HBM surveillance program for PCBs and heavy metals in the Czech Republic

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Introduction

In the Czech Republic, the Human Biomonitoring Project (CZ-HBM) was launched in 1994 as an integral part of the nationwide Environmental Health Monitoring System (EHMS).

The EHMS is an integrated survey connecting monitoring of environmental pollution, dietary exposure, biomonitoring, monitoring of health status of the Czech population, soil contamination and occupational health.

The CZ-HBM itself does not cover the whole country, but it is oriented on population living in selected urban/suburban areas (see map).
A map of monitored areas

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Legislation of EHMS/HBM

Resolution No. 369/91 of the Government of the Czech Republic


Act No: 258/2000 on Public Health Protection

The system has been operated under the guaranty of Ministry of Health

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Structure of EHMS

EHMS consists of eight subsystems (projects)

- Health effects and risks of air pollution
- Health effects and risks of drinking water pollution
- Health risks related to urban soil contamination
- Health effects and risks of dietary exposure
- Human biomonitoring (HBM)
- Health status and health determinants
- Health effects and risks of occupational environment
- Harmful effects of ambient noise
Objectives of the CZ-HBM

• To assess the current internal exposure of the Czech population to important environmental pollutants and to evaluate their determinants (age, region, gender etc.).
• To follow up long-term time trends.
• To establish reference values.
• To generate data necessary for preventive measures and control of their effectiveness.
• To use these data for health risk assessment.
• To produce data essential for international comparison and regulation (e.g. Stockholm Convention for POPs)
Selected matrices and biomarkers

Altogether three groups of biomarkers are regularly monitored:

1) **heavy metals** (Pb, Cd, Hg) and essential elements (Cu, Se, Zn) in blood and urine of adults and children,

2) **indicator PCBs, DDT, DDE, HCB and HCHs** in human milk and blood serum of adults,

3) **chromosomal aberrations** in peripheral lymphocytes in blood of adults and children.

Some biomarkers were introduced into system irregularly (e.g., ochratoxin A in serum, aflatoxin M in urine, As in urine, Mn in blood, iodine in urine, cotinine in urine, PCDDs/DFs in human milk or subcutaneous fat).

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The reasons for selection of given biomarkers (1)

Toxic metals:

Pb – use of leaded petrol (till 2001), existing leaded water pipes in some houses

Cd – dietary exposure (use of phosphate fertilizers contaminated with Cd in the past, smoking habit (about 30% of adults)

Hg – industrial utilization, use of amalgam filling in dental care
The reasons for selection of given biomarkers (2)

Essential trace elements:

Se – insufficient saturation of the Czech population
   possible interaction with Cd
Zn – possible interaction with toxic metals
Cu – possible interaction with toxic metals
The reasons for selection of given biomarkers (3)

PCBs - they were produced in former Czechoslovakia until 1984 and intensively used in industry. WHO study in 1992 has shown high levels of PCBs in human milk from hot spot areas.

DDT - it was used frequently in 1950s as insecticide and is still found in some food commodities.

HCB and HCHs

This group of compounds has been later included among the POPs regulated by Stockholm convention.
The reasons for selection of given biomarkers (4)

Cytogenetic analysis of blood peripheral lymphocytes

- used in the CR since 1975s as a collective biological exposure test (biomarker) for occupational exposure to genotoxic factors; it was necessary to have comparable data from general population (biomarker of exposure)
- according to epidemiological studies, higher levels of chromosomal aberrations correlate with increased risk of oncological diseases (biomarker of effect)
QAQC

Fieldwork manual
SOPs for sampling, manipulation with samples and analyses
Accreditation of the labs at the Czech Institute for Accreditation and their participation in the international comparison investigations)
Analysis of each analyte in one lab only (prevention of interlaboratory variability

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Ethical issues

„Primum non nocere“ (no harm for participants)
Benefit for public health
Protection of personality
Data protection
Right to know (and not to know)

Approval by the Ethical Committee
Information letter and written consent
Coding system

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Data communication and dissemination

To policymakers
To decision-makers in public health protection
To decision-makers in environmental protection
To health care public (general practitioners, pediatricians, hygienists, public health professionals etc.)
To general public
To NGO
To individual body fluids and tissues donors

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Are the CZ-HBM results helpful for preventive actions?

The results of the CZ-HBM are used:

1) For documentation of downward trends of internal exposure to several environmental chemicals (e.g. lead, cadmium in nonsmoker or chlorinated pesticides or PCBs in human milk
Blood lead levels (in ug/L) of the Czech adults – time trends

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Blood cadmium levels in adults, 2005 - 2009

<table>
<thead>
<tr>
<th>Smokers</th>
<th>Non-smokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>Median</td>
</tr>
<tr>
<td>1.30</td>
<td>0.50</td>
</tr>
<tr>
<td>1.02</td>
<td>0.30</td>
</tr>
<tr>
<td>0.97</td>
<td>0.30</td>
</tr>
</tbody>
</table>

[µg/L]
Reference values of indicator PCB 153 in human milk fat: changes in time
Are the CZ-HBM results helpful for preventive actions?

2) The slight increase of blood cadmium and urine cotinine levels in passive smokers may help in enforcement of legislative regulation of environmental exposure to tabacco smoke. However, our politicians are very resistant to these arguments.

- Smokers: 1.02 µg/l (median)
- Passive smokers: 0.5 µg/l (median)
- Nonsmokers: 0.3 µg/l (median)
Urinary cotinine concentration in smokers, passive smokers and nonsmokers, 2007

- Smokers: 94 mg/g creatinine (median)
- Passive smokers: 49 mg/g creatinine (median)
- Nonsmokers: 28.4 mg/g creatinine (median)
Are the CZ-HBM results helpful for preventive actions?

3) Upward trend of blood selenium levels in adults in the last few years as compared with the data from 1990s.

No increase in selenium saturation was observed in children or seniors.
Blood selenium levels (ug/l) of adults

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Blood selenium levels in seniors compared with CZ-HBM adults

- Grant IGA - seniors
- MZSO, 2009

<table>
<thead>
<tr>
<th></th>
<th>Grant IGA - seniors</th>
<th>MZSO, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muži</td>
<td>75 µg/l (geom. průmě)</td>
<td>110 µg/l</td>
</tr>
<tr>
<td>Ženy</td>
<td>74 µg/l (geom. průmě)</td>
<td></td>
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<tr>
<td>Muži a ženy - celkem</td>
<td></td>
<td></td>
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</tbody>
</table>
Are the CZ-HBM results helpful for preventive actions?

4) Descending time trend in blood mercury levels was observed in the last 3 years.
   Blood mercury levels were higher in women than in men.
   In a few of women in reproductive age (less than 45 y) the blood mercury exceeded the stricter limit value of 3.4 ug/l recommended by the Nat. Res. Council in 2000 for women in reproductive age.
   It means that more attention is necessary to pay to this problem.

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Blood mercury levels in adults, 2005 - 2009

Median  25%-75% percentile  5%-95% percentile

<table>
<thead>
<tr>
<th>Year</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0.91</td>
<td>0.89</td>
</tr>
<tr>
<td>2007</td>
<td>0.85</td>
<td>0.75</td>
</tr>
<tr>
<td>2009</td>
<td>0.60</td>
<td></td>
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</tbody>
</table>
Blood mercury level in women of reproductive age – the percentage of women over limit value of 3.4 ug/l
Are the CZ-HBM results helpful for preventive actions?

5) The monitoring of PCBs and selected chlorinated pesticides in human milk is an important part of the performance of Stockholm convention by the Czech republic. Moreover, the data are used in the National implementation plan for regulation of POPs. Though the PCB body burden of the Czech population is somewhat higher than in most other European countries, downward trend is observed even in hot-spot location.
Polychlorinated biphenyls in human milk, indicator congener PCB 153
median value, 1996 - 2008

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Time-related trend of PCB 153 levels in human milk from hot-spot Uherské Hradiště

- Median

<table>
<thead>
<tr>
<th>Year</th>
<th>Median (ng/g fat)</th>
</tr>
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<tbody>
<tr>
<td>WHO UH 1992</td>
<td>425</td>
</tr>
<tr>
<td>WHO UH 2000</td>
<td>379</td>
</tr>
<tr>
<td>WHO UH 2005</td>
<td>262</td>
</tr>
</tbody>
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11% decrease from 1992 to 2000, 30% decrease from 2000 to 2005.

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CZ-HBM

Cooperation with EU projects:

ESBIO
PHIME
INTARESE
CASCADE

Cophes/Democophes

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HBM participants

NIPH:
R. Kubínová
   EHMS coordinator
M. Černá, A. Krsková
   HBM coordinators
Laboratory staff

Regional Publ. Health Institutes:
Staff for field work, sampling, questionnaires, analyses of POPs, communication with general public etc.

Many donors of body fluids and tissues

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Thank you for your attention