuries. Three studies that examined neck injuries found an increased risk that appeared to be associated with certain helmet designs. **58.** This article considered evidence from the same 16 studies as reference 57, and added 4 newer studies. This analysis also found reduced risk of head and face injuries. It confirmed an increase risk of neck injuries related to certain helmet designs.

Appendix D. List of Education Materials

British Columbia
Insurance Corporation of British Columbia. Sharing the Road. Learn to Drive Smart: Your Guide to Driving Safely. 2011
Insurance Corporation of British Columbia. Bike Smarts: Your Guide to Teaching Bike Safety. 2011
Abbotsford Cycling Action Group. BC Bike Law. 2011
City of Nanaimo. Bike Route Brochure. Nanaimo, BC 2009
i Go. Rules of the Road. Kelowna, BC: Green Transportation. 2009
Bicycle Transportation Alliance. Tips for Bicycling Around Cars and Driving Around Bicyclists. From Vancouver Area Cycling Coalition website, Vancouver, BC undated
Vancouver Area Cycling Coalition. Streetwise Cycling. Vancouver, BC undated
Vancouver Area Cycling Coalition. Bike Basics 101. Vancouver, BC 2010
Vancouver Area Cycling Coalition. The Metro Vancouver Cyclists Handbook. Vancouver, BC 2011
Bike to Work. Vancouver, BC 2002
Greater Victoria Cycling Coalition. Bike Sense: The British Columbia Bicycle Operator's Manual. Victoria, BC 2004
Alberta
Alberta Ministry of Transportation. Basic License Driver's Handbook. AB 2010
City of Calgary. On-Street Cycling Safety. Calgary, AB 2006
City of Calgary. Calgary Traffic Tips. 2007
Saskatchewan
Saskatchewan General Insurance Provincial Insurance Company. Saskatchewan Driver's handbook: A guide to safe driving. 2011
Canadian Cycling Association. Roads Are For Sharing: The Cyclist. Regina, SK: From Saskatchewan Cycling Association website 1984
Canadian Cycling Association. Roads Are For Sharing: The Motorist. Regina, SK: From Saskatchewan Cycling Association website 1984

Manitoba
Manitoba Public Insurance. Bike Safely. Winnipeg, MB 2011 Available from: http://www.mpi.mb.ca/english/rd_safety/BikeSafe/AdultsCyclingBooklet.pdf
Manitoba Public Insurance. Driver's Handbook. Winnipeg, MB 2011 Available from: http://www.mpi.mb.ca/PDFs/DriverHandbook/CompleteHandbook.pdf.
Manitoba Public Insurance. I Cycle Safely. Winnipeg, MB 2012 Available from: http://www.mpi.mb.ca/english/rd_safety/BikeSafe/MPI_KidsCyclingBrochure_ENGLISH.pdf.
Bike to the Future. Bike Commuting Safety. Winnipeg, MB, undated
Ontario
Ontario Ministry of Transportation. Young Cyclist's Guide. undated
Ontario Ministry of Transportation. Sharing the Road with Cyclists. 2010
Ontario Ministry of Transportation. Cycling Skills: Ontario's Guide to Safe Cycling. undated
Quebec
Quebec Societe de l'Assurance Automobile. Driver's handbook. 2009
Quebec Provincial Transportation Department. Safe Cycling Guide. undated.
Quebec Société de l'Assurance Automobile. Driving a Passenger Vehicle. 2006
Quebec Société de l'Assurance Automobile. Road Access Binder. 2009
Quebec Société de l'Assurance Automobile. Let's all share the road ... safely. undated
VeloQuebec. Bike-to-Work Practical Guide. Montreal, QC undated
New Brunswick
New Brunswick Provincial Transportation Department. New Brunswick Driver's Handbook: A Guide to Learning Safe Driving Skills. 2009
Prince Edward Island
Prince Edward Island Provincial Transportation Department. Driver's handbook. 2011
Nova Scotia
Nova Scotia Provincial Transportation Department. Rules of the Road Ch. 2. 2007

Newfoundland and Labrador
Newfoundland and Labrador Provincial Transportation Department. Road User Guide. 2009
Yukon
Yukon Provincial Transportation Department. Yukon Driver's Basic Handbook. 2011
City of Whitehorse. Bike Safety & Regulations. Whitehorse, YK undated
Northwest Territories
Northwest Territories Transportation. Basic License Driver's Handbook. 2007
City of Yellowknife. Cycling in Yellowknife - Safety Tips. Yellowknife, NWT undated
City of Yellowknife. Bicycle Etiquette. Yellowknife, NWT undated
City of Yellowknife. Cycling Guide. Yellowknife, NWT 2009
Canada
Canadian Cycling Association. CAN-BIKE. Bike Maintenance. undated
Canadian Cycling Association. CAN-BIKE. Five Basic Traffic Cycling Principles (Adapted from Effective Cycling by John Forester) undated
Canadian Cycling Association. CAN-BIKE. Why We Don't Ride on Sidewalks. undated
Canadian Cycling Association. CAN-BIKE. Welcome to CAN-BIKE. undated
Canadian Cycling Association. CAN-BIKE. Traffic Skills: Riding and Riding with Confidence. undated
Canadian Cycling Association. CAN-BIKE. Traffic Skills Pt II: Four Types of Falls. undated
Canadian Cycling Association. CAN-BIKE II Course Material. undated
Canadian Cycling Association. CAN-BIKE II Workbook. undated

Cycling in Cities Research Program

A multi-university program of research investigating factors that encourage or discourage bicycling & increase or decrease cycling safety.

http://cyclingincities.spph.ubc.ca/

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