Pedestrian and Cyclist Death Rates: a Comparison between several Major Cities

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1   Introduction

Working Paper. This is not the final report.

During the Summer of 2016 in Toronto, more than 1,000 pedestrians and cyclists were struck by automobiles. This finding grabbed headlines because, at a rate of a dozen collisions per day, the number sounds shockingly high. In the previous year, Toronto saw more deaths by motor vehicle than by gun, again shocking the city with a death toll that *seemed* high.

But is the automobile death toll *unreasonably* high? After all, isn't a bustling city with millions of trips per day bound to lead to a few collisions, if only by accident? Furthermore, how do we know Toronto even has a problem in the first place? It's possible comparable cities have similar or even worse fatality rates. From a cynical viewpoint, it's possible these deaths are an inevitable cost of civic progress.

The question of pedestrian and cyclist safety is particularly important right now. There is a widely shared "gut feeling" that Toronto streets are becoming more chaotic, but there is uncertainty about the fundamental facts of the debate. This report seeks to provide a comparison between Toronto and other cities on the basis of pedestrian and cyclist fatalities. By looking at Toronto in the context of other major cities across North America and Europe, it will be possible to determine whether Toronto is relatively safe or not.

To perform this comparison, yearly pedestrian and cyclist fatality data were collected from seven major cities. The historical results were plotted and trend lines were fitted to the data, permitting a projection into the near future. The results of this report suggest that Toronto has become more dangerous to pedestrians and cyclists during the previous seven years. During the same time period, several other cities in the study exhibited safety improvements. If these trends continue for another 3 years, Toronto will become significantly more dangerous to pedestrians and cyclists than every other city in the study.

2   Methods

Toronto pedestrian and cyclist fatality data were collected for the 7-year period of 2009-2015. Similar data were collected for comparable cities. The cities in this study are:

- Amsterdam
- Chicago
- Copenhagen
- London
- Los Angeles
- New York City
- Toronto

The four US and Canadian cities were selected because they are the largest cities in those countries. The three European cities were chosen for other reasons. London was selected for its political relationship to Canada, but otherwise this choice was largely convenient. Finally, Amsterdam and Copenhagen were selected for their good transit safety reputations, which would permit a baseline comparison.

2.1   Data Collection

The following data fields were collected for each year and city in this study:

- city
- metro area population
- year
- number of pedestrian fatalities in each year
- number of cyclist fatalities in each year

In addition to raw fields, citation data were collected for each observation. These data are stored as Comma Separated Values, and the resulting CSV file is available for download.

2.2   Population and Road Use

Both city population and metro area population were collected for consideration. Population estimates provided by Wikipedia were held constant across all years for each city. City populations ranged from 0.6 million to 8.7 million (14.5:1), whereas metro area populations ranged from 2.0 million to 23.7 million (11.85:1). Between these population measures, the metro area population results in a less extreme ratio between cities.

It is a common pattern for people to commute into cities during the workday even though they do not live in the city. Larger metro areas will generate more trips, so a population measure that includes outlying areas will be a better proxy for actual traffic and, therefore, opportunities for automobile, pedestrian, and cyclist interactions. For these reasons, Metro area population is used as an indicator of road use. Yearly *per capita* fatality rates were calculated based on Metro Area populations, and are reported as rates per 100,000 residents throughout the results.

2.3   Data Collection Challenges

The task of data collection presented several challenges: 1) language translation; 2) local traffic safety data reporting policies; and 3) length of historical record.

The issue of language can be overcome with automated translation software. Traffic safety data varies across international jurisdictions due to subtle differences in the definition of key terms like "collision" and "cyclist." Another factor affecting the traffic safety record is the agency responsible for recording that data. In the case of the City of Amsterdam, this responsibility shifted from the police to the health system, resulting in a "hiccup" in the available data during the transition. In other cases, city-wide traffic mortality data were not stratified by transit method to permit the differentiation of cyclists from pedestrians. In yet other cases, there may have simply been no political will to record pedestrian and cyclist fatality data until recently. Together, these factors limit the number of years of data available for various cities.

2.4   Reproducibility

The R Statistical Environment was used for analysis and plotting. All scripts used to generate this report are available online: https://github.com/iandennismiller/road-safety/. Together with the raw data, which are available from the same source, this report may be reproduced.
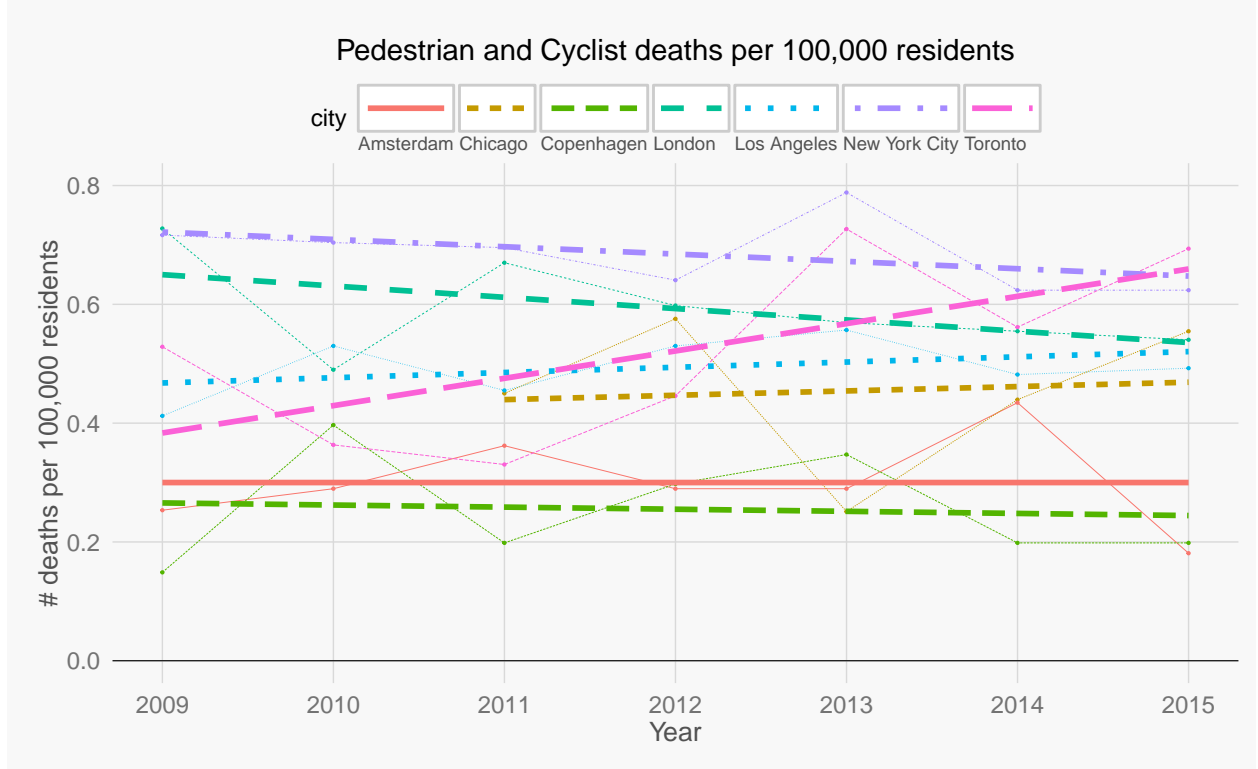
Figure 1: Pedestrian and Cyclist deaths per 100,000 Residents

3 Results

The general analytic approach for this work is to visualize the historical record and fit trend lines. This approach permits the basic exploration of past years as well as rudimentary predictions for the near future. Because there are many measurements for each city, it is possible to isolate variance both within and between cities. When this variance is visualized as 95% confidence interval bands, cities may be directly compared to determine the statistical significance of any differences.

3.1 Historical trends

The rate of pedestrian and cyclist fatalities per 100,000 residents are plotted in Figure 1. The trend line for each city is fit to the raw values with a simple least squared error method.

3.2 Near Future trends

A more sophisticated model, in which each city

fixed = fatalities_per_capita ~ 1 + year_offset, random = ~ 1 + year_offset | city,

3.3 Direct Comparison: NYC and Toronto

95% confidence intervals have been added around the trend lines, enabling direct comparisons between cities.
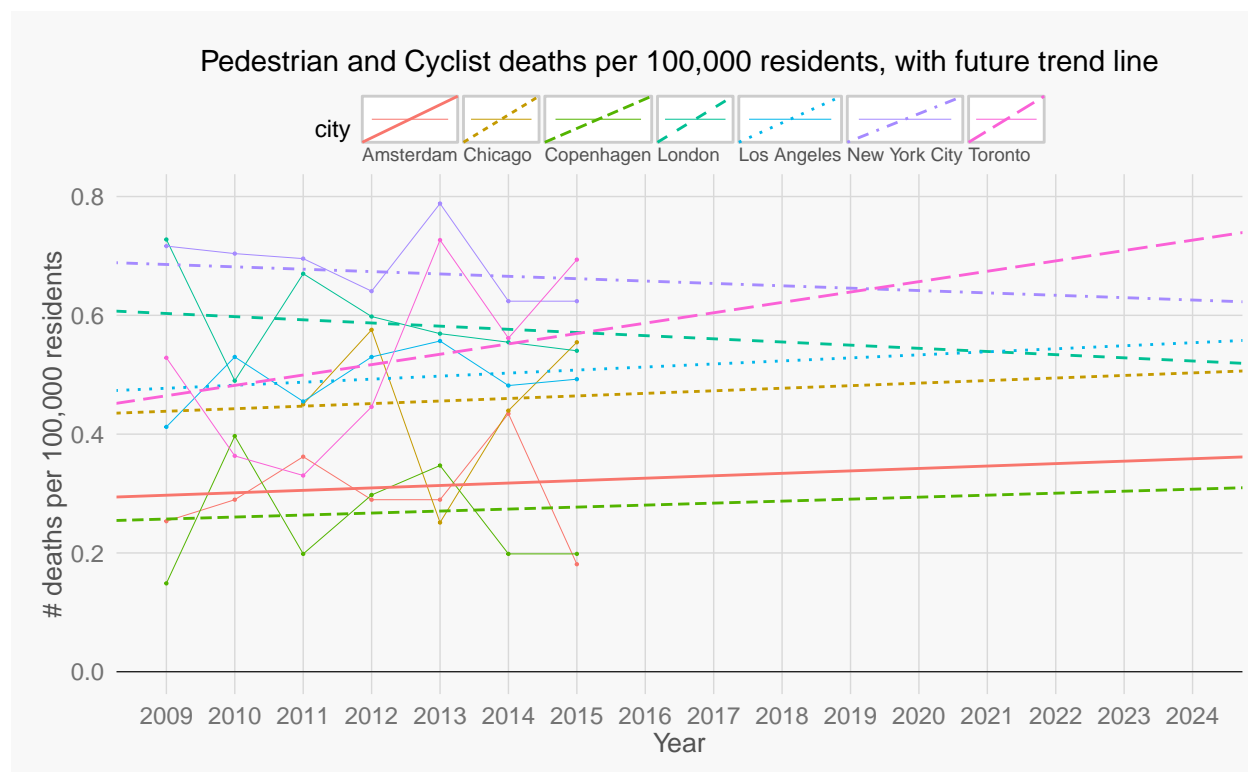
Figure 2: A

In 2009, New York City had the greatest pedestrian and cyclist fatality rate among all cities included in the study. Toronto caught up to New York City in 2013, and by 2015 actually surpasses New York City in absolute terms - although this difference is not statistically significant.

If the trend lines are extended into the near future, we would expect to find that Toronto will become significantly more dangerous than New York City for pedestrians and cyclists. As New York City was previously the most dangerous, Toronto is therefore trending to become most dangerous among the 7 cities studied.

In the case of New York City, we see that Toronto begins comparatively safer but quickly catches up. Although Toronto was significantly safer in 2009, the difference between the two cities becomes non-significant by 2013, and by 2015 Toronto actually surpasses New York in absolute terms (although the difference is still not significant).

The 7-year trend for New York is negative, whereas the 7-year trend for Toronto is positive. If these trends are extended just 2 or 3 years into the future, then we would expect to find that Toronto has become significantly more dangerous than New York City.

3.4 Direct Comparison: Amsterdam and Toronto

Interestingly, in 2009 pedestrian and cyclist fatalities in Toronto were not significantly different from Amsterdam's rates. However, by 2011 Toronto did have significantly more fatalities and the gap appears to be widening. In contrast, Amsterdam appears to have a relatively constant rate of pedestrian and cyclist fatalities per capita.
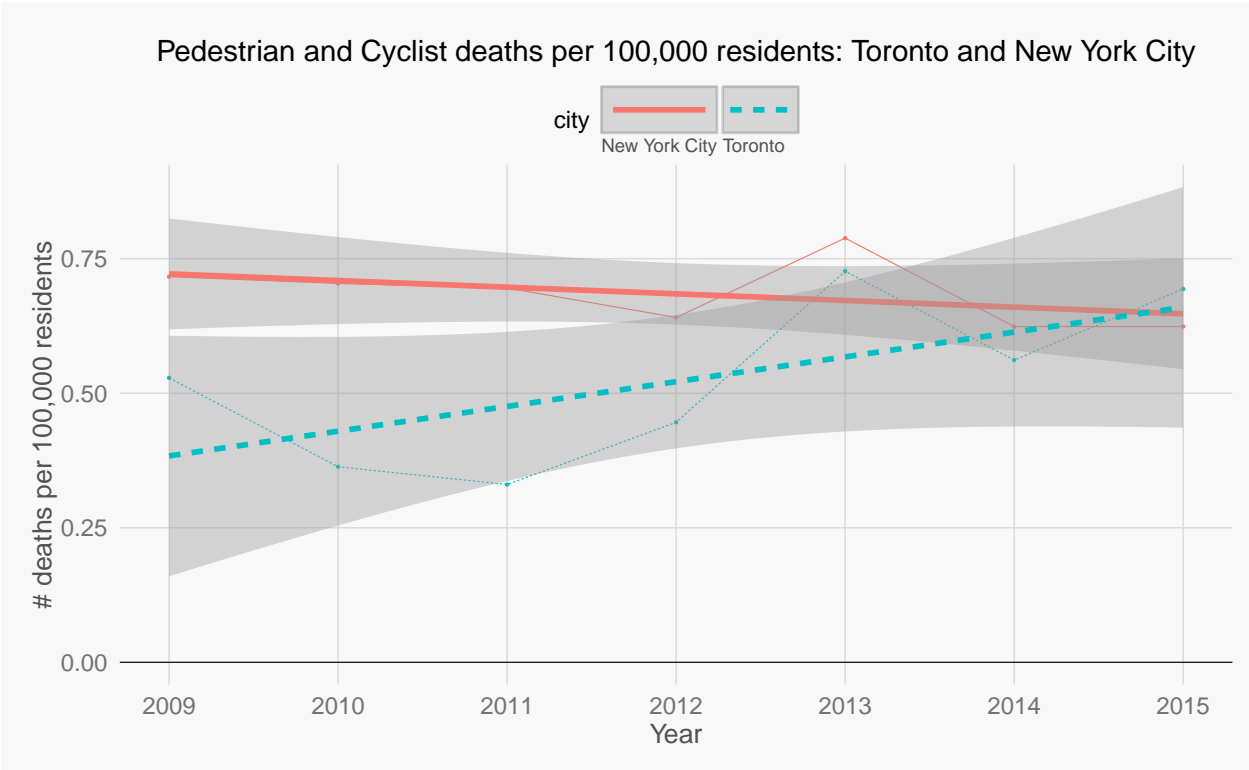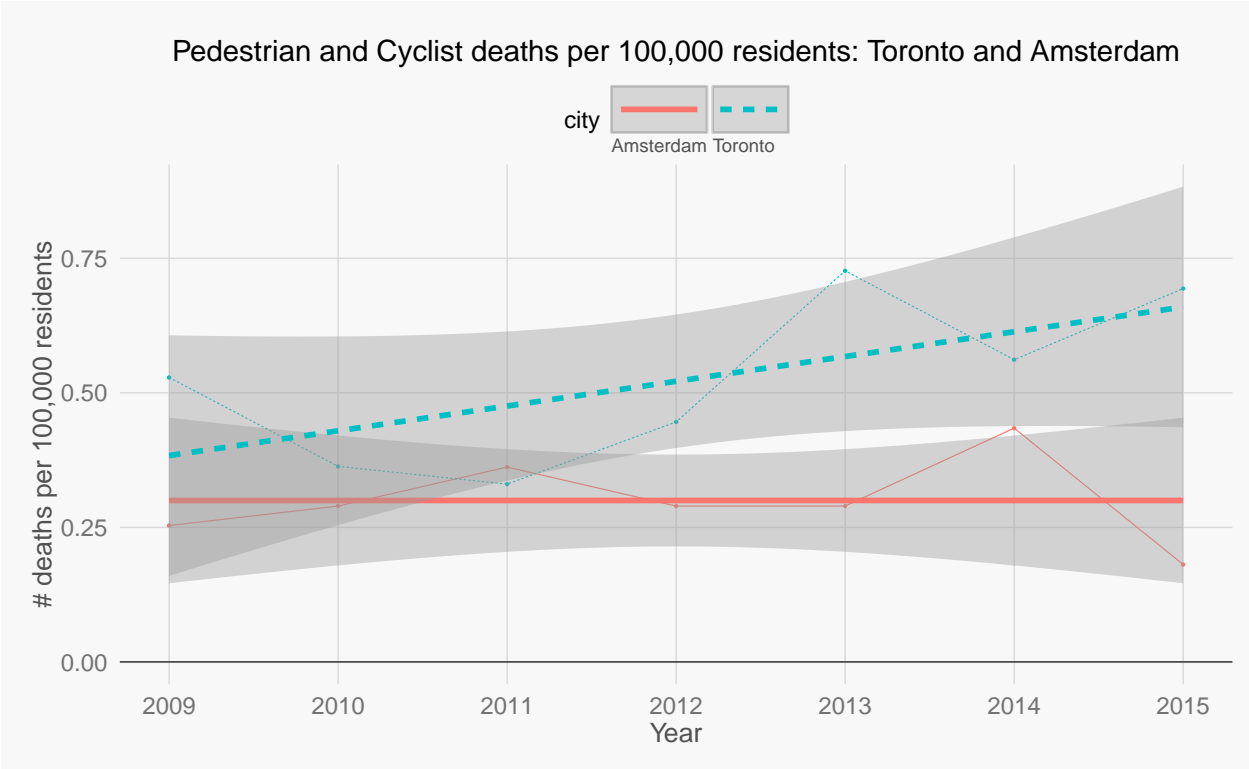
Figure 3: Caption as

Figure 4: Caption er

4 Discussion

This analysis suggests that in 2009 Toronto was one of the safer cities in the study. However, by 2015 Toronto had risen to the highest number of pedestrian and cyclist fatalities per capita among the 7 cities studied, and is trending to become significantly more dangerous than all other cities studied.

Although this report was originally motivated by conditions in the city of Toronto, the results can be used to tell a story about each city.

It is worth considering what London is doing, because it is trending to become safer than every North American city in the study. Although this study cannot answer this question, it is worth considering whether any policies enacted by London might be responsible for the drop in fatality rates. For example, London has adopted . . .

5 Conclusion

- There are risks inherint in following trends
- Likewise, there are risks in ignoring them
- Toronto is on track to become more dangerous

6 Appendix

6.1 Trend lines

	intercept	slope
Amsterdam	0.2971794	0.0040929
Chicago	0.4385113	0.0043063
Copenhagen	0.2571088	0.0033455
London	0.6031259	-0.0053331
Los Angeles	0.4772473	0.0051122
New York City	0.6856390	-0.0039906
Toronto	0.4646308	0.0174627

6.2 License