Gevolgen van zeer zorgwekkende stoffen voor de Gezondheid: Human biomonitoring

Greet Schoeters
VITO health
KEEPING AN EYE ON CHEMICALS

- Eurostat: about **30 M t of carcinogenic, mutagenic and reprotoxic** Chemicals produced in 2009
- > 90 000 registration dossiers under REACH in Europe
- 70% of checked dossiers were not compliant
- 197 chemicals on the candidate list of substances of very high concern
- 42 substances regulated between 2014 and 2017

Chemicals at home, in work environment → 1.3 million deaths from NCDs in 2016,
  - cardiovascular diseases,
  - Chronic obstructive pulmonary disease
  - cancers.

Neurological and mental disorders: lead, arsenic, mercury, PCBs, organophosphate pesticides
Phthalates: diabetes type 2, male infertility,

*Pruss-Ustun A. BMJ, 2019*
*Trasande et al, J Clin Endocrinol Metab. 2015*
Human biomonitoring measures chemicals, their metabolites or reaction products in human tissues.

Dose = f (C environment, behaviour, kinetics, personal characteristics)
HUMAN BIOMONITORING: FROM EXPOSURE TO EFFECT

Environmental - food monitoring → biomarkers of exposure → biomarkers of effects → adverse health effects

- Air
- Dust
- Consumer products
- Water
- Food

Pollutant levels in:
- Blood
- Urine
- Hair
- Saliva
- Exhaled breath

Changes in:
- Hormone levels
- Gene expression
- Epigenetic changes
- DNA damage

Specificity

Health relevance

- Fertility
- Growth
- Immune responses
- Cancer
- Death
THE FLEMISH HUMAN BIOMONITORING PROGRAM (FLEHS)

2002-2006

2007-2011

2012-2015

2016-2020

Financed by the Flemish Dept. of Science and Innovation, Nature and Energy and the Agency for Care and Health (FLEHS I, II, III), and by the Department of Environment (FLEHS IV)
15 years of follow up of general population
3 hot spots
More than 5500 participants
samples stored in biobank

More than 50 biomarkers of exposure and effects
*POPs, heavy metals, organophosphates, pyrethroids, phthalates, musks, perfluorinated compounds, glyphosate,*
...

**Structured policy translation process**

www.milieu-en-gezondheid.be
PERSONAL CHARACTERISTICS

FLEHS II adolescents: DDE exposure determinants

![Diagram showing serum p,p'-DDE (ng/g vet) - geometric mean per subgroup](image)

- **Gender:** $p=0.25$
- **Age:** $p=0.72$
- **Education:** $p=0.01$
- **BMI class:** $p=0.003$
- **Breastfeeding:** $p<0.001$
- **Local eggs:** $p=0.02$
PERSONAL ENVIRONMENTAL CHARACTERISTICS

Tobacco smoke and PAH levels in adolescents FLEHS III
DIETARY HABITS

**FLEHS II, 2009**

**FLEHS III, 2013**

% change in serum levels compared to ‘never’

- DDE and local food
- p,p’-DDT
- PFOS

Consumption of home produced eggs

**Dietary Habits**

- p,p’-DDT
- PFOS

**FLEHS II, 2009**

**FLEHS III, 2013**

- never
- less than weekly
- more than weekly

- p,p’-DDT
- PFOS

Consumption of home produced eggs
% change in urine levels compared to 'no wall paper in the house'
Flemish center of expertise on E&H: FLEHS IV

FLEHS IV: ECOBEHAVIOUR

Human biomonitoring:
internal exposure to environmental substances & Effects on health

Emerging chemicals

Green spaces

Eco-behavior

Changing environment
- built environment
- proximity to green
- proximity to blue
- organic food
- home grown food (city gardening)
- ventilation
- aeration
- eco-friendly materials
...

Universiteit Antwerpen
VITO
VUB
Universiteit Hasselt
Universiteit Gent
KU Leuven
Provincie Antwerpen
## SES AND CHEMICAL EXPOSURES

### Mothers of Newborns (FLEHS III- 2014)

<table>
<thead>
<tr>
<th>Lower education vs high education</th>
<th>Low income vs high income</th>
<th>Non-EU origin vs Belgian origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lood (+35%)</td>
<td>Lood (+20%)</td>
<td>Lood (+49%)</td>
</tr>
<tr>
<td>Arseen (-7%)</td>
<td>Cadmium (+25%)</td>
<td>Mangaan (+18%)</td>
</tr>
<tr>
<td>PCB's (-24%)</td>
<td>PCB's (-24%)</td>
<td>Thallium (+7%)</td>
</tr>
<tr>
<td>Oxychlorodaan (-16%)</td>
<td>Oxychlorodaan (-18%)</td>
<td>Lindaan (+47%)</td>
</tr>
<tr>
<td>PFOS (-26%)</td>
<td>Lindaan (-13%)</td>
<td>DDE (+48%)</td>
</tr>
<tr>
<td></td>
<td>PFOS (-33%)</td>
<td>Oxychlorodaan (-25%)</td>
</tr>
</tbody>
</table>

**Inverse social gradient:** low SES → higher exposure

**Positive social gradient:** high SES → higher exposure

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BEHAVIOUR AND LIFE STYLE INFLUENCE CHEMICAL LOADS

Expensive textiles
Herzke, 2012
Tyrrell, 2013

Fish and shellfish consumption
Tyrrell, 2013
Castano, 2015

Use of sunscreen
Tyrrell, 2013
Castano, 2015

Smoking, occupation and diet
Tyrrell, 2013

Canned food
Arbuckle, 2015

PVC floors and walls
Geens, 2014
Larsson, 2014

\( \text{Expensive textiles} \)

\( \text{Fish and shellfish consumption} \)

\( \text{Use of sunscreen} \)

\( \text{Smoking, occupation and diet} \)

\( \text{Canned food} \)

\( \text{PVC floors and walls} \)
TIME TRENDS IN ADOLESCENTS (GEOMETRIC MEANS AND 95% CI)

**POPs**
- pp'-DDE
- PCB138+153+180
- HCB

(n=200)

**METALS**
- Pb
- Cd

**PAHs**
- 1-hydroxypyrene
- benzene
TIME TRENDS IN NEWBORN CORD SAMPLES
(GEOMETRIC MEANS + 95% CI)

Arsenic in µg/L adjusted for age and smoking mother

PFOA in µg/L

PFOS in µg/L

adjusted for age and BMI mother
Higher concentrations of PFOA were associated with greater risk of SGA (adjusted OR of 1.64 [95% CI: 0.97–2.76]).

<table>
<thead>
<tr>
<th>Exposure</th>
<th>IQR (ng/L)</th>
<th>Model</th>
<th>OR (95% CI)</th>
<th>#SGA</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS</td>
<td>1808</td>
<td>Global estimate</td>
<td>0.823 (0.742–0.913)</td>
<td>63</td>
<td>657</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate non-smoking</td>
<td>0.861 (0.611–0.717)</td>
<td>49</td>
<td>573</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate smoking</td>
<td>1.627 (1.024–2.588)</td>
<td>14</td>
<td>84</td>
</tr>
<tr>
<td>PFOA</td>
<td>901</td>
<td>Global estimate</td>
<td>1.637 (0.971–2.761)</td>
<td>64</td>
<td>662</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate non-smoking</td>
<td>0.869 (0.869–2.632)</td>
<td>50</td>
<td>578</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate smoking</td>
<td>2.177 (1.022–4.643)</td>
<td>14</td>
<td>84</td>
</tr>
</tbody>
</table>
HUMAN BIOMONITORING FOR EUROPE (HBM4EU)

Timeframe and budget:
5 years (2017-2021)
European Joint Programme under Horizon 2020
Total budget: € 74 million

28 countries and the European Environment Agency:
24 EU Member States
3 associated countries
Switzerland

Coordinated by the German Environment Agency (UBA)
Co-coordinated by VITO

https://www.hbm4eu.eu/
Building on expertise from within the consortium...

- Provide robust, legitimate and credible evidence to support policy making
- Harmonise approaches to human biomonitoring
  - Produce comparable datasets representative of the European population
- Linking to sources
  - Linking to health
  - Mixtures
  - Emerging chemicals
First round
Prioritisation 2016

9 substance groups:

1. Phthalates/DINCH
2. Bisphenols
3. Per-/Polyfluorinated
4. Flame Retardants
5. Cadmium & Chromium
6. PAHs and air pollutants
7. Anilin family: MOCA
8. Chemical mixtures
9. Emerging chemicals

Second round
Prioritisation 2018

9 substance groups:

1. Acrylamide
2. Aprotic solvents
3. Arsenic
4. Diisocyananites
5. Lead
6. Mercury
7. Mycotoxines
8. Pesticides
9. UV filters
Generate new harmonized data on recent exposure (2014-2018)

27 European countries- 497 Million inhabitants

2 - 3 sampling units selected per region

North - 21%
West - 41%
South – 28%
East-11%

10-11 PSU selected
300 participants per PSU

~2950 Children 6-11 y

Phthalates
DINCH
Flame retardants

NO
DK
FR
DE
NL
IT
SL
EL
HU
SK
PL

~2900 Teenagers 12-18 y

Phthalates
DINCH
PFASs

NO
SE
FR
DE
BE
ES
SL
EL
CZ
PL
SK

~3165 Adults 19--39 y

Bisphenols
Cadmium
PAHsW

DK
FI
IS
FR
CH
DE
LU
PT
HR
CZ
PL
21 mei 2019, Antwerpen

Complexe blootstellingen in een complexe omgeving – een uitdaging?