

A photograph of a Toronto streetcar (number 4409) on a city street. The streetcar is red and white, moving from left to right. In the background, the CN Tower is visible against a blue sky with scattered white clouds. The street is lined with brick buildings and trees. A cyclist is visible in the distance on the right side of the street. A utility pole with a 'MAXIMUM 50' speed limit sign and a 'No Left Turn' sign is on the right. A blue newspaper box for 'The Epoch Times' is in the foreground on the right.

# Bicyclist injuries and route infrastructure: Streetcar tracks and finding a better groove

Presenter: Anne Harris

School of Occupational and Public Health, Ryerson University

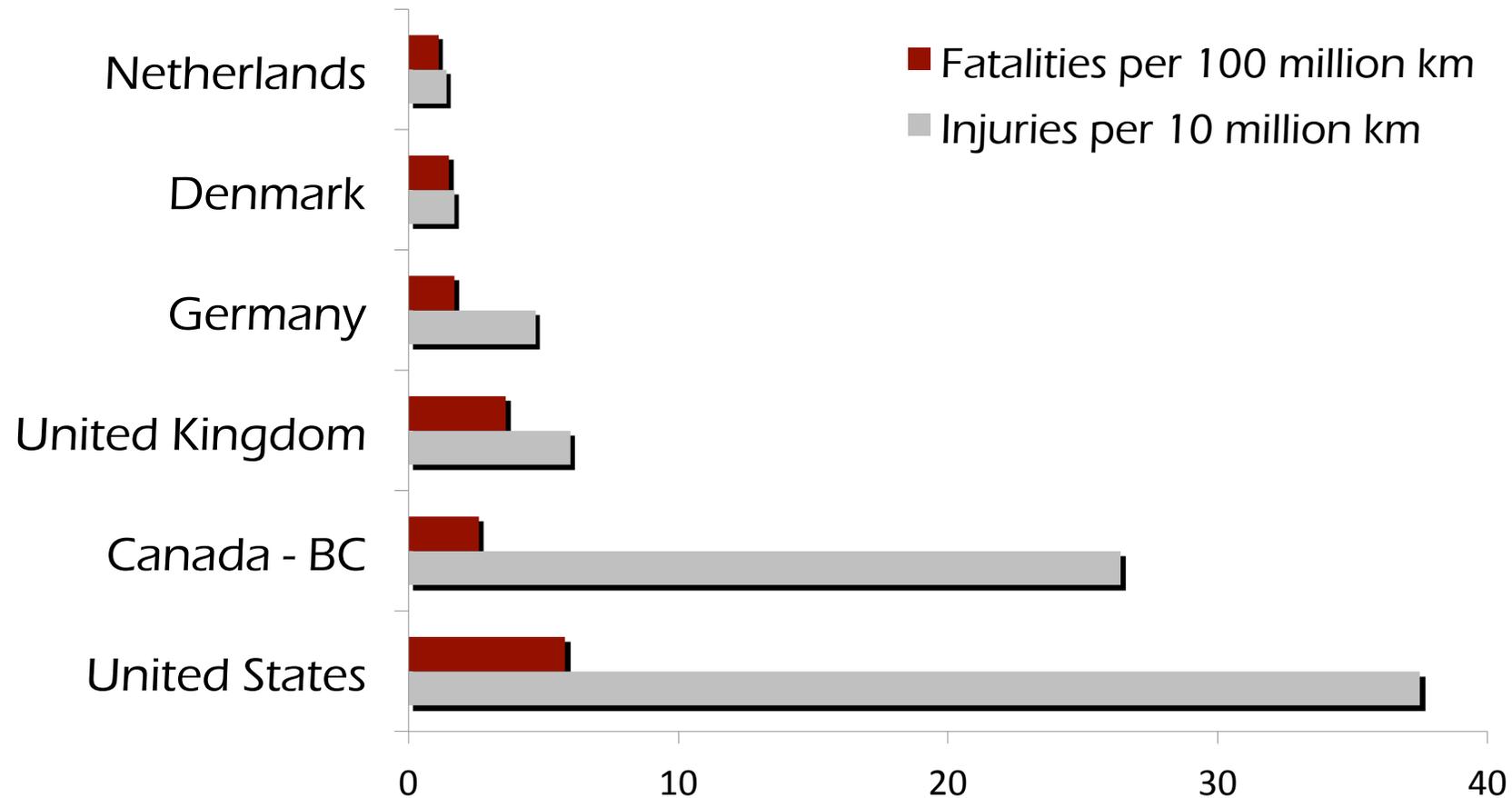
- Background: original case-crossover study
- Key results of case-crossover study
- Approach to delving deeper into streetcar track injuries
- Factors associated with streetcar track injuries among 276 injured Toronto cyclists
- Could wider wheeled bikes prevent track injuries? visit to retailers
- Media interviews



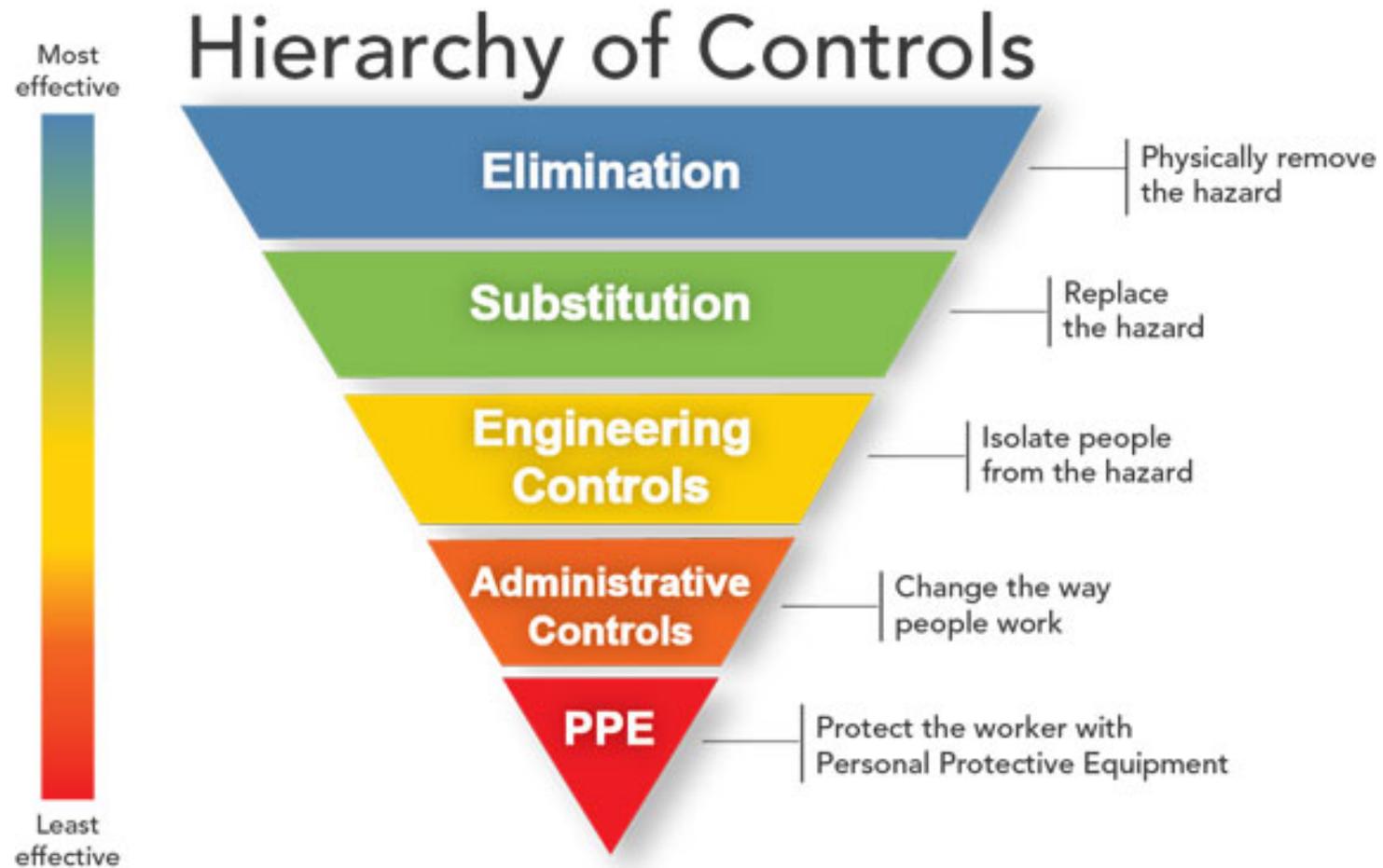
# Why infrastructure?



# differences in cycling injury rates Europe v. North America



[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]



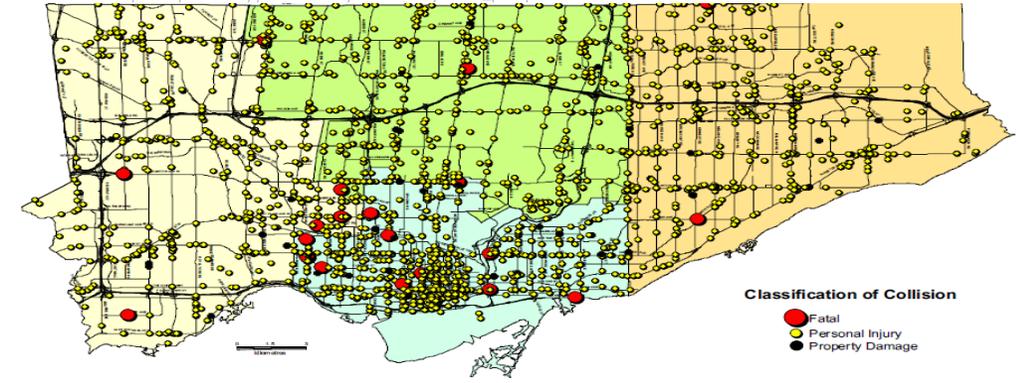
Source: NIOSH

<https://www.cdc.gov/niosh/topics/hierarchy/>

# Challenges to studying route infrastructure

- **Comparing locations** -> are you sure the number of users travelling through these locations is comparable?
- **Comparing injured to non-injured individuals** -> are you sure any risk differences can be attributed to route design?

[http://www.toronto.ca/transportation/publications/brochures/2010\\_ped.pdf](http://www.toronto.ca/transportation/publications/brochures/2010_ped.pdf)



# Bicyclists' Injuries & the Cycling Environment

## BICE



- Utilitarian cycling
- Infrastructural characteristics
- Case-crossover design

# 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

**INTERVIEW FORM**

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

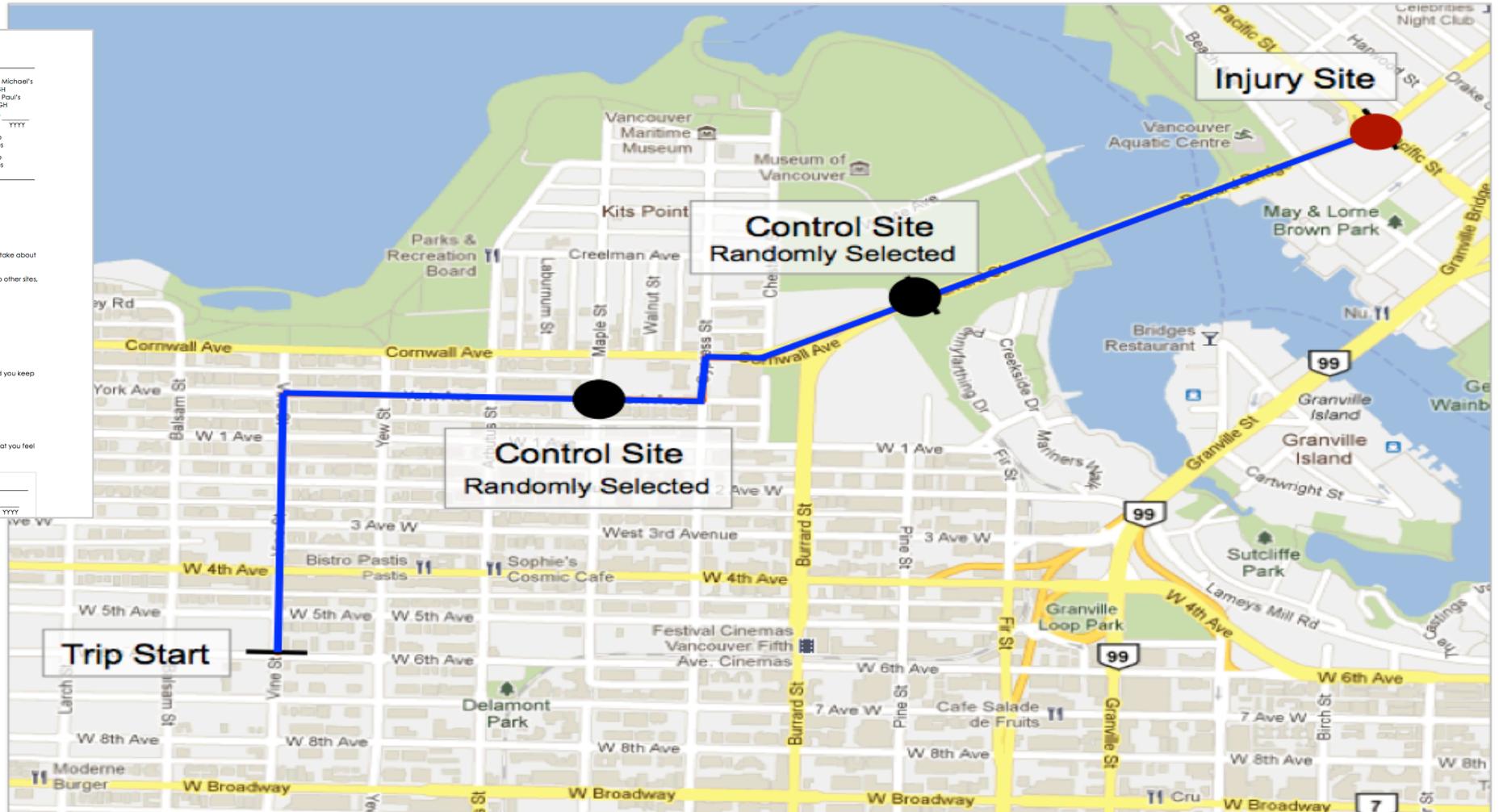
I'll ask you about the route you cycled when you were injured, including the injury site, and two other sites, randomly selected along the route.

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.

Sequential Number: \_\_\_\_\_  
Hospital: 1. St. Michael's  
2. IGH  
3. St. Paul's  
4. VGH  
Date Attended ED: / / YYYY  
DD MM  
Came by ambulance: 0. No  
1. Yes  
Admitted to Hospital: 0. No  
1. Yes  
CIAS: \_\_\_\_\_

Interviewer: \_\_\_\_\_  
Date of interview: / / YYYY  
DD MM



# Observations of injury & control sites

injury site

control site 1

control site 2

Sequential # - Site ID: \_\_\_\_\_ Injury Site **B.**  
Additional Site **D.**  
Additional Site **E.**

### SITE OBSERVATION FORM

#### 1. Instructions & Site ID

1.1 Preferred day of week: \_\_\_\_\_ [From Interview Form, Q 1] [Match weekday or week end]

1.2 Preferred time of day: \_\_\_\_\_ am pm to \_\_\_\_\_ am pm [On weekdays, match morning rush (7 to 9:30),  
day (9:30 to 3:30), afternoon rush (3:30 to 6),  
evening (6 to 10), night (10 to 12).]  
hr: min hr: min [From Interview Form, Q 1.1 and 1.2] [On weekends, match day (9 to 6),  
evening (6-10), and night (10 to 9)]

1.3 Sections of this form to complete for this site

Instructions & Site ID

Off-road If Question 11.2 = 1

Road If Question 11.2 = 2

Intersection If Question 11.2 = 3

General Route Characteristics If Question 11.1 = 1 and Question 11.2 = 2

Photographs If Question 11.1 = 2

*Based on Interview Form, Question 11*

1.4 Find the site from the attached photo and Interview Form question 11 & site diagram. The following features should be indicated:

- Names of streets & other identifiable features
- The cyclist's location (marked with an X) including
  - o whether on the road, sidewalk, or path, and which side & which lane
  - o whether at an intersection or not
  - The cyclist's direction of travel (marked with an arrow, before and after the X)

If the photo is incorrect (e.g. out of date), modify photo or provide corrected sketch of site with these features on Rip side of the photo.

Site Observer: \_\_\_\_\_

Observation Day of Week: \_\_\_\_\_

Observation Date: DD / MM / YYYY

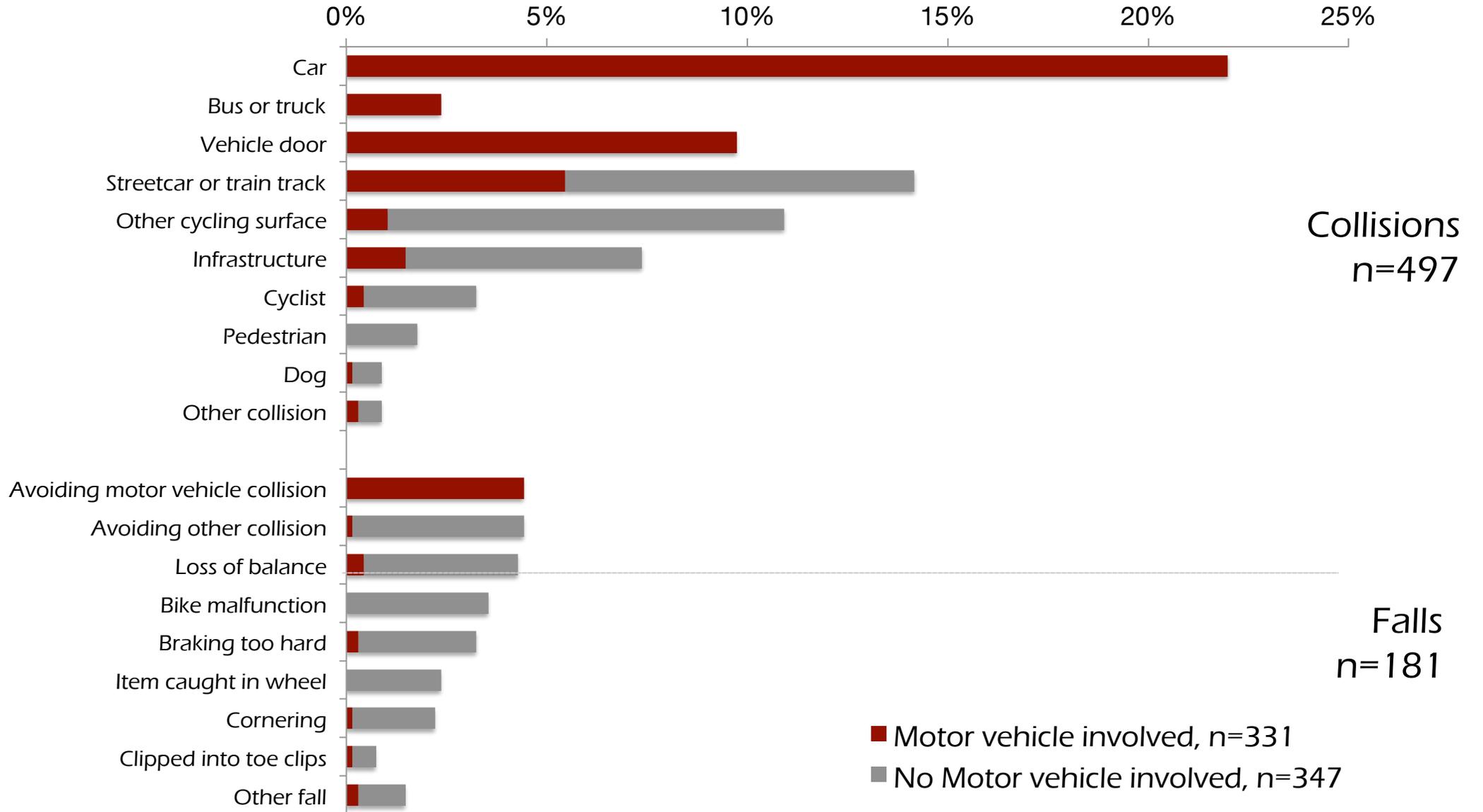


# Case-crossover design features

Comparisons cumulated over all person-trips,  
using conditional likelihood method in Proc Logistic



# % of injury events



# Key conclusions – overall risk analyses

- reduce obstacles/obstructions



Streetcar tracks  
OR: 3.0, 95% CI: 1.8 to 5.1



construction  
OR: 2.1, 95% CI: 1.3 to 2.9



traffic circles

- increase traffic separation/protection



cycle tracks  
OR: 0.12, 95% CI 0.03 to 0.60



local streets with traffic diverter  
OR 0.04, 95% CI 0.003 to 0.60

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local streets with traffic diverter  
OR 0.04, 95% CI 0.003 to 0.60





## Toronto cyclist dies after wheel gets trapped in unused streetcar track

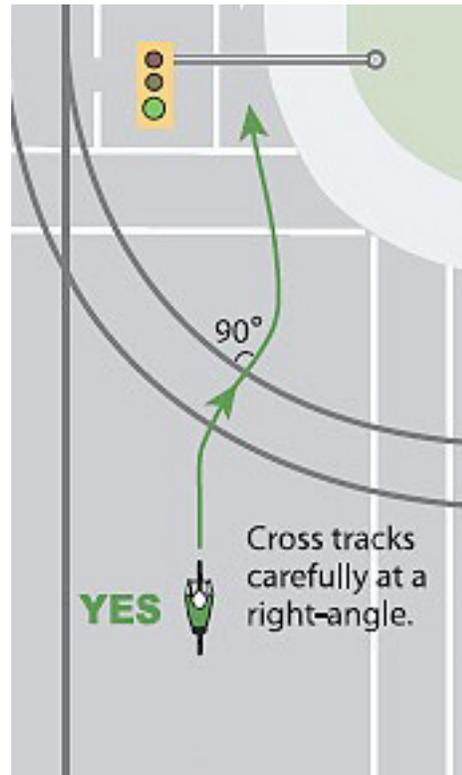
**STEPHEN SPENCER DAVIS**

The Globe and Mail

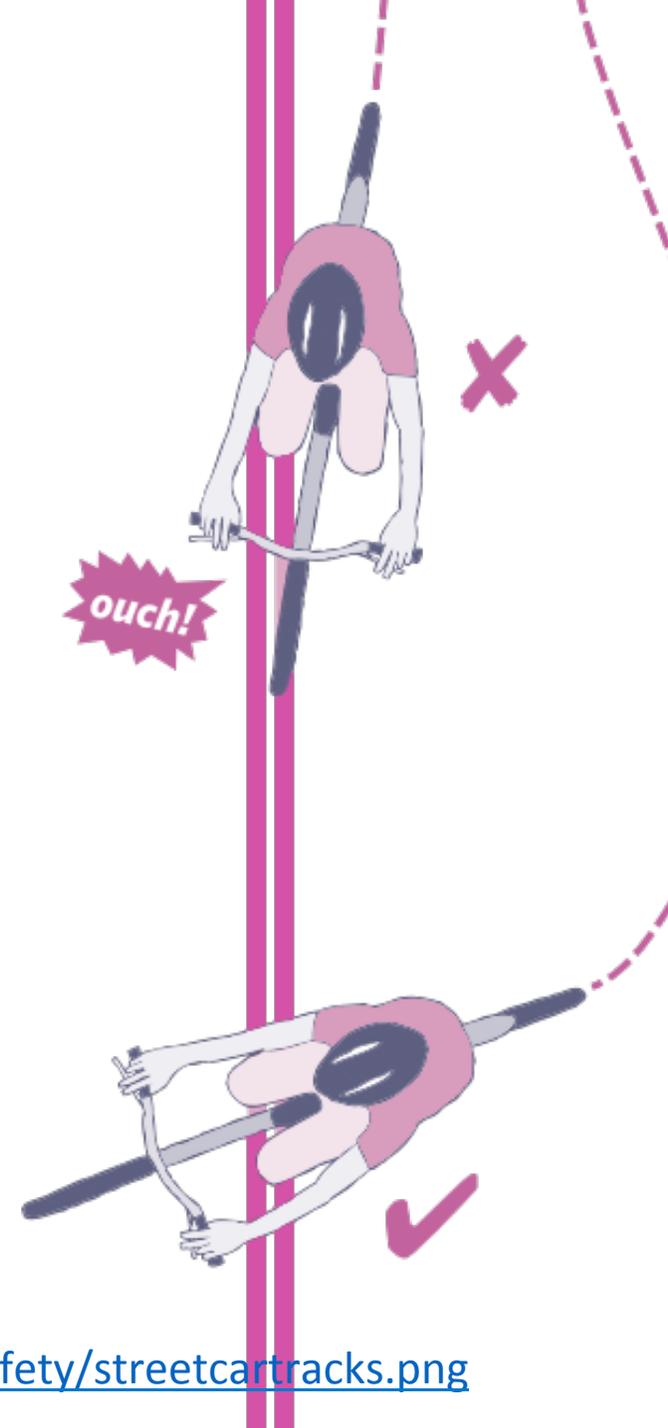
Published Tuesday, Aug. 07, 2012 12:36PM EDT

Last updated Wednesday, Aug. 08, 2012 11:36AM EDT

<http://www.theglobeandmail.com/news/toronto/toronto-cyclist-dies-after-wheel-gets-trapped-in-unused-streetcar-track/article4466970/>



<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=7a430995bbbc1410VgnVCM10000071d60f89RCRD&vgnextchannel=bfb5970aa08c1410VgnVCM10000071d60f89RCRD>



<http://www.startcycling.ca/img/safety/streetcartracks.png>

# **Bicycles and Streetcar Tracks in Toronto: Getting into a Better Groove!**

PHOTO OF THE DAY: Queen and Spadina

November 18, 2016 by Joe T. — 0 Comments



<http://bikingtontoronto.com/blog/2016/11/photo-of-the-day-queen-and-spadina-3/>

Source: Original photo — by siama, on Flickr.

# Participating cities



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- 0.6 million people
- rain in winter, temperate summer
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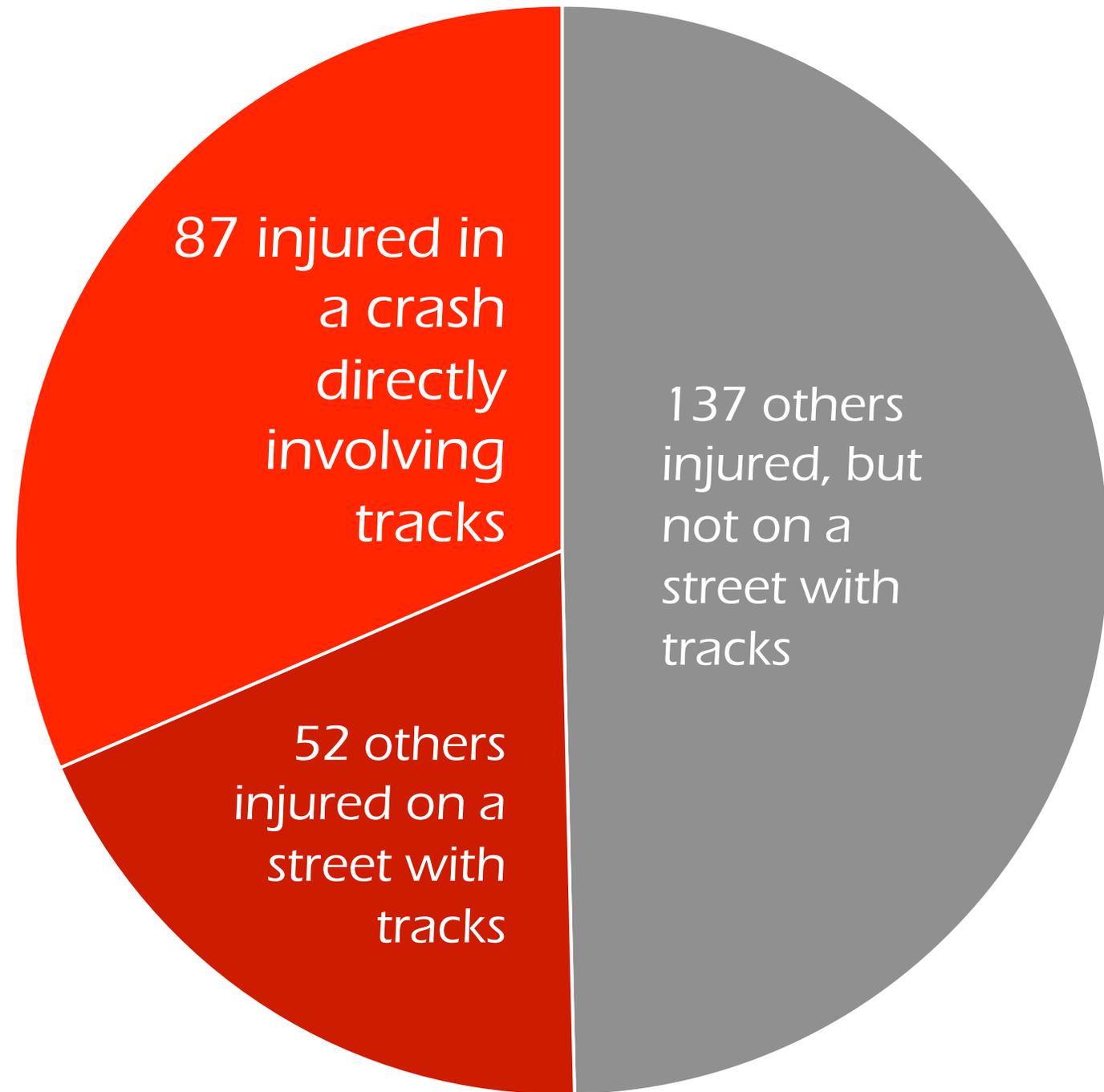
## Toronto

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# Questions and approaches

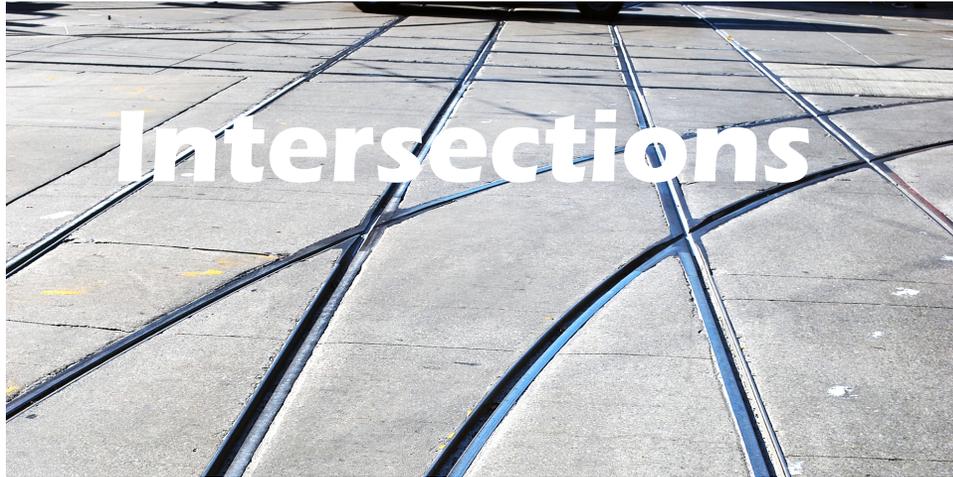
- In depth analysis of 276 Toronto crashes
- Examine participant descriptions of circumstances
- Compare crashes involving streetcar tracks to those occurring in other circumstances: what distinguishes streetcar track crashes?
- Visit bicycle shops:
  - Could wider tires on commonly available bicycles reduce vulnerability to crashes?
  - Do patrons request advice on avoiding streetcar track crashes? What do retailers advise?

276 cyclists  
injured in  
Toronto



**Bike tires caught in rail flangeways – 85 % of track crashes**

Bike tires slipped on rails – 15 % of track crashes



“I had been cycling on the right side of the road but I wanted to make a left turn and while moving to the centre of the lane my bike wheels got caught in the streetcar tracks.”

“As I approached an intersection, there was a car in front of me turning right. To go straight, I moved around the car into the left lane but as I did, my front tire got stuck in the streetcar track.”

“I had a green light so I proceeded through the light. A cyclist turned right onto the bike path I came from. I swerved to avoid her and my wheel got caught in the train track.”

**Bike tires caught in rail flangeways – 85 % of track crashes**

Bike tires slipped on rails – 15 % of track crashes



“As I was cycling in the curb lane, a truck passed me, stopped and turned on his hazards. I went around him on the left which put me between the street car tracks. As I was going over the street car tracks my back wheel got caught.”

“I was biking in the right hand lane and in front of me a woman opened her car door. I moved to the center lane, but as I was moving back to the right lane my front tire got caught in a streetcar track.”

“There was another cyclist ahead of me. I moved into the left lane and passed her. When I attempted to move back into the right lane, my front wheel got caught in a street car track.”

Bike tires caught in rail flangeways – 85 % of track crashes

**Bike tires slipped on rails – 15 % of track crashes**



“The roads were very wet and slick. I was travelling south, turning left. I was leaning into the turn. I hopped over the first streetcar rail and was getting ready to cross the next rail when my back tire slipped on the track.”



**Table 3** Factors associated with crashes directly involving streetcar or train track vs. other or unknown circumstances

	OR <sup>a</sup>	95 % CI <sup>b</sup>
<b>Route type</b>		
Major street with parked cars, no bike infrastructure	1.0	ref
Major street, no parked cars, no bike infrastructure	<b>0.44</b>	<b>(0.22, 0.86)</b>
Major street with painted bike lane	<b>0.15</b>	<b>(0.04, 0.43)</b>
Residential street	<b>0.12</b>	<b>(0.02, 0.46)</b>
Sidewalk or multiuse path	<b>0.12</b>	<b>(0.03, 0.38)</b>
<b>Intersection status</b>		
Non-intersection	1.0	ref
Intersection, straight through	0.84	(0.38, 1.77)
Intersection, right turn	1.03	(0.12, 7.26)
Intersection, left turn	<b>43.4</b>	<b>(7.54, 838)</b>
<b>Sex</b>		
Male	1.0	ref
Female	<b>2.10</b>	<b>(1.13, 3.92)</b>
<b>Cycling frequency</b>		
Additional 100 times cycling per year	<b>0.67</b>	<b>(0.44, 0.99)</b>

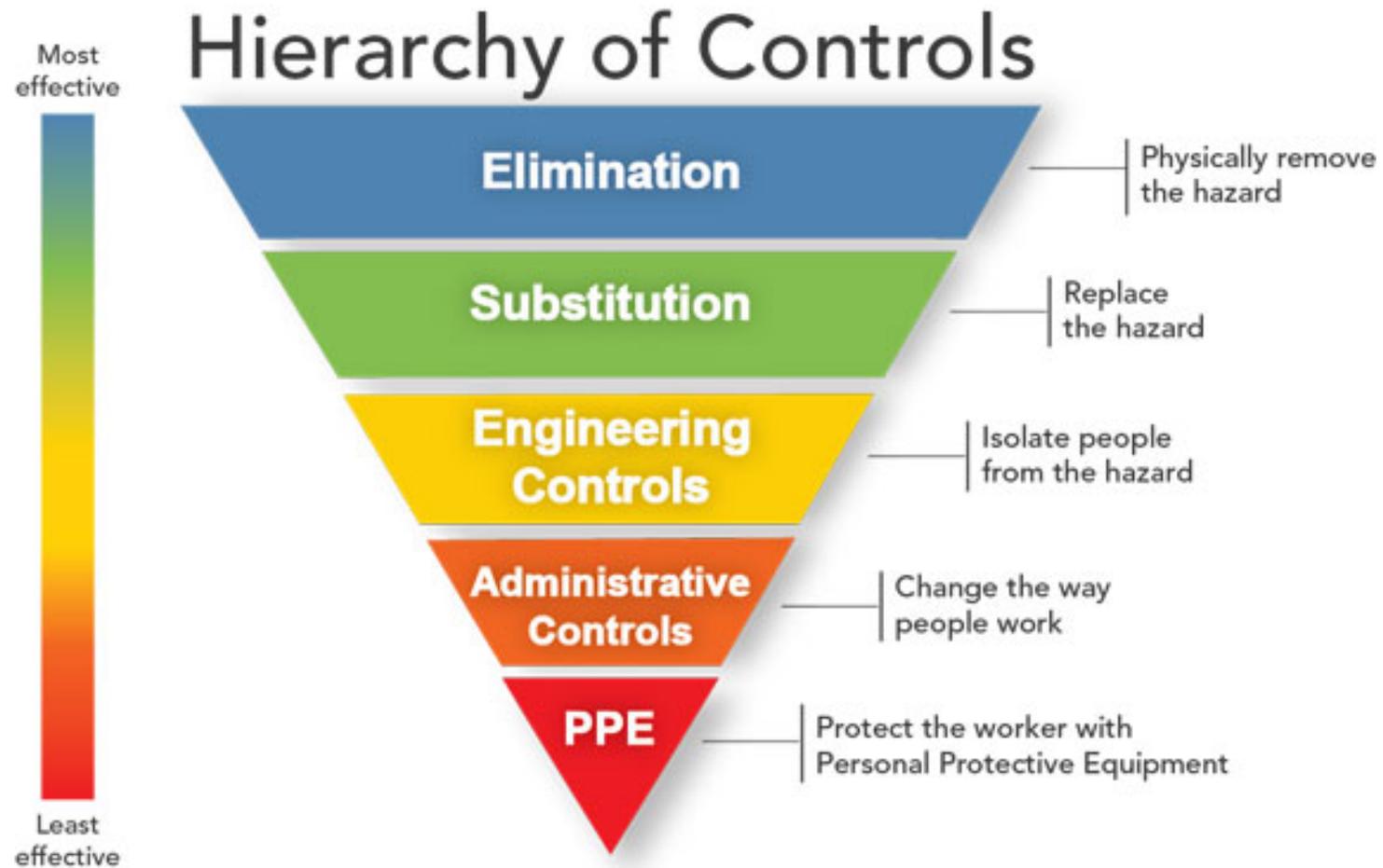
<sup>a</sup> Odds ratios (OR) from multiple logistic regression, N = 276 injured cyclists in Toronto. Bold indicates odds ratio is statistically significant  
<sup>b</sup> 95 % confidence interval (CI)

# Could wider tires/wheels avoid track catches?



These Bikes can Use Wider Tires Up to 700x40c = More Comfort + Stability ==>>>>  
**Thinner = Faster <===> Wider = More Comfort**

Image source: [http://www.bikesdirect.com/products/mercier/images/tires\\_1600.jpg](http://www.bikesdirect.com/products/mercier/images/tires_1600.jpg)



Source: NIOSH

<https://www.cdc.gov/niosh/topics/hierarchy/>

# Visits to bicycle shops

- Recruited from bicycle shops serving utilitarian/commuter cyclists around the downtown core
- Participating shops: Bateman's Bicycle Company, Broom Wagon Cyclery, Curbside Cycle, The Cyclepath Danforth, Duke's Cycle, Sweet Pete's, and Urbane Cyclist
- Interviewed a retail staff member at each location (n=7), then took measurements of the tires/wheels of commonly sold bicycles



Image credit: BlogTO <http://www.blogto.com/services/urbane-cyclist-college-toronto>

# Retailer interviews



- What types of cyclists shop at this store?
- Do any shoppers ask about ways to avoid streetcar track injuries? What advice do you give? To your knowledge, does this store have a policy or standard recommendation for customers concerned about streetcar track injuries?
- There are hundreds of tire sizes and styles. Do you sell any tires (or do you know of any tires) that are less likely to get caught in a streetcar track groove or slip on streetcar track surfaces?
- Do you think there are any other bicycle, wheel, or tire design elements that could reduce the risk of streetcar track injuries?

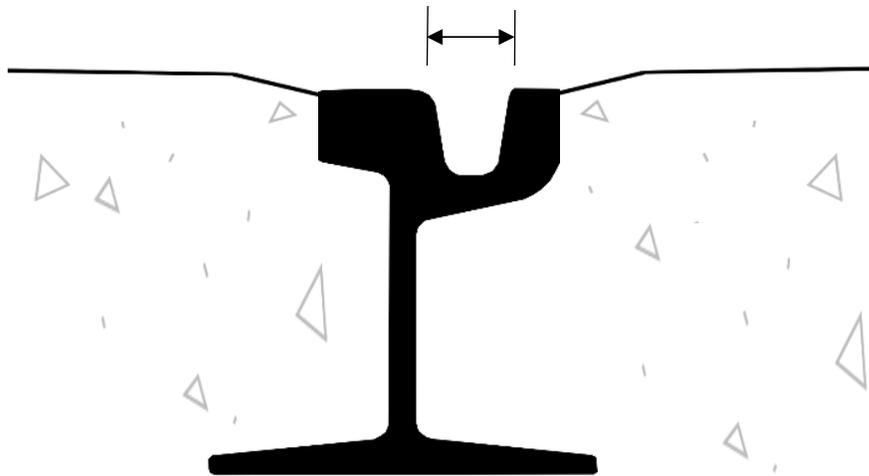
# Retailer responses

- Commuter cyclists main customers, buying commuter, hybrid, comfort and city bikes
- All personnel reported some customers asking about handling streetcar tracks
- All indicated advice on track angle (minimum 45°, ideally 90°)
- Some reported selling wider tires to those concerned with tracks, many reluctant to advise this:
  - Consider wide tires slower and less efficient
  - Only extreme (fat bike tires) thought wide enough
  - Wide tires could get stuck
  - Still risk slipping
- Other advice: two-stage lefts, plan route to avoid, tacky rubber

# Wheel measurement results

50 % narrow enough to be caught in narrowest girder rail flangeways

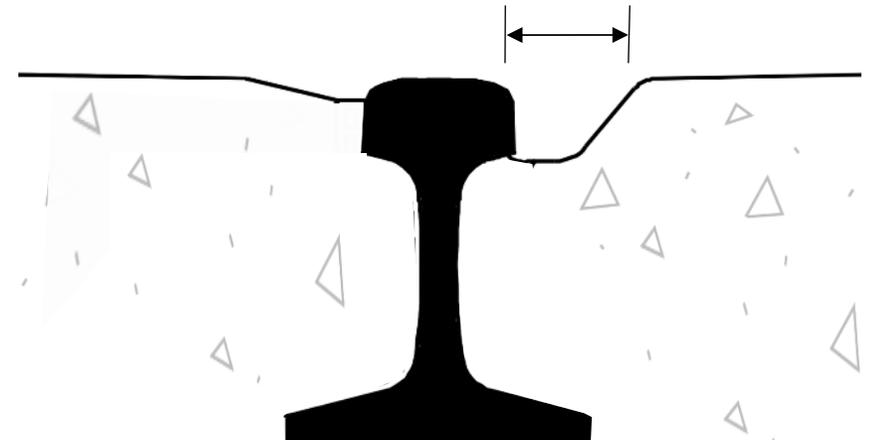
34.5 to 37.5 mm



Toronto bike share tire width  
49.5 mm

Only 8 % wider than widest t-rail flangeway

38 to 50 mm



# Preventing streetcar track injuries

- **Training on angle of approach?**
  - Inexperience, younger age, gender significant in our comparison of track injuries to non-track injuries
  - BUT! Those injured on tracks not all that inexperienced (average 123 cycling trips/year) and reported having to make sudden maneuvers to avoid other road users
- **Bicycle tires:** most tires on popular bicycles narrow enough to be caught in any flangeway. Wider commuter bicycle tires could prevent some “catches?”
- **Infrastructure:** remove car parking, increase separation, implement solutions at intersections

# Media Interview Experiences

# Acknowledgements

- Co-authors: Kay Teschke, Jessica Dennis, Conor Reynolds, Meghan Winters
- Participating bicycle shops
- TTC staff: provided information on flangeway widths/design
- Toronto Bike Share staff: provided specs of bike share wheels
- BICE study investigators, full list: <http://cyclingincities.spph.ubc.ca/>
- Injury Study funding: Heart and Stroke Foundation of Canada and the Canadian Institutes of Health Research (Institute of Musculoskeletal Health and Arthritis, and Institute of Nutrition, Metabolism and Diabetes).

# For more...

- Our published article in BMC Public Health is open access:  
<https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3242-3>
- The Cycling in Cities study website has many resources and articles: <http://cyclingincities.spph.ubc.ca/>
- Email me: [anne.harris@ryerson.ca](mailto:anne.harris@ryerson.ca)
- Thank you!