Impact of ambient fine particulate matter carbon measurement methods on observed associations with acute cardiorespiratory morbidity

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Motivation

- **First Study**: PM$_{2.5}$ components and emergency department visits for cardiovascular and respiratory diseases in St. Louis Missouri-Illinois metropolitan area
- St. Louis – Midwest Supersite measurements, June 2001 – April 2003
- Time series analysis using daily data for air quality and emergency department visits at 36 of 43 acute care hospitals in the area

Air Quality Parameters

- 24-hour integrated PM$_{2.5}$
- Gravimetric mass
- Major ions (SO$_4^-$, NO$_3^-$)
- Carbon (EC, OC by NIOSH / ACE-Asia protocol)
- Organic Speciation: $n$-alkanes (2), hopanes (2), PAHs (4)
- Metals and metalloids (Si, K, Ca, Fe, Cu, Zn, Pb)
- Criteria Gases (Illinois EPA East St. Louis station)
  - 8-hr max O$_3$
  - 1-hr max CO, NO$_2$, SO$_2$
Hospital Admissions Type

• Cardiovascular Diseases (CVD)
  • Ischemic Heart Disease
  • Dysrhythmia
  • Congestive Heart Failure (CHF)
• Respiratory Diseases (RD)
  • Pneumonia
  • Chronic Obstructive Pulmonary Disease (COPD)
  • Asthma/Wheeze
Asthma & Wheeze

Risk Ratio per Interquartile Range of pollutant concentration... if bar is entirely to the right of this arrow then the association is statistically significant (95% C.L.)

Asthma & Wheeze... Ozone
Congestive Heart Failure… Soot (Elemental Carbon)
Key Findings

- Robust associations for:
  - CVD and $17\alpha(H),21\beta(H)$-hopane
  - CHF and Elemental Carbon (EC)
  - RD and $O_3$
  - Asthma/Wheeze and $O_3$, NO$_2$, PM$_{2.5}$

- Used St. Louis area SLAMS data with Supersite data to assess spatial variability
  - Rate ratios for components with high spatial variability may be biased towards the null
Rate Ratios and Partial Correlation

• Asthma/Wheeze
  • Components with highest RR were also most correlated across sites

• Congestive Heart Failure
  • No relationship between strength of association and spatial correlation
St. Louis – Midwest Supersite PM$_{2.5}$ Carbon Measurements

- 5-minute Aethalometer Black Carbon (BC) and UV-absorbing carbon (UV-C)
- Hourly EC and OC (Sunset labs analyzers)
- Daily 24-hour integrated filters (U. Wisconsin sampler)
  - Organics speciation by extraction-GCMS (1-in-6 day)
  - Organics speciation by thermal desorption-GCMS (remaining days)
- EC/OC using NIOSH analysis protocol
- EC/OC using IMPROVE analysis protocol
OC and EC by Method

**OC**
- $\text{OC} = 0.85 \pm 0.02$
- $b = -0.10 \pm 0.08$
- $r^2 = 0.92$

**EC**
- $\text{EC} = 1.88 \pm 0.07$
- $b = 0.22 \pm 0.04$
- $r^2 = 0.62$
Objective of Second Study*

- Examine associations between PM components and emergency department visits
- Focus on comparison of results using EC and OC from the NIOSH and IMPROVE analysis methods

i.e. does the carbon analysis method matter?

## Pearson Correlation Coefficients

<table>
<thead>
<tr>
<th>Method</th>
<th>EC-N</th>
<th>EC-I</th>
<th>OC-N</th>
<th>OC-I</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC NIOSH (EC-N)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>EC IMPROVE (EC-I)</td>
<td>0.78</td>
<td>1.00</td>
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<tr>
<td>OC NIOSH (OC-N)</td>
<td>0.64</td>
<td>0.81</td>
<td>1.00</td>
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<td></td>
</tr>
<tr>
<td>OC IMPROVE (OC-I)</td>
<td>0.63</td>
<td>0.78</td>
<td>0.95</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Aethalometer BC</td>
<td>0.77</td>
<td>0.85</td>
<td>0.81</td>
<td>0.80</td>
<td>1.00</td>
</tr>
</tbody>
</table>

In St. Louis, BC may be an indicator of both EC and OC, and not EC only.
Key Findings & Summary

- Associations generally concordant when using EC and OC measures from NIOSH and IMPROVE
  - Confidence intervals for the rate ratios overlap
- Some evidence of differences between methods
  - Associations between CHF and EC stronger for NIOSH than for IMPROVE (warm season)
  - Associations between Asthma/Wheeze and EC stronger for IMPROVE than for NIOSH (warm season)
- Differences in associations could be because of chance, or may arise from differences in the composition of the PM assigned as EC and OC
Acknowledgements

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