Impact of Air Quality on Health

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Over 4,000 deaths (cardiopulmonary) were attributable to the Great London Smog of December 1952.
Deaths Registered in London Administrative County Classified by Age (Bates, 1995)

<table>
<thead>
<tr>
<th></th>
<th>&lt; 1 Month of Age</th>
<th>1-12 Mo. Old</th>
<th>1-14 Years of Age</th>
<th>15-44 Years of Age</th>
<th>45-64 Years of Age</th>
<th>65-74 Years of Age</th>
<th>75+ Years of Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week Before the Episode</td>
<td>16</td>
<td>12</td>
<td>10</td>
<td>61</td>
<td>237</td>
<td>254</td>
<td>335</td>
</tr>
<tr>
<td>Week After the Episode</td>
<td>28</td>
<td>26</td>
<td>13</td>
<td>99</td>
<td>652</td>
<td>717</td>
<td>949</td>
</tr>
<tr>
<td>Before/After Episode Ratio</td>
<td>1.75</td>
<td>2.17</td>
<td>1.3</td>
<td>1.62</td>
<td>2.75</td>
<td>2.82</td>
<td>2.83</td>
</tr>
</tbody>
</table>

The greatest relative increase in mortality was from bronchitis, which rose nine-fold
Health Effects of Ambient Particulate Matter

1952 London Fog
- Hospital admissions rose by 50%
- Respiratory admissions by 160%

- Asthma attacks, medication use, symptoms
- Lung function changes, immune cell responses, heart rate or heart rate variability responses
- Doctor visits
- Hospital Admissions
- Death

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Health impact of fine particulate pollution

Steubenville
St. Louis
Harrimen
Watertown
Topeka
Portage

The Six Cities study

PM$_{2.5}$ Reduction & Mortality: 6 Cities follow-up

Period 1: 1974-89
Period 2: 1990-98

Ranking of PM$_{10}$ estimates for all-cause mortality by annual average levels of PM$_{10}$
Truck traffic and symptoms

Janssen EHP 2003; 111: 1512

Odds ratio for 22,326 vs. 5,190 trucks/day

- asthma
- hayfever
- phlegm
- itchy rash
- bronchitis
- wheeze last year
Understanding the mechanisms driving PM-induced health effects

**Healthy Airway**

- Oxidative potential
- Antioxidant defense

**PM**

- **Oxidative Stress**
  - Acute effects
    - Inflammation
    - Tissue injury
    - Impaired lung function
    - Increased bronchial hyper-reactivity
  - Recurrent episodes
    - Chronic effects
      - Heart failure
      - Stroke
Controlled Diesel Exposures

Exposure to DE: $\text{PM}_{10} \ 300\mu g/m^3$ and filtered air for 1 hour & $100\mu g/m^3$ and filtered air for 2 hours
Diesel induced inflammation (300µg/m³)

Neutrophils after air

Neutrophils after DE

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Pulmonary responses to DE

Impaired lung function
(100µg/m³)

Increase airway hyper-reactivity (300µg/m³)
Responses to PM in the Real World

Impaired lung function

Summary

• Prolonged exposure to elevated PM is associated with significant life-shortening and poor respiratory health
• The strength of the health impacts varies between locations for reasons that are not fully understood
• Subjects with pre-existing cardiopulmonary conditions are particularly sensitive
• Reductions in ambient PM provide measurable health benefits
• Human chamber and field exposures have provided mechanistic evidence to underpin the validity of the epidemiological observations
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