Is the Link between Fine Particulate Matter Air Pollution and Cognitive Function Stronger among Stroke Survivors?

Jennifer Ailshire
*University of Southern California*

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Background: Stroke

- Brain’s equivalent of a heart attack
- **Second** leading cause of death globally
- Estimated **14 millions DALYs lost** among ages 75+ in high income countries
- About **half of stroke survivors** experience some degree of physical/cognitive impairment
- Incidence of stroke is declining as a result of treatment, but total numbers increasing due to aging

Sources:
PM$_{2.5}$, Cognitive Function, Stroke

- Residential concentrations of fine particulate matter air pollution (PM 2.5) associated with:
  - Worse cognitive function (Ailshire & Crimmins 2014; Gatto et al. 2014; Weuve et al. 2012)
  - Increased risk of cardiovascular events, including stroke (Miller et al. 2007; Wellenius et al 2012)

PM$_{2.5}$ = 2.5 micrometers in diameter and smaller

Small diameter particles inhaled deep into lungs; can also pass through olfactory cells and deposit in brain

Produced mainly by combustion of fossil fuels from traffic-related and industrial sources
Role of Stroke?

- Older adults with cardiovascular conditions and respiratory problems are more adversely affected by pollution
  - Prior stroke history => worse cog function among those in polluted areas

- Some conditions and diseases have an impact on cognitive function – stroke known to have large impact on functioning
  - Post-stroke recovery is a critical period for maintaining function/preventing short and long-term decline

- Very little research on role of pre-existing conditions in the pollution-cognition relationship, and nothing on role of stroke
  - Most studies exclude people with history of stroke
National Data on Adults Ages 50+

- **Health and Retirement Study (2004)**
  - Nationally-representative, longitudinal (1992-)
  - Americans over age 50
  - Non-Hispanic whites and blacks, Hispanics, other race/ethnicity
  - Community-dwelling
    ~N=16,344

- **Linked geographic identifiers**
  - Census tract id

- **Census 2000 tract characteristics**

- **EPA/AQS criteria pollutant data (2004)**
  - Levels of PM$_{2.5}$ recorded at EPA monitoring stations
Cognitive Function

- Immediate and delayed recall of 10 nouns (0-20 pts)
- Serial 7’s subtraction test (0-5 pts)
- Backward counting from 20 (0-2 pts)
- Current date (0-4 pts)
- Object naming (0-2 pts)
- Pres/VP naming (0-2 pts)

- Combined total cognitive function score (0-35)
Air Pollution

- Annual average PM$_{2.5}$ from monitors located within 60km of Census tract centroid
- HRS respondents linked to Year 2004 tract-level PM$_{2.5}$ using tract ids
- N=270 respondents with no tract id
- N=1,689 respondents who did not live within 60km of a monitor
Distribution of PM$_{2.5}$ $\mu$g/m$^3$ in Study Sample

- Mean = 12

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<thead>
<tr>
<th>Quartiles</th>
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<th>3rd</th>
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<tr>
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<td>8.9</td>
<td>11.1</td>
<td>13.0</td>
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<td>S.D.</td>
<td>0.8</td>
<td>0.7</td>
<td>0.5</td>
<td>1.6</td>
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<tr>
<td>Min</td>
<td>4.5</td>
<td>9.9</td>
<td>12.2</td>
<td>13.8</td>
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<tr>
<td>Max</td>
<td>9.9</td>
<td>12.2</td>
<td>13.8</td>
<td>20.7</td>
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</tbody>
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- 11% live in areas $\geq$ 15 $\mu$g/m$^3$
- 51% live in areas $\geq$ 12 $\mu$g/m$^3$
PM$_{2.5}$ $\mu g/m^3$ by Select Metro Area
# HRS - Sample Characteristics

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<tr>
<td></td>
<td>[4.5-9.9]</td>
<td>[9.9-12.2]</td>
<td>[12.2-13.8]</td>
<td>[13.8-20.7]</td>
</tr>
<tr>
<td>Cognitive Function</td>
<td>22.7</td>
<td>22.1</td>
<td>21.7</td>
<td>22.0</td>
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<tr>
<td>Age, years</td>
<td>65.3</td>
<td>64.4</td>
<td>64.3</td>
<td>64.3</td>
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<tr>
<td>Stroke</td>
<td>5.70%</td>
<td>6.97%</td>
<td>6.83%</td>
<td>6.91%</td>
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*Statistically significant differences, p<.05*
Statistical Methods

• Multilevel linear regression with random intercept
  – Accounts for spatial clustering of observations

• Models adjusted for:
  – Individual level - age; sex, race/ethnicity; education; income; marital status; working status; smoking status; residential tenure
  – Tract level - % college educated adults; median income; % non-white

• Analyses weighted to account for complex sample design
Cognitive Function by PM$_{2.5}$ Quartile

Adjusted for age; sex; race/ethnicity; education; income; marital status; working status; smoking status; residential tenure; tract level - % college educated adults; median income; % non-white

Source: Ailshire, JA, Crimmins, EM. 2014. Am J Epidemiology
Assoc. between PM 2.5 and Cognitive Function by Stroke

The graph shows the association between PM 2.5 levels and total cognitive function, differentiated by stroke status. The blue line represents participants without stroke, and the red line represents those with stroke. The x-axis represents the quartiles of PM 2.5, while the y-axis represents total cognitive function. The p-value indicated is less than 0.05, suggesting a statistically significant association.
Conclusions

• Growing evidence for the importance of air pollution exposure for brain health and functioning in older adults

• Not all older adults will experience the same adverse effects of air pollution
  – Stroke survivors represent particularly vulnerable population

• Need for further investigation of pollution as risk factor in stroke and post-stroke recovery/well being
Thank you.

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