Higher-than-Usual Monthly Temperatures are Associated with Pedestrian Crashes

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Pedestrian Fatalities

• Pedestrian deaths at 28-year high, account for 16 percent of traffic fatalities  
  – LeBeau (2019, Feb 28)
Minnesota Pedestrian Fatalities

• String of pedestrian deaths in Minnesota in January 2019

January Weather

• January was unusually warm for Minnesota in 2019
• Is there a relationship?
Risk Factors to Pedestrian Crashes

• Dai (2012) – Georgia
  – Personal Factors
    • Age, Intoxication, Gender
  – Environmental Factors
    • Darkness / Night
    • Weekend

• Ha & Thill (2011) – Buffalo, New York
  • Traffic exposure
  • Population density
  • Areas with less SES / affluence

Ambient Temperature and Safety

• Exposure effect?

• Routine activity theory
  • (Cohen & Felson, 1979)
    – Activities within social groups change over time, increased traveling in public spaces during higher temperatures

• High temperature is associated with aggression and impulsive behavior
  – Primes aggression and is distracting/irritating
    • (Anderson & Bushman, 2002)
  – Demonstrated for individuals and small groups
    • (Craig et al., 2016; 2019)
Method

- Publicly available data
  - Minnesota Department of Natural Resources
    - Monthly temperature averages statewide since 1895
  - Minnesota Department of Public Safety
    - Pedestrian fatalities and injuries since 2004

Measurements

- Count of pedestrian injuries and fatalities per month since 2004
- Monthly average temperature in Fahrenheit across the state for each year since 2004
- Measurement of unusual temperature deviation
  - Subtracting the average temperature for a specific month (e.g., January of 2014) from the average temperature for that month across the last 124 years (e.g., January from 1895-2019)
Results

• Pedestrian Injury Count

<table>
<thead>
<tr>
<th>Table 1. Pedestrian injury count simultaneous regression</th>
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</thead>
<tbody>
<tr>
<td>Ped Injury Count</td>
</tr>
<tr>
<td>R²          Beta  p-value</td>
</tr>
<tr>
<td>Overall Model 0.247 &lt;.001</td>
</tr>
<tr>
<td>Year        0.068 .322</td>
</tr>
<tr>
<td>Season      0.475 &lt;.001</td>
</tr>
<tr>
<td>Temperature (Fahrenheit) 0.330 &lt;.001</td>
</tr>
<tr>
<td>Temperature Change (Fahrenheit) 0.241 &lt;.001</td>
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</tbody>
</table>

• Pedestrian Fatal Count

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<tr>
<td>Ped Fatal Count</td>
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<td>R²          Beta  p-value</td>
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<tr>
<td>Overall Model 0.191 &lt;.001</td>
</tr>
<tr>
<td>Year        0.050 .475</td>
</tr>
<tr>
<td>Season      0.324 &lt;.001</td>
</tr>
<tr>
<td>Temperature (Fahrenheit) 0.273 .002</td>
</tr>
<tr>
<td>Temperature Change (Fahrenheit) 0.291 &lt;.001</td>
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</tbody>
</table>
Results - Season

Estimated Marginal Means of Injury

Estimated Marginal Means of Fatals

Results - Temperature
Results – Temperature Change

- Main effect of season
  - Fall season has higher rate of pedestrian crashes
- Main effect of temperature
  - Higher temperatures in general are associated with higher pedestrian crash rate
- Main effect of temperature change
  - Higher temperatures than the average are associated with higher pedestrian crash rates

Summary

- Main effect of season
  - Fall season has higher rate of pedestrian crashes
- Main effect of temperature
  - Higher temperatures in general are associated with higher pedestrian crash rate
- Main effect of temperature change
  - Higher temperatures than the average are associated with higher pedestrian crash rates
Why Would This Happen?

• Expectancy
• Cold weather protective effect
  – Exposure
• Psychological
  – However, aggression/impulse effect more likely at higher temperatures, not lower
• Use of pedestrian spaces change

• Potential interactions with other risk factors?

Limitations

• Results are specific to Minnesota
  – Needs to be replicated in other states/countries
• Scores are averaged statewide
  – Could dilute the real size of the effect
• Deviation calculation uses century average
  – Less sensitive to changing trends
• Direction of relationship untested
  – Potential third variable problem
Interventions?

• Weather forecasting for warmer days
• Public outreach / education
  – Improve expectancy
• Engineering at high risk areas
  – In-street signs
  – Potential diffusion effect
  • Morris, Craig, and Van Houten (2019)

References

QUESTIONS?