Spatial Variation in Local Road Pedestrian and Bicycle Crashes

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- Background
- Methodology
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## Background

### National Statistics for 2012

<table>
<thead>
<tr>
<th></th>
<th>Fatalities</th>
<th>Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrians</td>
<td>4,743</td>
<td>76,000</td>
</tr>
<tr>
<td>Bicyclists</td>
<td>726</td>
<td>49,000</td>
</tr>
</tbody>
</table>

Source (NHTSA, 2014).
Background
Crash experience in Tennessee

TDOT crash records: 2008-2012
On what Roads are these crashes?

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Percent of total pedestrian fatalities</th>
<th>Percent of total pedestrian injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>11.68</td>
<td>15.51</td>
</tr>
<tr>
<td>Principal Arterial-Interstate</td>
<td>11.37</td>
<td>10.25</td>
</tr>
<tr>
<td>Principal Arterial-Other Freeways</td>
<td>30.34</td>
<td>26.04</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>18.76</td>
<td>16.07</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>5.66</td>
<td>4.99</td>
</tr>
<tr>
<td>Collector</td>
<td>20.82</td>
<td>23.27</td>
</tr>
<tr>
<td>Local Road or Street</td>
<td>1.37</td>
<td>1.66</td>
</tr>
<tr>
<td>Unknown or Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rural</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural Principal Arterial-Interstate</td>
<td>3.62</td>
<td>3.88</td>
</tr>
<tr>
<td>Rural Principal Arterial-Other</td>
<td>6.63</td>
<td>4.43</td>
</tr>
<tr>
<td>Rural Minor Arterial</td>
<td>4.19</td>
<td>5.54</td>
</tr>
<tr>
<td>Rural Major Collector</td>
<td>5.05</td>
<td>4.99</td>
</tr>
<tr>
<td>Rural Minor Collector</td>
<td>1.41</td>
<td>1.66</td>
</tr>
<tr>
<td>Rural Local Road or Street</td>
<td>6.42</td>
<td>5.82</td>
</tr>
<tr>
<td>Unknown Rural</td>
<td>0.19</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Principal Arterial-Interstate</td>
<td>8.06</td>
<td>11.63</td>
</tr>
<tr>
<td>Urban Principal Arterial-Other Freeways or Expressways</td>
<td>4.74</td>
<td>5.82</td>
</tr>
<tr>
<td>Urban Other Principal Arterial</td>
<td>26.15</td>
<td>20.50</td>
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<tr>
<td>Urban Minor Arterial</td>
<td>13.71</td>
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<tr>
<td>Urban Collector</td>
<td>4.25</td>
<td>3.32</td>
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<tr>
<td>Urban Local Road or Street</td>
<td>14.40</td>
<td>17.45</td>
</tr>
<tr>
<td>Unknown Urban</td>
<td>0.21</td>
<td>1.11</td>
</tr>
</tbody>
</table>

(Source: FARS, 2008). *Note: May not add up to 100 percent as blank responses were not available for the urban and rural strata.)
Background
Policy and Funding Changes

What is 2009 US DOT Agenda?

- Creating sustainable communities through;
  - Enhancing transportation options and reducing travel times.
  - Coordinating transportation and land use planning.
  - Supporting the livability and health of neighborhoods and communities.
  - Pedestrian and Bike safety research.

(U.S. DOT, 2009)
Background
Policy and Funding Changes

Federal Pedestrian and Bicycle Funding and Total Federal Aid Highway Program Funding
Fiscal Years 1995–2008

Figure 5. Federal Pedestrian and Bicycle Funding Trends.
(Source: FHWA, 2006a).
**Background**

**Problem**

- How will communities take advantage of this funding or adjust their budgets to make better use of already available resources?

- Identification of high-risk sociodemographic groups is essential to guide appropriate allocation of safety improvement resources.
Methodology

Study Area - Shelby County

- **Tennessee State**
  - 2008-2012: 5,845 pedestrian crashes

- **Shelby County, TN**
  - 2008-2012: 1,809 pedestrian crashes
  - Pop: 927,644 (2010 Census)
  - Geographical Area: 784 mi²
Methodology

Data

Crash data
- Obtained from TDOT traffic crash database
- 5 years 2008-2012 data: 5,845 crash records
- Filtered out 492 local road crashes

Socioeconomic data
- US census bureau, 2006-2010 America Community Survey
- Block group data for Tennessee
- Income, Car ownership, poverty status, Transport mode to work

Demographic data
- US census bureau, 2006-2010 America Community Survey
- Block group data for Tennessee
- Population counts, age, race
Methodology
Poisson distribution and Chi Square Statistic

• **Poisson distribution**: Test if crashes create a clustered pattern

• Observed frequency Vs. Expected frequency

\[ p(x) = \frac{e^{-\mu} \mu^x}{x!} \]

• **Chi Square**: Test goodness of fit of data to a Poisson distribution

\[ \chi^2 = \sum_1^k \frac{(f_o-f_e)^2}{f_e} \]
Methodology

Cluster identification- GIS Kernel density

\[ f(x, y) = \frac{1}{nh^2} \sum_{i=1}^{n} K \left( \frac{d_i}{h} \right) \]

- \( f(x, y) \): density estimate at the location \((x, y)\),
- \( n \): number of observations,
- \( h \): bandwidth or search radius,
- \( K \): kernel function,
- \( d_i \): distance between the location \((x, y)\) and the location of the \(i^{th}\) observation
## Results and Discussion

### Poisson probability

<table>
<thead>
<tr>
<th>Number of crashes (x)</th>
<th>Observed No. of block groups ($f_0$)</th>
<th>Total crashes</th>
<th>Probability $P(x)$</th>
<th>Expected No. of block groups ($f_e$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3,724</td>
<td>0</td>
<td>0.888</td>
<td>3,661.21</td>
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<tr>
<td>1</td>
<td>328</td>
<td>328</td>
<td>0.106</td>
<td>436.68</td>
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<tr>
<td>2</td>
<td>58</td>
<td>116</td>
<td>0.006</td>
<td>26.04</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>36</td>
<td>0.000</td>
<td>1.04</td>
</tr>
<tr>
<td>4 or more</td>
<td>3</td>
<td>12</td>
<td>0.000</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td><strong>4,125</strong></td>
<td><strong>492</strong></td>
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</table>
Results and Discussion

Probability curve
## Results and Discussion

### Chi Square Test goodness of fit test

<table>
<thead>
<tr>
<th>x</th>
<th>f_o</th>
<th>f_e</th>
<th>f_o-f_e</th>
<th>(f_o-f_e)^2</th>
<th>(f_o-f_e)^2/f_e</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3724</td>
<td>3661.21</td>
<td>62.791</td>
<td>3942.77</td>
<td>1.08</td>
</tr>
<tr>
<td>1</td>
<td>328</td>
<td>436.68</td>
<td>-108.682</td>
<td>11811.85</td>
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<tr>
<td>2</td>
<td>58</td>
<td>26.04</td>
<td>31.958</td>
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<td>3</td>
<td>12</td>
<td>1.04</td>
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<td>116.12</td>
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<tr>
<td>4 or more</td>
<td>3</td>
<td>0.03</td>
<td>2.969</td>
<td>8.82</td>
<td>285.55</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>469.01</td>
</tr>
</tbody>
</table>
Results and Discussion

Chi Square Test goodness of fit test

• The critical value of $\chi^2$ with 3 df at 0.05 level of significance, is **7.815** (From the Table)

• The decision rule is;

• Reject $H_0$ if $\chi^2 > $ Critical value; otherwise do not reject $H_0$.

• since $\chi^2 = 469.01 > 7.815$, the decision is to reject $H_0$. 
Results and Discussion

Chi Square Test goodness of fit test
Results and Discussion

Cluster Identification - Kernel Density

Legend
Crash density
- 0 - 17
- 18 - 34
- 35 - 50
- Block groups
- County Boundary

Miles
Results and Discussion

Identification of associated factors
Results and Discussion

Identification of associated factors
Results and Discussion

Identification of associated factors

[Map showing crash density and households at or above poverty level]
Results and Discussion

Identification of associated factors
Summary and Conclusions

• Local road pedestrian crashes were analyzed using statistics and GIS.

• Identification of crash clusters was conducted at block group level using GIS kernel density tool.

• Findings help to explain why pedestrian crashes are more frequent with certain sociodemographic groups than with others.

• These results are useful to guide traffic planning process and can assist local decision-makers to develop effective countermeasures to reduce pedestrian crashes.
Thank you!

Acknowledgment
This work is supported by US Department of Transportation