Learning example: outdoor and indoor air pollution

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Long term exposure to PM and risk of mortality in ACS cohort (ca. 0.5 million people followed for 16 years)

Source: Pope et al, JAMA 2002
Lung cancer deaths attributable to urban air pollution: WHO Global Burden of Disease study (WHO 2004)

RR=1.082 (1.011-1.158) per 10 µg/m3 PM2.5
Health impacts of fine PM – update analysis of ACS cohort

Hazard rates for PM2.5 by cause-of-death (with adjustment for ecologic covariates). 18 years follow up of 360,000 participants of ACS cohort

Krewski et al, HEI 140, May 2009
Fine PM and mortality.
Extended Harvard Six-cities Study

Follow-up period: 1974 – 1998 (24 years)
158,978 person-years of follow up; 2,732 deaths

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>RR per 10 µg/m³ of average PM2.5</th>
<th>95% CI of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1.16</td>
<td>1.07 – 1.26</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>1.28</td>
<td>1.13 – 1.44</td>
</tr>
<tr>
<td>Respiratory</td>
<td>1.08</td>
<td>0.79 – 1.49</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>1.27</td>
<td>0.96 – 1.69</td>
</tr>
<tr>
<td>Other</td>
<td>1.02</td>
<td>0.90 – 1.17</td>
</tr>
</tbody>
</table>

Laden et al, AJRCCM 2006
PM and survival: the effects of exposure timing.

Extended Harvard Six Cities Study

The increase in risk of death associated with PM2.5 is manifested within 2 (up to 3 for LCA) years of exposure.

Schwartz et al, EHP 2008
Reduction of PM exposure and increase of life expectancy in the US

A decrease of 10 µg/m³ of PM2.5 associated with increase of life expectancy by 0.61 years between 1980 and 2000

Reduction in PM accounts for 15% of overall increase in life expectancy

Pope AC et al, NEJM 2009
Benefits and costs of the Clean Air Act of the USA

Source: US EPA 2011
Effect of the Clean Air Act on lifetime risks of benzene-related leukaemia in the Houston area

Source: US EPA 2011
Reducing exposure to second-hand smoke: example from Italy (1 of 2)

- Comprehensive smoking ban (offices, shops, restaurants, bars…) in Jan 2005

<table>
<thead>
<tr>
<th>Indoor air pollution in 40 public places in Rome:</th>
<th>before</th>
<th>after</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5 (µg/m³)</td>
<td>119</td>
<td>38-43</td>
</tr>
<tr>
<td>Urinary cotinine, nonsmoking workers (ng/mL)</td>
<td>17.8</td>
<td>3.7-5.5</td>
</tr>
</tbody>
</table>

Cesaroni et al., Circulation 2008
Effectiveness of smoke-free policy


“in view of the long lag time between second-hand smoke exposure and the development of lung cancer, data are not yet available regarding the expected decline in lung cancer after implementation of smoke-free policies”.

Air pollution and cancer
Avilés (Asturias, Spain), 17-18 March 2011
Reducing exposure to second-hand smoke: example from Italy (2 of 2)


Cesaroni et al., Circulation 2008
WHO Guidelines for IAQ: selected pollutants

• Benzene*,
• Carbon monoxide,
• Formaldehyde*,
• Naphthalene*,
• Nitrogen dioxide,
• Polycyclic aromatic hydrocarbons*,
• Radon*,
• Trichloroethylene*
• Tetrachloroethylene*

* Carcinogens
WHO Guidelines for IAQ: Benzene

- Benzene is a genotoxic carcinogen (IARC Group 1)
- Lifetime excess risk for leukaemia related to airborne benzene:
  - 0.17 µg/m³: 1/1,000,000
  - 1.7 µg/m³: 1/100,000
  - 17 µg/m³: 1/10,000

Benzene levels in homes (µg/m³)

[Graph showing benzene levels in homes across different regions with and without ETS.]
Formaldehyde : indoor exposures and guidelines

- Formaldehyde is (non-genotoxic) carcinogen (IARC Group 1)
- WHO IAQG: 100 µg/m³ (30 min average) to prevent acute sensory effects and CA

Formaldehyde levels at homes (µg/m³)

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>95%tile</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>170</td>
<td>115</td>
<td>220</td>
</tr>
<tr>
<td>Germany</td>
<td>70</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Helsinki</td>
<td>40</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Austria</td>
<td>120</td>
<td>80</td>
<td>180</td>
</tr>
<tr>
<td>France</td>
<td>90</td>
<td>60</td>
<td>140</td>
</tr>
</tbody>
</table>
Radon: indoor exposures, guidelines and relevance of additional risk factors

Radon is genotoxic carcinogen (IARC Group 1) – no safe level

<table>
<thead>
<tr>
<th>Radon concentration (Bq/m³)</th>
<th>Risk of death per 1000 lifelong non-smokers</th>
<th>Risk of death per 1000 current smokers of 15–24 cigarettes per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.1</td>
<td>101</td>
</tr>
<tr>
<td>100</td>
<td>4.7</td>
<td>116</td>
</tr>
<tr>
<td>200</td>
<td>5.4</td>
<td>131</td>
</tr>
<tr>
<td>400</td>
<td>6.7</td>
<td>160</td>
</tr>
<tr>
<td>800</td>
<td>9.3</td>
<td>216</td>
</tr>
</tbody>
</table>

Mean levels Rn at homes Bq/m3

Source: Darby et al, SJWEH 2006
Conclusions

• The evidence is sufficient to support reduction of air pollution exposure as one of the measures for cancer risk prevention and should be effectively used by public health community in support of inter-sectorial actions;

• Health benefits (prevention of LCA, CVD, respiratory diseases) of air pollution reduction exceed by far the costs of actions;

• The health benefits occur soon after the air pollution reduction, but are not manifested by immediate decrease of cancer incidence;

• Exposure levels are good predictor of cancer risks and should be used as the indicators for successful actions.