Review of evidence on health aspects of air pollution- REVIHAAP
WHO Regional Office for Europe

Key new findings and impact of evidence review for EU policies and WHO guidelines

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From *scientific evidence* to *guidelines and standards*

Scientific investigations provide *quantitative associations* between *exposures* and *health outcomes*, often accompanied with *uncertainties and limitations*.

These get “translated” into information more directly useful for setting guidelines and standards through the application of Health Impact Assessment (HIA) and Cost Benefit Analysis (CBA).
Issues to be considered

• Simplicity vs complexity in the legislation (i.e. can we have few standards for pollutants/metrics & few reference times)

• Legislation (or guidance) in the absence of a safe level (threshold). Is there an “acceptable” level of risk?

• Balance between precaution/proactive action vs post-hoc interventions
Important aspects of the REVIHAAP review which will influence policy decision making processes

• Which pollutants or indices of mixtures/metrics or sources are independently important?

• Which time periods of exposure are independently important?
Key findings: $\text{PM}_{2.5}$
Existing Regulation and context

- **EC regulation:** Only annual limit value of $25\mu g/m^3$, implemented in 2008.

- **Context:**
  - Few EU studies assessing $\text{PM}_{2.5}$ effects (since there were no measurements!)
  - There were adequate studies from the U.S.
Key findings: $\text{PM}_{2.5}$

Long-term effects - annual limit value

- REVIHAAP concludes that the evidence base is now very much stronger indicating effects from studies in the U.S., E.U. countries and other countries in the World, from levels lower than $10 \mu g/m^3$.

- The additional evidence concerns the known (respiratory & cardiovascular) and new (reproductive, atherosclerosis, neurodevelopment, cognitive function) health outcomes.
Key findings: $\text{PM}_{2.5}$
Short-term effects: need for a value over a shorter period?

- More evidence on the effect of high concentrations with short duration
- May concern different individuals
- Will allow for emergency protective actions
Percent change (95% CIs) in mortality associated with 10μg/m³ increase in particles (Samoli et al, EHP 2013)

<table>
<thead>
<tr>
<th>Health outcome</th>
<th>$PM_{2.5}$</th>
<th>$PM_{10}$</th>
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<tbody>
<tr>
<td>All-cause mortality (lag 0-1)</td>
<td>0.55 (0.27, 0.84)</td>
<td>0.32 (0.13, 0.52)</td>
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<tr>
<td>Cardiovascular mortality (lag 0-1)</td>
<td>0.57 (0.07, 1.08)</td>
<td>0.31 (-0.01, 0.62)</td>
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<tr>
<td>Respiratory mortality (lag 0-5)</td>
<td>1.91 (0.71, 3.12)</td>
<td>1.12 (0.29, 1.95)</td>
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Percent change (95% CIs) in hospital admissions associated with 10μg/m³ increase in PM$_{2.5}$ and 6.3 μg/m³ in PM$_{2.5-10}$ (Staffogia et al, EHP 2013, in press)

<table>
<thead>
<tr>
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<th>Cardiovascular admissions</th>
<th>Respiratory admissions</th>
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</thead>
<tbody>
<tr>
<td>PM$_{2.5}$ (lag 0-1)</td>
<td>0.51 (0.12, 0.90)</td>
<td>0.49 (-0.12, 1.09)</td>
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<tr>
<td>PM$_{2.5}$ (lag 0-5)</td>
<td>0.49 (0.03, 0.95)</td>
<td>1.36 (0.23, 2.49)</td>
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<tr>
<td>PM$_{2.5-10}$ (lag 0-1)</td>
<td>0.46 (0.10, 0.82)</td>
<td>0.60 (0.08, 1.13)</td>
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<tr>
<td>PM$_{2.5-10}$ (lag 0-5)</td>
<td>0.05 (-0.68, 0.78)</td>
<td>1.24 (-0.32, 2.82)</td>
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Key findings: PM
physical and chemical characteristics which may be additional air quality metrics

- Black carbon particles (metric for evaluating health risks of primary combustion particles).
- Secondary inorganic particles (sulfates, nitrates)
- Coarse particles
- Ultrafines
Key findings: $PM_{2.5}$ and $PM_{10}$

- Coarse particles appear to have independent effects on partly different health outcomes and act via different mechanisms than $PM_{2.5}$.

- They originate from different sources, deposit at different locations in the respiratory system.
Key findings: Ozone

• The short-term effects evidence strengthened from epidemiological and toxicological studies

• Now also substantial evidence for ozone long-term effects, particularly on respiratory mortality. The most important exposure appears to be exposure during the warm period.

• Evidence for a threshold not consistent, but effects observed below 90μg/m³
Key findings: NO$_2$

- Additional evidence both for short and long-term effects, suggesting causal role.

- Necessity for a 1-hour limit value
Exposure-response curves of the PM - mortality association for cities with high and low NO$_2$
(from Samoli et al EHP 2005; 113: 88-95)
Key findings: Proximity to roads

- Near roads: higher levels of ultrafine particles, CO, NO$_2$, BC, PAHs, metals (PM$_{2.5}$ more homogeneously distributed across space)

- Evidence linking proximity of residence to roads with health outcomes even when other important pollutants are taken into account

- How can this be reflected in regulations??
Conclusions- important messages

• The regulated standards should target the protection of public health. They cannot be oversimplified.

• The absence of an identified threshold does not mean effects are evident from zero concentrations. The lower limits of the concentrations studies should be identified.

• The evidence on the health effects of air pollution is accumulating and is remarkably consistent and persuasive. Therefore a more proactive policy is justified.

• The efficiency of legally binding standards and targets should be evaluated. Do the latter pose any pressure on national governments??
Future considerations (1)

• In Europe the lack of evidence on the health effects of particular pollutants is often due to lack of measurements (regulations and requirements are introduced late).

• A more flexible system of measurements can be adopted by DG Environment, including e.g. short-term targeted campaigns, establishing super-sites, introduce validated modeling (see recommendations of the AirMonTech project presented on June 6).

• The design of the requirements for measurements should be done in collaboration with the health research community- new institutions should be introduced (see also recommendations of the AirMonTech project presented on June 6).
• Evaluating air pollution as a whole (i.e. a mixture of pollutants) may lead to a shift in the paradigm of how pollutants may be regulated. There is scope in starting to think along these lines.

• Similarly, the identification of sources of hazardous pollution (e.g. traffic) leads to possible policies to protect public health that may be related to other disciplines (such as urban planning).