The Flemish Human biomonitoring program
the causal chain: from exposure to effects

Wij doen mee aan de meetcampagne van het Steunpunt Milieu en Gezondheid.
Jij ook?

www.milieu-en-gezondheid.be
Steunpunt Milieu en Gezondheid, in opdracht van de Vlaamse Gemeenschap
Tel.: 014/33 51 07 VITO

G. Schoeters VITO Belgium
## Flanders ‘fields’

<table>
<thead>
<tr>
<th></th>
<th>Flanders</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants/km² (‘98)</td>
<td>446</td>
<td>116</td>
</tr>
<tr>
<td>private cars/km² (’00)</td>
<td>205</td>
<td>52</td>
</tr>
<tr>
<td>km motorways/100 km² (’99)</td>
<td>472</td>
<td>108</td>
</tr>
</tbody>
</table>
The Flemish government:

1. Can set up a network for surveillance of exposure (measured in humans) and/or effects of exposure to physical and chemical factors in the population, with the intention to take measures to protect public health.

2. Takes at least measures for the development and execution of a program for biomonitoring.

3. Can - in execution of §1 - set up a fund (...). For this purpose a mandatory financial contribution can be imposed on industries or citizens that are responsible for the presence of physical or chemical factors harmful to health.
Goals

• Develop a surveillance program for environmental health → policy support
  
  – Identify “base line values” or “reference values” for environmental pollutants in the Flemish population
  
  – Has the area of residence an impact on the internal pollutant levels and potential biological effects?
  
  – Can we find a relation between exposure and early effect at the current exposure levels?
Selection of population

- Flemish biomonitoring campaign
  - 2002-2006
  - 3 age groups

- Cancer risk
- Asthma & allergy
- Puberty development
- Asthma & allergy
- Growth & Development
  - Fertility
  - Asthma & allergy
- Exposure at start of life
- Exposure to traffic, life environment
- Accumulating exposures
- Cancer risk
  - Asthma & allergy

- Adolescents
- Newborns
- Adults
Recruitment

- **1200 Newborns and mothers**
  - Cord blood – questionnaires
  - Medical files of maternity

- **1600 Adolescents (14-15y)**
  - Blood – urine – questionnaires
  - Medical files of school doctors

- **1600 Elderly Adults (50-65y)**
  - Period: Sept. 2004 – June 2005
  - Blood – urine – questionnaires
Study areas:

8 study areas in Flanders with typical and different environmental load

- **Urban regions**
  - Antwerp
  - Ghent

- **Rural areas**
  - Rural Flanders
  - Fruit orchard region

- **Industrial areas**
  - Seaport Antwerp/Ghent
  - Non ferro metalurgic
  - Petrochemical
  - Waste incinerator regions

Representing 20% of the Flanders region
Study areas

8 study areas in Flanders with typical and different environmental load:

1. Conurbation of Antwerp
2. Conurbation of Gent
   IRCEL environmental monitoring network
3. Seaport of Antwerp and Gent
4. Rural area
   population density <250 persons/km², < 5% industry, no motorways, no data in emission register

1. Fruit Region
   apple+fruit: > 10 ha/km²
2. Incinerators
   SS with smoke emission > 1.20 mg /m³
3. Olen (Non Ferro)
   SS with lead emission > 0.9 ng / m³ (> Olen)
4. Albertcanal (Petrochemica)
   SS with emission of a fictive pollutants
   Eindhoven
## Characteristics of population

<table>
<thead>
<tr>
<th></th>
<th>Newborns &amp; mothers</th>
<th>Adolescents</th>
<th>Elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) – range</td>
<td>18-44</td>
<td>14-15</td>
<td>50-65</td>
</tr>
<tr>
<td>Age (years) - mean</td>
<td>29.6</td>
<td>14.9</td>
<td>57.6</td>
</tr>
<tr>
<td>% women</td>
<td>100%</td>
<td>47%</td>
<td>51%</td>
</tr>
<tr>
<td>% smokers</td>
<td>15%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>Mean BMI (kg/m²)</td>
<td>23.3</td>
<td>20.5</td>
<td>26.9</td>
</tr>
<tr>
<td>Higher education</td>
<td>22%</td>
<td>49%</td>
<td>32%</td>
</tr>
<tr>
<td>Use of local food</td>
<td>42%</td>
<td>51%</td>
<td>49%</td>
</tr>
</tbody>
</table>
Biomarkers of exposure
Biomarkers of exposure

Persistent chlorinated compounds (serum)
- Dioxin-like compounds (pg Calux TEQ/g fat)
- Marker PCBs 138.153 & 180 (ng/g fat)
- p,p’-DDE (ng/g fat)
- Hexachlorobenzene (ng/g fat)

Heavy metals (blood & urine)
- Blood lead (µg/L)
- Blood cadmium (µg/L)
- Urinary cadmium (µg/g creatinine)

Metabolites of PAH and benzene (urine)
- 1-hydroxy-pyrene (ng/g creatinine)
- t,t’-muconic acid (µg/g creatinine)
Comparison with health based action limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Adolescents</th>
<th>Elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood lead &gt; 100 µg/L</td>
<td>0.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Blood cadmium &gt; 5 µg/L</td>
<td>0%</td>
<td>n=1</td>
</tr>
<tr>
<td>Urinary cadmium &gt; 2 µg/g crt</td>
<td>-</td>
<td>2.3%</td>
</tr>
<tr>
<td>Urinary 1-OH-pyrene &gt; 2 µg/g crt</td>
<td>0.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Urinary t,t’-MA &gt; 0.5 µg/g crt</td>
<td>3.5%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>
Exposure: conclusions

- Area of residence is a determinant of exposure
- No alarming trends were detected
- People living in rural areas have high exposure to persistent chlorinated compounds
- Cadmium is problematic in some regions
- Although DDT is forbidden, metabolites are still detected in the human body in considerable amounts
- Factors such as age, gender, smoking and nutritional intake are important determinants of exposure
Biomarkers of effect

Asthma and allergy
Endocrine effect markers
Genotoxic effect markers
Biomarkers of effect

• Extra monitoring instrument:
  – Large number of pollutants in the environment
  – Limited possibility for analysis: technically and financially
  – Pollutants with the same mechanism of action in the body
Biomarkers of effect

• Early markers for important health problems
  – Asthma and allergy
  – Endocrine effect
    Hormone disruption: TSH, sex hormones,
    • Diabetes
    • Puberty
    • Fertility, time to pregnancy
    • Miscarriages
  – Genotoxic effect
    • Tumor markers (CEA, P53, PSA for men)
    • DNA damage (Komet assay, micronucleustest, 8OHdeoxyguanosine)
# Asthma & allergy – reference means

<table>
<thead>
<tr>
<th>Condition</th>
<th>Adolesc.</th>
<th>14-15 y.</th>
<th>18-44 y.</th>
<th>50-65 y.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma - doctor</td>
<td>8.8%</td>
<td>4.3%</td>
<td>5.5%</td>
<td></td>
</tr>
<tr>
<td>Asthma - ever</td>
<td>25.3%</td>
<td>16.2%</td>
<td>15.3%</td>
<td></td>
</tr>
<tr>
<td>Hay fever - doctor</td>
<td>22.8%</td>
<td>34.2%</td>
<td>21.4%</td>
<td></td>
</tr>
<tr>
<td>Food allergy</td>
<td>25.5%</td>
<td>7.0%</td>
<td>22.7%</td>
<td></td>
</tr>
<tr>
<td>Contact allergy</td>
<td>21.5%</td>
<td>11.3%</td>
<td>24.9%</td>
<td></td>
</tr>
<tr>
<td>Allergy for animals</td>
<td>10.8%</td>
<td>12.0%</td>
<td>1.1%</td>
<td></td>
</tr>
</tbody>
</table>
Endocrine effects

- Thyroid hormones (♀ & ♂) and sex hormones (♂)
- Age at menarche (♀) and pubertal stages of Marshall and Tanner (♀ & ♂)
  - validation against questionnaires and blood hormones

![Graphs showing testosterone levels and breast development in adolescents.](chart.png)
Health effects: conclusions

- Asthma and allergy occur frequently in Flanders; regional differences are present between cities and rural areas.

- Some endocrine and genotoxic markers differ between regions, but the clinical relevance is probably low.

- Several dose-response relationships were detected:
  - asthma and allergy vs. heavy metals and chlorinated persistent pollutants
  - endocrine effects vs. lead and chlorinated persistent pollutants
  - genotoxic markers vs. heavy metals and PAHs
Follow-up research programs (health effects)

• Neuro-psychological development of children
  • 209 children
  • 42 months
  • 4 areas (Rural, Non ferro, Waste incinerators, Harbours)

  *Dr. M. Viaene- OPZ Geel*

  – Asthma and allergy
  • 36 months
  • 145 children
  • 2 areas (Rural, Antwerp city)

  *Prof K. Desager (UZA) & Dr. V. Nelen (PIH)*
Policy support

• Follow-up programs (Policy support)
  – Multiphase approach
    • Phase 0: Identification of deviating HBM values;
    • Phase 1: Evaluation of the severity of deviations with regard to seriousness and priority;
    • Phase 2: Identification of the cause of the deviation, potential sources
    • Phase 3: Proposal of policy and risk management options
Multidisciplinary team operating via a fieldwork committee

- Biomonitoring
- Impact assessment
- coördination
- fieldwork
- toxicology
- Foodintake
- Health registers
- Statistical analysis
- communication

http://www.milieu-en-gezondheid.be
HBM a participatory process based on transparency and openness

- Approval by ethical and privacy commission
- Communication of individual results to the participants
- Communication of collective results to participants, policy makers, local authorities and large public
- Information network including MMKs
- BIOMONITOR newsletters
- Web site http://www.milieu-en-gezondheid.be
Health in the centre of environmental policy

Development of an environmental health care system

- Monitoring
- Evaluation: action plan
- Remediation
- Advice
- Legal actions
- Follow up
Scientific partners

Coordination : Prof. G. Schoeters (VITO)
Field work: Dr V. Nelen and E. Van de Mieroop
Statistics : Prof G. Molenberghs and L. Bruckers (UH)
Toxicology : Dr G. Koppen, Dr E. Den Hond, E. Brits (VITO)
  Prof. W. Baeyens (VUB), Prof N. Van Larebeke (U Ghent)
Astma and allergy: Prof K. Desager; Dr. V. Nelen
Food : Prof G. De Backer , Prof. Dehenauw, M. Bilau, Prof. J. Willems
Communication: Prof I. Loots; Prof L.Goorden; H. Keune;G. Nulens
  (UA)
Registers : Prof. Van loon; Dr. G. Van Kersschaver, C. Reynders

Environment and health admistration : D. Aerts, L. Casteleyn,
  K. Van Campenhout
Health Administration : D. Wildemeersch, H. Chovanova
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26 maternities: midwaves, nurses, pediatricians, gynecologists
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Center for diagnosis of metabolic diseases: Antwerpen, Gent en Brugge
Kind en Gezin
Environmental health professionals