Childhood Asthma and Air Quality in Louisville, Kentucky

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Asthma
- Asthma one of the most common serious chronic diseases of childhood
- Inflamed and constricted airways → breathing difficulties
- Coughing, shortness of breath, wheezing, tightness in the chest

Asthma Triggers
- Dust mites
- Molds
- Cockroaches
- Pet dander
- Secondhand smoke
- Ozone and particulate matter
- Leaf mold (alternaria, cladosporium)

Asthma in Louisville: Recent Studies
- Strong spatial patterns and seasonal variations
- Jones et al. (2004): highest rates in NW Louisville
- Louisville Metro Housing Coalition (2005): same pattern
- Differs from statewide seasonal pattern of winter peak, followed by fall
- Lee (2006): precipitation (R=0.28), PM$_{2.5}$ (R=0.32)
- Northwestern Louisville: high African-American population, high poverty rates → environmental justice concerns

Study Goal
- Use GIS and statistical analysis to examine air quality and asthma occurrence among urban children in Louisville.

Asthma
- Third leading diagnosis for hospitalization among children
- In 2010, one in 11 U.S. children had asthma (7 million, 9%)
- 12% increase from 2001-2009 [all ages]
- Kentucky rates (2009 Asthma Surveillance Report)
  - 10.6% < 11 years, 13.6% middle school, 11.8% high school
  - Rates for African American high school students double those for whites
  - Prevalence highest in Appalachia
- Louisville one of 100 worst cities in U.S. for people with asthma
  (ranking = 53)


### Current Study
- Hospital discharge data
- 2005-2008
- Children 0-19
- Jefferson County

#### Characteristic

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number of Cases</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1078</td>
<td>58.1</td>
</tr>
<tr>
<td>Female</td>
<td>778</td>
<td>41.9</td>
</tr>
</tbody>
</table>

#### Age in Years

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of Cases</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>930</td>
<td>50.1</td>
</tr>
<tr>
<td>5-9</td>
<td>495</td>
<td>26.7</td>
</tr>
<tr>
<td>10-14</td>
<td>261</td>
<td>14.1</td>
</tr>
<tr>
<td>15-19</td>
<td>170</td>
<td>9.2</td>
</tr>
</tbody>
</table>

#### Referral source

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of Cases</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician</td>
<td>389</td>
<td>21.0</td>
</tr>
<tr>
<td>Emergency</td>
<td>1456</td>
<td>78.4</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>0.6</td>
</tr>
</tbody>
</table>

#### Insurance Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of Cases</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>452</td>
<td>24.4</td>
</tr>
<tr>
<td>Federal</td>
<td>1245</td>
<td>67.1</td>
</tr>
<tr>
<td>Other</td>
<td>159</td>
<td>8.6</td>
</tr>
</tbody>
</table>

**Total** | 1856 | 100 |

### Spatial Patterns
- Choropleth mapping (USPS Zip Codes)
- Local Index of Spatial Autocorrelation (LISA)*

*Empirical Bayes LISA option, queen's contiguity, spatial lag of 1, Moran's I = 0.5961

### Environmental Justice Issues
Disproportionate Siting vs Minority Move-In

- Shading = Census tracts greater than 50% African-American

### Socio-Economic Issues

### Data and Methods
- Seasonal Trends
  - Asthma hospitalizations for the 6 study zip codes (n=832)
  - Coded by season (solstice and equinox dates)
  - ANOVA with square-root transformation of counts
  - Tukey's least significant difference test

### Study Area*
* Six zip codes: 40203, 40210, 40211, 40212, 40215, and 40216
Data and Methods

- Air Pollutants
  - EPA criteria pollutants (CO, NO\textsubscript{2}, O\textsubscript{3}, PM\textsubscript{2.5}, SO\textsubscript{2})
  - Continuous monitoring, 1-h averages
  - PM\textsubscript{2.5} 24-h average
  - O\textsubscript{3} March 1 – October 31
  - Six chemical compounds Louisville Firearms Training Site (West Jefferson Community Task Force)
    - 1,3 butadiene, acetone, acrylonitrile, benzene, chloroform, toluene (12-day sampling frequency)
  - Bivariate correlations: average and maximum, Spearman’s rank
  - Exposure lag of 0 (same-day)

Air Pollutant Monitoring Sites

Seasonal Trends

<table>
<thead>
<tr>
<th>Year/Season</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>146</td>
<td>17.5</td>
</tr>
<tr>
<td>Spring</td>
<td>169</td>
<td>20.3</td>
</tr>
<tr>
<td>Summer</td>
<td>187</td>
<td>22.5</td>
</tr>
<tr>
<td>Fall</td>
<td>330</td>
<td>39.7</td>
</tr>
<tr>
<td>Total</td>
<td>832</td>
<td>100.0</td>
</tr>
</tbody>
</table>

p = 0.01
Greatest difference: fall vs. other seasons
No post-2005 summer trough

Air Pollutants

- All correlations with criteria pollutants negative
- Correlations with compounds negative or low
- Acrylonitrile R = 0.199
- Lack of data aggregation (daily counts)

<table>
<thead>
<tr>
<th>Pollutant/VOC</th>
<th>Sampling Frequency</th>
<th>No. Records</th>
<th>Days with cases</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,3 Butadiene</td>
<td>varied</td>
<td>54</td>
<td>24</td>
<td>-.36</td>
</tr>
<tr>
<td>Benzene</td>
<td>12 days</td>
<td>48</td>
<td>15</td>
<td>-0.90</td>
</tr>
<tr>
<td>Chloroform</td>
<td>varied</td>
<td>34</td>
<td>19</td>
<td>-1.00</td>
</tr>
<tr>
<td>Toluene</td>
<td>12 days</td>
<td>68</td>
<td>48</td>
<td>-0.69</td>
</tr>
<tr>
<td>Toluene</td>
<td>varied</td>
<td>41</td>
<td>20</td>
<td>-1.90</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>117</td>
<td>67</td>
<td>-0.30</td>
</tr>
</tbody>
</table>

Seasons vs. School Year

- Summer trough disappeared after 2005
- Asthma rates jump in mid-August
- Academic calendars for 2005-2008
- Binary coding (0 = not in school, 1 = in school)
- Accounted for summers, weekends, school holidays, teacher work days
- For all years, in-school rates higher than out-of-school rates

<table>
<thead>
<tr>
<th>Year</th>
<th>In-school Rate</th>
<th>Out-of-school Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0.9511</td>
<td>0.6712</td>
</tr>
<tr>
<td>2006</td>
<td>0.75</td>
<td>0.6775</td>
</tr>
<tr>
<td>2007</td>
<td>0.8496</td>
<td>0.5988</td>
</tr>
<tr>
<td>2008</td>
<td>0.7681</td>
<td>0.6269</td>
</tr>
<tr>
<td>All Years</td>
<td>0.8812</td>
<td>0.5391</td>
</tr>
</tbody>
</table>
Discussion and Conclusions

- Well-defined spatial and temporal patterns of childhood asthma in Louisville
- Negative correlations with criteria pollutants? Location of monitoring sites, monitoring frequency, time lag of 0
- Further investigation into higher in-school rates

Tables and Graphics from