Air pollution during pregnancy and lung function in newborns: a birth cohort study

June 23 2009
Philipp Latzin

Medizinische Universitätskinderklinik
Effects of air pollution on respiratory health

Acute effects on:
• Symptoms (e.g. cough)\(^1\)
• Lung function in adults (\(FEV_1\))\(^2\)
• Inflammation (eNO)\(^3\)

Chronic effects on lung growth:
• 3200 children in Mexico: regional pollution\(^4\)
• 1150 children in Austria: seasonal exposure\(^5\)

1 Ward et al., Occup Env Med, 2001  
2 McCreanor et al., NEJM, 2007  
3 Nickmilder et al., JAMA 2003  
4 Rojas-Martinez et al., AJRCCM, 2007  
5 Frischer et al., AJRCCM 1999
Chronic effects on lung growth

- Californian Health Study, 1700 children, 10-18 years:
  - background pollution\(^1\):

![Graph showing the relationship between NO\(_2\) exposure and lung function growth among girls and boys.

1 Gauderman et al., NEJM, 2004
2 Gauderman et al., Lancet, 2007
Growth and development of the airways

• Pre- and early postnatal phase important
• Dependent on genetics and environment
• Effect of prenatal smoke exposure well known
• E.g. on tidal breathing and lung growth
• No data on effects of prenatal air pollution
• Longterm effects of early lung function changes

1 Kotecha, Ped Resp Rev, 2000; 2 Stocks et al., Review in Respirology, 2003
3 Stick et al., Lancet, 1996 4 Hoo et al., AJRCCM 1998
5 Bush et al., COPD 2008 6 Kuehni et al., Lancet 2008
Question

Does prenatal exposure to air pollution influence lung growth and inflammation in the healthy newborn?
Subjects

- Prospective birth cohort since 1999
  (unselected term-born infants of healthy mothers)
- Lung function at age 5 weeks (unsedated)
Outcome parameters

- Minute-Ventilation (Frequency x Tidal volume)
- Mean expiratory flow
- Lung volume (FRC)
- Ventilation homogeneity (LCI)
- Inflammation (eNO)
Exposure to air pollution during pregnancy depends on temporal and spatial variability:

Temporal variability:
Mean background pollution level in pregnancy measured at regional monitor:

**Ozone (O\textsubscript{3}), NO\textsubscript{2} & PM\textsubscript{10}**

Spatial variability:
Local exposure (home address) GIS coded as distance to next class-II road (> 6m wide)
Analyses

Inclusion of 260 infants
No lung function (sleep status): 27 subjects
Respiratory tract infection at time of lung function (+1 wk): 10 subjects
Technical problems with eNO-analyser: 11 subjects
  ➢ Tidal breathing data in 223 (86%) infants.
  ➢ eNO data in 212 (82%) infants.

Analysis:
Linear regression analysis using 2 models:
• “Basic model” for mean pollution level and distance to street
• “Full model” adjusted additionally for possible confounders (gender, age at measurement, season of birth, outdoor temperature and smoking in pregnancy)
## Results I – associations

<table>
<thead>
<tr>
<th></th>
<th>Basic model</th>
<th></th>
<th>Full model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coefficient</td>
<td>CI 95%</td>
<td>p Value</td>
<td>coefficient</td>
</tr>
<tr>
<td>Prenatal PM$_{10}$ and</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minute ventilation [mL/min]</td>
<td>19.9</td>
<td>4.7 – 35.0</td>
<td>0.010</td>
<td>24.7</td>
</tr>
<tr>
<td>Prenatal PM$_{10}$ and</td>
<td>0.59</td>
<td>0.01 – 1.17</td>
<td>0.045</td>
<td>0.80</td>
</tr>
<tr>
<td>Mean expiratory flow [mL/sec]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prenatal NO$_{2}$ and</td>
<td>0.67</td>
<td>0.23 – 1.10</td>
<td>0.003</td>
<td>0.96</td>
</tr>
<tr>
<td>eNO [ppb]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Results are given as change per µg/m$^3$ increase in air pollution
- Results on PM$_{10}$ confirmed using other parameters of tidal breathing
- No association for ozone exposure
- No association for distance to street
- No association for FRC or ventilation inhomogeneity
Results II – time of exposure

![Graph showing the effect of air pollution during pregnancy on lung function in newborns, with trimester and postnatal exposure levels.](image-url)
## Results III – stratification

<table>
<thead>
<tr>
<th>Risk factor present</th>
<th>No risk factor</th>
<th>p-value for interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>coefficient</td>
<td>CI 95%</td>
<td>coefficient</td>
</tr>
<tr>
<td>PM$_{10}$ and minute ventilation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living within 200 m to major road (110 subjects)</td>
<td>41.2</td>
<td>19.1 – 63.4</td>
</tr>
<tr>
<td>Maternal smoking in pregnancy (26 subjects)</td>
<td>81.8</td>
<td>27.2 – 136</td>
</tr>
</tbody>
</table>

- Results were comparable for the association between prenatal NO$_2$ and eNO in the newborns.
What do the results mean?

IQR (25.-75. Percentile) increase in PM$_{10}$ is associated with an increase in respiratory rate of 6.4/min (mean 44/min).

Mean (IQR) Bern: 22 (20-24) μg/m$^3$
Mean (IQR) Mexico-City: 68 (56-92) μg/m$^3$
Possible relevance

“Tracking” of lung function into older age

Baraldi & Fillipone, NEJM 2007
Conclusions

Our results suggest that:

• Prenatal exposure to NO$_2$ leads to airway inflammation in the newborn (NO)
• Higher levels of PM$_{10}$ during pregnancy lead to increased respiratory need of the newborn
• Effects are more pronounced in infants exposed to additional risk factors
• Later pregnancy seems to be more important
Thanks to

Urs Frey & Team of Pediatric Pulmonology, Children's Hospital, University of Bern

Anke Huss, Martin Röösli, Claudia Kuehni, ISPM University of Bern