Impact of transportation infrastructure on risk of injuries while cycling

1. Non-Intersections
2. Intersections

Results of the "Bicyclists' Injuries and the Cycling Environment" Study

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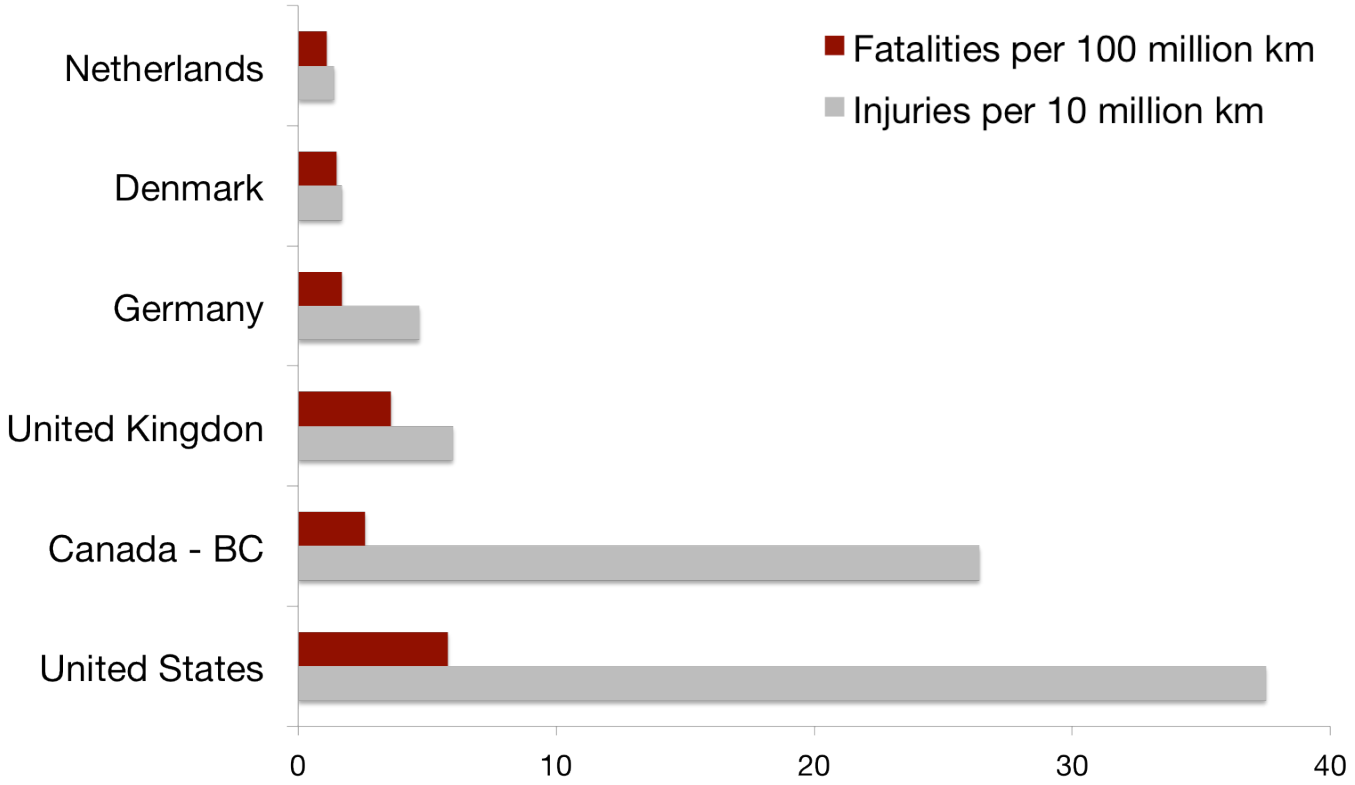
Mary Chipman, Michael Cusimano, Shelina Babul, Jack Becker, Nancy Smith Lea
Jeff Brubacher, Steve Friedman, Garth Hunte, Hui Shen, Meghan Winters

differences in cycling injury rates - Europe & NA



[data sources: International - Pucher & Buehler *Transport Reviews* 2008;28:495-528
BC - Motor Vehicle Branch, 2005 to 2007, TransLink's 2008 Trip Diary Survey, Census 2006]

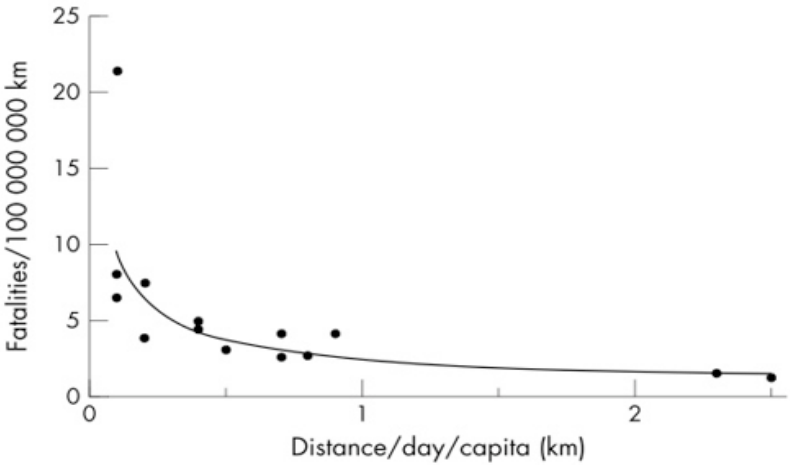
why the differences?

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**



[source: Jacobsen. *Injury Prevention* 2003;9:205-9]

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
- little research, results difficult to interpret

North America:
John Forester

'vehicular cycling'

Bicyclists' Injuries & the Cycling Environment

participating cities

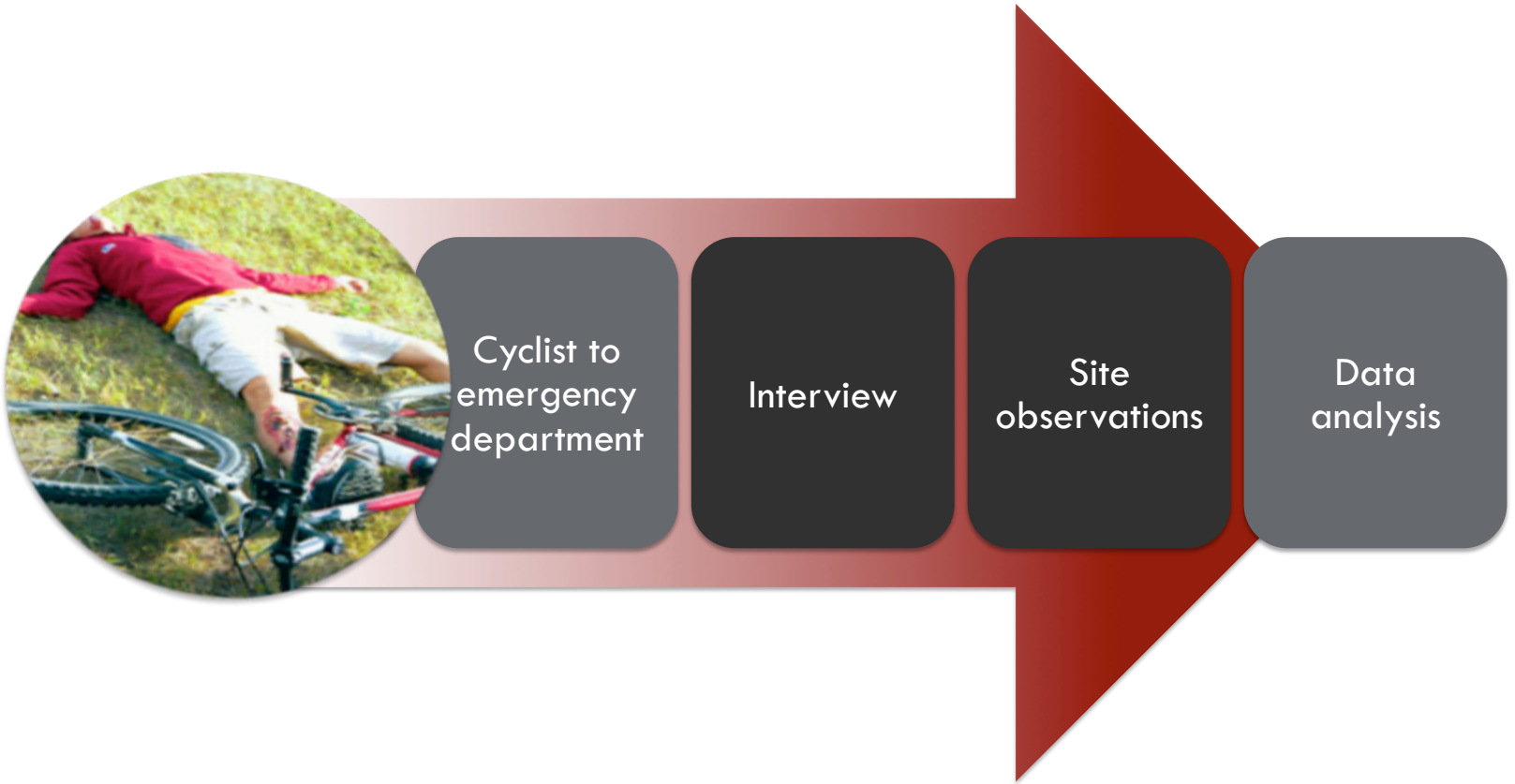
Vancouver

- 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
- 4% 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% of trips by bike

study overview



interview to map route & choose control sites

Sequential Number: _____

Hospital: 1. St. Michael's 2. TGH 3. St. Paul's 4. VGH

Date Attended ED: ___ / ___ / _____ DD MM YYYY

Came by ambulance: 0. No 1. Yes

Admitted to Hospital: 0. No 1. Yes

CTAS: _____

INTERVIEW FORM

Thanks so much, *[name of participant]*, for agreeing to take part in this study. The interview should take about 45 minutes.

I'll ask you about the route you cycled when you were injured, including the injury site, and two other sites, randomly selected along the route.

Did you receive a copy of the consent form with our letter of introduction to the study?

[If no, give a copy.]

[If yes:] Do you have it with you?

[If no, give a copy.]

Do you have any questions about it?

If you haven't already done so, could you please read it and sign 2 of them? I'll keep one, and you keep one.

[Proceed when the consent form has been signed.]

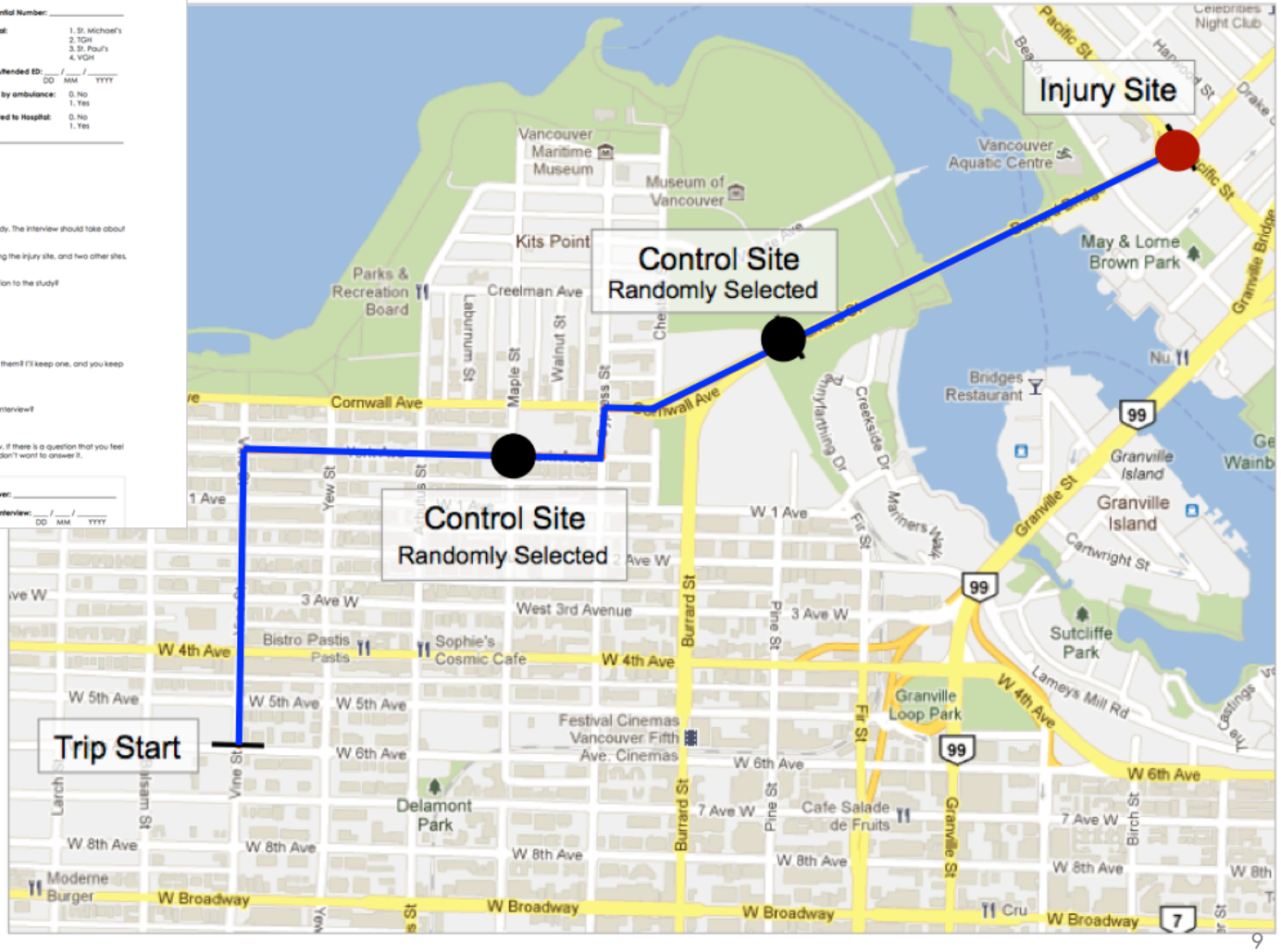
Are there any questions you'd like me to answer before we begin the interview?

[Give time to answer.]

Feel free to stop me and ask questions at any time during the interview. If there is a question that you feel uncomfortable answering, you are welcome to let me know that you don't want to answer it.

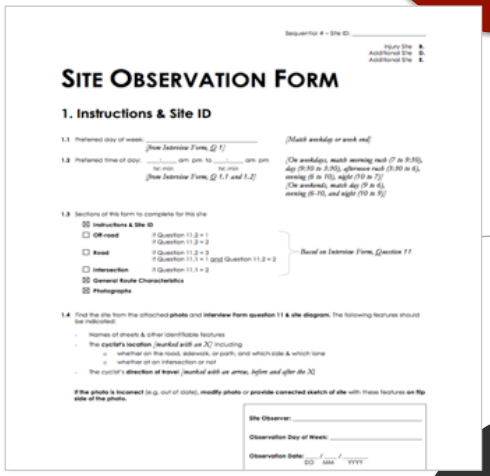
Interviewer: _____

Date of interview: ___ / ___ / _____ DD MM YYYY



observations of injury & control sites

injury site



SITE OBSERVATION FORM

1. Instructions & Site ID

control site 1

control site 2

“case-crossover” design features

Comparisons cumulated over all person-trips, using statistical modeling

Person-trip . . . n

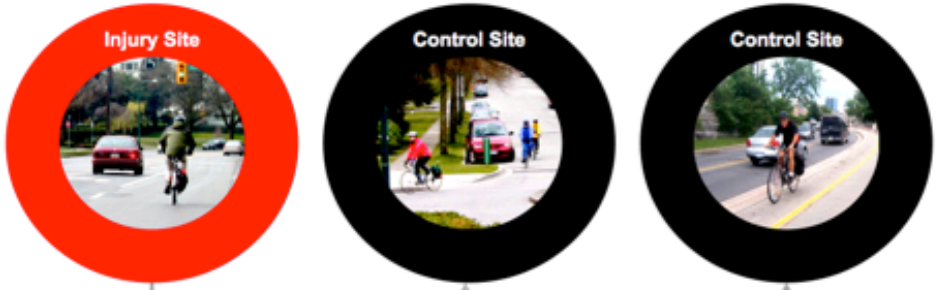
Person-trip 3

Person-trip 2

Person-trip 1

Control sites randomly selected from injury trip:
route type based on 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

two separate analyses

1. Non-Intersections

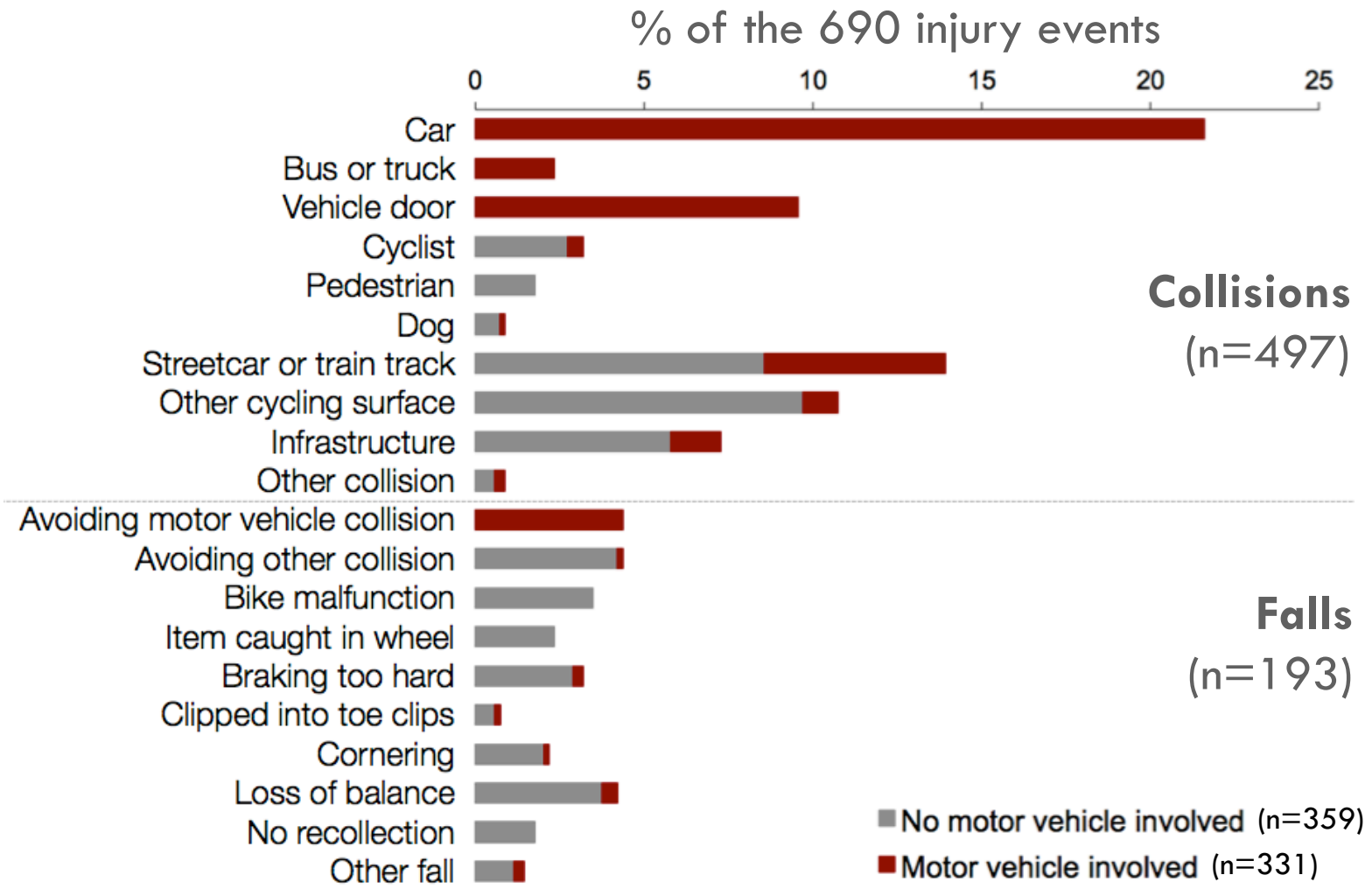
2. Intersections

Study results

participants & trips

• Toronto	273	} 690
• Vancouver	417	
• 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

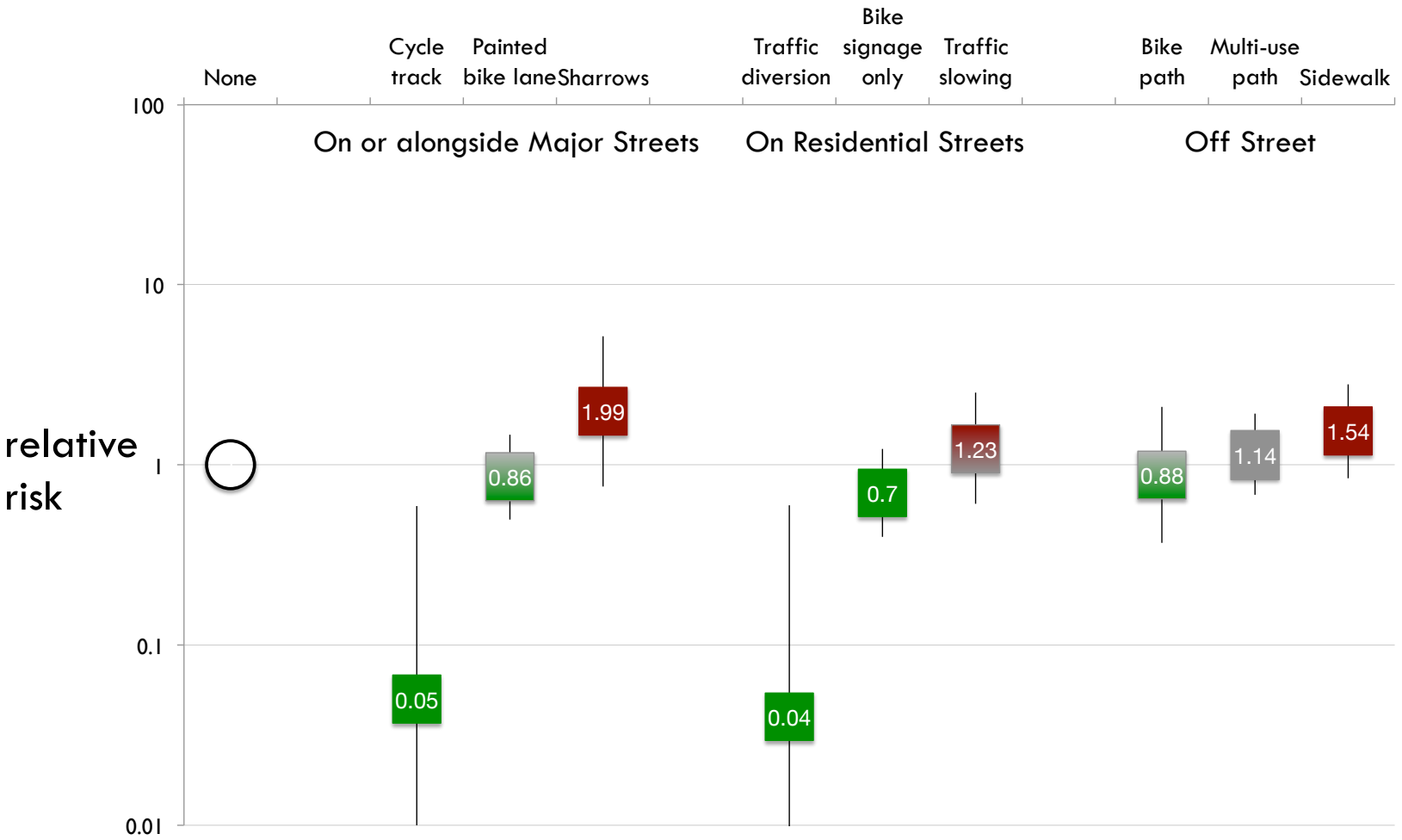


1. Non-intersections

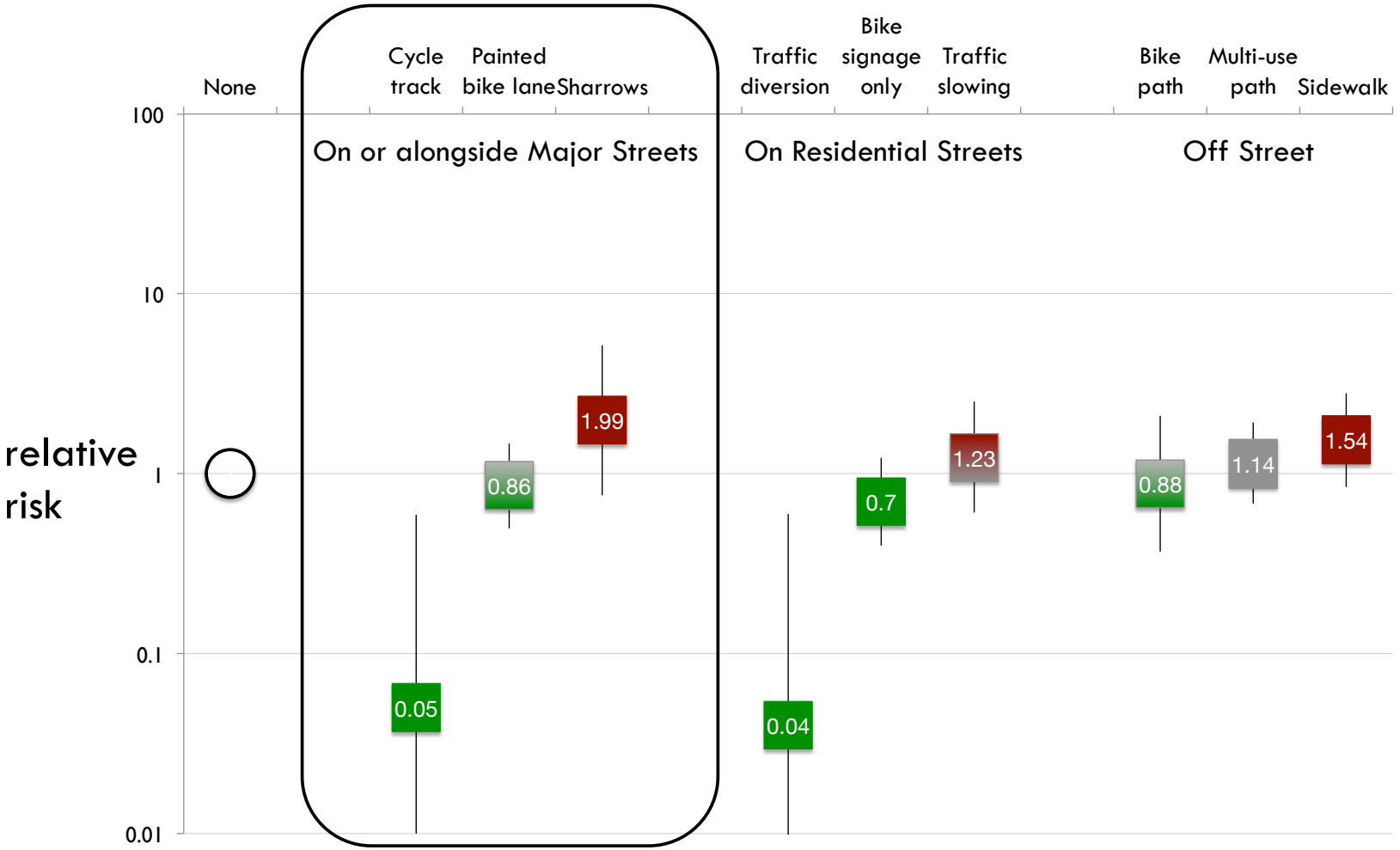
non-intersection injury sites compared to non-intersection control sites

Bike or Pedestrian Infrastructure

Bike or Pedestrian Infrastructure



Bike or Pedestrian Infrastructure



Cycle tracks

Lowest risk: 1/20 risk

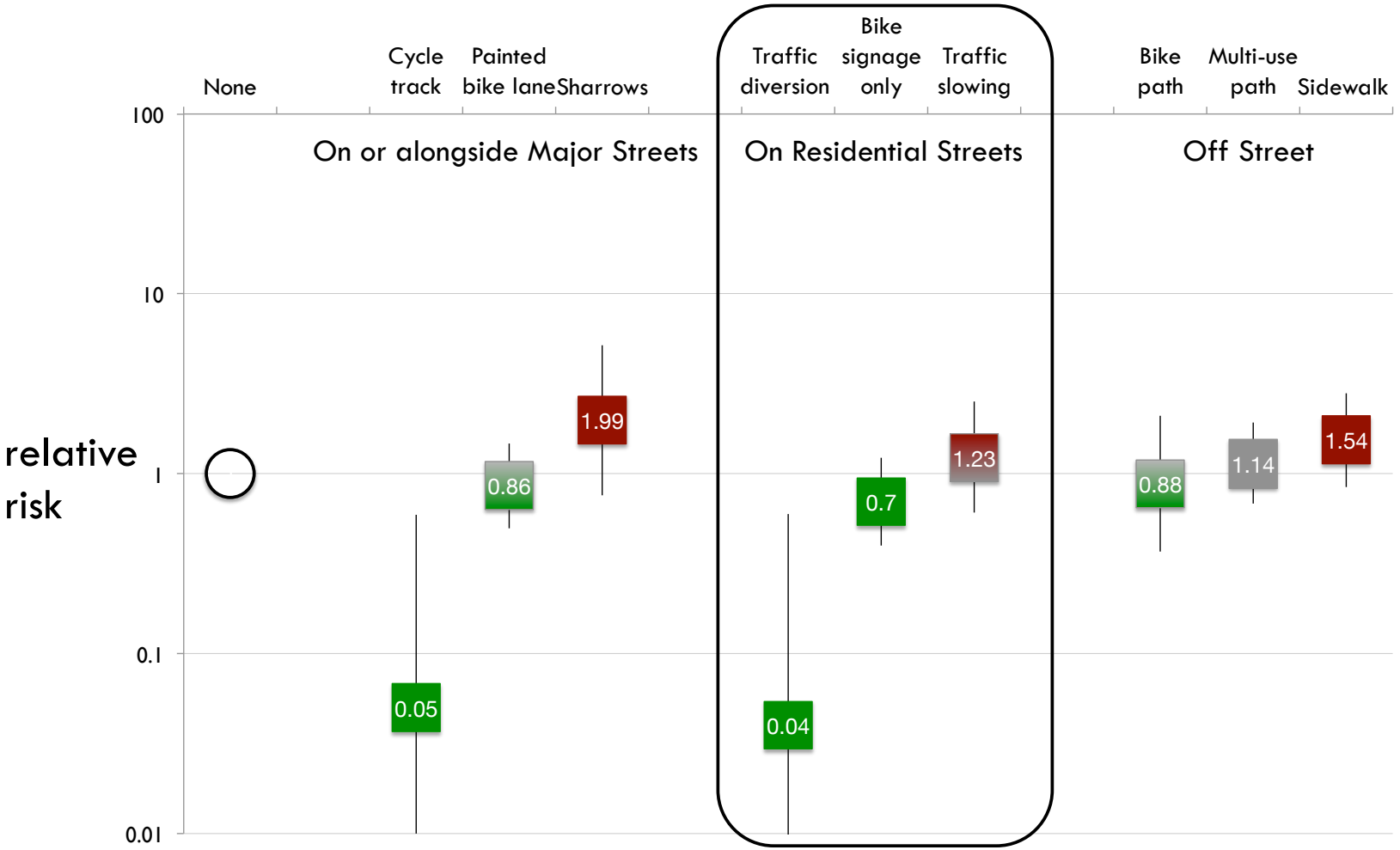
Bike lanes

Lower risk than no infrastructure

Sharrows

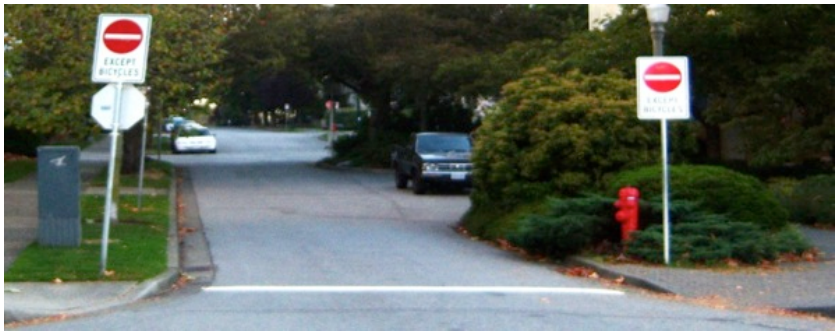
Higher risk than no infrastructure

Bike or Pedestrian Infrastructure



Traffic Diversion

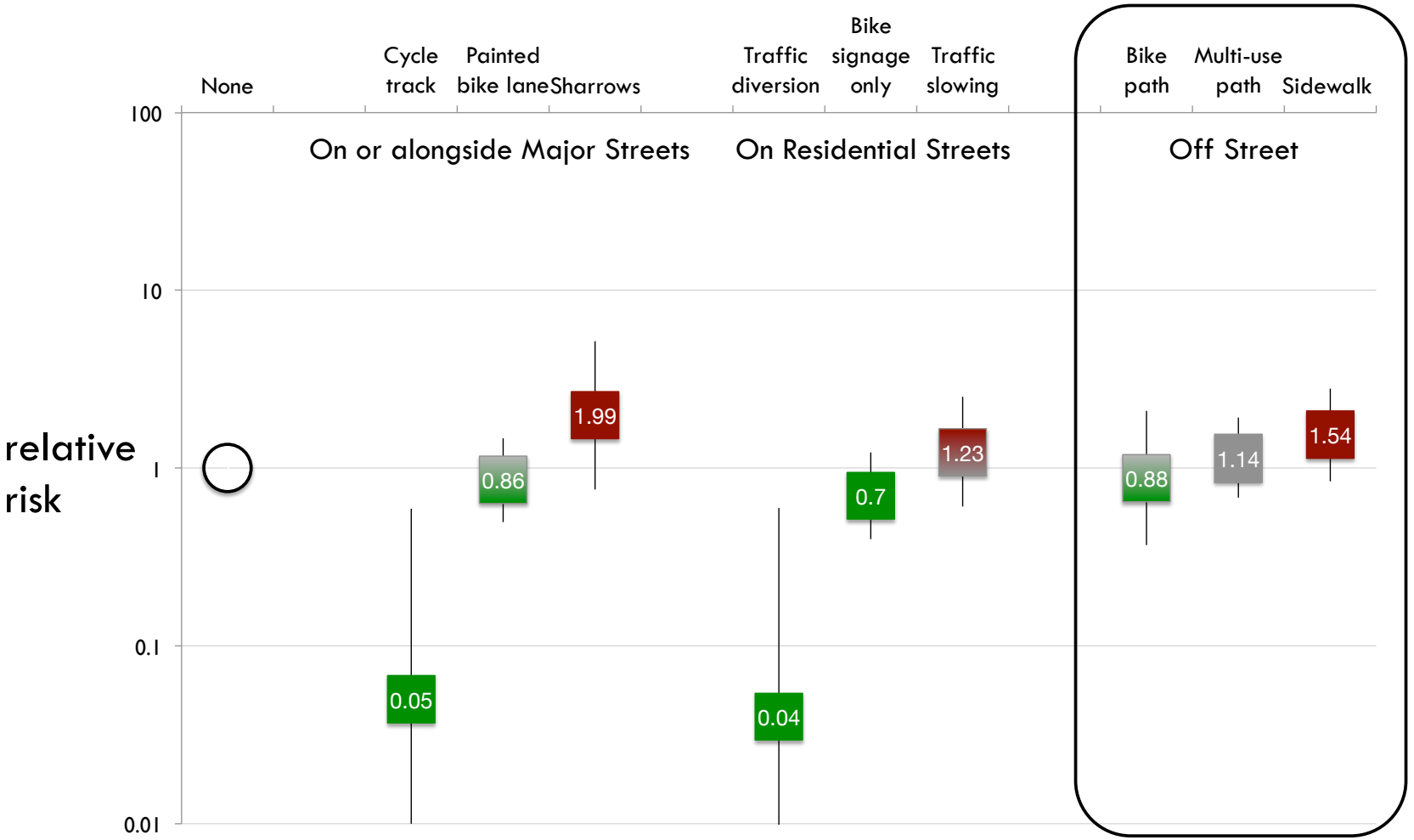
1/20 risk of no infrastructure



Traffic Slowing

slightly higher risk than no infrastructure

Bike or Pedestrian Infrastructure



Bike paths

lower risk than no infrastructure

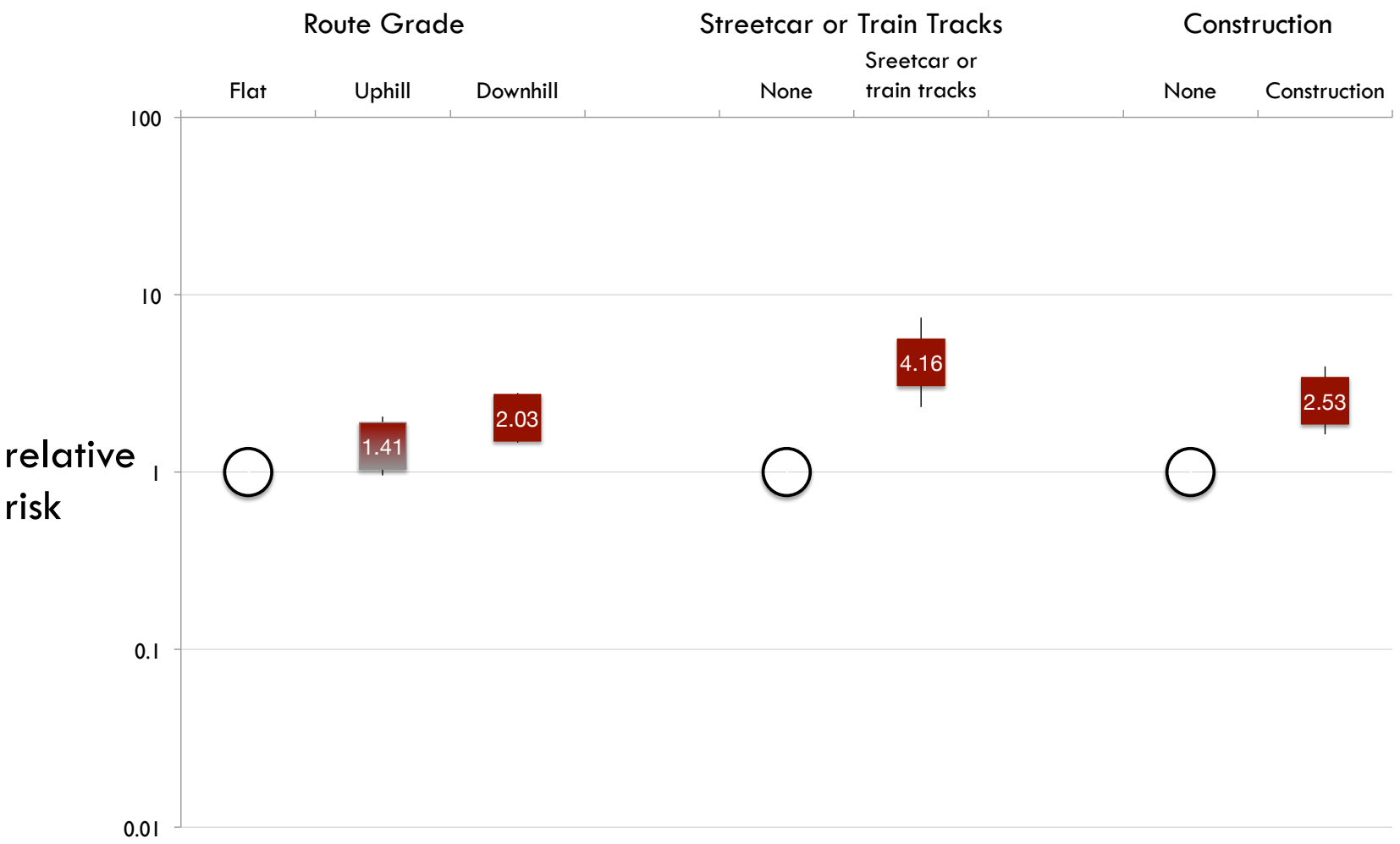
Multiuse paths

same as no infrastructure

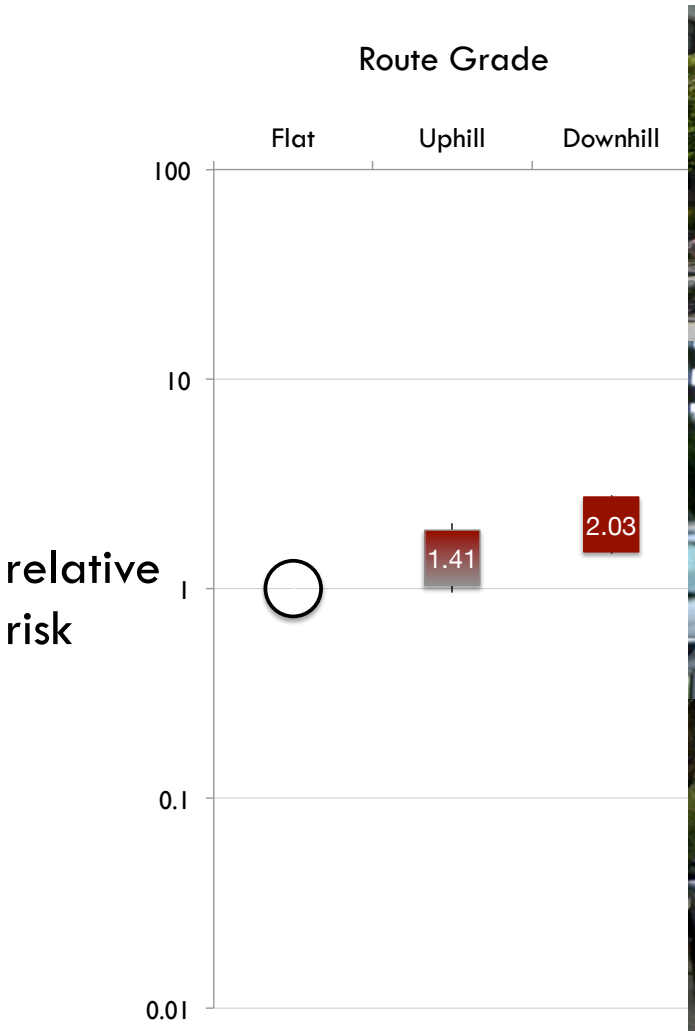
Sidewalks

higher risk than no infrastructure

Grade, Tracks, Construction

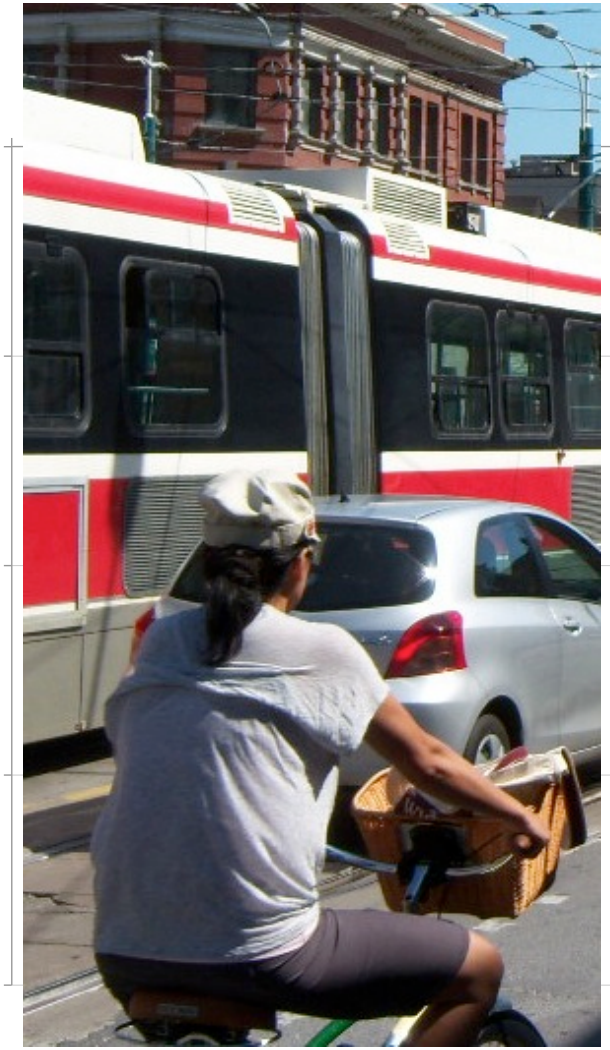


Route Grade


Route Grade
Flat
Uphill
Downhill
100
10
1
0.1
0.01
relative risk
1.41
2.03


LIMITED VISION

Streetcar or Train Tracks

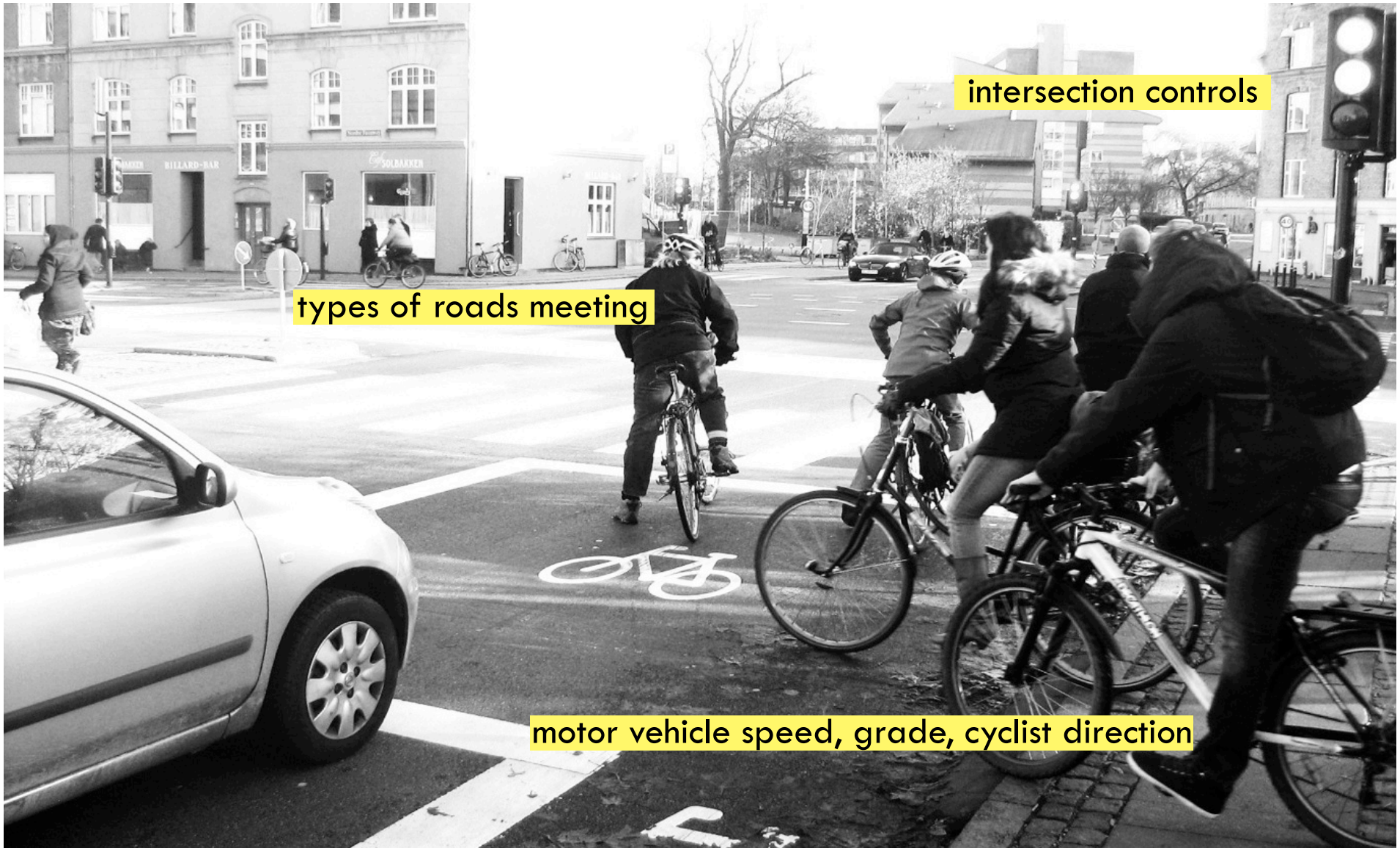


Construction

1. Non-intersections

non-intersection injury sites compared to non-intersection control sites

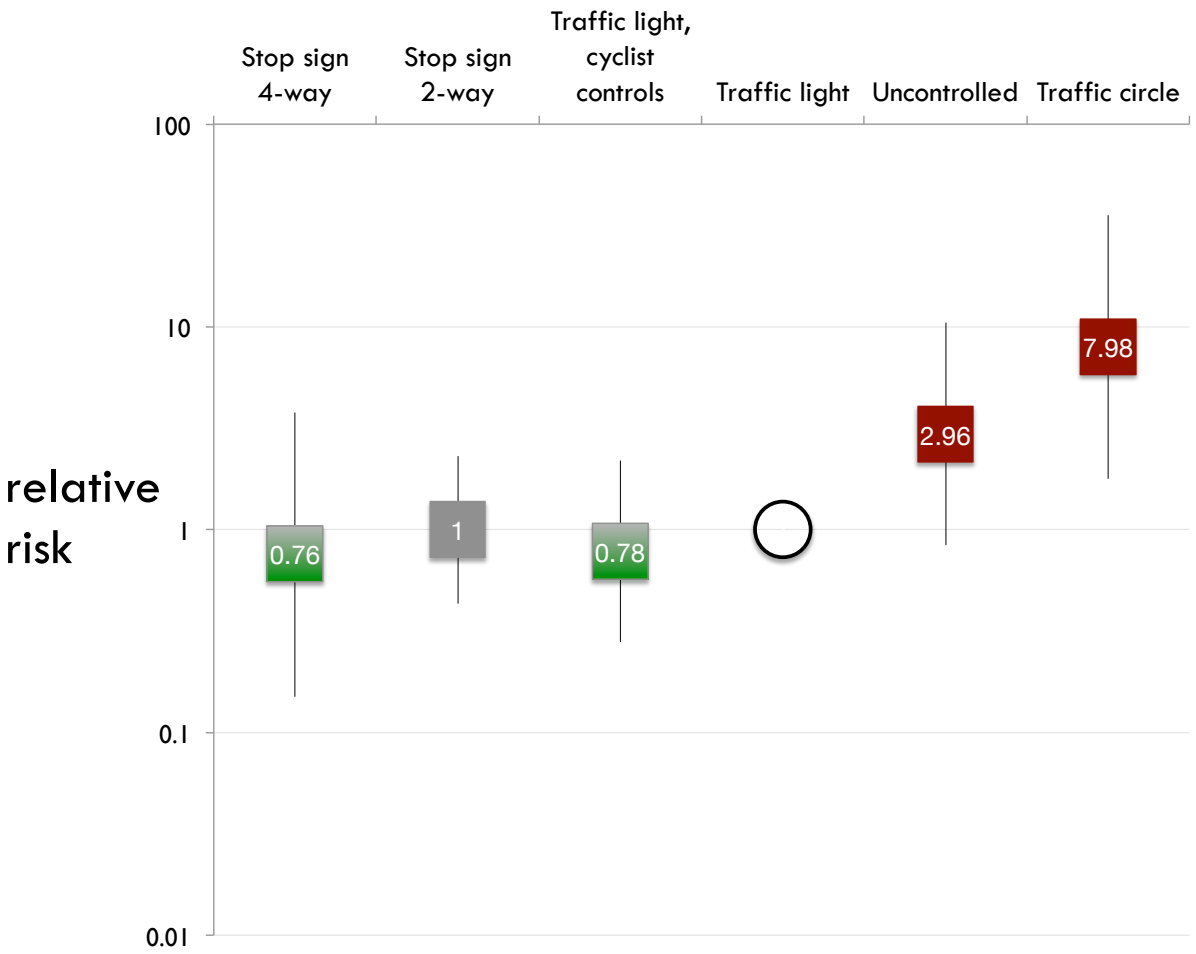
Comments or questions on non-intersection results?



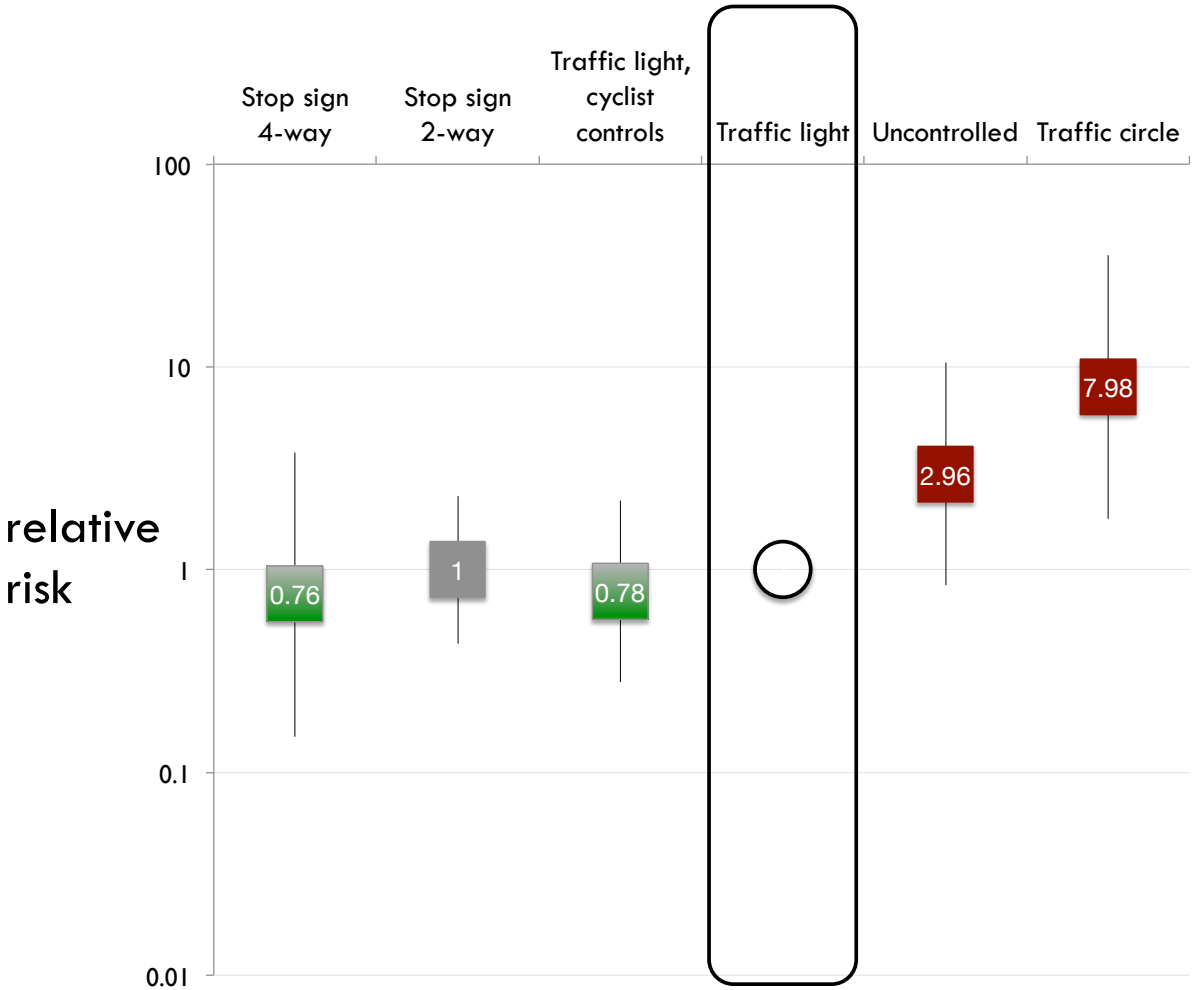
2. Intersections

intersection injury sites compared to intersection control sites

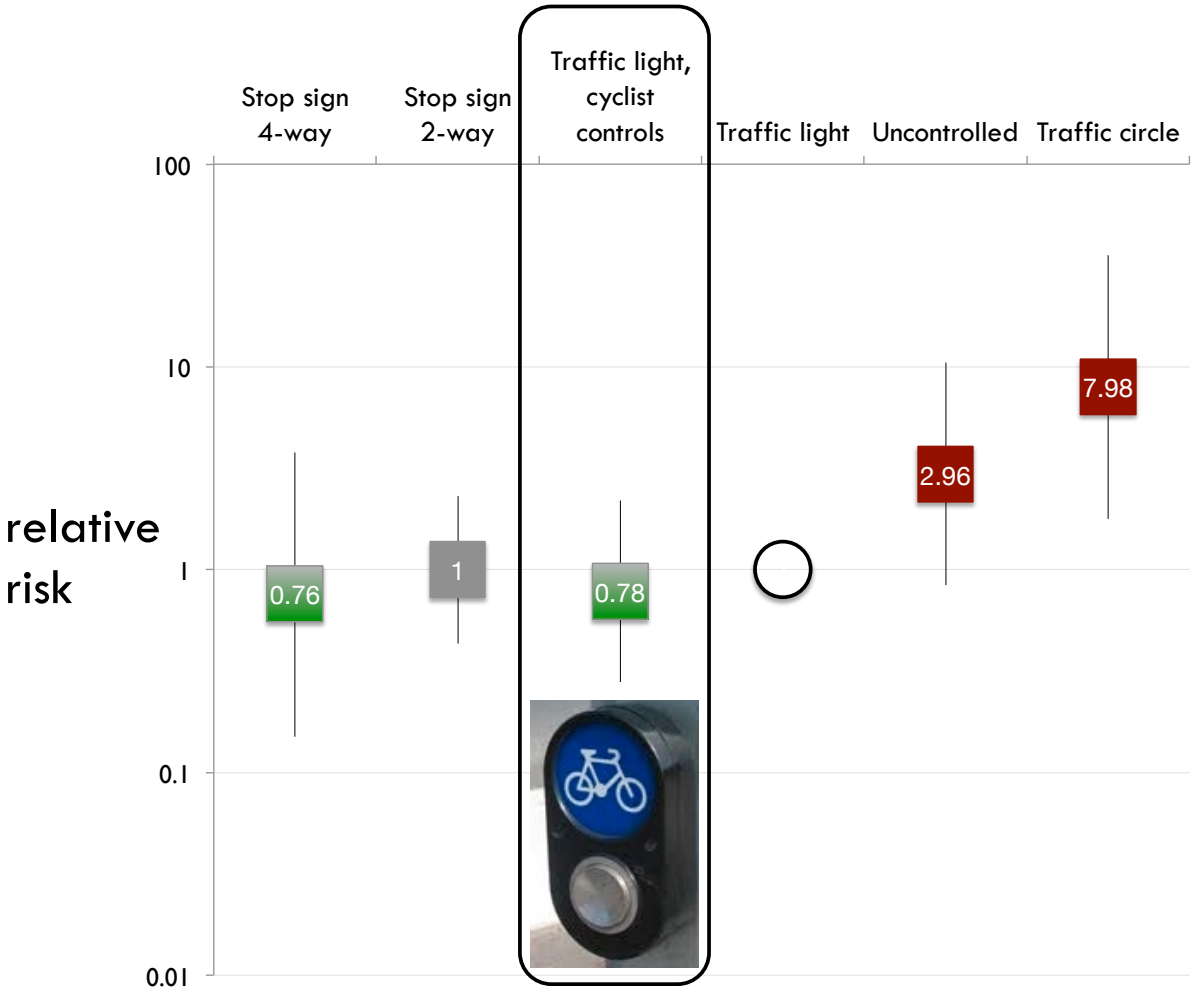
Intersection Controls



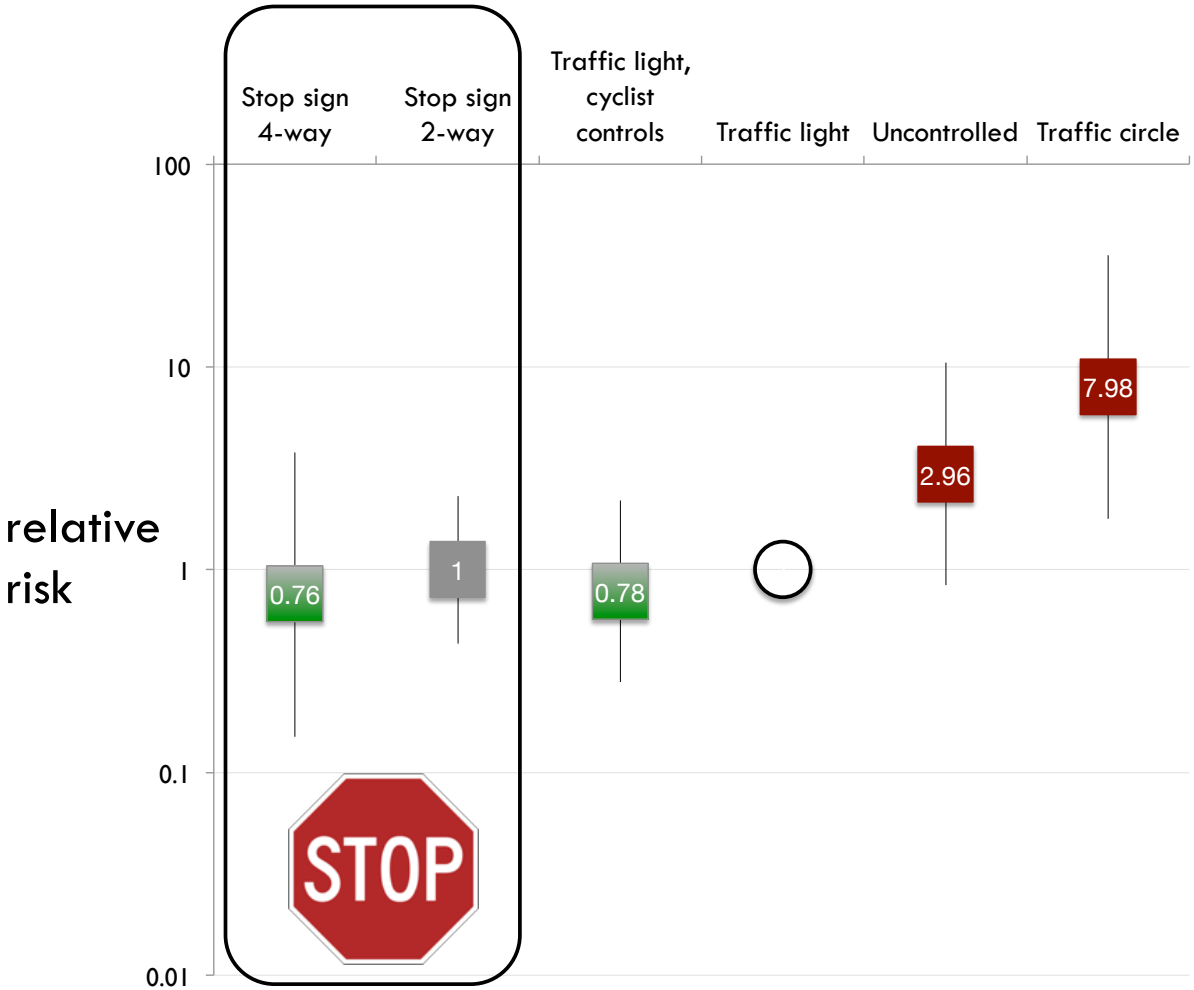
Intersection Controls



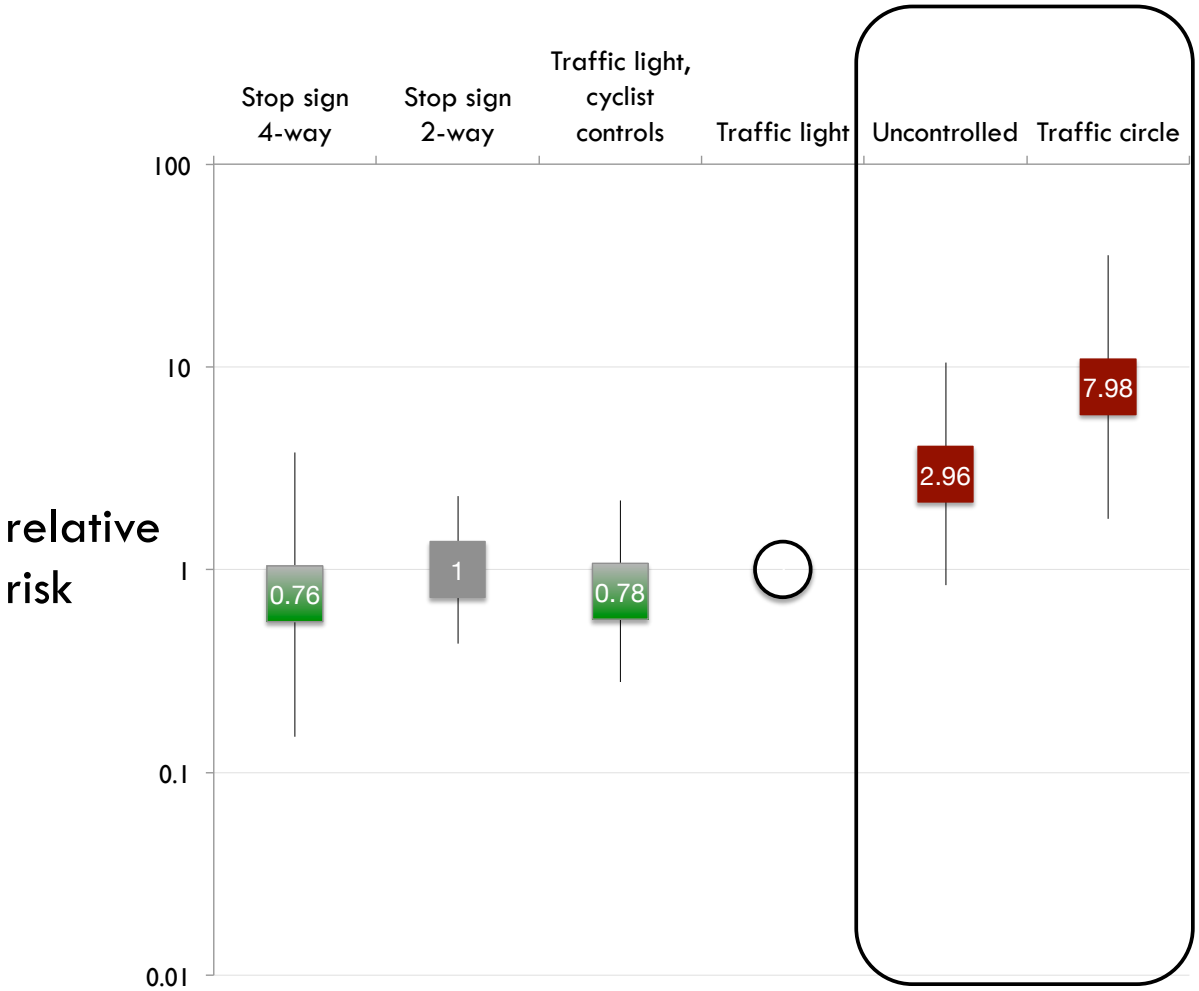
Intersection Controls



Intersection Controls



Intersection Controls



Types of Roads Meeting

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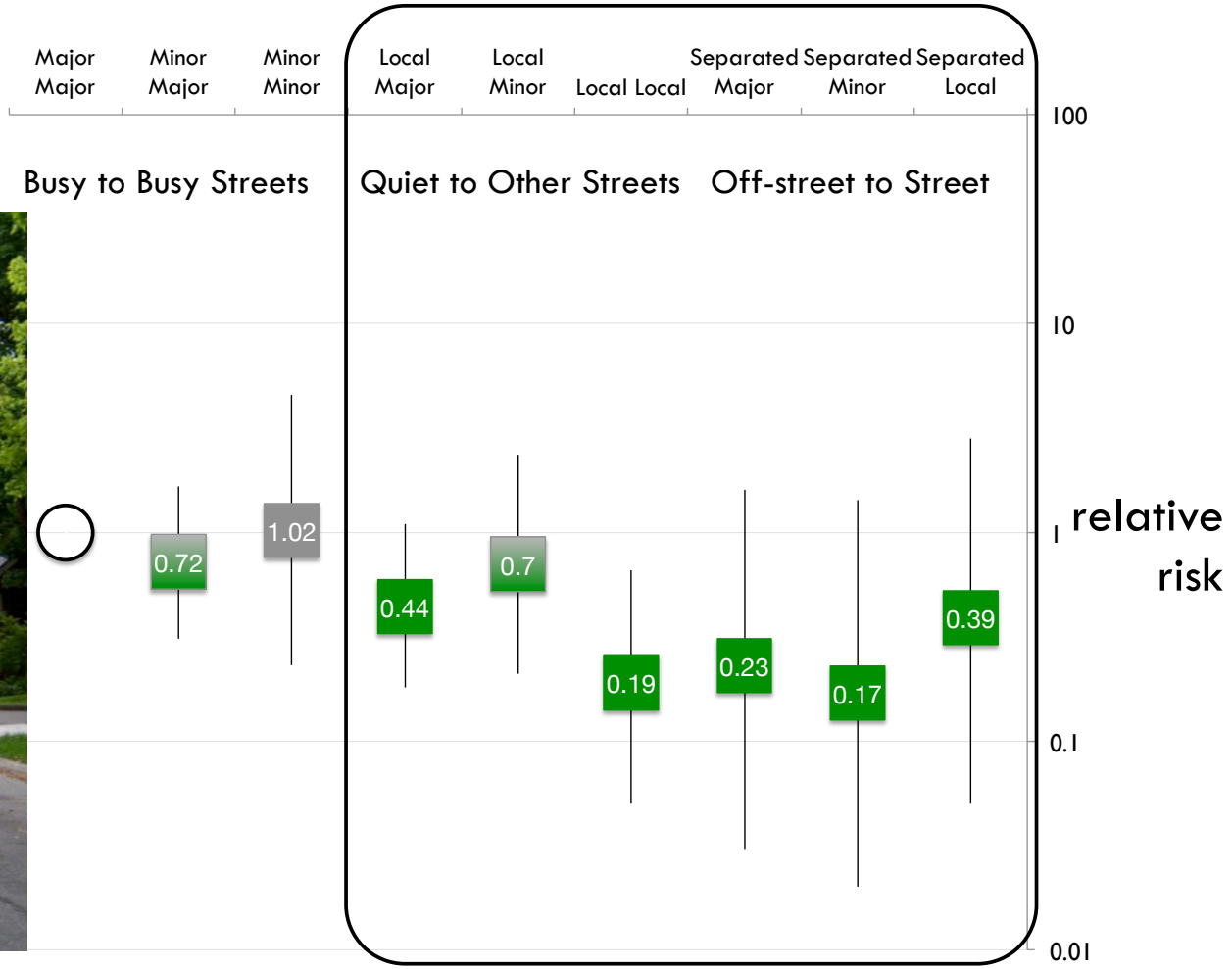
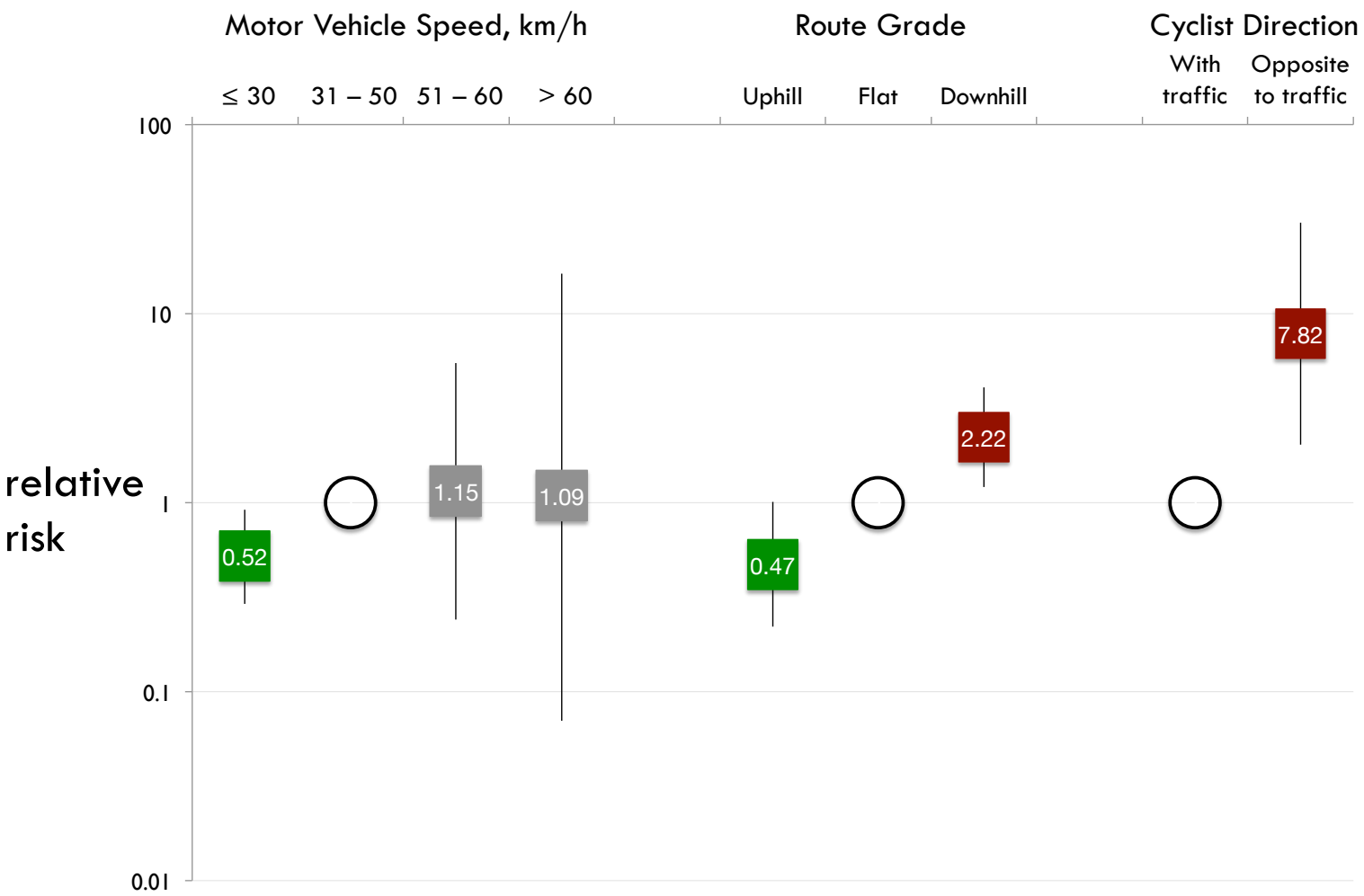
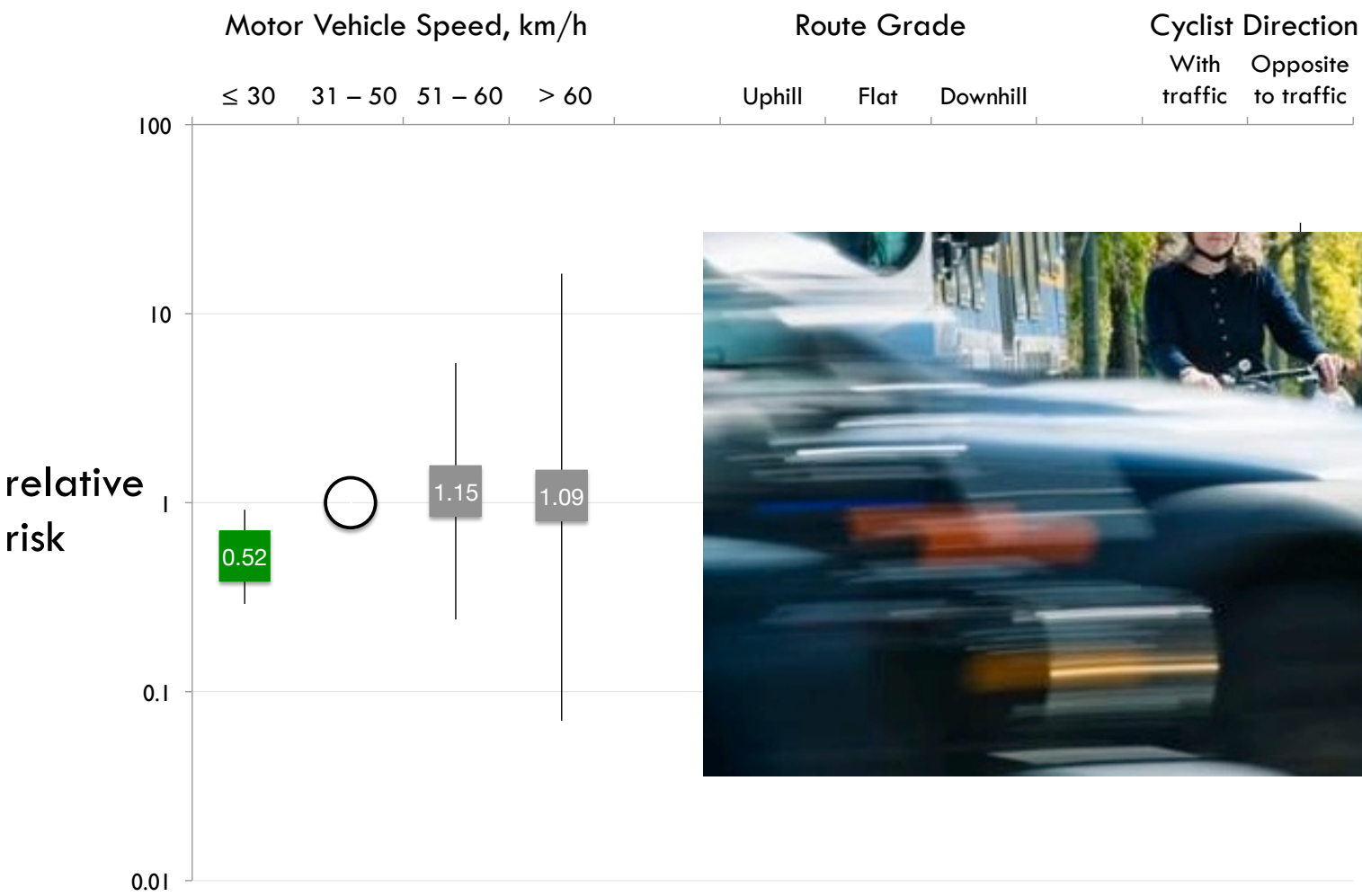


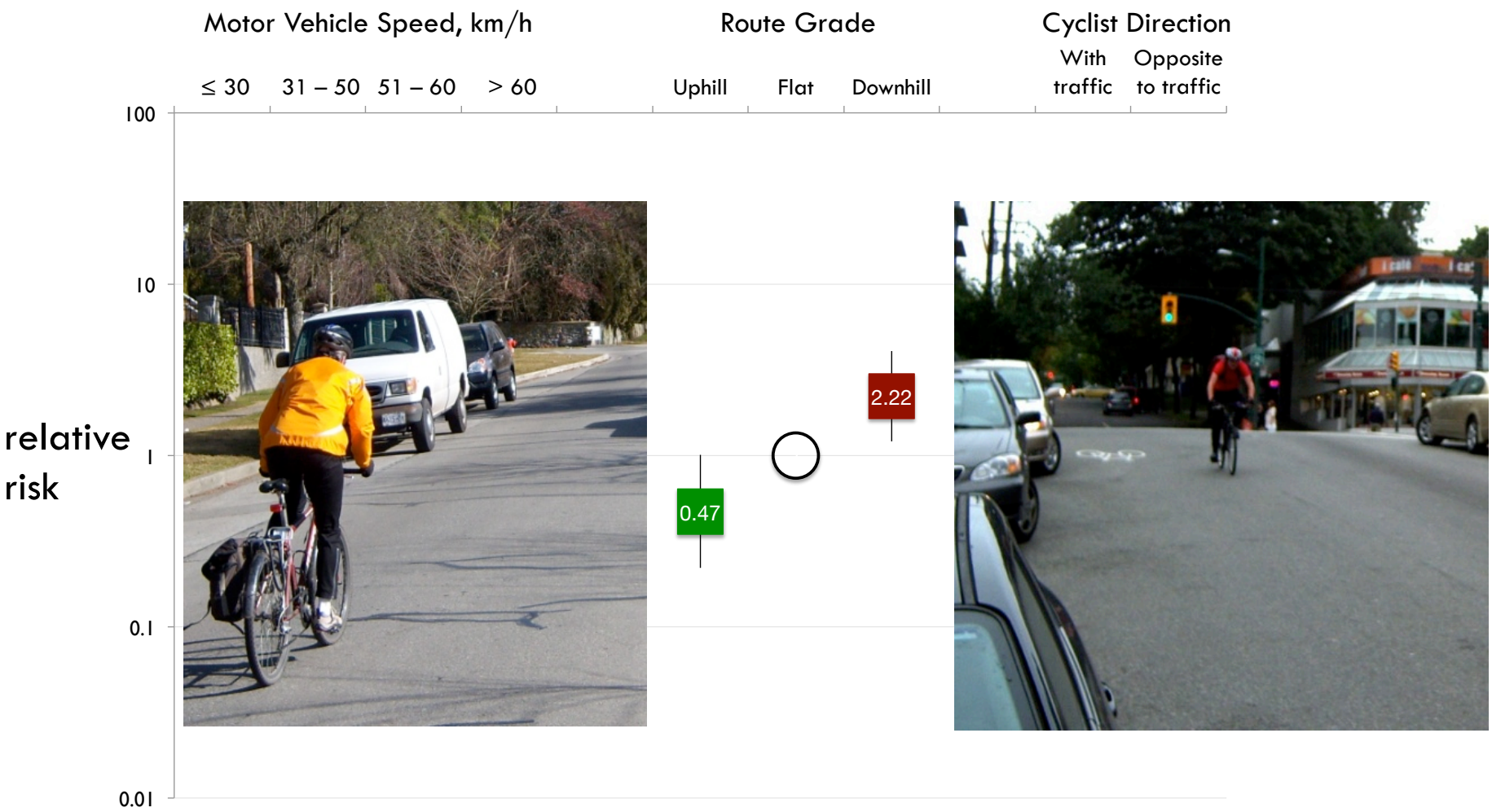
Vehicle Speed, Grade, Direction



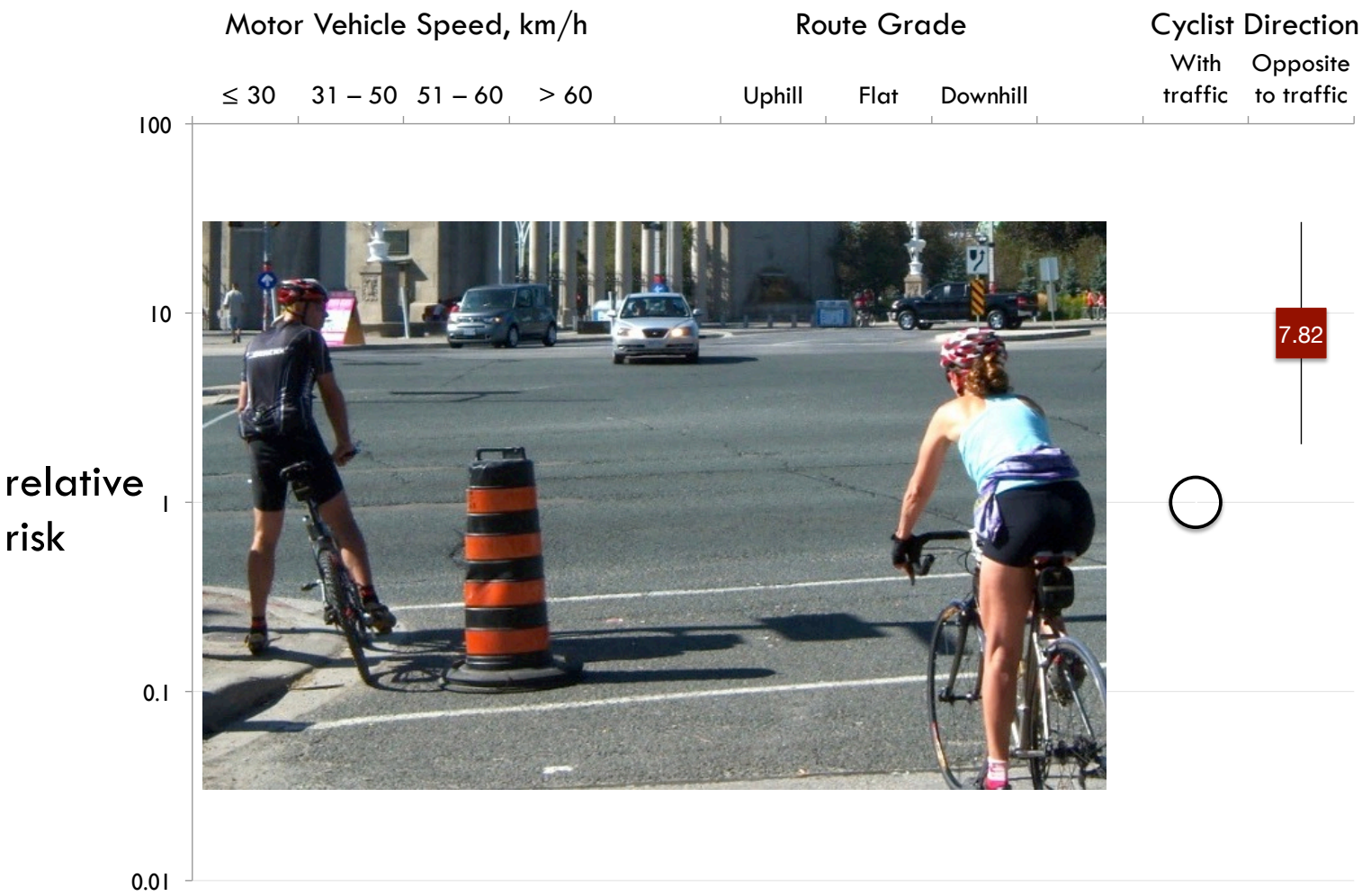
Motor Vehicle Speed

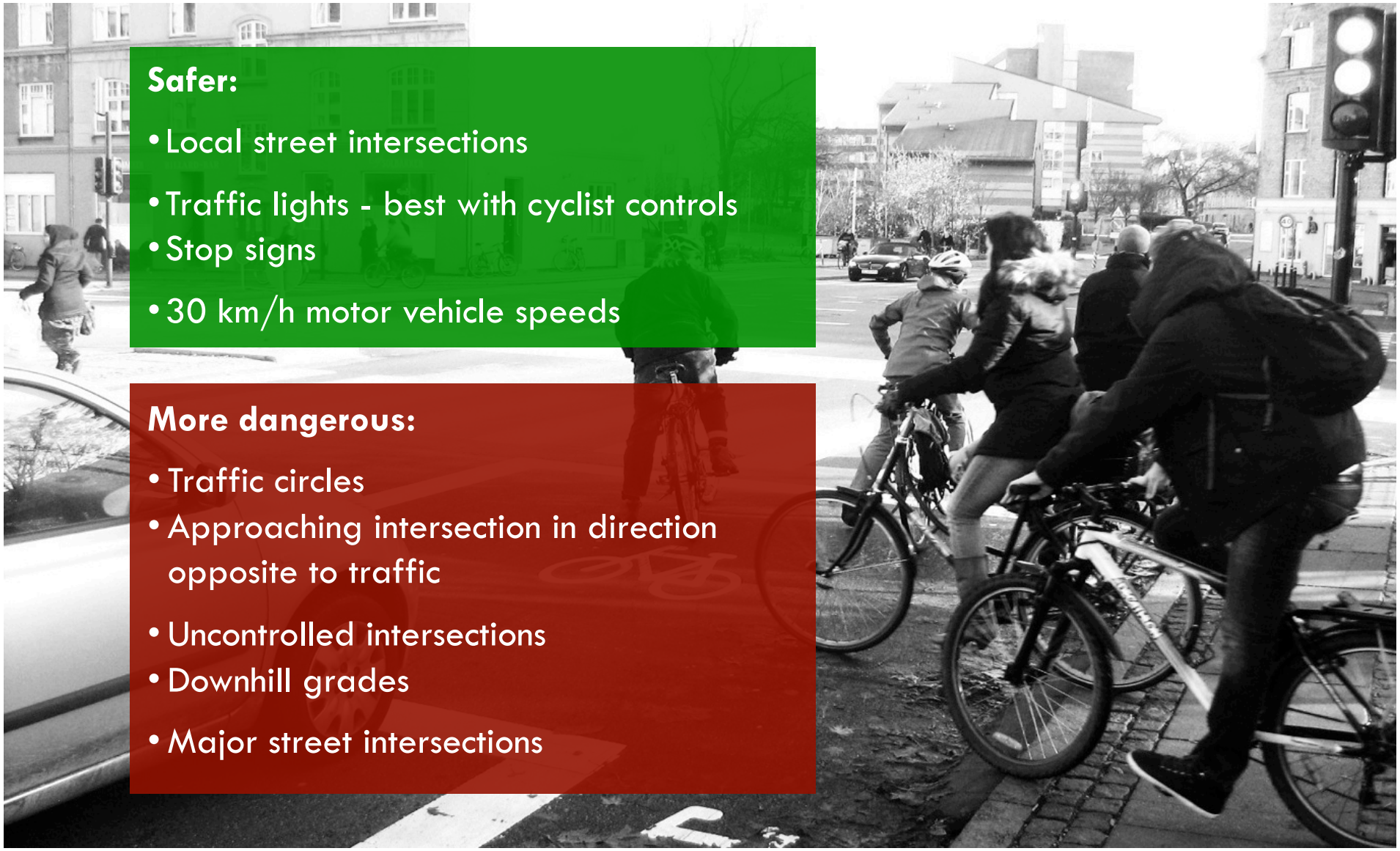


Route Grade


Motor Vehicle Speed, km/h
≤ 30
31 – 50
51 – 60
> 60
Route Grade
Uphill
Flat
Downhill
Cyclist Direction
With traffic
Opposite to traffic
100
10
1
0.1
0.01
relative risk
0.47
2.22

Cyclist Direction





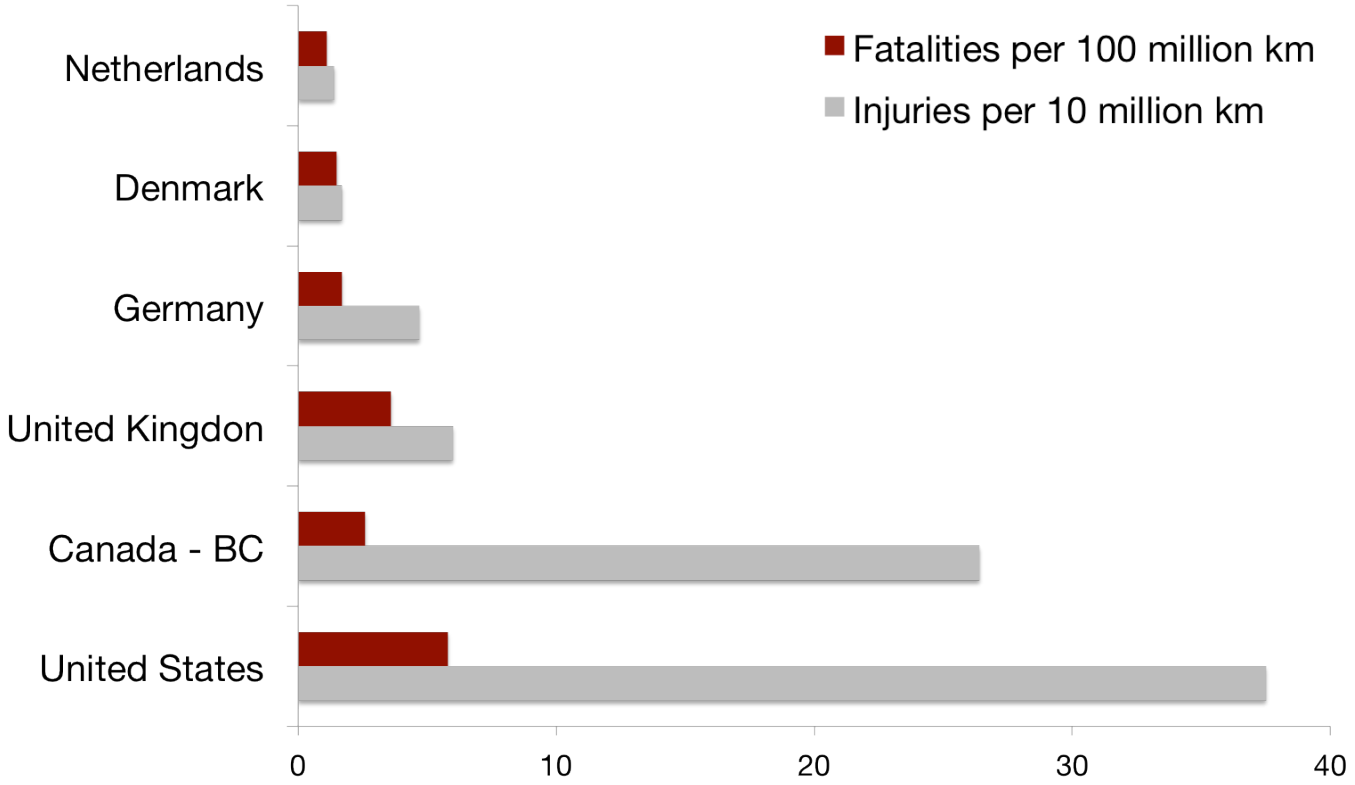
2. Intersections

intersection injury sites compared to intersection control sites

Concluding thoughts . . .

Why the differences?

Route infrastructure is a strong determinant of injury risk



[data sources: International - Pucher & Buehler *Transport Reviews* 2008;28:495-528
BC - Motor Vehicle Branch, 2005 to 2007, TransLink's 2008 Trip Diary Survey, Census 2006]

Bike-specific infrastructure is key

Previous research grouped

1. routes on or alongside streets:
   cycle tracks, **bike lanes**, sharrows, no infrastructure
2. off-street routes:
   bike paths, multiuse paths, trails, sidewalks

Not possible to observe the large differences in risk between them

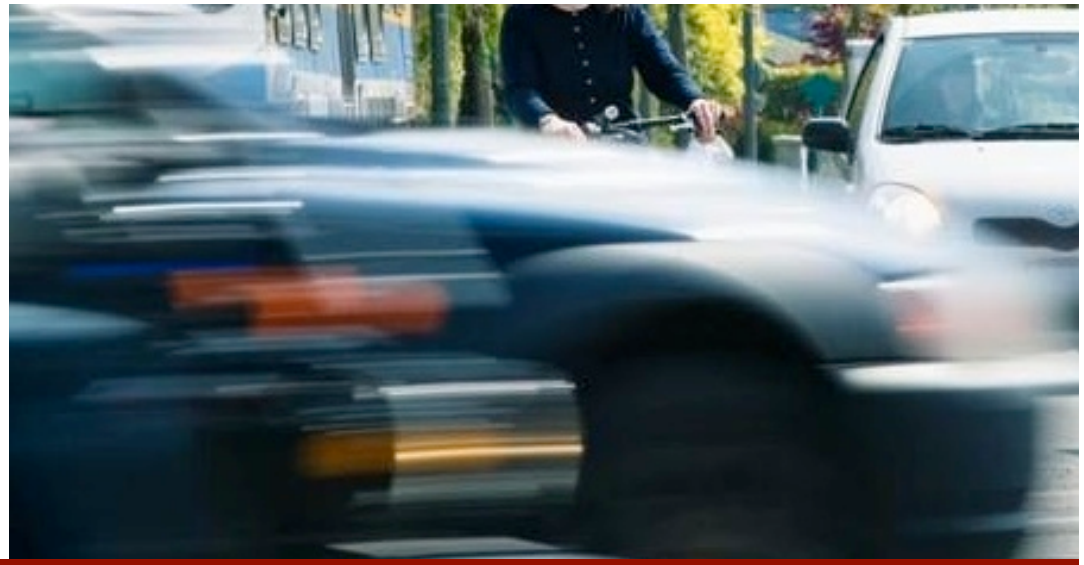
. . . so why did Forester think bike lanes & paths were unsafe?

Separation from traffic is key

Busy streets: physical barrier between cyclists and traffic

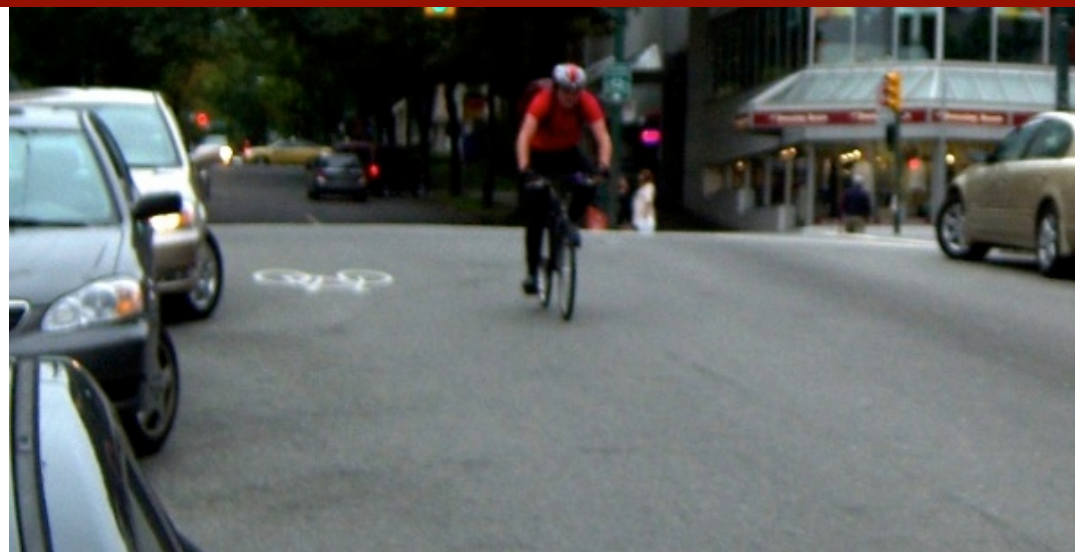
Residential streets: traffic diversion for "quiet" streets

Reducing speeds is key



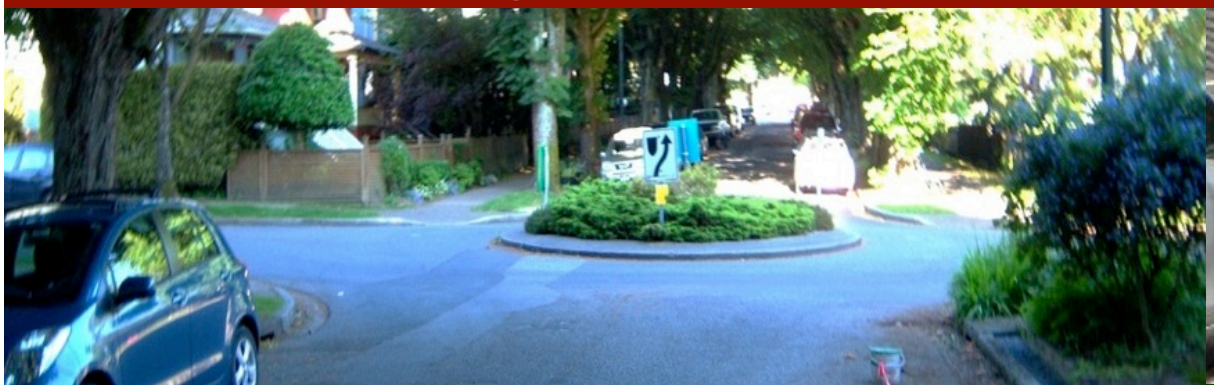
Motor vehicle speeds

Cyclist speeds down hills



Removing obstacles is key

- Streetcar or train tracks
- Traffic circles
- Construction
- Bollards
- Sharp or blind curves



limitations

Mildest and most severe injuries not included:

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

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.

thanks to everyone, especially study participants and . . .

Vancouver study team

- Melody Monro
- Evan Beaupre
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- Jill Dalton
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- Theresa Frendo
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Toronto study team

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- David Tomlinson
- Barbara Wentworth

Funders

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