Proximity to coal mining activity and cancer risk in Illinois: A geospatial approach

Presenter Disclosures
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No

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Objective
To determine the association between coal mining activity and cancer incidence and mortality.
– A distance-weighted exposure measure
– A coal production measure

Lung Cancer in Illinois
• Incidence rate is higher than the nation as a whole:
  – Illinois: 9.4 per 100,000
  – United States: 7.7 per 100,000
• Mortality rate is slightly higher than the nation as a whole:
  – Illinois: 4.7 per 100,000
  – United States: 4.2 per 100,000

Causes of Lung Cancer
• Active Smoking
• Radon Exposure
• Occupational Exposure
• Outdoor Air Pollution

Source: State Cancer Profiles www.statecancerprofiles.cancer.gov

10/27/2015
Coal Mining in Illinois

- Two-thirds of Illinois is underlain with coal-bearing strata
- Illinois has the 3rd largest coal reserve in the country
- Illinois is the 4th largest coal producing state
- Production has increased by 54.3% between 2001 and 2013

Data

- County-level data:
  - County-level cancer incidence and mortality rates (1987-2011) for all causes, lung, colorectal, prostate, and breast (female only)
  - Coal production (1987-2011)
  - Distance-weighted exposure
  - Variance contributions
- Socioeconomic deprivation (Anvik et al., 2013)
  - Income
  - Education
  - Employment
  - Health
  - Housing

Source: American Cancer Society, American Cancer Society, and American Cancer Society.

Coal Production Measure

- Annual coal production data obtained from the Energy Information Administration (EIA 2011)
  - Aggregated at the county level
  - Summed over the years
  - Only 27 counties had recent mining
  - Created categorical variable

Distance-Weighted Exposure Measure

- ARCGIS to create a single polygon for each of the 1,006 distinct mines in Illinois
- Calculated the distance between the center of each census tract and the center of the nearest mine
- Enables tract level populations to be considered at a county level

Cancer Incidence/mortality and mine feature by County

- Descriptive Statistics
- Spatial Statistics
- Correlations
- Stepwise Linear Regression
## Results

### Spatial Statistics
- **Univariate Morbidity**
  - Lower level of cancer incidence $\delta \approx 0.27$, $p = 0.005$, and mortality $\delta \approx 0.32$, $p = 0.046$
  - Incidence and production $\delta \approx 0.20$, $p = 0.049$
- **Spatially clustered**
  - Preliminary analysis suggested spatial variation in cancer incidence and mortality
- **Association between production and cancer incidence**
  - Preliminary analysis suggested a positive association between production and cancer incidence

### Cancer Incidence

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Production Exposure</th>
<th>Distance Exposure</th>
<th>Adjusted $\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.002</td>
<td>0.45</td>
<td>0.27</td>
</tr>
<tr>
<td>Breast</td>
<td>0.006</td>
<td>0.41</td>
<td>0.27</td>
</tr>
<tr>
<td>Prostate</td>
<td>0.002</td>
<td>0.41</td>
<td>0.27</td>
</tr>
<tr>
<td>Colorectal</td>
<td>0.003</td>
<td>0.42</td>
<td>0.27</td>
</tr>
<tr>
<td>Lung</td>
<td>0.003</td>
<td>0.42</td>
<td>0.27</td>
</tr>
</tbody>
</table>

### Cancer Mortality

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Production Exposure</th>
<th>Distance Exposure</th>
<th>Adjusted $\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.106</td>
<td>0.12</td>
<td>0.27</td>
</tr>
<tr>
<td>Breast</td>
<td>0.043</td>
<td>0.02</td>
<td>0.12</td>
</tr>
<tr>
<td>Prostate</td>
<td>0.286</td>
<td>0.02</td>
<td>0.12</td>
</tr>
<tr>
<td>Colorectal</td>
<td>0.133</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Lung</td>
<td>0.014</td>
<td>0.01</td>
<td>0.12</td>
</tr>
</tbody>
</table>

## Conclusion
- Cancer incidence and mortality are both positively correlated with the distance weighted exposure measure
- Cancer Incidence
  - Production exposure was associated with colorectal cancer
  - Distance exposure was associated with lung cancer
- Cancer Mortality
  - Production exposure was negatively associated with prostate cancer
  - Distance exposure was associated with all cancer and lung cancer

## Limitations
- Categorical coal production variable
- County level analyses
- Lack of distinction between mining features and types
- Temporal relationship between exposure/covariates and cancer incidence/mortality
- Ecological design
Future Research
- Environmental exposure to coal mining may play a role in increased cancer risk, but further research needs to be performed.

Questions???
Thank you for your attention.

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