Is children's health affected by particulate air pollutants in the Danube region?

The Danube Air Nexus
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Air pollution harms human health and ecosystems

EU Policy context:

• Directive 2008/50/EC on ambient air quality and cleaner air for Europe
• Directive 2004/107/EC on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air
• "Health" in all policies
Airborne polycyclic aromatic hydrocarbon levels falling faster in cities than rural areas

Growing evidence demonstrates that the legislation to reduce these harmful emissions has been successful. Concentrations of PAHs in urban areas were highest, the researchers found, but they were also declining at the fastest rate.

- Differences in the types of fuel used by the local populations (natural gas and petrol, whereas e.g. people living in Košetice predominantly use coal and wood, which release more PAHs).
Particulate matter (PM) emissions from domestic wood burning in London are higher than the PM reductions achieved through London’s Low Emission Zone, finds a new study.

- The research suggests that increases in wood burning could risk undermining policies aimed at meeting EU PM10 targets.
Source contribution estimations for Benzo(a)Pyrene in Northern Italy

<table>
<thead>
<tr>
<th>SITE TYPE</th>
<th>CONTR. OF BB TO BaP (ng/m³)</th>
<th>CONTR. OF BB TO BaP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95% CI</td>
<td>95% CI</td>
</tr>
<tr>
<td>KERBSIDE</td>
<td>1.0 ± 0.4</td>
<td>74 ± 32</td>
</tr>
<tr>
<td>URBAN BKG</td>
<td>1.0 ± 0.2</td>
<td>79 ± 18</td>
</tr>
<tr>
<td>RURAL BKG</td>
<td>0.7 ± 0.3</td>
<td>85 ± 33</td>
</tr>
<tr>
<td>URBAN BKG ALP</td>
<td>2.1 ± 1.1</td>
<td>84 ± 46</td>
</tr>
</tbody>
</table>

Uncertainty for emission factors (mg/g PM) 69% levo/PM and 68% (BaP/levo)

Source: Belis et al., 2011 Atmospheric Environment 45: 7266-7275
Rationale of an Integrated Approach to the Health Impact of Air Pollution in the Danube region

- Ambient air pollution is a major problem in the eastern European region, given the heavy reliance on coal-burning power plants, oil refineries with unsatisfactory filter systems and heating on solid fuels. The problem is endemic across the Danube region, but the types and sources of contaminants vary geographically.

- Biomass has the greatest significance among renewable energy sources in the Danube Region

- Further research is needed to delineate the relationship between particulate matter (PM) and its toxic constituents like Poly Aromatic Hydrocarbons (PAHs) and adverse respiratory effects.
Map of PAHs emissions in the Danube region from facilities included in the European Pollutant Register
PAHs are formed mainly as a result of the incomplete combustion of organic materials during industrial and other human activities, such as processing of coal and crude oil, biomass burning, combustion of natural gas, including for heating, combustion of refuse, vehicle traffic, cooking and tobacco smoking, as well as in natural processes such as carbonisation.
Exposure to environmental agents can occur in utero through trans-placental transfer from the mother to the foetus.
Some adverse outcomes of exposure have been shown to be irreversible and persist throughout life.

Despite the biological differences between children and adults, paediatric environmental health has received relatively little attention.
Genomics data have the potential to elucidate the mechanism of action, exposure assessment, identify biomarkers, and predict toxicity.
Concentrations of Benzo(a)Pyrene in different areas of the Czech Republic

- **Urban background**
- **Suburban**
- **Rural**
- **Traffic**
- **Industrial**

Concentration [ng.m⁻³]

- < 0.4 < LAT: 25.5%
- > 0.4-0.6 (LAT, UAT): 18.8%
- > 0.6-0.8 (UAT, 0.8): 14.3%
- > 0.8-1.0 (0.8, LV): 14.9%
- > 1.0-2.0 (LV, 2): 23.8%
- > 2.0 > 2.0: 2.7%
Children born in years 2001-2004 and living in Ostrava- Radvanice/Bartovice suffered during the first 6 years of their life by

the higher incidence of acute respiratory diseases

and

the higher prevalence of asthma bronchiale

than children in other districts of Ostrava City
Evaluate the impact of air pollution to gene expression in children

Study the gene expression of asthmatic and control children living in the **air polluted region** (Ostrava)

**vs**

Study the gene expression of asthmatic and control children living in the **clean region** (the District of Prachatice)
Results of genomic analysis in samples from Ostrava region

- Gene expression profiles for asthma children are different between the polluted and control regions.
- DNA damage in newborns is related to exposure to c-PAHs occurring in the ambient air.
- Gene expression changes induced by the exposure to c-PAHs during pregnancy influence pathways affecting immunity.
Ostrava - Region in the Czech Republic

European hot spot of air pollution by PM2.5 and B[a]P

A current high exposure should decrease within next 3-5 years. This unique situation should be used for an international study to analyze the health risk for population as well as the effect of remediation.
Aim of the Air Nexus Health Impact of Air Pollution project

-Impact of atmospheric carcinogenic/genotoxic PAHs (Polycyclic aromatic hydrocarbons) on genes affecting immunity

-Whole genome analysis on blood samples from pregnant women and umbilical cords at the delivery
Experimental design

Newborns from normal deliveries (week 38-41) from nonsmoking mothers

Cord blood collected in the summer and winter season

In each location 100 samples/season will be collected (total = 5 x 2 x 100 = 1,000 samples)

From each group in each location a cohort for further follow-up will be created

These children will be monitored up to 2 years of age (if possible longer) for their morbidity via questionnaires filled out by their pediatrician)
Facilities and expertise of the JRC platform
Final goal of the PAH2DAN project within Air Nexus cluster

Make new and innovative research strategies such as biomarkers of exposure and early effect available to paediatric environmental health scientists in Central and Eastern Europe.

Establish networks among Central and Eastern European scientists and their counterparts in the West to share state-of-the-art information regarding methods and health effects.

Provide access to existing protocols and help harmonize efforts
Partners

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Dagmar Gajdosova, Institute of Public Health, Kosice
Thank you for your attention