Bicyclists’ Injuries & the Cycling Environment . . .

Results of a case-crossover study in Toronto and Vancouver

Kay Teschke, Conor Reynolds, Anne Harris, Peter Cripton
Mary Chipman, Michael Cusimano, Shelina Babul, Meghan Winters
Jeff Brubacher, Steve Friedman, Garth Hunte, Hui Shen
safety concerns deter cycling

Survey of 1400 cyclists & potential cyclists in Metro Vancouver, top deterrents all related to safety

- ice & snow on route
- car, bus & truck traffic
- vehicles driving faster than 50 km/h
- glass or debris on route
- motorists who don’t know how to drive safely near bikes
- risk of injury from car-bike collisions

So how do we make cycling safer?
differences in cycling injury rates - Europe & NA

- Netherlands
- Denmark
- Germany
- United Kingdom
- Canada - BC
- United States

why the differences?

It’s not the Europeans who wear helmets

- helmets do reduce post-crash severity of head and face injuries
- but they don’t prevent crashes
why the differences?

Best evidence: safety in numbers

why the differences?

What about route infrastructure?

• typical in North America to provide little or no bike infrastructure

• in high cycling European countries, usually provide separated facilities where motor vehicle traffic volumes and speeds are high

North America: John Forester
‘vehicular cycling’
Bicyclists’ Injuries & the Cycling Environment
participating cities

Vancouver
- 2 participating hospitals
- 0.6 million people
- rain in winter, temperate summer
- lots of hills
- 26 km of bike lanes & paths per 100,000 population
- 3.7% of trips by bike

Toronto
- 3 participating hospitals
- 2.5 million people
- snow in winter, heat in summer
- mostly flat
- 11 km of bike lanes & paths per 100,000 population
- 1.7% of trips by bike
study overview

- Cyclist to emergency department
- Interview
- Site observations
- Data analysis
interview to map route & choose control sites
observations of injury & control sites

[Image of a site observation form]

injury site

control site 1

control site 2
“case-crossover” design features

Control sites randomly selected from injury trip: controlling for exposure to risk, i.e., distance ridden on each route type

Sites observed by researchers blinded to site status (injury or control): preventing observation bias

Comparisons made within a person-trip: controlling for personal & trip characteristics
Study results
participants & trips

- Toronto 273
- Vancouver 417 \[690\]
- male 59%
- 19 to 39 years old 62%
- income > $50,000 56%
- cycle > 52 times/year 88%
- wore helmet 69%
- wore high viz clothes 33%
- trip < 5 km 68%
- weekday, daylight 77%
- commute 42%
- other transport 32%
injury circumstances

% of injury events

Collisions
n=497

Falls
n=181

Motor vehicle involved, n=331
No Motor vehicle involved, n=347
comparison of 15 route types | main focus of study
relative risks by route type

- Major streets with parked cars
  - No bike infrastructure
- Local streets
  - No bike infrastructure
  - Bike route
  - Bike route with traffic diverters
  - Bike route with traffic slowing
- Separated from traffic
  - Sidewalk
  - Multiuse path, paved
  - Multiuse path, unpaved
  - Bike only path
  - Cycle track

The chart shows decreased risk from left to right on a scale from 1/100 to 1/10 to 1/2 to 1.
relative risks by route type

- **Major streets with parked cars**
  - no bike infrastructure
  - shared lane
  - bike lane

- **Major streets, no parked cars**
  - no bike infrastructure
  - shared lane
  - bike lane

- **Local streets**
  - no bike infrastructure
  - bike route
  - bike route with traffic diverters
  - bike route with traffic slowing

- **Separated from traffic**
  - sidewalk
  - multiuse path, paved
  - multiuse path, unpaved
  - bike only path
  - cycle track
on or alongside major streets . . .

<table>
<thead>
<tr>
<th>RR</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70</td>
<td>bike lane with parked cars</td>
</tr>
<tr>
<td>0.55</td>
<td>bike lane without parked cars</td>
</tr>
<tr>
<td>0.11</td>
<td>cycle track</td>
</tr>
</tbody>
</table>
on residential streets . . .

RR = 0.69

traffic slowing

RR = 0.38

traffic diversion
other features studied  
these not significant
relative risks of other significant features

- **Grade**
  - Flat
  - Uphill
  - **Downhill**: increased risk

- **Streetcar tracks**
  - No
  - Yes

- **Construction**
  - No
  - Yes
downhill grades . . .

a special risk in Vancouver

Sometimes compounded with difficult route features:

- limited sight lines
- traffic circles
- speed bumps
streetcar tracks . . .

a special risk in Toronto

almost one-third of crashes

interactions with cars important, because many crashes begin with aviodance manoueuvres
construction . . .

RR = 1.95
Are safe routes also preferred routes?
route preferences: top 5 of 16

bike only paths
85% likely to choose

paved multi-use paths
77% likely to choose

unpaved multi-use paths
71% likely to choose

cycle tracks
71% likely to choose

local street bike routes with traffic calming
65% likely to choose
best route types to encourage cycling & prevent injuries

- cycle tracks along major streets
- local street bike routes with traffic diverters
- off-street bike only paths

[review: Reynolds et al. *Environmental Health* 2009;8:47]
limitations

Most severe and mildest injuries not included

- all injury studies focus on defined categories of injuries
- here, those who attended emergency department within 24 hours

Not possible to test many route designs available in Europe:

- multiple types of cycle tracks
- innovative intersection designs

But more route designs tested than in other studies to date, all objectively measured.
Cycling injuries vs. health
transportation & illness
## Risks vs. Benefits of Cycling

<table>
<thead>
<tr>
<th>Authors</th>
<th>Location</th>
<th>Benefits &amp; Risks taken into account</th>
<th>Ratio of benefit : risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Medical Association, 1992</td>
<td>United Kingdom</td>
<td>↑ physical activity, ↑ traffic crashes</td>
<td>20 : 1 lives saved vs. lost</td>
</tr>
<tr>
<td>Woodcock et al., 2009</td>
<td>London, England</td>
<td>↑ physical activity, ↓ population air pollution, ↑ traffic crashes</td>
<td>49 : 1 lives saved vs. lost, 15 : 1 DALYs saved vs. lost</td>
</tr>
<tr>
<td>Johan de Hartog et al., 2010</td>
<td>Netherlands</td>
<td>↑ physical activity, ↑ traffic crashes, ↑ individual air pollution</td>
<td>9 : 1 lives saved vs. lost</td>
</tr>
<tr>
<td>Rojas-Rueda et al., 2011</td>
<td>Barcelona, Spain</td>
<td>↑ physical activity, ↑ traffic crashes, ↑ individual air pollution</td>
<td>96 : 1 lives saved vs. lost</td>
</tr>
<tr>
<td>Rabl &amp; de Nazelle, 2012</td>
<td>Europe</td>
<td>↑ physical activity, ↓ population air pollution, ↑ traffic crashes, ↑ individual air pollution</td>
<td>19 : 1 Euros saved vs. lost</td>
</tr>
</tbody>
</table>
thanks to everyone, especially study participants and . . .

Vancouver study team
• Melody Monro
• Evan Beaupre
• Niki Blakely
• Jill Dalton
• Martin Kang
• Theresa Frendo
• Jack Becker
• David Hay
• Peter Stary

Toronto study team
• Lee Vernich
• Vartouji Jazmaji
• Kevin McCurley
• Andrew Thomas
• Doug Chisholm
• Nancy Smith Lea
• Fred Sztabinski
• David Tomlinson
• Barbara Wentworth

Funders