Cumulative risk assessment on the dietary exposure of Finnish children to heavy metals

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Effects of heavy metals

Oxidative stress
Function of various enzymes
Ca metabolism (Cd, Pb)
Fe metabolism (Pb)
Metallohormones?

Type I carcinogens (As, Cd)
Type IIA carcinogen (Pb)
Type IIB carcinogen (Hg)
Effects on DNA repair mechanism

Pb, MeHg, iAs, Cd

Cd, Pb, iAs, iHg, MeHg

Cd, Pb, iAs, iHg

CNS / PNS

CVD or blood pressure

kidney damage

(Not exhaustive list)
Data used for exposure assessment

- Individual consumption data on 1Y, 3Y, 6Y Finnish children
  - Collected in national DIPP study
  - 3 days food diary

- Concentration data on the main food groups
  - Mainly Finnish monitoring data
  - Food produced in Finland or imported to Finland

+ ready-made foods for children
Exposure assessment

- MCRA (Monte Carlo Risk Assessment) [https://mcra8.rivm.nl/](https://mcra8.rivm.nl/)
- Exposure of each age group (1Y, 3Y, 6Y) assessed separately
  - For each heavy metal
  - As well as cumulative exposure to all heavy metals

![Diagram showing exposure assessment process]

- Database of consumption
- Probabilistic calc. 100 k simulations
- Database of concentrations
- Distribution of exposure to studied compound in studied population group

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### EFSA assessments of exposure to heavy metals (one at a time)

**Finnish results to be published this autumn!**

*Unit µg/kg body weight /day*

<table>
<thead>
<tr>
<th>Age group and level</th>
<th>i As</th>
<th>MeHg</th>
<th>i Hg</th>
<th>Cd</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2 years, mean</td>
<td>0.7</td>
<td>0.04</td>
<td>0.2</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>1–2 years, P95</td>
<td>1.4</td>
<td>0.2 / 0.7*</td>
<td>0.2</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>3–10 years, mean</td>
<td>0.5</td>
<td>0.05</td>
<td>0.1</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>3–10 years, P95</td>
<td>0.8</td>
<td>0.2 / 0.6*</td>
<td>0.2</td>
<td>0.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Adults, mean</td>
<td>0.2</td>
<td>0.03</td>
<td>0.06</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Adults, P95</td>
<td>0.4</td>
<td>0.2 / 0.3*</td>
<td>0.1</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>EFSA assessment year</td>
<td>2014</td>
<td>2012</td>
<td>2012</td>
<td>2012</td>
<td>2012</td>
</tr>
<tr>
<td>TDI or BMDL</td>
<td>0.3 – 8 3 (2 – 7)</td>
<td>0.19</td>
<td>0.57</td>
<td>0.36</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Values are EU member state median values (middle bound)

(*) consumers only
From exposure to single compounds to cumulative risk

• Assumed additive (1+1=2) effect on:
  – Nervous system damage (Pb, MeHg, iAs, Cd)
  – Kidney damage (Cd, Pb, iAs, iHg)

• Literature data on dose-response

• Cumulative effect:
  – $A \times Cd + B \times Pb + C \times iAs + D \times Hg$ (iHg or MeHg)
  – Factors A to D may be very different depending on toxicity of chemical to this tissue

• Consumption * cumulative concentration (on MCRA)

• Compare: CRA on pesticides
  – TEF’s for each compound → Total risk for mixture

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Cumulative risk of heavy metals

• Cumulative risk with neurotoxic endpoint
  – Dose-response values Pb < MeHg < Cd < iAs
  – Total cumulative exposure mainly from Pb
  – Contribution of Cd 16 – 21% and of iAs 6 – 8%
  – Contribution of MeHg 1 – 3% for age group median, for high users contribution of MeHg increases

• For kidney damage endpoint, dose-response values varied more. Main contributor to total cumulative exposure was Cd.
Cumulative risk of heavy metals: problems

• Toxicological data on chosen endpoints from literature
  **PROBLEM**: lack of comparable quantitative data
  → e.g. level of enzyme in urine vs. kidney weight change
  → source of error in the estimation

• More toxicological research needed to confirm results!

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Risk assessment project group (all from Evira RISK):
Johanna Suomi, Pirkko Tuominen, Kirsti Savela

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– Ministry of Agriculture and Forestry
– National Institute for Health and Welfare

Risk assessment report on the project to be published in September/October 2015 (www.evira.fi)
– Finnish, with extended English summary

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Thank you for your kind attention!