Short-term effects of fine and ultrafine particle pollution on mortality in Beijing


Helmholtz Zentrum München
Institute of Epidemiology

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Short-term health effects of fine and ultrafine particle pollution in Beijing, China

A collaborative study between

- Peking University
  - Health Science Center - School of Public Health
  - College of Environmental Sciences and Engineering
- Leibniz Institute for Tropospheric Research (IfT)
- Helmholtz Zentrum München
- UFZ Leipzig
Particulate matter air pollution has been consistently associated with daily mortality and morbidity around the world.

However, relatively little data is available on smaller particles or their composition, especially in China. Moreover, only little data is available on ultrafine particles (particles smaller than 100 nm), which become more important with increasing traffic density.

Newer findings suggest that ultrafine particles may be of special importance for human health (Ibald-Mulli et al. 2002; Peters et al. 2009).
Study aims

- To characterize the impact of particulate air pollution on daily cause-specific cardiovascular and respiratory mortality.
- To distinguish between the health effects of different fractions of particles including very small ones.
Study area

Beijing:

- One of the mega-cities with more than 16 million inhabitants.
- Combustion, traffic, construction, and dust from desert regions produce a complex mixture of aerosols.
- High variation in particle concentration and pollution level.

Study area for mortality outcomes:
- Data were obtained for the eight districts representing the urban area of Beijing:
  Dongcheng District, Xicheng District, Chongwen District, Xuanwu District, Chaoyang District, Fengtai District, Shijingshan District and Haidian District.
Map of Beijing urban (grey) and administrative (white) area with measurement points.

- Airport - Meteorological measuring station
- PNC measuring station
- Beijing Municipal Environmental monitoring stations
Mortality data:

- Available from 01/01/2003 to 04/30/2005.
- For cardiovascular mortality (ICD-10 code: I00-I99) and respiratory mortality (J00-J99), but also for specific sub-groups, e.g.:
  - I20-I25 Ischemic heart diseases
  - I30-I52 Other forms of heart disease
  - I60-I69 Cerebrovascular diseases
  - J40-J47 Chronic lower respiratory diseases
  - J10-J18 Influenza and pneumonia
Size-fractioned particle data:

- Measurement site on the campus of Peking University.
- Residential and commercial area with local sources: vehicular traffic, domestic cooking and heating, construction.
- Sampling on top of a 6-floor building, 20 m above ground.
- Data available from 03/04/2004 to 12/12/2006.
- Number size distributions from 3 nm to 10 µm.
- Additionally, daily mass concentrations were computed.
Descriptive statistics for mortality, daily 24h-averages of particulate air pollutants and meteorology in Beijing

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>25%</th>
<th>Median</th>
<th>75%</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular mortality (I00-I99)</td>
<td>32.1</td>
<td>6.8</td>
<td>15</td>
<td>28</td>
<td>32</td>
<td>37</td>
<td>54</td>
</tr>
<tr>
<td>Respiratory mortality (J00-J99)</td>
<td>7.2</td>
<td>2.9</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>PM 10 (µg/m³)</td>
<td>141.9</td>
<td>98.3</td>
<td>16.3</td>
<td>67.4</td>
<td>120.9</td>
<td>189.1</td>
<td>539.0</td>
</tr>
<tr>
<td>PM 2.5 (µg/m³)</td>
<td>112.7</td>
<td>83.0</td>
<td>10.9</td>
<td>50.7</td>
<td>90.0</td>
<td>152.6</td>
<td>436.7</td>
</tr>
<tr>
<td>NC 2.5 (cm⁻³)</td>
<td>37290</td>
<td>10530</td>
<td>12731</td>
<td>31265</td>
<td>36290</td>
<td>41987</td>
<td>86868</td>
</tr>
<tr>
<td>ACP (cm⁻³)</td>
<td>7836</td>
<td>4434</td>
<td>877</td>
<td>4717</td>
<td>7415</td>
<td>10406</td>
<td>23103</td>
</tr>
<tr>
<td>UFP (cm⁻³)</td>
<td>29130</td>
<td>10328</td>
<td>11849</td>
<td>21948</td>
<td>27810</td>
<td>34334</td>
<td>76283</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>12.9</td>
<td>10.4</td>
<td>-7.1</td>
<td>3.6</td>
<td>14.2</td>
<td>22.2</td>
<td>32.0</td>
</tr>
<tr>
<td>Humidity(%)</td>
<td>51.6</td>
<td>21.4</td>
<td>10.0</td>
<td>33.0</td>
<td>50.0</td>
<td>71.0</td>
<td>93.0</td>
</tr>
</tbody>
</table>

a) SD: standard deviation; Min: minimum; 25%: 25%-Quantil; 75%: 75%-Quantil; Max: Maximum.
b) obtained in the urban area of Beijing.
c) obtained at the measuring site at Peking University.
d) obtained by an international monitoring site.
Time series of daily 24h-averages of particulate air pollutants in Beijing
Relative risk (RR) of cardiovascular mortality per interquartile range (IQR) increase of different particle size classes in Beijing, China - March 2004 to April 2005.

The diagram shows the relative risk (RR) of cardiovascular mortality per interquartile range (IQR) increase of different particle size classes, categorized by lags (0 to 4) and 5-day average. The particle size classes include PM 10, PM 2.5, NC 10, NC 2.5, and UFP.
Relative risk (RR) of ischemic heart disease mortality per IQR increase of different particle size classes in Beijing, China for the period March 2004 to April 2005.
Relative risk (RR) of respiratory mortality per interquartile range (IQR) increase of different particle size classes in Beijing, China - March 2004 to April 2005.

<table>
<thead>
<tr>
<th>Lags</th>
<th>RR / IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag 0</td>
<td>0.90</td>
</tr>
<tr>
<td>Lag 1</td>
<td>0.95</td>
</tr>
<tr>
<td>Lag 2</td>
<td>1.00</td>
</tr>
<tr>
<td>Lag 3</td>
<td>1.05</td>
</tr>
<tr>
<td>Lag 4</td>
<td>1.10</td>
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</table>

- NC 10
- NC 300-1000
- UFP

J00-J99

Lags

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German Research Center for Environmental Health
Summary

- Consistent associations between cardio-respiratory mortality and particle number concentrations in different size classes.

- Effects of particle number concentrations were stronger than those for particle mass ($\text{PM}_{10}, \text{PM}_{2.5}$), except for ischemic heart disease mortality.

- For cardiovascular mortality, relative risks were largest for smaller particle size classes.

- For respiratory mortality, smaller particle size classes showed a delayed association, whereas for bigger particles an immediate effect could be seen.
Outlook

- Evaluating effect modification by age, meteorological conditions, ...

- Investigation of air mass origin defined by backward trajectories as a surrogate of different particle properties
  - effect modification of the associations between particle number and mass concentrations and mortality

- Investigation of the association between mortality and particle source factors obtained by source apportionment techniques
  - identification of specific sources associated with health effects.
Acknowledgements

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Thank you for your attention!
Any questions?