

TRAVELING BY BUS INSTEAD OF CAR IN MONTREAL: SAFETY BENEFITS FOR VEHICLE OCCUPANTS AND PEDESTRIANS AND ITS ASSOCIATION WITH GEOMETRY

Jillian Strauss

Postdoctoral fellow

École Polytechnique de Montréal

Patrick Morency

Medical advisor

Direction de Santé Publique de Montréal

Catherine Morency

Associate professor

École Polytechnique de Montréal

Collaborators: Francois Tessier, Sophie Goudreau, Jean-Simon Bourdeau, Pierre-Léo Bourbonnais

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OUTLINE

- Context
- Objectives and methodology
- Results
 - Car versus bus occupant injuries
 - Pedestrian injuries
 - Scenarios
- Discussion

Probability of death and injury ... in a car versus in a bus

➤ Fatality rate

- Per kilometre travelled: 10 times greater in a car
(Europe; 2001-2002)¹
- Per trip: 23 times greater
(USA; 1999-2003)²

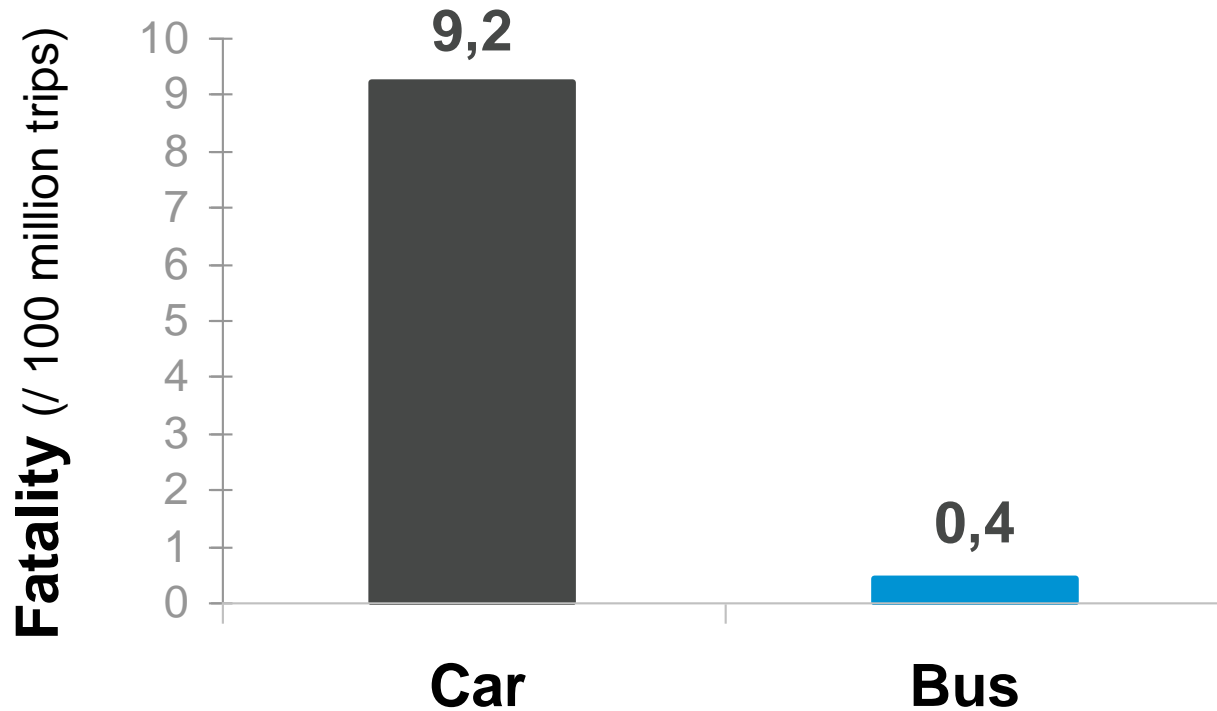
➤ Injury rate

- Per kilometre travelled: 4.3 times greater in a car
(Norvège; 1998-2005)³
- Per trip: 5 time greater
(USA; 1999-2003)²

1. ETSC (2003) Transport safety performance in the European Union: A Statistical Overview, European Transport Safety Council, Brussels
2. Beck, L.; Dellinger, A. & O'Neil, M. Motor vehicle crash injury rates by mode of travel, United States: using exposure-based methods to quantify differences. American Journal of Epidemiology, Oxford Univ Press, 2007, 166, 212-218
3. Elvik, R 2009, 'The non-linearity of risk and the promotion of environmentally sustainable transport' Accident Analysis & Prevention, vol 41, no. 4, pp. 849-855.

Probability of death ... in a car versus in a bus

(USA, 1999-2003*)



Limitations of « aggregated » studies at the country level

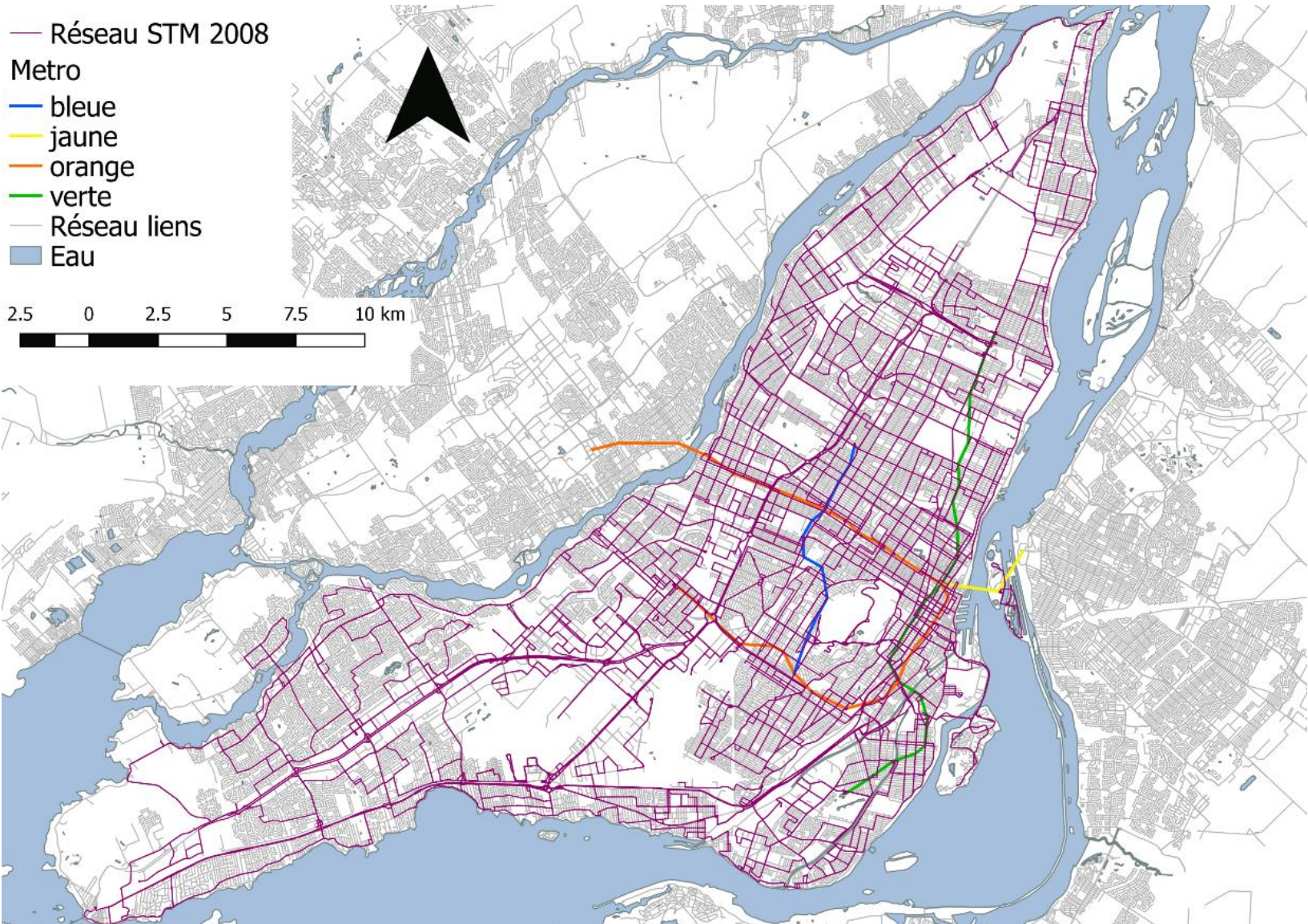
- Risk of injury can vary by context
(ex. urbain/rural)
- Include different types of buses
(ex. public, interurbain, écoliers)
- Do not explore the effects of road and intersection geometry
- Do not consider pedestrians and cyclists injured by cars and buses

OBJECTIVES AND METHODOLOGY

Objectives

1. Estimate and compare the injury risk for car and bus occupants
2. Investigate the impact of road geometry and vehicle exposure on injuries and injury risk
3. Compare pedestrian injuries and injury risk associated with car and bus travel

Study environment : Island of Montreal bus network (2008)



Data

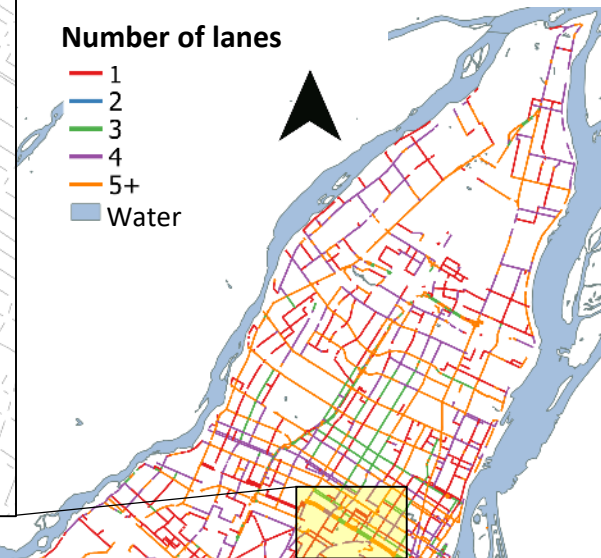
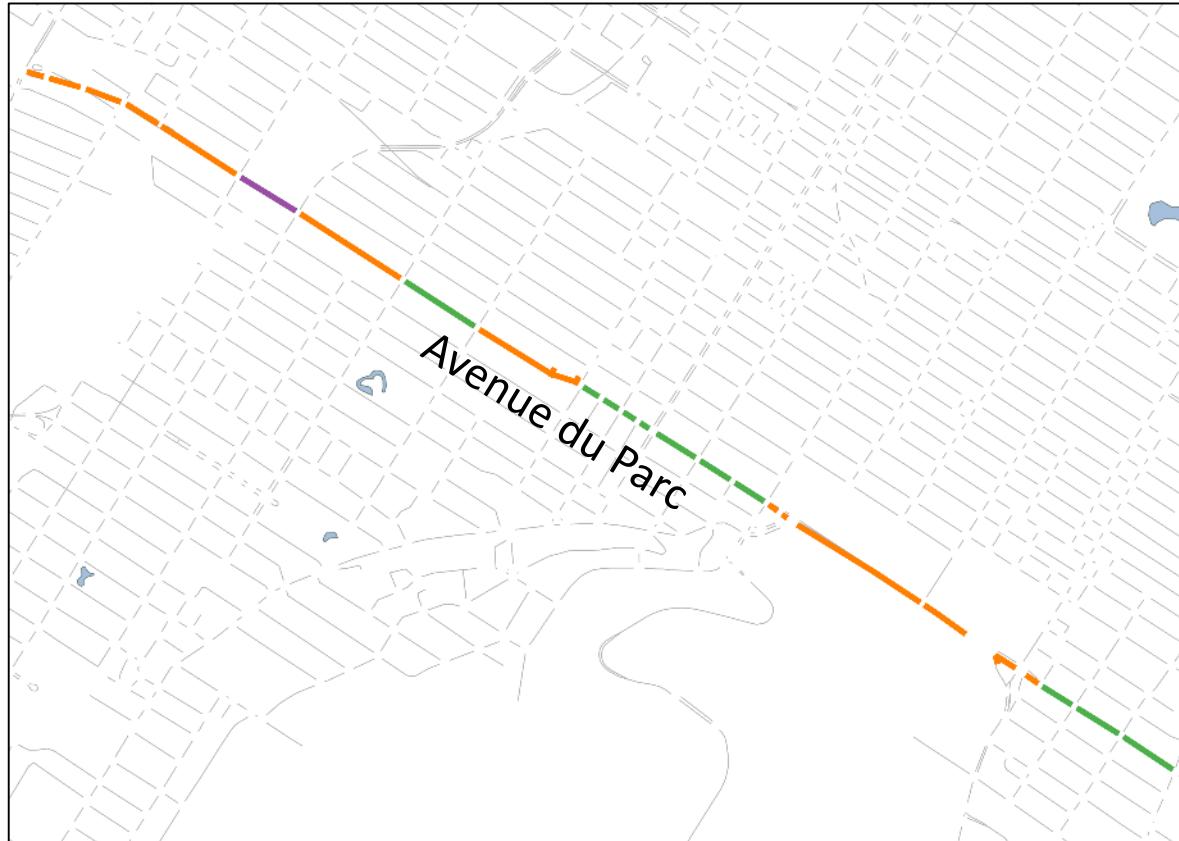
- **Estimated volumes** (2008 O-D survey)
 - Number of buses and cars
 - Number of vehicle occupants (bus & car)
 - Pedestrian volumes (walk only and to and from transit)

- **Infrastructures**
 - Road segments - number of lanes¹
 - Intersections - number of approaches²

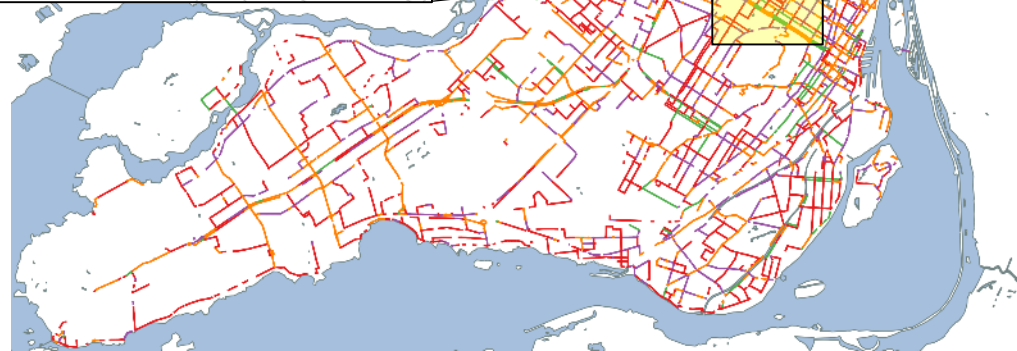
- **Injuries**
 - Geo-coded accidents from police reports^{4,5} (2004-2013)

Corridor definition:

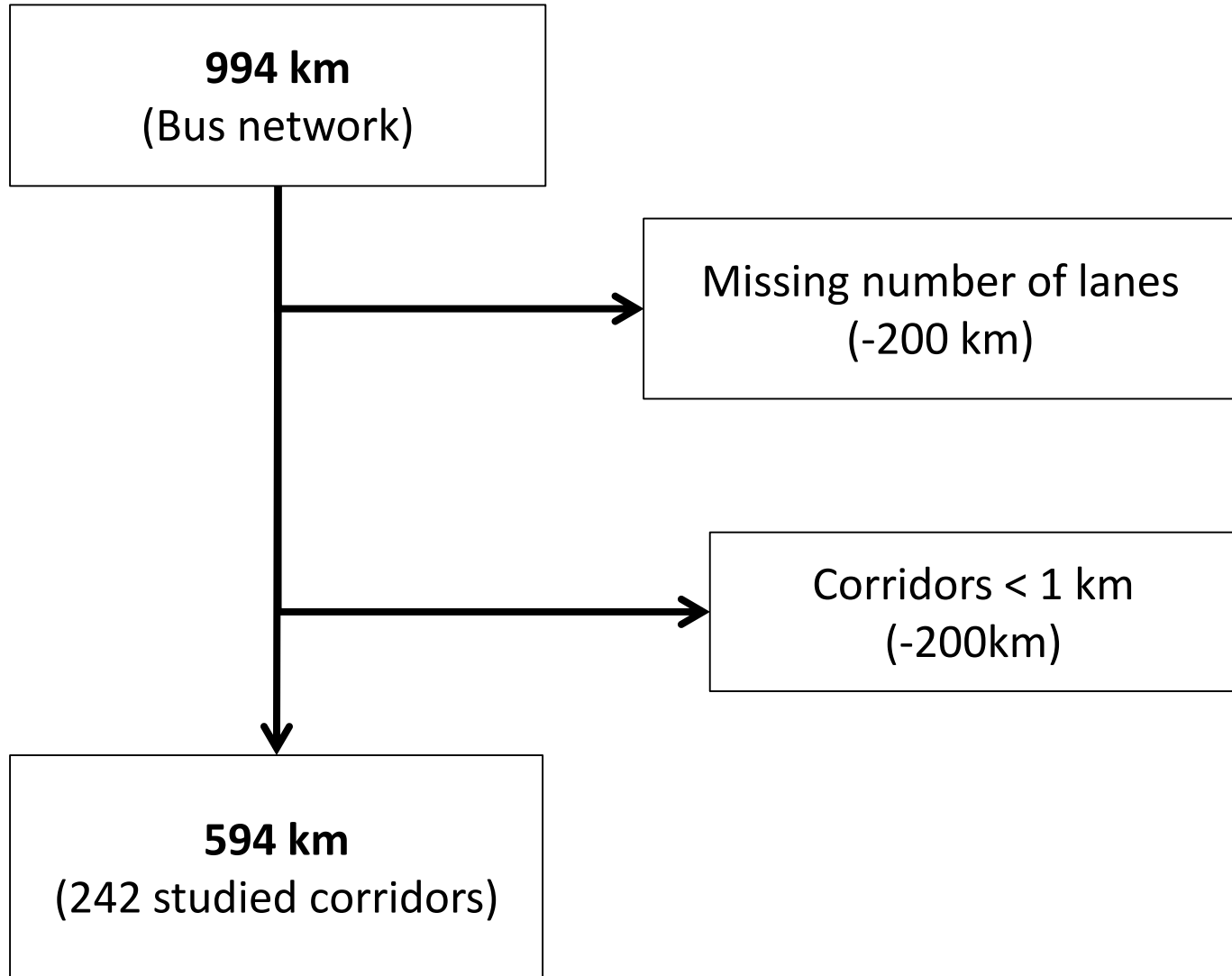
Same name and same number of lanes



Number of lanes	Σ length (km)
3 (green)	0.73
4 (purple)	0.20
5+ (orange)	1.42



Corridor selection



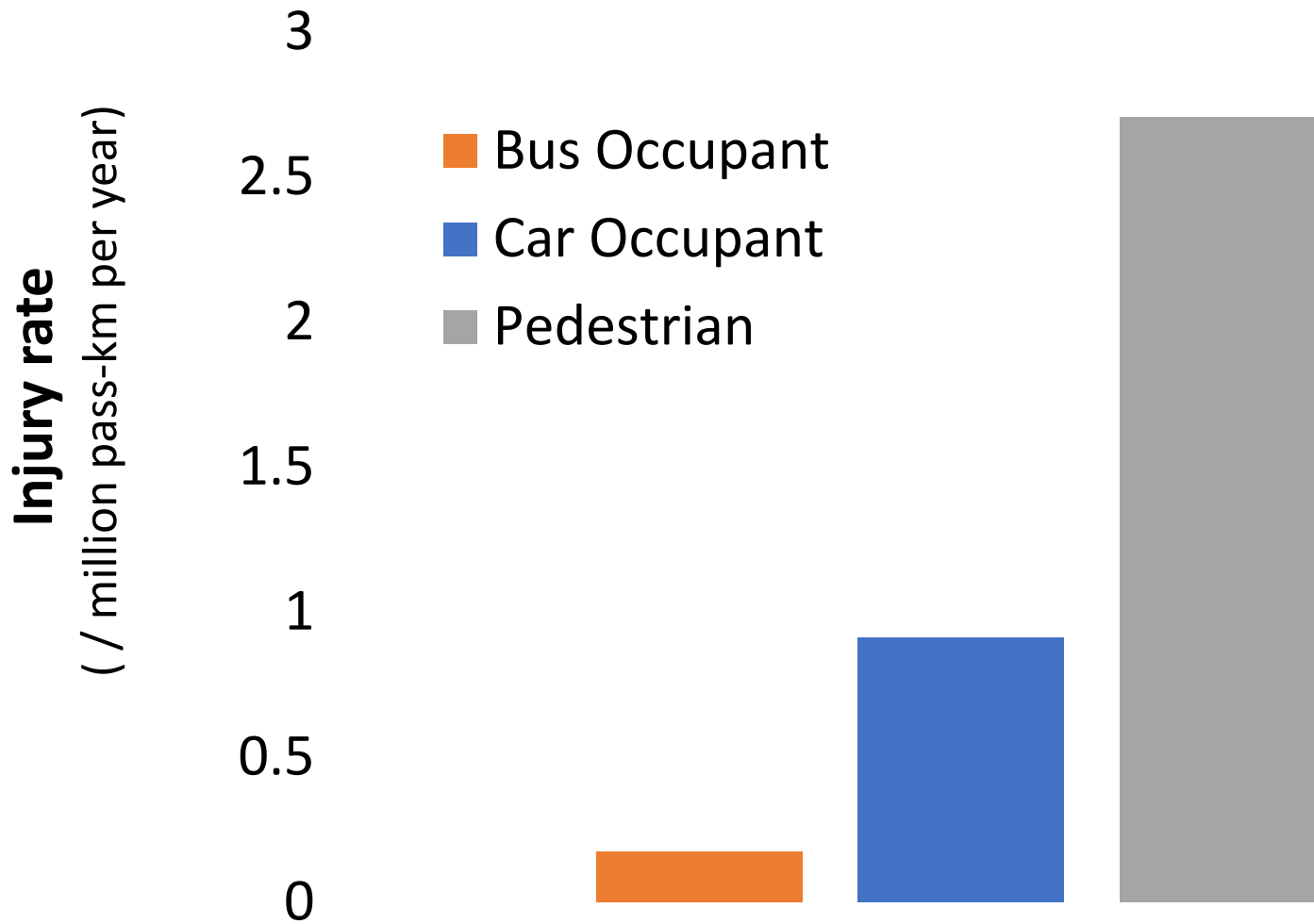
Analysis: negative binomial regression

		Car and bus occupants	Pedestrians
		Corridors*	Intersections
Injuries	Number of injuries / km	X	
	Number of injuries / intersection		X
Volumes	Car and bus occupants	X	
	Cars and buses		X
	Pedestrians		X
Infrastructure	Number of lanes (2, 3-4, 5+)	X	
	Reserved bus lane (Y/N)	X	
	Density of intersections	X	
	Number of approaches (3 ou 4+)		X

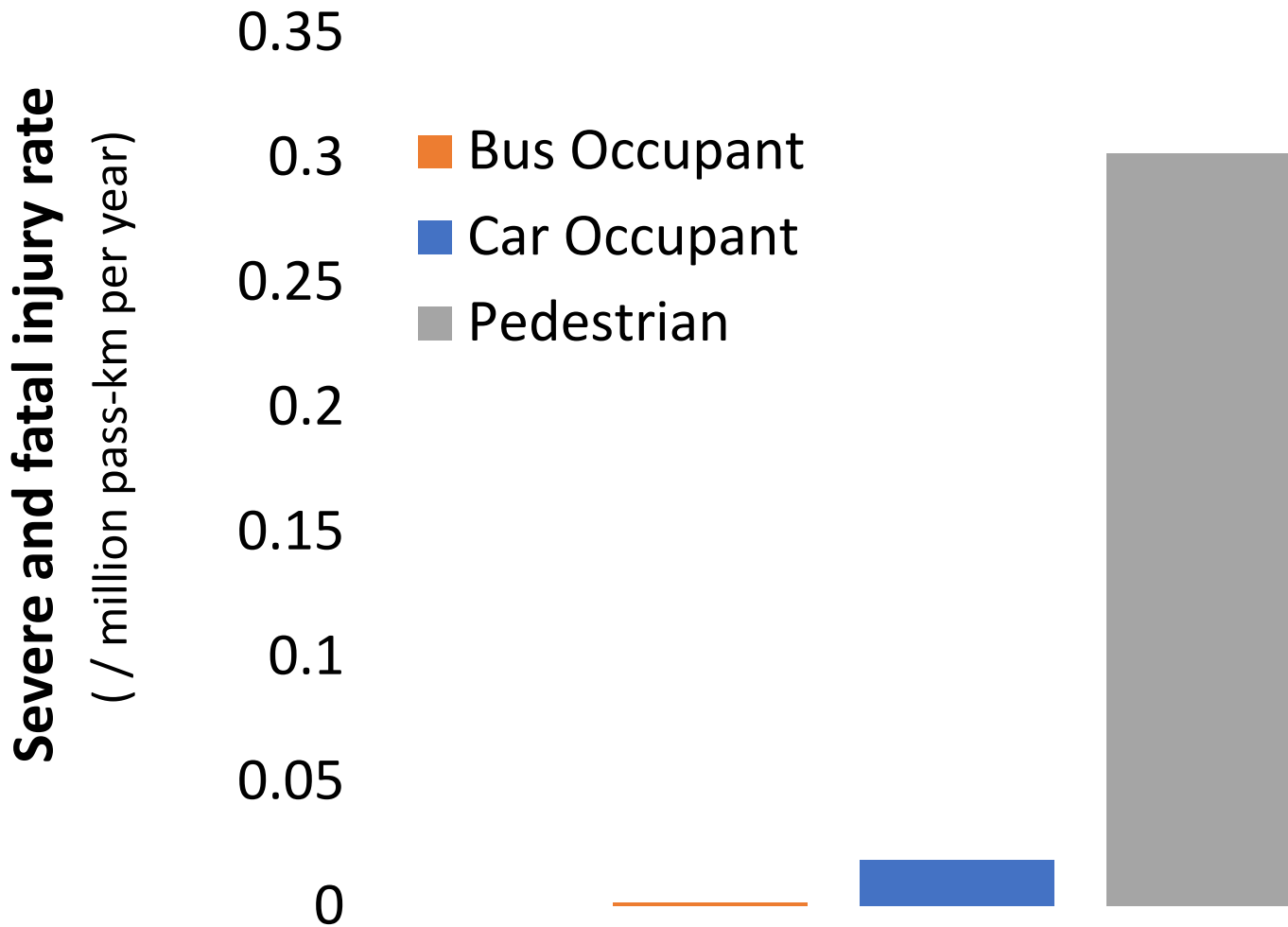
* Corridors include road segments and intersections

RESULTS

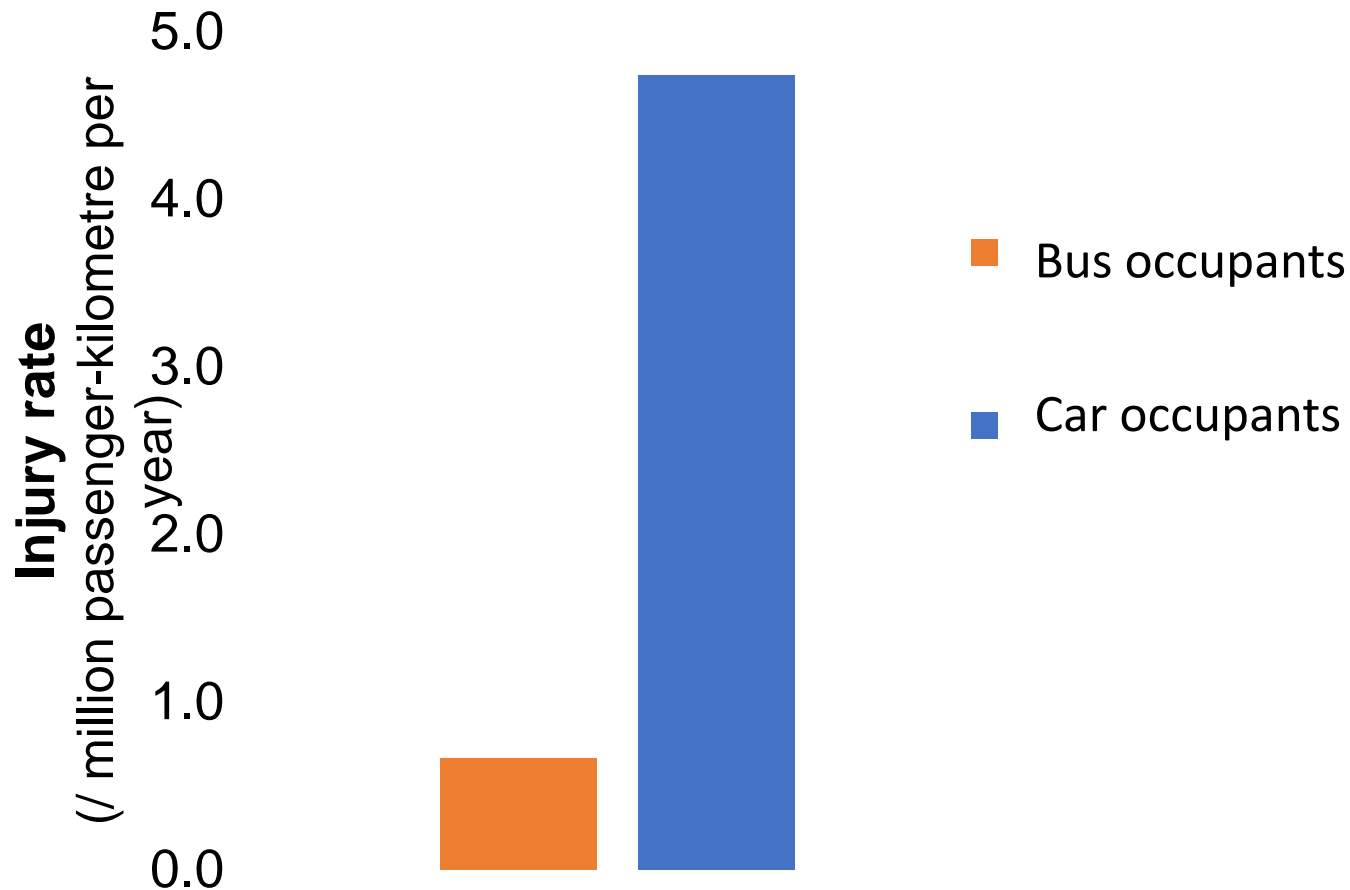
Injuries per passenger-kilometre (entire region)



Severe and fatal injuries per passenger-kilometre (entire region)



Probability of injury ... in a car versus in a bus (corridors)



Ratio of injury rate car/bus = 7.1

Traffic volume and geometry

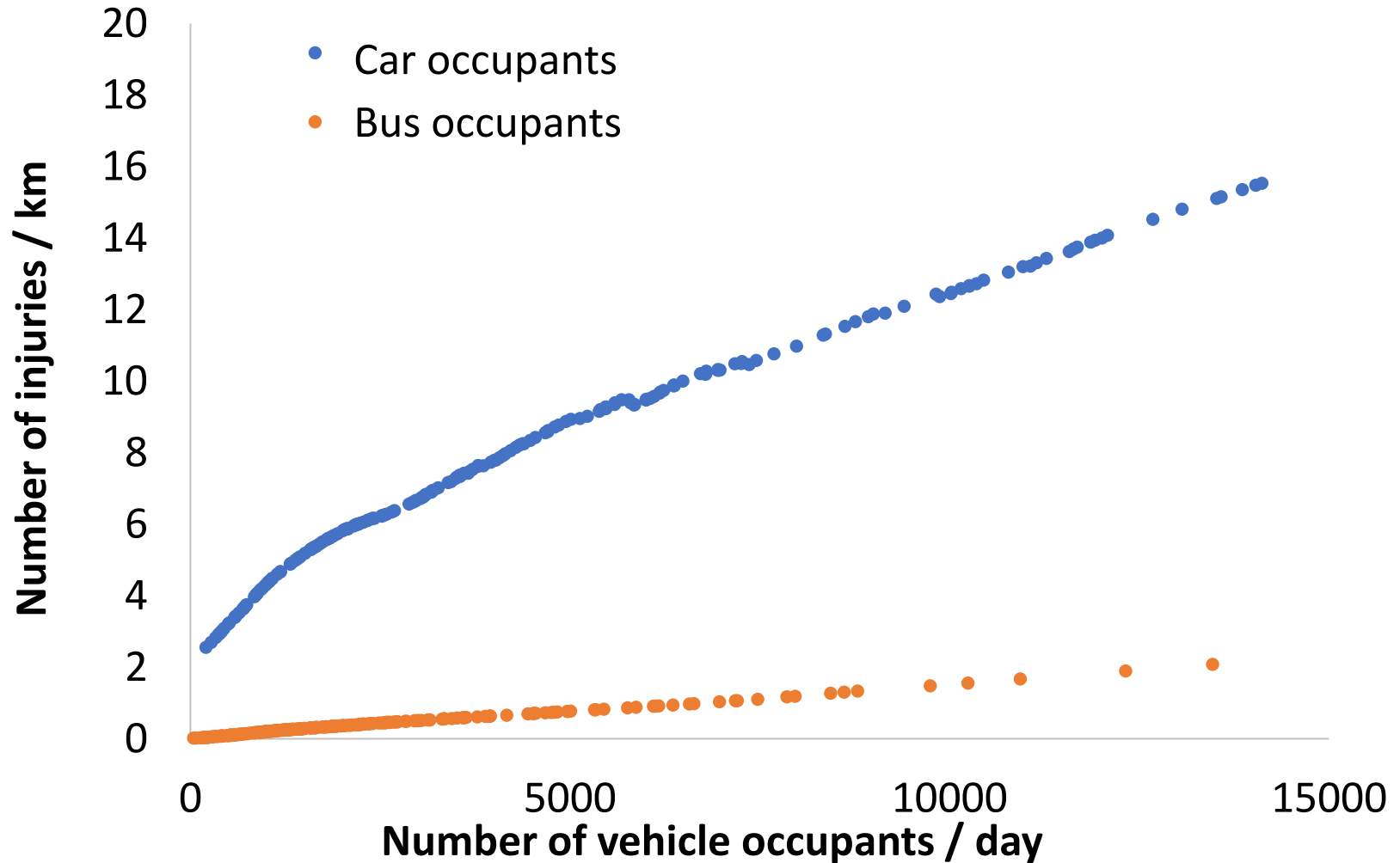
Effect on the number of injured car occupants / km

- Volume of car occupants (+ 10%) : ↑ injuries (+ 1.7%)
- Density of intersections / km (+ 1%) : ↑ injuries (+ 11%)
- Number of lanes
 - 3 or 4 lanes (vs 1 or 2) : ↑ injuries (+ 52%)
 - 5 voies ou + (vs 1 or 2) : ↑ injuries (+ 75%)

* Similar models were generated for injured bus occupants

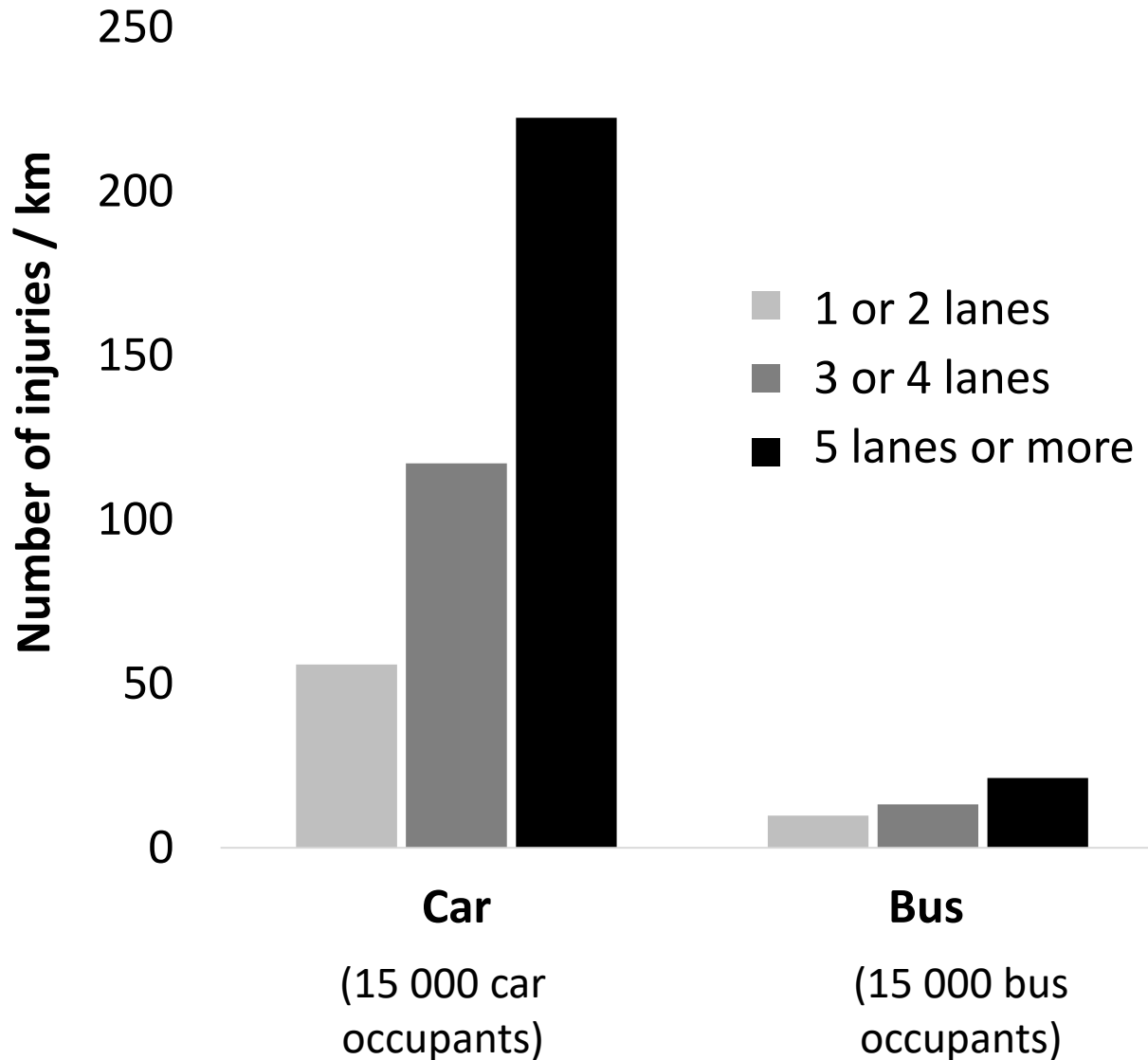
Volumes

Effect on the number of injuries / km

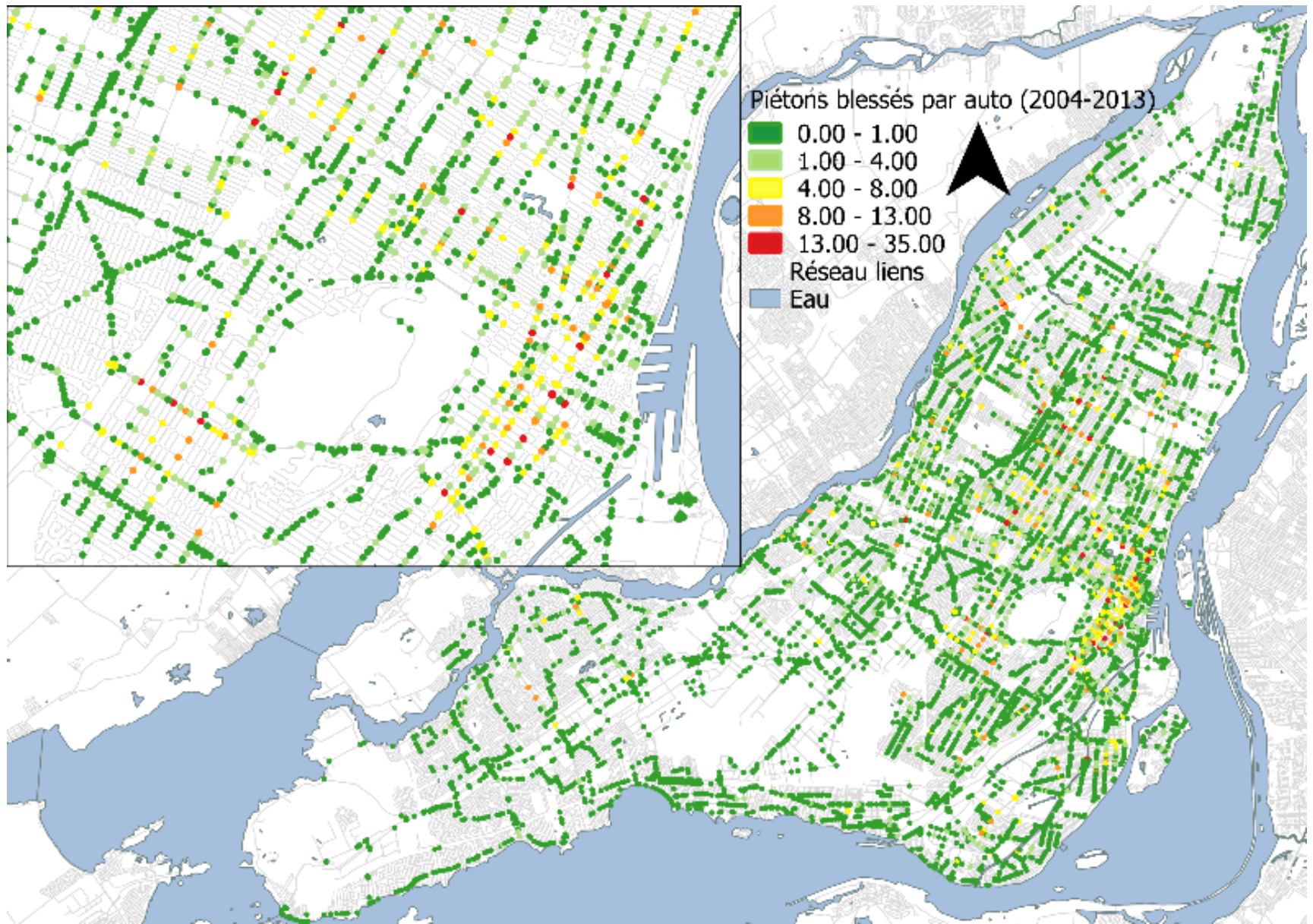


Geometry

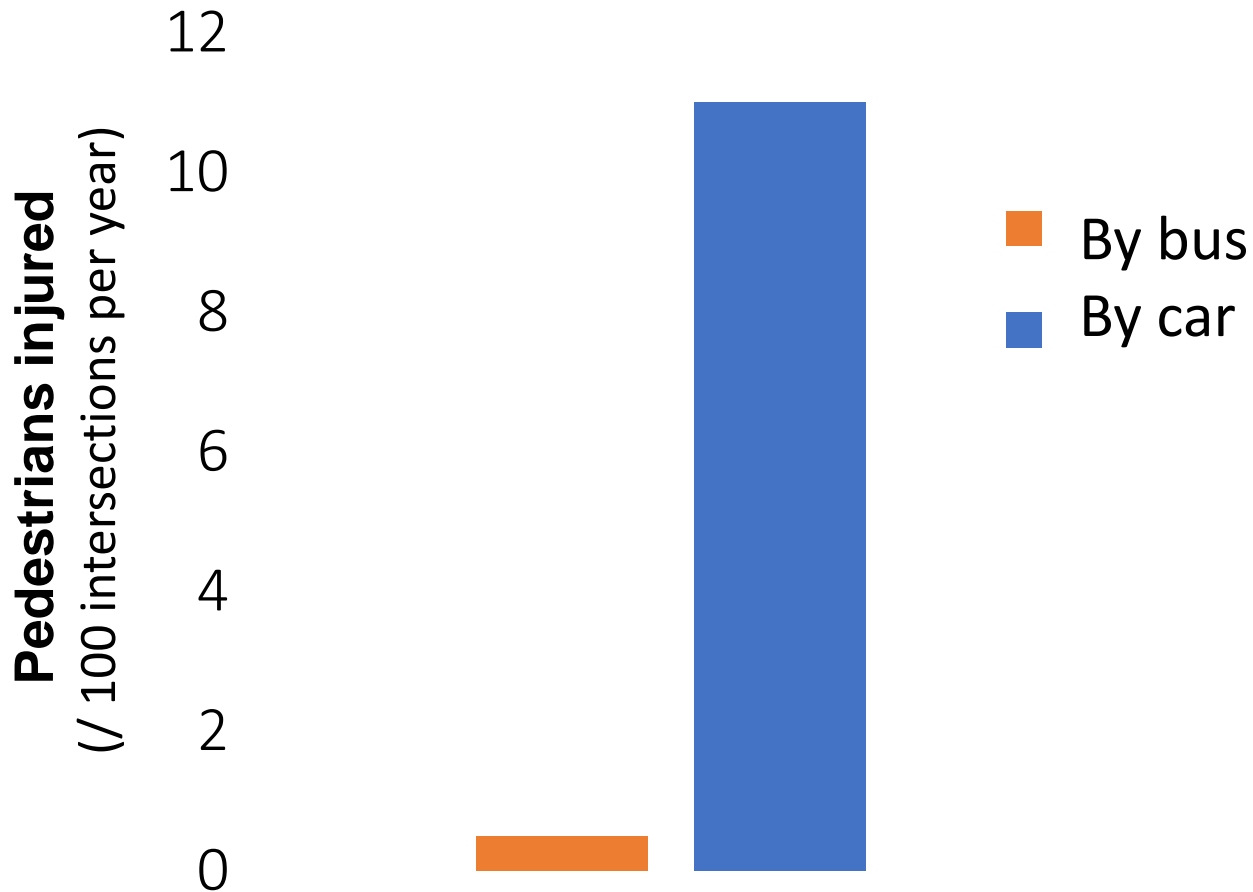
Effect on the number of injuries / km



Pedestrians injured at intersections



Pedestrians injured at intersections, Car vs. bus travel



Ratio of injuries by car/by bus = 22

Traffic volumes and geometry

Effect on the number of pedestrians injured at intersections

- Volume of cars (+ 10%) : ↑ injuries (+ 1.7%)
- Volume of pedestrians (+ 10%) : ↑ injuries (+ 7.7%)
- Number of approaches
 - 4 or + (vs. 3) : ↑ injuries (+39%)

* Similar models were generated for injured buses

Scenario

➤ Reduce number of cars by 25%

+

➤ Reduce number of lanes

- If 5 lanes or more

→ 3 or 4 lanes

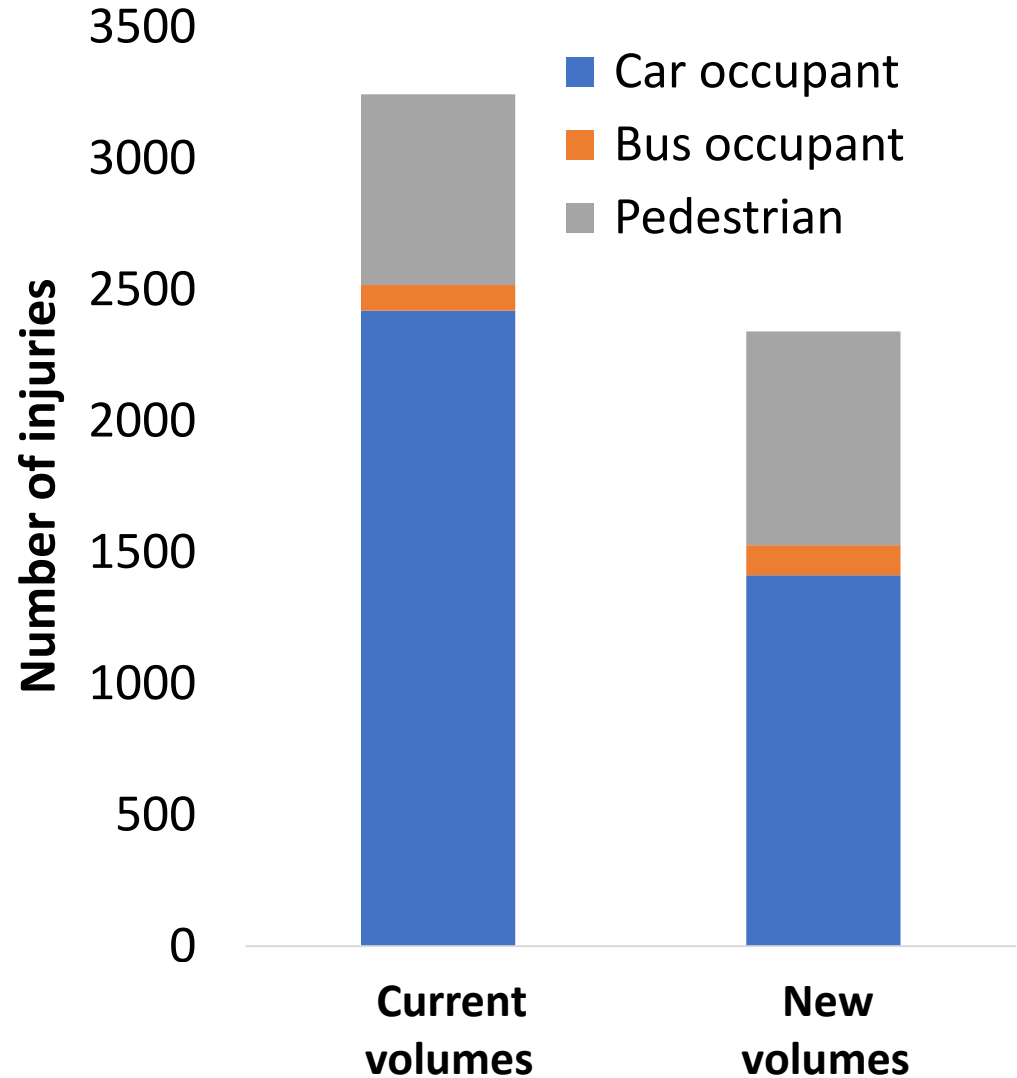
- If 3 or 4 lanes

→ 1 or 2 lanes

+

➤ Increase pedestrian volumes by 25%

Overall reduction of 28%



DISCUSSION

Principal results

➤ **Car and bus occupants injured along corridors**

- On the bus network, the probability of injury is (7x) higher for car occupants than for bus occupants
- For the same level of car and bus occupants, the probability of injury increases with the **number of lanes**
- The probability of injury increases with the density of intersections

➤ **Pedestrians injured at intersections**

- Number of pedestrians injured increases with:
 - Volume of vehicles
 - Number of pedestrians
 - Intersections with 4 approaches or more

Principal results

➤ Scenario

- Reducing number of cars and number of lanes
 - Reduces number of injuries
- Benefits persist even if the number of pedestrians increases

Strengths and limitations

➤ Strengths

- Disaggregate analysis (per corridor)
- Regression models include road geometry
- Consider pedestrian injuries associated with car and bus travel

➤ Limitations

- Incomplete bus network

Conclusion

Public transit can greatly contribute to the improvement of road safety,

- If reduce car volumes
- If reduce the number of lanes dedicated to cars

THANK YOU