Statistical Forecasting of Traffic-Related Pedestrian Fatalities in the United States

Jeff Pascua, B.Eng

Presentation prepared for:
Pedestrian Safety Session of the 2018 CARSP Conference, Victoria, B.C.
Overview

Introduction
- Background
- Objectives

Previous Work

Methodology
- Fatality Data
- Exposure Considerations
- Disaggregation
- Model Forecast Structure

Model Forecasts

Conclusions & Future Work
Pedestrians are the most vulnerable of all road users.

Figure 1: Annual U.S. Fatalities by Person Type (1994-2015).

Source: NHTSA Fatality Analysis Reporting System (FARS) [1]
Pedestrian activity appears to be on the rise.

~ 20 billion walk trips in 1983.

~ 40 billion walk trips in 2009.

Figure 2: Annual U.S. pedestrian travel trends (1977-2009) with linear interpolations and extrapolations.

Source: U.S. DOT FHWA NHTS [2]
What will pedestrian safety look like in the future?

FHWA’s *Strategic Agenda for Pedestrian and Bicycle Transportation* [3]:

1. Targets to increase AT mode share:

   "Increase the percentage of short trips represented by bicycle and walking from 20.1% (2009) to 30%..."
What will pedestrian safety look like in the future?

FHWA’s Strategic Agenda for Pedestrian and Bicycle Transportation [3]:

2. AT injury reduction targets:
   a) “Achieve an 80 percent reduction in pedestrian and bicycle fatalities and serious injuries in 15 years...”

AT: Active Transportation
What will pedestrian safety look like in the future?

FHWA’s Strategic Agenda for Pedestrian and Bicycle Transportation [3]:

2. AT injury reduction targets:

b) “…zero pedestrian and bicycle fatalities and serious injuries in the next 20 to 30 years.”

100% ~ 2036 - 2046
To quantitively assess long-term pedestrian safety on a national scale.

To identify at-risk pedestrian cohorts that are more susceptible to traffic-related fatality.
Previous Work

Current State of Research

• Few studies have exclusively forecasted safety of non-motorized transportation modes

• Majority of pedestrian safety literature is cross-sectional [4]

• Previous studies utilize macro-level predictor variables [5,6]

• VMT is changing among American millennials and baby-boomers [7, 8]
Previous Work
Setting Road Safety Targets

Three general approaches to establishing road safety targets [9]:

<table>
<thead>
<tr>
<th></th>
<th>Aspirational</th>
<th>Model-Based</th>
<th>Evidence-Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>relatively arbitrary</td>
<td>data-driven, reliant on assumptions</td>
<td>quantitatively-based targets</td>
</tr>
<tr>
<td></td>
<td>limited numerical justification</td>
<td>model structure dictates trend</td>
<td>accounting for recent and future trends</td>
</tr>
<tr>
<td></td>
<td>“top-down”</td>
<td>“baseline forecasts”</td>
<td>“bottom-up”</td>
</tr>
</tbody>
</table>
Methodology
Fatality Data

NHTSA FARS

- Fatality Analysis Reporting System (1975 - present)
- Census of all reported vehicle-related crashes that:
  - Are on publicly-available roadways.
  - Resulted in death of at least one motorist or non-motorist
  - Victim pronounced fatally injured within 30 days of crash.
Methodology

Exposure Considerations

- FHWA NHTS
  - National Household Travel Survey (1969 - present)
  - Sample-based inventory of American travel
    - Demographics, trip metrics, etc.
  - Representative weights for national estimates.
Methodology

Disaggregation

- classify fatality and travel data
- 12 age-sex categories
- model forecasts for cohorts marked with ★ are shown in the next section.
Methodology
Model Forecast Structure

- **SPSS CURVEFIT**
  - 11 regression models including (but not limited to):
    - Polynomials*
    - Logistic
    - Exponential / Logarithmic

- models chosen based on AIC & appropriateness
Model Forecasts
Females, Aged 5 - 15

Females, 5 - 15

\[\text{Fatality Frequency}\]

\[\text{Year}\]

\[\diamond \text{Observed}\]

\[\text{Cubic Model}\]

\[\text{Quadratic Model}\]

\[\text{Exponential Model}\]
Model Forecasts
Males, Aged 5 - 15

![Graph showing fatality frequency over years with observed, quadratic, cubic, and exponential models.](Image)
## Model Forecasts

### Females, Aged 55 - 64

<table>
<thead>
<tr>
<th>Year</th>
<th>Observed</th>
<th>Quadratic Model</th>
<th>Cubic Model</th>
<th>Exponential Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fatality Frequency**

**Year**

**CARSP 2018 – Pedestrian Safety**
Model Forecasts
Males, Aged 55 - 64
Model Forecasts

Females, 65+

Observed
Cubic Model
Quadratic Model
Exponential Model
Model Forecasts

Males, 65+

![Graph showing fatality frequency over years for Males, 65+ with observed data and model forecasts (Quadratic, Cubic, Exponential)]
Conclusions
Key Findings from Forecasts

• Child pedestrian injuries (age 5 – 15) have been consistently declining since 1975.

• Pedestrian fatalities appear to be rising for those aged 55+:

• Generally speaking, males appear to be more at risk when compared to females.

• Polynomial-based forecasts can be misleading.
Future Work
Framework Refinement

• using advanced models
• accounting for all severity levels
• rate-based metrics vs. absolute injury counts
• critical age?
• contribution of infrastructure
• quantify and incorporate safety effects of policy changes
Future Work

Implementation in Canada

- **Canada’s RSS 2025** [10] does not specify any quantitative targets.
- Potential for framework implementation at sub-macroscopic geographical units:
  - Provincial / Territorial
  - Municipal
  - etc.
Future Work
The Influence of Emerging Technologies

How a Self-Driving Uber Killed a Pedestrian in Arizona

By TROY CRIGGS and DAISUKE WAKABAYASHI  UPDATED MARCH 21, 2018

[11]
The development of an effective traffic fatality forecast would be:

collaborative  human-focused

data-driven
To improve forecast reliability, the **quantity** and **quality** of data should be improved.

Counterintuitive to want more injury data!  

Improvements in capturing travel data can be made!

The objective is to reduce injuries!  

Leveraging technology to gather “big data”!
References


Questions?

Jeff Pascua  
M.Sc Candidate  
Department of Civil Engineering  
Lakehead University  
jpascua@lakeheadu.ca

Michel Bédard, Ph.D., FGSA  
Juan Pernia, Ph.D., P. Eng  
Sacha Dubois, MPH

Thank you! Merci!