AIR POLLUTION AND HEART DISEASE

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POLLUTION

Nearly 150,000 cardiovascular deaths in the US
Globally, air pollution kills 7 million people annually
Ambient Air Particles

- Molecules
- Virus
- Bacteria
- RBCs
- Cell
- Pollen
- Pin
- Hair

Particulate matter size distribution:
- PM$_{10}$: Thoracic particles
- PM$_{10-2.5}$: Coarse fraction
- PM$_{2.5}$: Fine particles
- UFP (PM$_{0.1}$): Ultrafine particles
Ambient Air Particles

- **PM$_{2.5}$**: Combustion particles, organic compounds, metals, etc. 
  - $<2.5 \mu m$ (microns) in diameter

- **PM$_{10}$**: Dust, pollen, mold, etc. 
  - $<10 \mu m$ (microns) in diameter

- **Human Hair**: 50-70 $\mu m$ (microns) in diameter

- **Fine Beach Sand**: 90 $\mu m$ (microns) in diameter
PM is derived from many sources:

- Wood-Burning Stoves
- Forest Fires
- Heavy Duty Diesel Engines
- Cars and Trucks
- Natural Sources
- Non-Road Vehicles
- Leaf Burning
- Industrial Sources
PM sources vary by geographic location

Sources of PM in Midtown Manhattan

- Residential Fuel Oil (1%)
- Sea Salt (6%)
- Automobile (6%)
- Road Dust (9%)
- Ammonium Sulfates (9%)
- Ammonium Nitrate (13%)
- Diesel (52%)

Bar chart showing PM sources for various cities:

- Boston
- St Louis
- Knoxville
- Portage
- Steubenville
- Topeka

Legend:
- Green: Residual
- Purple: Mn
- White: Salt
- Blue: Metals
- Gray: Fuel Oil
- Red: Coal
- Yellow: Mobile
- Brown: Crustal

Pie chart showing sources of PM in Midtown Manhattan:

- Residential Fuel Oil (1%)
- Sea Salt (6%)
- Automobile (6%)
- Road Dust (9%)
- Ammonium Sulfates (9%)
- Ammonium Nitrate (13%)
- Diesel (52%)
Premature mortality risk attributable to PM

### Excessive Mortality Associated with PM Exposure

<table>
<thead>
<tr>
<th>RR (95% CI)</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.65 - 0.70</td>
<td>Ischemic heart disease, Hypertensive disease, Other Atherosclerosis, aortic aneurysms</td>
</tr>
<tr>
<td>0.75 - 0.80</td>
<td>Other Cardiovascular Diseases, Respiratory Diseases, COPD and allied conditions</td>
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<tr>
<td>0.85 - 0.90</td>
<td>Cerebrovascular, Diabetes</td>
</tr>
<tr>
<td>0.90 - 1.00</td>
<td>All Cardiovascular plus Diabetes, Dysrhythmias, Heart failure, Cardiac arrest, Ischemic heart disease, Hypertensive disease, Other Atherosclerosis, aortic aneurysms</td>
</tr>
<tr>
<td>1.00 - 1.10</td>
<td>COPD and allied conditions, All other respiratory</td>
</tr>
<tr>
<td>1.15 - 1.20</td>
<td>Other Cardiovascular Diseases, Respiratory Diseases, COPD and allied conditions</td>
</tr>
<tr>
<td>1.25 - 1.30</td>
<td>Cerebrovascular, Diabetes</td>
</tr>
<tr>
<td>1.35 - 1.40</td>
<td>Other Cardiovascular Diseases, Respiratory Diseases, COPD and allied conditions</td>
</tr>
</tbody>
</table>

**Figure 1.** Adjusted relative risk ratios for cardiovascular and respiratory mortality associated with a 10 µg/m³ change in PM$_{2.5}$ for 1979-1983, 1999-2000, and the average of the two periods. (Relative size of the dots correspond to the relative number of deaths for each cause.)

*Circulation* 109, 71, 2004
Episodic increase in PM decreases EPC levels
Experimental Setup for exposing mice to concentrated air particulates
Exposure to PM Decreases Circulating EPC levels

Circ Res 107, 107, 2010
Exposure to PM induces low-grade inflammation
Exposure to PM induces endothelial injury
Diabetes Prevalence and PM$_{2.5}$ for US Counties

Diabetes Care 33, 2196, 2010
PM increase insulin resistance
Air Pollution

EXPOSURE

Inhalation

PULMONARY INJURY

Pulmonary Oxidative stress
Pulmonary Inflammation
Sensory-receptor activation

SYSTEMIC CHANGES

Alterations in circulating cells and thrombosis
Systemic oxidative stress and inflammation
Autonomic nervous system imbalance

SUBCLINICAL EFFECTS

Endothelial dysfunction
Insulin resistance
Atherosclerosis
Hypertension
Cardiac Dysfunction

CLINICAL MANIFESTATIONS

Peripheral arterial disease
Acute myocardial infarction
Arrhythmic events
Sudden Cardiac Death
Heart Failure