European Conference on Human Biomonitoring
From the use of human biomarkers to human biomonitoring
November 4-5, 2008, Paris, France

Conference organised under the auspices of the
French Presidency of the European Union Council

Conference Report

This report was prepared by Helena Medeiros (h.medeiros@invs.sante.fr) and Anne-Catherine Viso (ac.viso@invs.sante.fr).

The report is based on the conference transcripts and speaker presentations.

We would like to thank all speakers/moderators for allowing us to make use of their presentations.

Conference Programme and presentations are available:
http://www.invs.sante.fr/agenda/biosurveillance_2008/programme_2008.pdf
http://www.invs.sante.fr/publications/2008/biosurveillance/index.html

Highlights and conclusions of the conference are available at
http://ec.europa.eu/environment/health/pdf/hbm_minutes.pdf

INTRODUCTION

In June 2003, the European Environment and Health Strategy was adopted by the European Commission (EC) with the following objectives:

- To reduce the disease burden caused by environmental factors
- To identify and to prevent new health threats caused by environmental factors
- To strengthen the policy making capacity of the European Union in this domain

The Strategy was followed by The Environment and Health Action Plan 2004 - 2010, which was passed in June 2004 and was presented at the Fourth Ministerial Conference on Environment and Health in Budapest in June 2004. Action 3 of the Plan declares the need to develop a coherent approach to Human biomonitoring (HBM) in Europe in close cooperation with the Member States. To assist the EC in the implementation of Action 3, a Technical Working Group (TWG) Biomonitoring of Children was created. The Group consisted of HBM experts from several Member States and is now called the Implementation Group on HBM. The Health Strategy paid particular attention to the potential of HBM. Nevertheless, the report of the HBM working group illustrated that while significant resources have been devoted to collecting data, comparisons between and within countries, remains difficult as methodologies differ.

In order to address these issues, and to work towards a more coherent approach, the Expert Team to Support BIO Monitoring in Europe (ESBIO) produced guidelines with the aim to provide support to countries in the development of their national HBM programmes and to assist in the preparation of the European pilot project. As indicated in the mid-term review of the Action Plan:

> Since 2004, the Commission has collaborated closely with Member States and experts to prepare an EU pilot project on human biomonitoring (HBM) to test out the feasibility of a coherent HBM approach in Europe. The pilot phase is meant to focus on capacity building and harmonisation of procedures, on the future policy role of HBM, and on appropriate communication at individual and at Community level. For the post-pilot phase, the Commission is exploring the possibility to embed future HBM activities in an established framework such as the EU Health Examination Survey and will ensure that HBM is linked to the existing regulatory frameworks.

In addition, the Council of the European Union (Environment) held in Brussels on December 20, 2007 "invites the Commission to ensure adequate funding for the EU pilot project on human biomonitoring (HBM), as endorsed by the mid-term review, in order to implement this project as early as possible, fulfilling the commitment established in the European Environment and Health Action Plan 2004-2010, providing therefore data to develop, adapt and evaluate environmental policies".

Thus, systematic over time, the need for a coordinated approach to HBM in Europe has grown. However, despite extensive debate at the EU level, there is still much work to be undertaken and in particular, there is a need to:

- Share basic definitions with stakeholders as there are no commonly accepted definitions
- Clarify issues related to the significance of guidance, reference, and health-based values
- Better understand the governance of HBM programmes at the national level and in the future at the European level including the distribution of tasks and responsibilities
- Benefit further from the work and practices acquired in occupational health
- Discuss ethical and communication issues with stakeholders including study subjects, the public, and the media
- Provide an appraisal of resources needed at the national, regional or local level to be able to implement long term and sustainable HBM programmes (financial and human resources, mobilisation of scientific competences, infrastructures such as labs and bio banks and access to them, and coupling HBM with other health surveillance activities such as health examination surveys)
- Identify trends in HBM research and their application to environmental health studies

In this context and to clarify these issues a European Conference on Human Biomonitoring was held on November 4th and 5th, 2008 in Paris, France. The conference was organised by the French Institute for Public Health Surveillance (InVS) in collaboration with the French Ministry of Health, Youth, Sport and the Voluntary Sector, under the auspices of the French Presidency of the European Union (June–December 2008). The aim was to bring together stakeholders to demonstrate the usefulness and added value of HBM as a tool for policy and for public health actions and interventions by sharing of experiences based on examples of existing programmes and activities at national or regional level.

The conference was organised around five themes and included 41 speakers from Europe, WHO, the European Commission, Canada and the United States. The agenda is provided in Appendix A and full presentations are available at http://www.invs.sante.fr/publications/2008/biosurveillance/index.html.

Day 1 included Sessions 1-3 and Day 2 included Sessions 4 and 5.

Session 1: Concepts, history and general use: The aim of this session was to bring all participants to the same level of understanding with regards to basic definitions, concepts, reference and health-based values. The session also acknowledged the expertise within occupational health.

Session 2: Human biomonitoring in Environment health policy: The aim was to give an overview of activities implemented by different countries (Spain, UK, France, Czech Republic, Ireland, Cyprus, Belgium (Flanders), Sweden, and Germany). Outcomes of country programmes and challenges for the future were also discussed.

Session 3: Added value of human biomonitoring in environmental health: Based on several examples the added value and potential limitations of HBM were discussed. An evaluation of the cost benefit of HBM versus environmental monitoring was provided as part of the presentation related to the National Children's Study, which is being launched in the US. Efforts, perspectives and the vision of industry (CEFIC) and NGOs (HEAL and the Commonweal Biomonitoring Resource Center) were also presented.

Session 4: Contribution of research to human biomonitoring: The contribution of research and how HBM activities provide information that leads to the identification of knowledge gaps was discussed. Several areas of research were covered including: from the use and limitations of biomarkers of exposure and effects in population, studies to advanced risk assessment modelling techniques.

Research needs were highlighted through their challenging and stimulating potential contribution to HBM.

Session 5: Sustainable organisation of human biomonitoring: If countries are willing to implement programmes, they will need to design resources, programmes and funding in a coherent manner. This will require the exchange and harmonisation of practices between countries in order to avoid duplication. This session illustrated in which context the national programmes were planned, the role of regulatory instruments and the underlying national policies, and the importance of ensuring comparability across Europe.

A summary of the sessions and highlights of the presentations are presented in the sections that follow. Copies of all presentations are available at

http://www.invs.sante.fr/publications/2008/biosurveillance/index.html.

SESSION 1: CONCEPTS, HISTORY AND GENERAL USE

The aim of this session was to bring the conference participants to the same level of understanding with regards to HBM definitions and concepts, in particular with regards to reference values for a given population and to health-based values and the session acknowledged the expertise within occupational health.

Moderated by Ovnair SEPAI from the Health Protection Agency in the United Kingdom, the session was composed of four presentations.

Presentations

1. Introduction to human biomonitoring and biomarkers
2. Human biomonitoring in the framework of the European Environment and Health Action Plan
3. Human biomonitoring in occupational health: lessons for environmental health
4. Human biomonitoring and reference values, German HBM Commission: mandate and achievements

Key Issues

- importance of definitions in particular with regards to different types of guidance values for action and methods used to derive these values (either reference values for a given population or health-based values)
- importance of continuous update of the reference values
- sharing achievements of the German HBM Commission (set up in 1992) in particular with regards to the development of health-based values that could be used by other countries (for lead, mercury, PCP, DEHP in blood, urine and human milk). The mandate of the German Commission is to support the Federal Environment Agency (UBA) in its work by providing expert opinion, to advice local health authorities, to advice physicians in environmental medicine, to comment HBM related topics in environmental medicine. Its main task is to harmonise assessment of exposure and risks, to look at the sound use of chemical analysis, to derive guidance values (reference and HBM values).
- differences between occupational health and environmental health practices as well as lessons learned from occupational health that could benefit environmental health

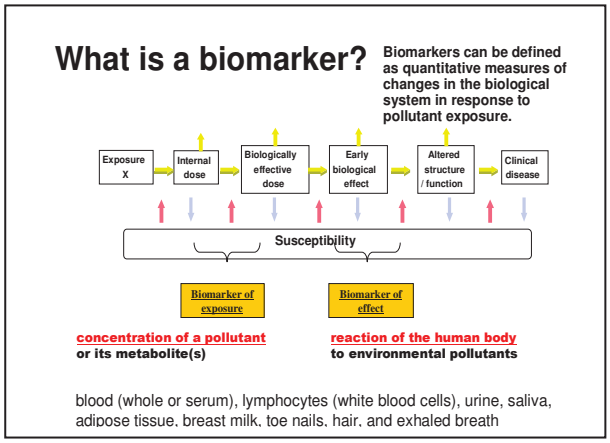
Introduction to human biomonitoring and biomarkers

Ludwine CASTELEYN
Center for Human Genetics, University of Leuven, Belgium

As HBM encompasses scientists from different fields, there are often different understandings of the same terms and a common definition for HBM is currently not available.

To clarify the terms and to ensure that the participants used the same definitions the first speaker introduced definitions used in HBM.

HBM began in occupational health after the Second World War at which time many countries introduced mandatory medical surveillance of workers. As workplaces evolved and techniques became available, it became a tool that was used in preventive strategy to protect the health of workers.



Over time, it was also introduced into the field of environmental health (EH). In environmental health, HBM is used as a tool in three different types of activities and it is important to make a distinction between the three activities as they have different objectives and study designs:

What is Human Biomonitoring?

"Monitoring activities, using biomarkers, that focus on environmental exposures, diseases and/or disorders and genetic susceptibility, and their potential relationships" (European Commission) [1]

"…a method of assessing human exposure to chemicals by measuring the chemicals or their metabolites in human tissues or specimens, such as blood and urine" (NRC) [2]

1. ***Survey projects***: which provide information on the prevalence of exposure to environmental agents and the related public health impact and are intended to develop and evaluate health protection policies
2. ***Research projects:*** that seek the causal links between exposure and disease and hypothesis generation and testing
3. ***Awareness-raising projects***: that raise awareness and bring HBM to the attention of the media and the general population

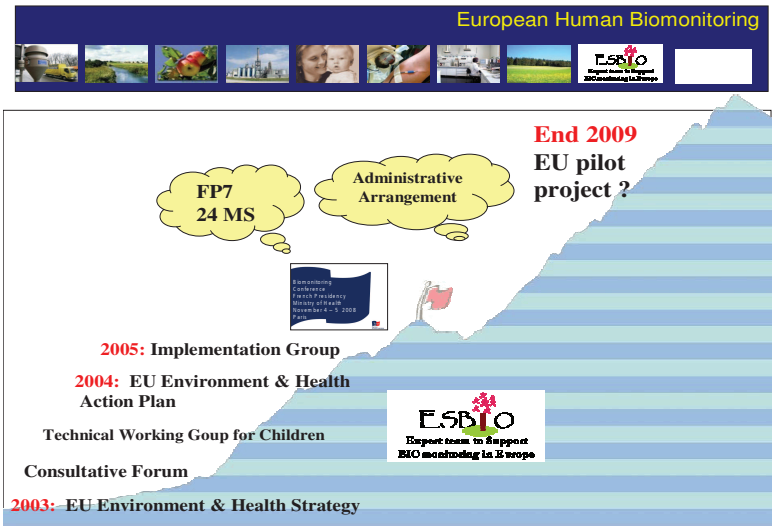
From an overall perspective, HBM is closer to health than is environmental monitoring and it integrates studies of the chemical contributions from various sources of exposure into the human body. Close to the individual, HBM may be a trigger for action. The effect of measurements can have a powerful effect for preventive measures at a political level and has raised awareness at a societal level for NGOs. It is a message to the population that policy-makers care about the problems caused by pollution. The full potential of the HBM tool has yet to be realised and numerous challenges exist including:

> "The complete potential of this tool has yet to be realized, in as much as the science (epidemiology, toxicology, pharmacokinetic modelling, and exposure assessment) needed to understand the implications of biomonitoring data for human health is still in its nascent stages. For most of the chemicals currently measured, the risks cannot be interpreted. Tremendous ethical and communication challenges exist." [3]

Human Biomonitoring in the Framework of the European Environment and Health Action Plan

Birgit VAN TONGELEN
European Commission, DG Environment

The second speaker was Birgit Van Tongelen from the European Commission (DG Environment) who discussed HBM in the framework of the European Environment and Health Action Plan. The focus in this presentation was on the value of HBM in environment and health policy, the progress of the Action Plan since 2003, and on the outlook for the future.



In the European Union Commission Directorate General for Environment, HBM is a priority area and as such, the Commission has undertaken numerous actions. The first step was the adoption in 2003 of the European Environment and Health Strategy. In this strategy, HBM was identified as an essential element in the strategy to integrate environment and health.

To assist in this endeavour a technical working group (TWG) on biomonitoring of children was established. The mandate of the group was to establish a baseline on the current situation of HBM in Europe and devise options for action. The group prepared two reports:

1. Baseline Report On Biomonitoring Of Children (December 2003)
2. Options For Action On Biomonitoring Of Children (March 2004)

The TWG concluded that biomonitoring can provide useful information on total exposure to environmental pollutants and that HBM can contribute to policy needs by:

- Identify emerging issues
- Assessing the extent of environmental health problems
- Evaluating policies, and assessing the effectiveness of policies (analysis of time trends)
- Developing geographically differentiated environmental health policy (analysis of spatial trends)

Based on these reports the Commission included in the Action Plan, which was adopted in 2004, a specific action (Action 3) on HBM. There are three main objectives in the Action Plan:

1. Improve the information chain:
    i. Develop environmental health indicators
    ii. Develop integrated monitoring of the environment to allow determination of relevant human exposure
    iii. Develop a coherent approach to human biomonitoring in Europe
    iv. Enhance coordination and joint activities on environmental health

2. Fill the knowledge gap:
    i. Integrate and strengthen European Environmental Health research
    ii. Target research on diseases, disorders and exposures
    iii. Develop methodological systems to analyse interactions between environmental health
    iv. Ensure that potential hazards on environmental health are identified and addressed

3. Review policies and improve communication:
    i. Develop public health activities and networking on environmental health determinants through the PHP
    ii. Promote training of professionals and improve organisational capacity in environmental health by reviewing and adjusting risk reduction policy
    iii. Coordinate ongoing risk reduction measures and focus on the priority diseases
    iv. Improve indoor air quality
    v. Follow developments regarding electromagnetic fields

Furthermore, in Action 3, the Commission stated that it would develop, in close co-operation with Member States, a coherent approach to HBM in Europe and that a Pilot Project to test the feasibility of a European HBM approach would be launched. The pilot project was deemed a necessary owing to the fact that in several Member States HBM activities are ongoing but use different methodologies, which hinders the ability to use the data at the EU level to support policy. The main recommendation was for a coherent harmonised approach.

In the implementation of the Action Plan, the Commission aimed to have a transparent process that involved Member States and to further this the TWG and a Consultative Forum on Environment and Health was established. The Consultative Forum has been an important player in this process and ensures the interface and knowledge exchange between scientists and decision makers. The Commission had high expectations for the Consultative Forum. In a meeting in 2005, the Consultative Forum indicated that HBM is very promising for policy purposes and the Consultative Forum was mentioned in the REACH Framework, the POPS convention and in the WHO breast milk survey.

Support for the EU HBM policy has also been aided by the support received from other EU institutions such as the EU Parliament, which stressed the role of HBM in risk assessment, and the European Economic and Social committee, which in its opinion in 2004 urged the Commission to further establish HBM as a tool for policymaking. In a Council Conclusion on December 20, 2007, it stated, "the Council invites the Commission to ensure adequate funding for the EU pilot project on human biomonitoring." In an EU Parliament Resolution on September 4, 2008, it stated: "the EU Parliament deeply regrets the fact that the Commission has not provided sufficient funding for human biomonitoring in 2008."

The next step in the process was the preparation of the Pilot Project. This was a complex project as it encompasses technical, political and financial aspects and it functions at the both the member state and European levels. In 2005, the research project (ESBIO) was launched under the 6th Framework Program and terminated on October 2007. The aim of the project was to provide guidelines for an EU coordinated approach, to deal with issues such as data integration, communication, ethics, HBM inventory and the relevance of biomarkers. The final aim being to test the feasibility of a European approach to HBM. The recommendation made by the project was for a coherent, harmonised approach among Member States.

In 2006, a call for proposals for an EU network on HBM was launched. In response to this call, a proposal was submitted (COPHES) which was a consortium of 24 Member States. Unfortunately, the proposal was not selected for funding. In 2008, there was another call for proposals, and a new proposal has been submitted, of which the results are to be announced in the last quarter of 2009.

In order to bridge the gap between the start of the pilot project an administrative arrangement between DG Environment and the Joint Research Centre (JRC) was established to prepare the pilot project. The objectives of the administrative arrangement are to:

- Facilitate the start of a European HBM Pilot Project by involving MS in different ways
- Circulate a questionnaire on what is currently available in MS
- Create a dedicated communication forum
- Arrange a final workshop
- Tasks include:
    1. Inventory of what is currently available in Member States
    2. Creation of a dedicated forum
    3. Harmonised protocols to be used in the pilot project
    4. Integration of environment and health monitoring data

The figure below illustrates the steps taken by the Commission. As it illustrates there have been many challenges and difficulties since 2003 but at the same time, there has been much active work undertaken, although it has not been an easy road the Commission is committed to the further implementation of this Action. Within the coming months there will be a decision on a follow up of the Action plan as the current plan will end in 2010.

European Commission Legislation and Timeline

2003: **THE EUROPEAN ENVIRONMENT AND HEALTH STRATEGY** (SCALE) Initiative

Objectives

- to reduce the disease burden caused by environmental factors;
- to identify and to prevent new health threats caused by environmental factors
- to strengthen EU capacity for policymaking in this area

Baseline Report on" Biomonitoring of Children» December 2003

Options for action on" Biomonitoring of Children" March 2004

2004: **EU ENVIRONMENT & HEALTH ACTION PLAN 2004-2010:**

- **ACTION 3**: Develop a coherent approach to HBM in Europe
- Launching a EU Pilot Project to test out the feasibility of a European HBM approach

Transparency & Member States involvement via:

- Governmental representatives
- Member States meetings
- Consultative Forum on Environment and Health

EU Parliament: Committee on the Environment, Public Health and Food Safety. "Essential role of HBM in the gradual setting-up of an integrated European environment and health data system. HBM should soon become the norm when evaluating the risks of environmental pollutants.

European Economic and Social Committee: Opinion of 15/12/2004: "Immediate steps should be taken to ensure that HBM is an effective and a credible tool at both national and Community levels and that optimal coordination procedures amongst specialised operational centres be developed.

Council Conclusions 20 December 2007:"The Council invites the Commission to ensure adequate funding for the EU pilot project on human biomonitoring"

EU Parliament Resolution 4 Sept. 2008: "The EU Parliament deeply regrets the fact that the Commission has not provided sufficient funding for human biomonitoring in 2008"

Human Biomonitoring in Occupational Health: Lessons Learnt for Environmental Health

Robert GARNIER
Paris Poison Centre, France

The theme of HBM in occupational health and the lessons learned for environmental health was presented by Robert Garnier (Paris Poison Centre) who focused on the experience gained in biomonitoring at the workplace. Biomonitoring for occupational exposure began in the 1950's but in most countries full-scale biomonitoring at the workplace started in the 1980's. It has developed considerably since then, making it possible to validate an increasing number of indicators. There are now benchmarks for most types of exposure and tools have been developed for training and informing physicians on how to carry out additional tests. In many countries, a set of rules and regulations have been set up and implemented to define scientific tests carried out at the workplace. Although there remains much to be done, we can draw lessons from the experience of occupational health.

Lessons learned from Occupational Health

1. Need to be able to choose the appropriate bio-indicator to carry out the tests. Need to determine where to do the sampling, the choice of matrix, the timetable for sampling, the method, the precautions to take at the moment of sampling, and the ability to interpret the results of the sample being analysed, such as metabolism, toxo-kinetics, toxicodynamics, and the correlations between the biological indicator and the toxic effects.
2. Have to know the advantages and limits of Biomonitoring with regard to external exposure. The main advantage is that it takes account of all possible sources for observing chemical agents. Biomonitoring also has limits. It is inappropriate for certain forms of chemical agents, which have local effects in pharmacology. It cannot be used for measuring the effects of chemical agents, which have peaks of exposure.
3. Precautions have to be taken to ensure reliable results at all stages of monitoring: in taking the sample, protecting and preserving the sample during transportation, storing the sample, determining the dosages, choosing methods that are sufficiently sensitive, choosing a laboratory with the right expertise and know-how, and interpreting the results.
4. The test method has to be acceptable. The technical level has to be such that it can be carried out during a routine examination with acceptable costs, and with few constraints for the participants.
5. There must be communication of detailed relevant information (such as medical history) between the individuals doing the dosing and the individuals doing the prescribing, so that the laboratory can carry out its analysis satisfactorily.
6. It is important to have valid reference values and precise information on the individual. This includes observed reference values in the general population and individual reference values for the study participant.
7. Before setting up HBM programs, it is important to know how the results are to be sent back to the individual who has been sampled and to the community at large. Most

occupational health professionals working on HMB believe that the results have to be given to the individual by a physician and with information on the significance of the results including providing comparisons of reference values and benchmarkers and results within the same exposure routes. They also need to be given information on preventive measures. The same also applies for collective results.

8. It is vital for the potential HBM medical teams to have specific information on the available indicators and the corresponding reference values. Basic training needs to be provided at universities and medical schools.

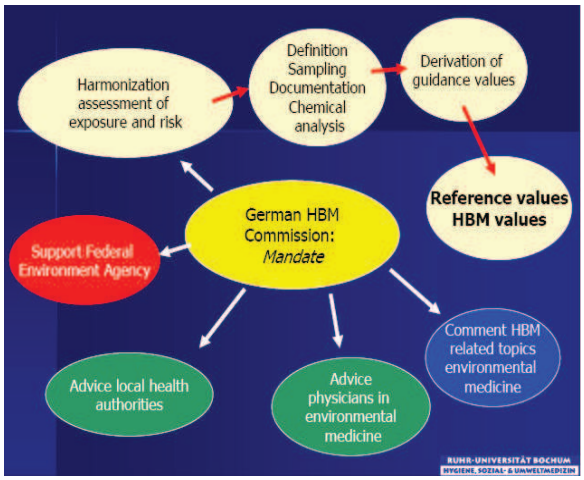
9. Recommendation: There must be support from public authorities in order to have lasting monitoring of exposures at the workplace. That there be a body of rules encouraging the use of biomonitoring tools and that there be financial support.

Human Biomonitoring and Reference Values, German HBM Commission - Mandate and Achievements

Michael WILHELM
Ruhr-University, Bochum, Germany

The final speaker was Michael Wilhelm (Ruhr-University Bochum) who spoke about the mandate and achievements of the German HBM Commission.[4] The German Commission was established in 1992 and published its first report on the working principles in 1999 [5]. This document has been cited 54 times, which is an indication that the scientific committee has taken notice of the work. The recommendations are regularly updated and the most recent update, published in 2007, can be found in *The International Journal of Hygiene and Environmental Health* [6].

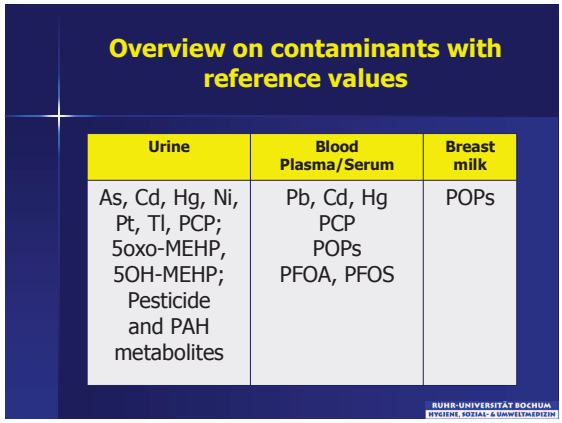
The German HBM Commission is an expert group of the German Federal Environment Agency (Umweltbundesamt). The mandate and activities of the Commission are manifold including harmonising the assessment of risk and exposure in environmental health. In addition, they provide definitions, sampling requirements, publish documentation and carry out quality controls and chemical analysis. They also provide basic criteria to derive guidance values and give advice to local health authorities and to physicians.



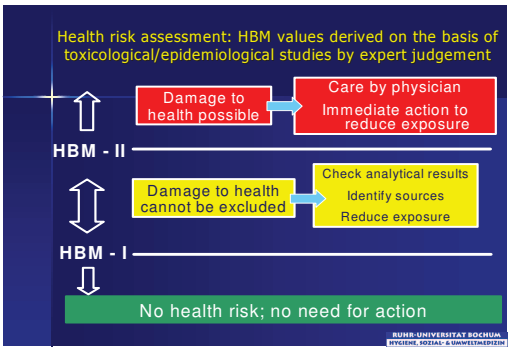
On of the main tasks is to develop basic criteria to derive both reference and HBM values. Reference values are statistically derived according to IUPAC guidelines using the 95th percentile of concentration levels in a representative sample of the general population. [6] Reference values indicate background exposure and are usually derived for non-specific exposed groups, for example, the reference value for mercury in urine is based on individuals without amalgam fillings. As environmental conditions change, they continuously check and if necessary update references values. The most sticking example is the clear decrease of lead levels in children was has resulted in the decrease of the reference value from 50 µg/l to 35 µg/l.

In case of new upcoming contaminants, the commission tries to release preliminary evaluations and provides provisional reference values. This was illustrated by the case of the high contamination of drinking water with perfluorinated compounds (PFC) in the Region Sauerland, North Rhine-Westphalia in 2006. Industrial waste with high concentrations of PFC was manufactured into a soil improver by a recycling company and spread by farmers, which led to substantial environmental pollution. In parts of the affected area, perfluorooctanoic acid (PFOA) concentrations in drinking water were > 0.5 µg/l. The HBM study revealed close associations between drinking water consumption and PFOA levels in children and other residents from the area with levels five to eight times higher compared to control groups.

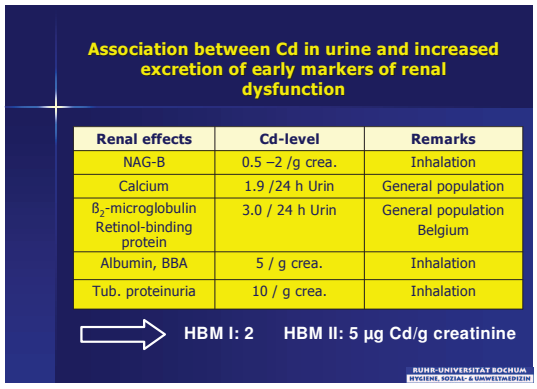
In the case of contaminants not studied in the German environment survey (GeRES) the Commission first compiles available data from Germany and then proceed to look for comparisons with international data such as NHANES. For PFC after controlling for suitability according to the basic criteria they derived the following values: 10 for PFOA and 10, 20, 25 for PFOS for various populations. [7] In contrast to reference values, HBM values are derived based on toxicological and epidemiological studies by expert judgement. The Commission has derived values for lead, cadmium, mercury, PCP and DEHP in blood, urine, and human milk. They have two levels:



1. HBM I: levels below it indicate that there is no health risk and no action is needed
2. HBM II: levels above may pose a health risk and they advise consultation with a physician and immediate action to reduce exposure
3. For values between they recommend checking analytical results to identify the sources and to reduce exposure

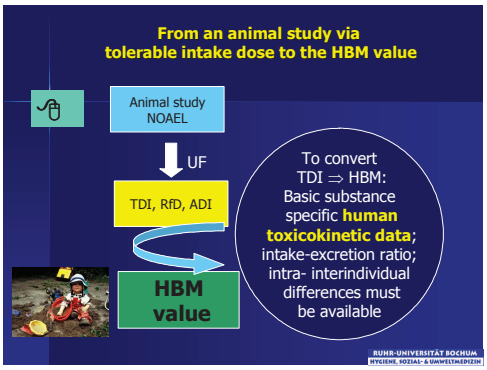


The first contaminant for which this concept was realised was Cadium (Cd) based on association between Cd in urine and increased levels of early markers of renal dysfunction.



For lead, they adopted the CDC level of concern (10 µg/dl) and HBM I was 100 µg/l for children and women of childbearing age. This evaluation is based on the association between pre-natal lead exposure and developmental toxicity. There are now indications that lead levels below this level may pose a health risk (Brown et al) and even with levels of < 20 µg/l there have been observed lead related effects. Therefore, there is no threshold and the German Commission will cancel the Pb HBM value for children. Under discussion is the value of 40 µg/l, which is the reference value plus 20% of analytical uncertainty.

To date more than 50 comments have been published and reference values have been derived for more than 20 substances. However, only four HBM values (Cd, PCP, Hg, and Pb) have been set due to the lack of data in humans. Therefore, the decision was taken to derive HBM values based on tolerable daily intake such as TDI, RfD, or ADI values.



The first substance, which realised this new concept, was the DEHP exposure of which low dose causes effects in animal experiments. Largely due to the work of Holger Koch, we know a great deal about the toxokinetics. The main message is that 40% of the total oral DEHP doses are excreted in urine in the form of two metabolites (5OH-MEHP and 5oxo-MEHP) and MEHP values are derived based on the sum of these two metabolites. [8]

SESSION 2: HUMAN BIOMONITORING IN ENVIRONMENTAL HEALTH POLICY

The aim of this session was to give an overview of activities implemented by Spain, UK, France, Czech Republic, Ireland, Cyprus, Belgium (Flanders), Sweden, and Germany presented their ongoing HBM activities.

Marike KOLOSSA-GEHRING from the Federal Environment Agency, Germany moderated the session with nine presentations.

Presentations

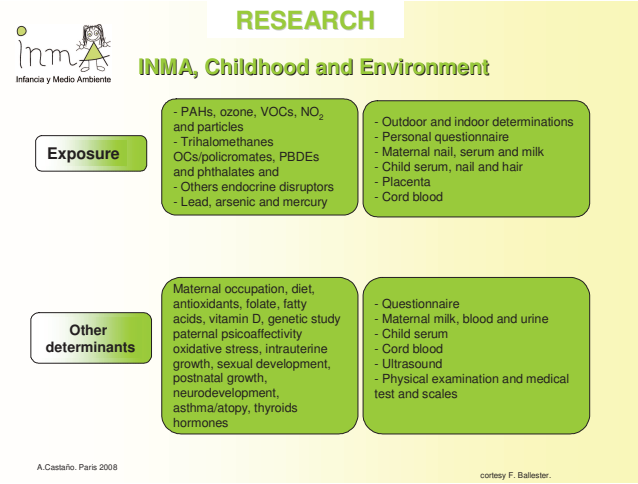
1. Human Biomonitoring in Spain
2. Human Biomonitoring in the United Kingdom
3. The French Dioxin and Incinerators Study
4. Human Biomonitoring in the Czech Republic
5. A Case Study of the Health Impacts in an Abandoned Lead Mining Area Using
6. Human Biomonitoring in Cyprus: Cotinine in Children – The Impact of Smoking
7. Biomonitoring in Flanders: Assessing Exposure in the General Population and in Hot Spot Areas
8. The Swedish National Health Related Environmental Monitoring Program
9. The German Environmental Survey (GerES)

Human Biomonitoring in Spain

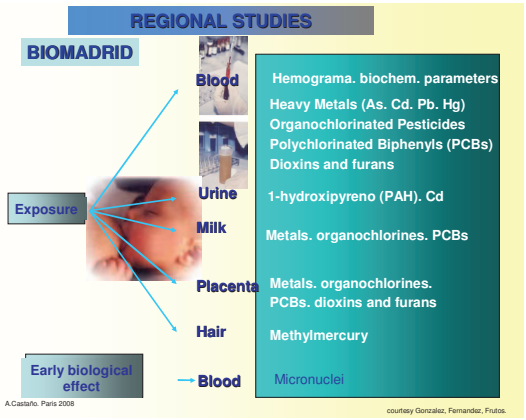
Argelia CASTAÑO
National Centre of Environmental Health, Institute of Health Carlos III, Spain

A national Human Biomonitoring program was introduced in Spain in 2007. Until this time, the only activities in the field until then were those related to research or to local and regional initiatives including INMA, BioMadrid and ENCA.

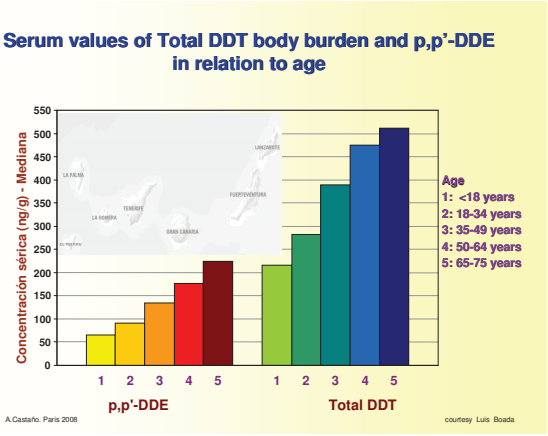
INMA (Infancia y Medio Ambiente).The purpose of this study, undertaken in 1997 and followed up until 2007, was to evaluate the effects of contaminants on infant health, growth, and development.



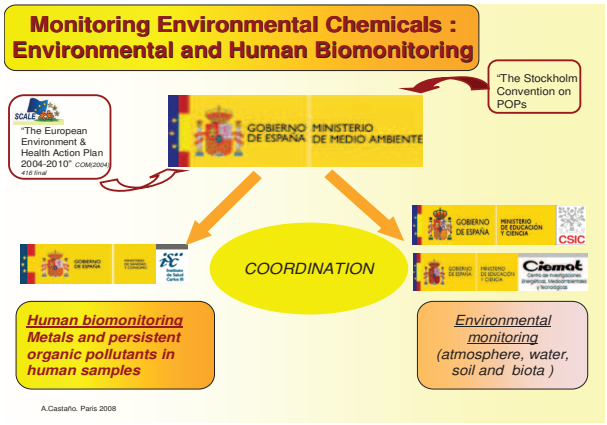
BioMadrid: This descriptive, cross-sectional study was set up by the community of Madrid in 2003 to study the early biological effect of contaminants.



ENCA (Canary Islands Nutritional Survey): This survey (carried out in 1997 and 1998), involved 707 participants both male and female (a representative sample of the Canary Archipelago population) aged from six to seventy-five years, to measure total cholesterol and triglycerides, dietary variables, socio-demographic factors, lifestyle, and health conditions. One result of the study was that DDT was found in all the participants.



Ongoing Activities and Future Plans:



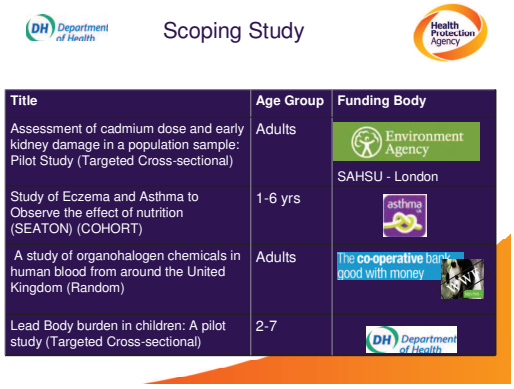
The Spanish Ministry of the Environment and the Institute of Health Carlos III are undertaking a joint project for the period 2007–2010. The aim of the research is the Biomonitoring of POPs (persistent organic pollutants) and other contaminants in the Spanish population and to carry out environmental monitoring of the atmosphere, water, soil and biota, in order to determine the relationships between the human and environmental samples. The matrices used are blood, urine, placenta, and hair. The preliminary results of the Pilot Study show very high values for mercury in the participants who consumed large quantities of fish. Collaboration is planned at the national level between the National Centre of Environmental Health and the National Centre of Epidemiology.

Human Biomonitoring in the United Kingdom

Ovnair SEPAI
Health Protection Agency, United Kingdom

At the present time, there is no national program on Human Biomonitoring in the United Kingdom but there are numerous regional activities in HBM. The ongoing goal is to determine the need for a national program and to establish which ongoing studies could be used within the context of such a program. To answer this question a scoping study was undertaken. The aims of the study were to observe the range and scope of biomonitoring projects across the UK, to identify capabilities and possible opportunities for collaboration, and to develop a network.

Unfortunately, the study could not identify a sufficient number of projects and therefore could not come to satisfactory conclusions. Although a number of studies were of interest including: an assessment of cadmium dose and early kidney damage, the effect of nutrition on the occurrence of eczema and asthma in children, a study of organo-halogen chemicals in human blood, and a pilot study of the effects of lead in children's teeth.

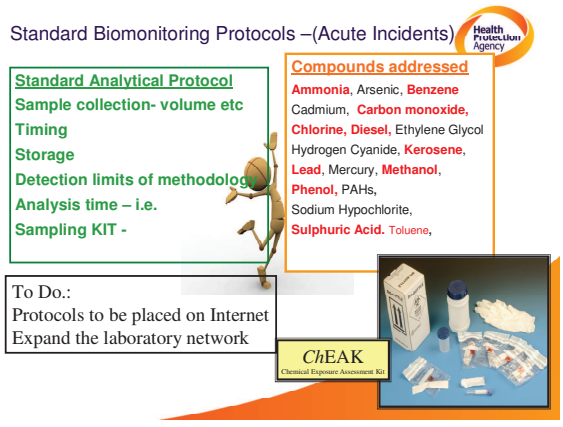


There are also five large-scale pilot studies:

1. **The Reference Range Study:** Sponsored by the Health Protection Agency, is carried out at the Medical Toxicology Centre at the University of Newcastle. By sampling blood alone, the study aims to define the range and variation in human exposure to environmental chemical pollutants in the general UK population.

2. **The Background Incidence Study:** Sponsored by the European Chemical Industry Council (Cefic) examines the background incidence of key biomarkers of chemical exposure in urine and relating it to various lifestyle factors.

3. **Standard Protocols:** The Health Protection Agency is attempting to develop standard Human Biomonitoring analytical protocols for acute incidents, such as disasters in industrial accidents. Through the compounds addressed, it has created a sampling kit for potentially exposed persons.

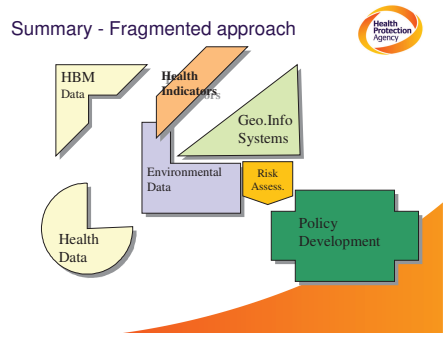


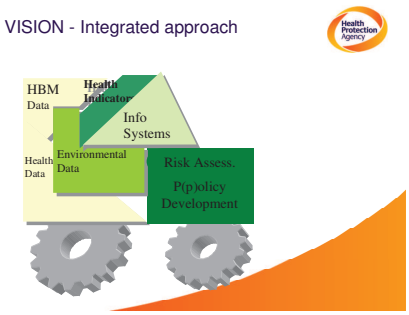
4. **ALSPAC: The Avon Longitudinal Study of Parents and Children (ALSPAC):** involved more than 14,000 mothers who were recruited during pregnancy and subsequently monitored the health and development of their children. The ALSPAC families have provided a vast amount of genetic and environmental information over the years.

5. **The UK Biobank**: Started in 2006, collects and stores samples and intends to follow up over a period of 25 years.

6. **The UK Household Longitudinal Study:** Will start in 2009 and will support a wider range of biomarkers and health indicators than any previous social science survey.

As can be seen there is much fragmentation. The hope is to transform the fragmentation of Human Biomonitoring data, health data, environmental data, information systems, risk assessment, and policy development into one harmonised and integrated approach. Such a method would enable a larger scope for evidence-based regulations and public health policies and could be expanded to cross-boundary comparisons and regulations at the European level.

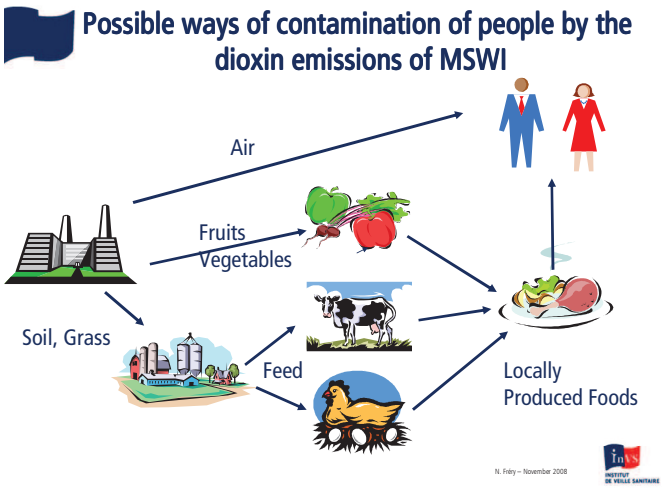




The French Dioxin and Incinerators Study

Nadine FRÉRY
French Institute for Public Health Surveillance (InVS), France

In France, there are also biomonitoring activities that have been undertaken to assess the exposure of the French population to various pollutants and to establish reference values. The French study on dioxins and incinerators is one illustration of this. The National Institute conducted this study for Public Health Surveillance (InVS) in collaboration with the French Food Safety Agency (AFSSA). The full report is available at http://www.invs.sante.fr/publications/2009/impregnation_dioxines_uiom/index.html



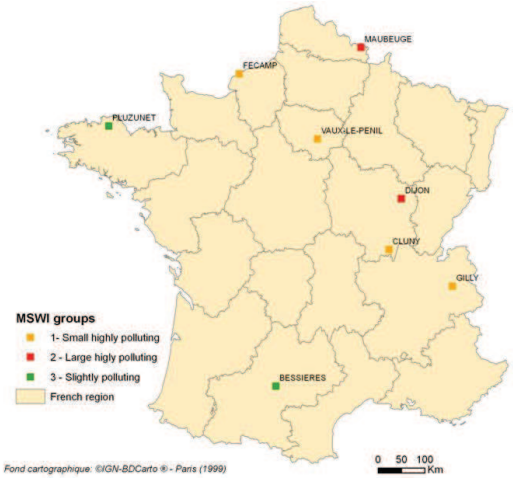
France has a large number of municipal solid waste incinerators (MSWI). There are 130 sites today compared to approximately 300 in 1998. Today, emissions from these incinerators respect the European restrictions for dioxins. In the past, there were several crises in agricultural areas surrounding the incinerators, with dioxin contamination both in the environment and in food products. These events caused considerable anxiety in the French population living near incinerators.

The two main goals of the study was to:

- evaluate whether emissions of the MSWI contribute to the body-burden of dioxins in the nearby population;
- study the influence of locally produced food products on serum dioxin levels.

Methods

The study involved 1030 adults aged thirty to sixty-five, randomly selected, living near eight different incinerators (there were 3 types of incinerators – new, small, large and old) and in control areas. Samples were taken to measure dioxin and dioxin-type agents. Questionnaires were distributed to gather socio-demographic data as well as information on food consumption, occupation, and environment.



Results on Serum Dioxin Levels

The average dioxin level in France was found to be similar to that in other countries. Factors that influence serum dioxin levels regardless of incinerator emissions include personal criteria, such as age, sex, body mass index, tobacco smoking, and geographical location, and other exposure factors to dioxins such as the presence of an open fireplace in the house or the consumption of certain foods not locally produced. In the global comparison of exposed and unexposed groups, it was seen that living near an incinerator did not increase the mean concentration of serum dioxin or PCB levels. Furthermore, there was no evidence of contamination by inhalation of people living around incinerators. Lastly, dioxin intake through ingestion of fruits and vegetables produced under the plume of an incinerator did not contribute significantly to contamination.

Table 1- Mean and median concentrations of serum PCDD/F in different countries (pg TEQ/g lipids)

Countries	Year of collect	N	Age M, range	Concentrations	References
Finland	1998	45	40-70	**32** (Nato, median)	Kiviranta et al. 2000
Belgium (Flanders)	1999	200 47 pools	58,5 50-65	**48** (WHO, median)	Koppen et al. . 2002
(Wallonia)	2000	63	53 33-66	**24** (WHO, median)	Fierens et al. 2003
Japan	1999 2002	253 80	20-76 26-43	**9,8** (WHO, median) **16.1** (WHO, median)	Arisawa et al. 2003 Tsukito et al. 2006
Russia, Irkuts region	2000	50 (pool)	41	**14.5** (WHO, mean)	Mamontova et al. 2002
Portugal, Oporto region	2001	46	42,7 21-70	**21.7** (WHO, mean)	Calheiros et al. 2002
Germany	2001	13	na	**20.4** (WHO, mean)	Fürst and Päpke, 2002
Spain, Tarragone around MSWIr	2002	20	19-62	**17.8** (WHO, mean)	Agramunt et al. 2005
Greece, Athens region	2003	105 10 pools	43,5 28-65	**6.8** (WHO, mean)	Costopoulou 2006
Taïwan, around MSWI	2000-2004	1708	18-65	**19.7** (WHO, median)	Chen et al. 2006
France, this study	2005	1030	51,9 30-65	**13.6** (WHO, median)	Fréry et al. 2

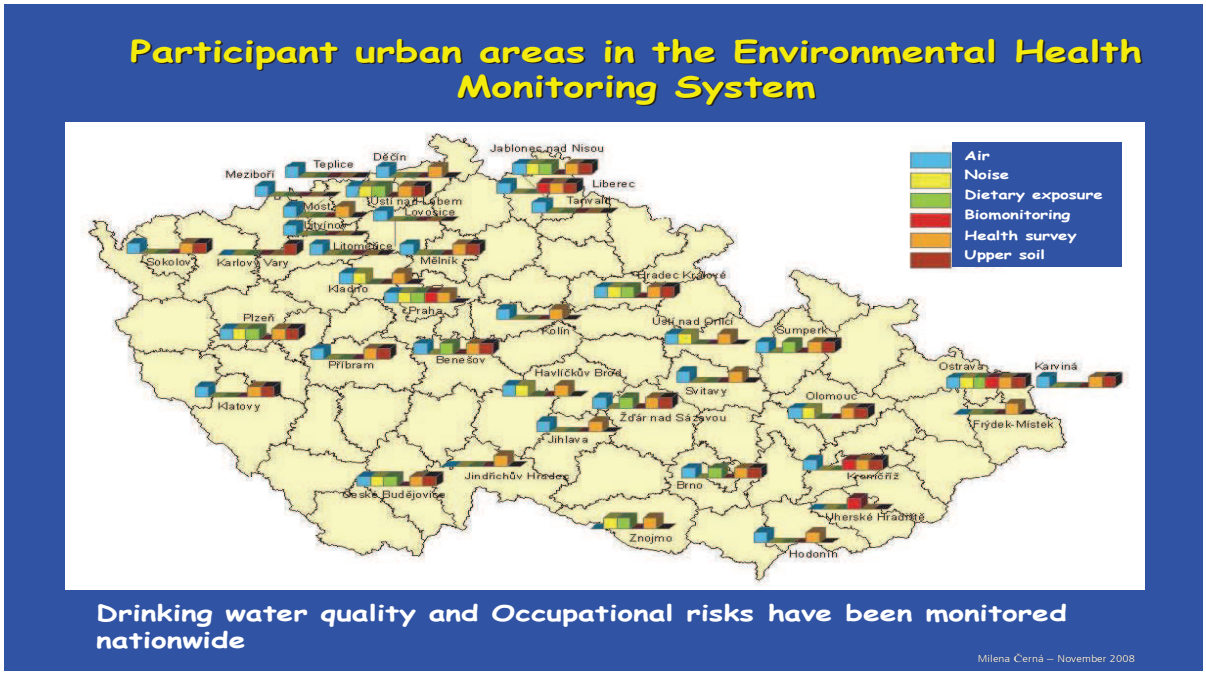
However, people living in the vicinity of an incinerator and who consume local animal lipids and vegetables have higher serum dioxin levels than people living in the same area who eat only vegetables or people in the same area who do not ingest local products. At the same time, in populations living in the vicinity of a recent incinerator, people consuming local animal lipids and vegetables had similar serum dioxin levels to people who do not consume local food. In populations living near an old polluting incinerator, people consuming local animal lipids and vegetables had higher serum dioxin levels than people who do not consume local food.

Human Biomonitoring in the Czech Republic

Milena CERNA
National Institute of Public Health, Czech Republic

History

The biomonitoring system in the Czech Republic, based on scientific results, began in the 1950s in the field of occupational medicine. The biomonitoring of toxin exposure was carried out in the 1970s and 1980s. Due to the lack of sufficient and reliable data on environmental pollution and exposure, in 1990 the Czech Republic adopted legislation for the initiation of a national survey. Referred to as the Environmental Health Monitoring System (EHMS), the program integrates the monitoring of environmental pollution, dietary exposure, and the biomonitoring of the health status of the overall Czech population. Human Biomonitoring became an integral part of the Environmental Health Monitoring System in 1994. In addition to the country work, the Czech Republic cooperates with several European Human Biomonitoring projects including ESBIO, PHIME, INTARESE and CASCADE.



Objectives

The main objectives of the Czech Human Biomonitoring system are to:

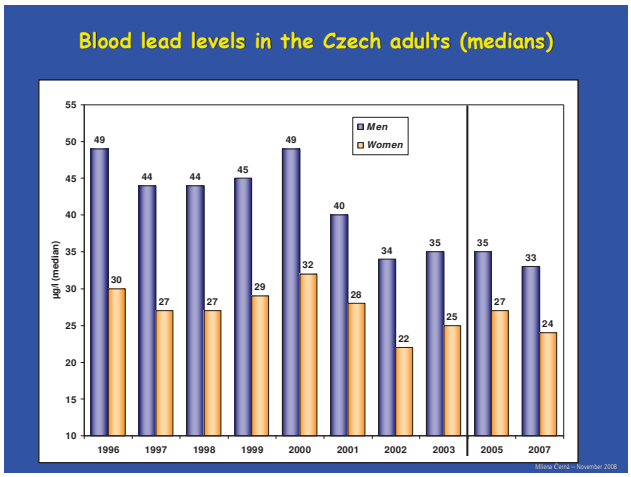
- Assess and evaluate the exposure of the Czech population to environmental pollutants,
- Follow up on long-term trends,
- Establish reference values,
- Generate data necessary for preventive measures,
- Use data for health risk assessment and for international comparison and regulation.

Basic Procedure

A basic procedure was defined and the program selected four urban areas with different pollution levels and studied specific population groups (adult blood donors, children aged 8 to 10, breast-feeding mothers). An estimation of exposure was based on lifestyle questionnaires and on samplings of body fluids and tissues. They studied the biomarkers of exposure and of early adverse effects over yearly, two-year, or five-year intervals, depending on the biomarker under study.

Selected Results

A few examples of the results of Human Biomonitoring in the Czech Republic include:



- Determination of blood lead levels in Czech adults: declining time-related trend in blood lead levels.
- Determination of blood cadmium levels in adults as related to smokers, passive smokers, and non-smokers: Decreasing tendency in blood Cd, but not urinary Cd levels in non-smokers.
- Determination of urinary cotinine concentration in adults as related to smokers, passive smokers, and non-smokers,
- Determination of blood mercury levels related to fish consumption in adults,
- Determination of concentrations of selected persistent chlorinated organic compounds in breast milk and serum,
- A cytogenetic analysis of the frequency of chromosomal aberrations in the peripheral lymphocytes of the Czech population.
- Declining time-related trend in blood lead levels.
- Significant upward trend of blood selenium levels in adults, but not in children.
- Declining time-related trend of PCB levels in human milk lipids in the first years of monitoring, but almost unchanging values in the last years.
- Long-term declining trends in HCB, DDT and HCH levels in human milk fat
- Frequency of chromosomal aberration revealed U-shape curve with downward trend in 1994-1999 followed by upward trend since 2001

Advantages of contemporary HBM in the Czech Republic

- Reliable, consistent and comparable data on population exposure to environmental toxicants and/or body burden of the population.
- Integration of HBM data with environmental and dietary exposure.
- Cooperation of the National Institute of Public Health with Regional Institutes of Public Health.
- Use of the data for health risk assessment and for international comparisons.
- Communication of the results to the public.

Limitations of contemporary HBM in the Czech Republic

- Data on environmental pollution are not closely linked to the monitored population groups.
- Only urban and suburban population is monitored, no data are available for rural populations.
- Blood donors are not the best representatives for general population.
- No preschool children are involved in the HBM
- The data on the relationship between the HBM results and health status of donors are inadequate.
- The results are not sufficiently presented in scientific journals.

A Case Study of the Health Impacts in an Abandoned Lead Mining Area Using Children's Blood Lead Levels

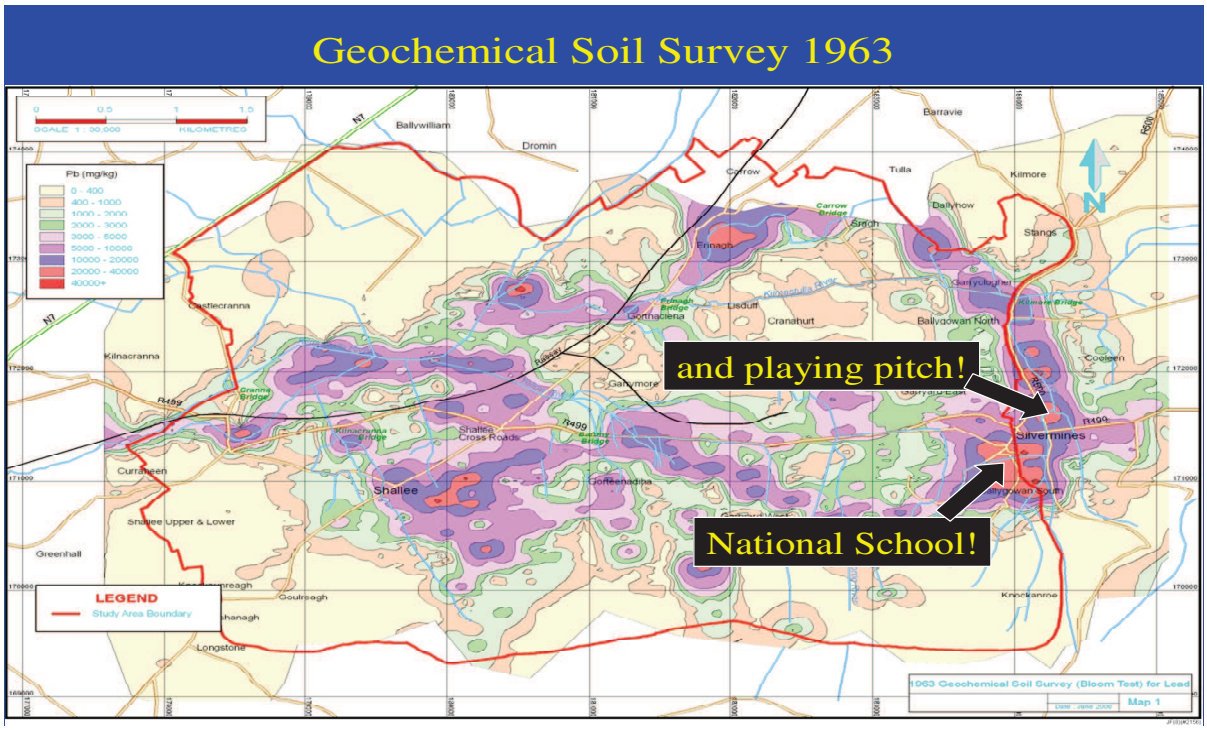
Carrie GARAVAN
Environmental Protection Agency, Ireland

Background

The study took place in Silvermines, a small village in the South Midwest of Ireland. Mining in the area had been going on since the tenth century and left a permanent mark on the landscape. Large holes were left by the barite mines form deep cuts into the hillside. The Tailings Management Facility (TMF), of 76 hectares, was opencast. The material used was kept under water and began to pile up leaving a very acidic "die-off" area around it, composed of 9 million tons of waste. The environmental investigation was triggered in 1999 when it was revealed that three cattle died of lead poisoning. There had been a history of dust blowing from the Tailings Management Facility. In the late 1990s, the Environment Protection Agency asked for a report on the state of the Facility and its impact on human and animal health.

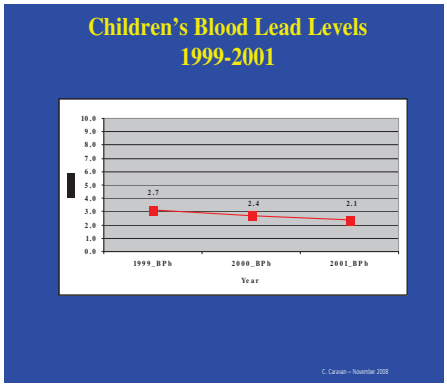
Stages of Investigation

The elements of the investigation included human and animal health, food, water, soil, dust, rivers, water supplies, and mining sites. Only the human blood sample results from the child population will be reported here. A geochemical soil survey revealed that a national school was built on a Geographical "hot spot" and that the school football playing field contained 40,000 ppm of lead, an extremely high level. The researchers informed the Department of Education who subsequently encapsulated the entire area. To determine the effects on human health, an environmental assessment questionnaire was developed and was completed by 436 children less than 18 years of age. In addition, 776 child blood samples were collected over the three-year period.



Results

Over the period a decrease in the mean blood level in the children, from 2.7 µg/dL in 1999 to 2.1 µg/dL in 2001 was observed. The results in 2000 and 2001 suggested that all of the children's blood lead levels were within the acceptable level. At the same time, the soil samples exceeded the 1000-ppm international guideline value. The literature suggests that the lead levels in children are highly dependent on factors affecting exposure dose.



Conclusions

Ireland has no reference values for lead. However, at the end of the study the children's blood lead levels in the area under investigation were lower than any values reported from other former mining communities. The study suggests that environmental lead in the area is not currently being transferred to children.

Human Biomonitoring in Cyprus: Cotinine in Children – The Impact of Smoking

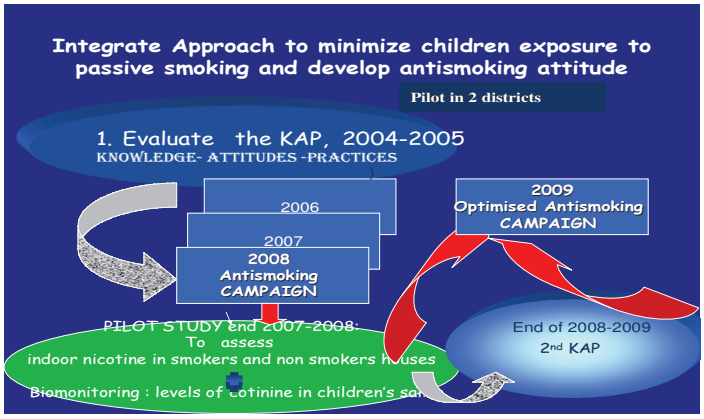
Stella CANNA-MICHAELIDOU
State General Laboratory, Ministry of Health, Cyprus

Tobacco smoke is one of the worst exposures for children in homes and in public places. It contains more than 4000 chemicals, including many endocrine disruptors and carcinogens. There is no safe exposure level for children or for adults. The effects of ETS and maternal tobacco smoking can increase the risk of: sudden infant death syndrome, low birth weight, reduced lung function, asthma, lower respiratory illness, middle ear infection, behaviour and cancer to name a few.

Aim and Targets

The overall aim of the campaign is to reduce children's exposure to passive smoking and to create households free of tobacco smoke for every child. The specific targets are:

- An evaluation of the knowledge and attitudes of Cypriot parents in relation to passive smoking and their practices in daily life,
- An assessment of nicotine pollution and the level of cotinine, a major metabolite of nicotine, in the saliva of preschool children,
- The implementation of an anti-smoking campaign.



The First Pilot Study 2004 - 2005

A first questionnaire was distributed to 524 families to determine the knowledge, attitudes, and smoking habits of the adults in smoking and non-smoking homes. As a result of this study, the researchers drew up preliminary statistical conclusions on smoking practices and on the degree of knowledge of Environmental Tobacco Smoke and its relation to cancer, asthma, lung function, and other serious health problems. An awareness-raising campaign based on the results of the preliminary study, involving TV and radio spots, seminars, videos, and educational measures was then developed. Researchers attempted to make parents who smoke accountable for the health of their children.

The results showed that in 42% of the homes one or both parents were smokers and in the families with smokers (221 houses): 25% of parents never smoked in the house, 32% do not smoke if a child is present in the same room, 28% if a child is in the next room, and 73% of parents never smoke in the car if a child is present. In houses with smokers, 25-32% do not smoke in the house.

An intervention program was launched with two challenges:

1. To develop anti-smoking attitudes from early life through adolescence
    a. Making children understand why they should not start smoking
    b. Making them demand their right to clean air
    c. And knowing how to protect themselves

2. Create smoke free environment in homes
    a. Change the attitudes and practices
    b. Deepen the knowledge, making parents understand
        i. Why children are more vulnerable , that children are not simply "Little Adults" and make them understand that the development and future of their child is also dependent on their behaviour
        ii. How they can protect their children: clear , precise information , simple things they can do to even if they cannot stop smoking

The Second Pilot Study, 2007 - 2008

Researchers also launched a new small-scale biomonitoring pilot study to determine the nicotine levels in households with young children and the associated levels of cotinine in the saliva of the children.
64 households and 71 children aged 4-8 participated in the study. No correlation could be established between higher levels of nicotine inside the family home and higher levels of cotinine in the children's saliva. It was also observed that the percentage of smoking parents who did not smoke in the home increased from approximately 25% during the first study to 64% during the second study. This may be a first indication of an improvement in attitudes and practices. The results also revealed average salivary cotinine concentrations in children of smokers to be only slightly higher than in children of non-smokers.

Conclusions and Recommendations

Children are exposed to Environmental Tobacco Smoke regardless of their parents' smoking habits and that most of the exposure is outside of the home. The overall recommendation was that data from biomonitoring must be transformed into a structured program oriented toward public information and coordination with policy makers.

Biomonitoring in Flanders: Assessing Exposure in the General Population and in Hot Spot Areas

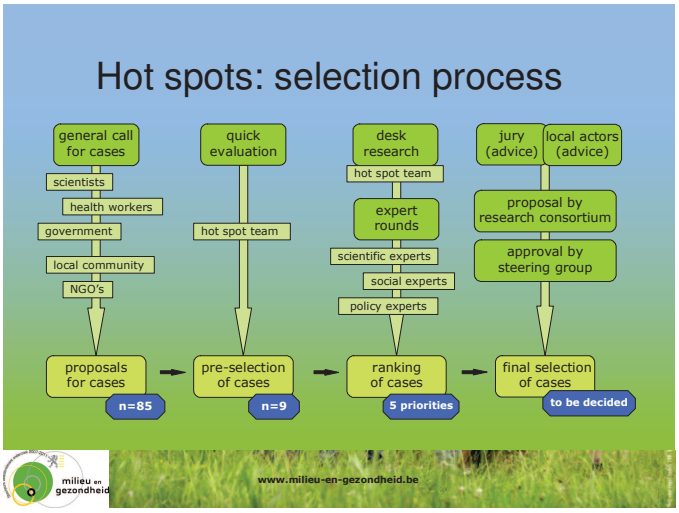
Elly DEN HOND
Flemish Institute for Technology Research (VITO), Belgium

Flanders has had a number of biomonitoring campaigns. During the first campaign, conducted from 2001 to 2006, they monitored three age groups and measured specific pollutants in specific regions in Flanders. The current ongoing campaign runs from 2007 until 2011. During the first phase, they intend to establish reference values for numerous pollutants in newborns, adolescents and adults, by means of studies of a representative sample of the general Flemish population. The study will involve both biomarkers of exposure and effect. The protocols and choice of biomarkers will be different for each age group.

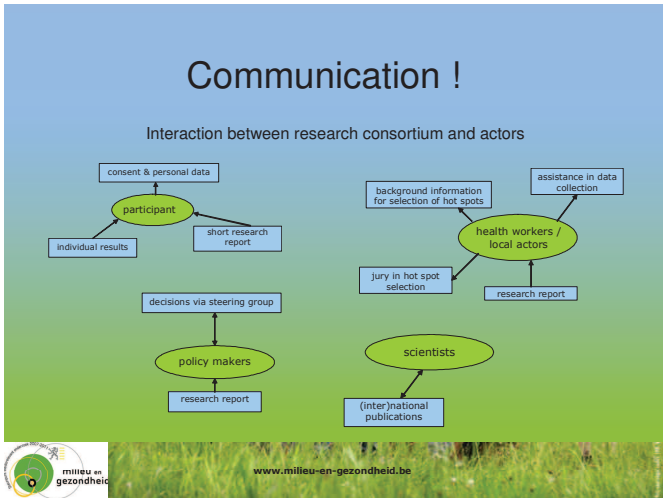
For the selection of the biomarkers of exposure, blood, urine, and hair samples will be taken from three age groups in a representative sampling of the general population, involving stratification by region, sex, and level of education. The selected biomarkers of effect are to be related to the biomarkers of exposure and will be used as control values of the general population. They will focus on immune, endocrine, gentoxic, and neurological effects.

Targeted Biomonitoring Campaigns

During the second phase, targeted Biomonitoring campaigns will be carried out on specific biomarkers in specific areas with a specific environmental problem. Such "hot spots" will be selected through a transparent, participative process with the coordination of scientists, policy makers, stakeholders, and the public. The target may also be a population with a specific hobby or with specific food habits. The goals are to: generate reference values for biomarkers of exposure and biomarkers of effect in the general Flemish population and to focus biomonitoring in 'hot spot' areas.



Communication will also be addressed, as it is of importance that there is clear communication between the partners in the project. At each stage, they will emphasize the strong interaction between the exact sciences, social sciences; the research consortium and the policy makers; and the scientists, local health workers, and policy makers.



The Swedish National Health Related Environmental Monitoring Program

Marika BERGLUND
Karolinska Institute, Sweden

Sweden has a long tradition in environmental monitoring. Since 1993, there have been programmes on health related environmental monitoring and on toxic substances coordination, leading to the various aspects of Human Biomonitoring. Biomonitoring is co-ordinated by the Swedish Environmental Protection Agency.

Aims and Objectives

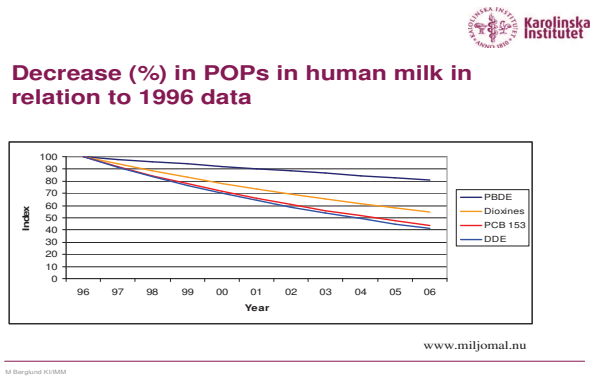
The main aims of health related environmental monitoring are: to document the status of the environment, to carry out trend studies, and to warn of emerging environmental risks. In 1999, the Swedish Parliament drew up sixteen quality objectives:

1. Reduced Climate Impact
2. Clean Air
3. Natural Acidification Only
4. A Non-Toxic Environment
5. A Protective Ozone Layer
6. A Safe Radiation Environment
7. Zero Eutrophication
8. Flourishing Lakes and streams
9. Good-Quality Groundwater
10. A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos
11. Thriving Wetlands
12. Sustainable Forests
13. A Varied Agricultural Landscape
14. A Magnificent Mountain Landscape
15. A Good Built Environment
16. A rich diversity of plant and animal life

Human Biomonitoring data is used as indicators of environmental quality to track progress in meeting these objectives. The indicators are presented at The Environmental Objectives Portal www.miljomal.nu.

Time Series Studies

A number of time series studies have been undertaken and include measures of lead in children's blood in relation to the decrease of exposure to lead in petrol, measures of methyl mercury in the hair of pregnant women in relation to fish consumption and risk, and cadmium measures in urine for smoking and non-smoking women in several geographical regions, resulting in an increased risk for kidney dysfunction. Measurements of persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs), dioxins, pesticides, and phthalates have been measured in potential risk groups, and most particularly in human milk, over ten and twenty-year periods, showing a decreasing trend.



Strengths, Weaknesses, and Challenges

The strengths of the national program lie in the coordination of activities, the long-term perspective of the investigations, the stable government funding, and the capacity for building at the national, regional, and local levels. Weaknesses in the program are related to the limited capacity of the system. New chemicals are constantly being released, and there is a lack of toxicological knowledge. The challenges ahead lie in the increased integration and harmonisation for more effective use of the data, at both the national and international level.

The German Environmental Survey (GerES)

Marike KOLOSSA-GEHRING
Federal Environment Agency (UBA), Germany

Germany has a long tradition in human biomonitoring by way of the German Environmental Survey (GerES) http://www.umweltbundesamt.de/gesundheit-e/survey/. The survey is a representative population study to determine the exposure of the Germany population to environmental contaminants. Staring in 1985, four surveys have been undertaken.

Umwelt Bundes Amt

20 Years of GerES

Survey	Period	Age in years	N
GerES I	1985 - 1986	25 - 69	2,700
GerES II	1990 – 1992	25 - 69 6 - 14	4,000 730
GerES III	1997 – 1999	18 - 69	4,800
GerES IV - Pilot	2001 – 2002	0 - 17	500
GerES IV	2003 – 2006	3 - 14	1,790

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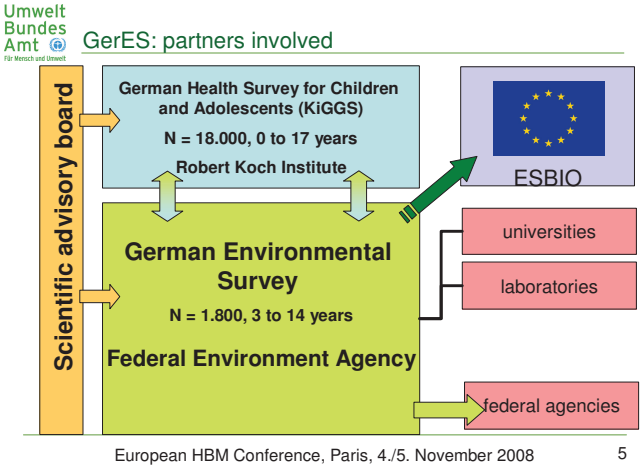
Objectives of GerES

The main objectives of GerES are:

- To generate representative data on exposure to environmental pollution
- To identify relevant exposure pathways
- To propose strategies on prevention and reduction of exposure
- To evaluate the environmental policy measures already taken

GerES IV

This is the fourth GerES but the first one conducted on children, using representative data for the years 2003 to 2006 for children aged 3 to 14. They investigated close to 1800 children, representative of the overall population with regard to age, gender, community size, and region from 150 sampling locations. The survey is a sub-sample of the German Health Institute and Examination Survey for Children and Adolescents (KiGGS) run by the Robert Koch Institute.



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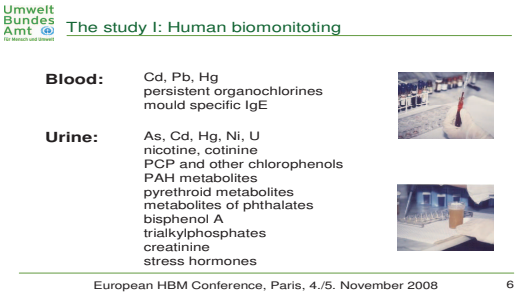
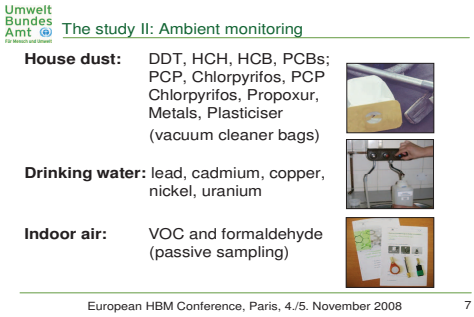
The partners included a scientific advisory board, universities, laboratories, and federal agencies, and the results and insights are shared with the ESBIO project. A number of instruments have been used in GeRES including human biomonitoring in urine and blood; ambient monitoring of chemicals in house dust, drinking water, and indoor air; questionnaires; sensitisation to biological factors; and measurements of noise levels. In total, approximately 2000 pieces of information per child was available.





The Studies

Human biomonitoring and ambient monitoring (Phthalates):

A number of extensive studies of phthalates in HBM, in ambient monitoring and on the health effects of volatile organic compounds (VOCs) from indoor fragrances and other household products of questionable toxicity were undertaken. The results show that children have higher exposure levels than children – three to five fold higher. There is a concern about the impact of phthalates on male reproduction from phthalates. Therefore, it is important to note that measuring adults does not supply the information needed to protect developing testes and their functionality. The study looked for other sources, and measured phthalates in house dust, and found high amounts. They then looked at the influence on body burden and correlated the metabolite content of the phthalates in urine with house dust phthalates content. Another investigation was on the influence of socio-economic status on the level of cotinine in children's urine for households with smokers or with non-smokers. It was observed that children from lower socio-economic status families were more exposed to tobacco smoke than are children from medium and high socio-economic status homes, even when there are smokers living in the home.

Conclusions

Children are exposed to various chemicals affecting reproduction and development, and persistent chemicals with chronic toxicity can be detected in every child living in Germany. For many, the exposure levels are related to the socio-economic level of the family. The health impact assessment should be supported by data from cohorts and information and education could raise public awareness as the exposure could be reduced by changes in behaviour and in policies.

SESSION 3: THE ADDED VALUE OF HUMAN BIOMONITORING IN ENVIRONMENTAL HEALTH

Some may argue against investing in HBM activities while other monitoring activities (environmental monitoring or health surveillance, or surveys) exist. Based on several examples the added value and potential limitations of HBM were discussed. An evaluation of cost benefit of HBM versus environmental monitoring was provided as part of the presentation related to the National Children study, which is being launched in the US. Efforts, perspectives and vision of industry (CEFIC) and NGOs (HEAL and the Commonweal Biomonitoring Resource Center) with regard to HBM added value were also reported in this session.

Louis BLOEMEN from Environmental Health Sciences International in Belgium moderated the session.

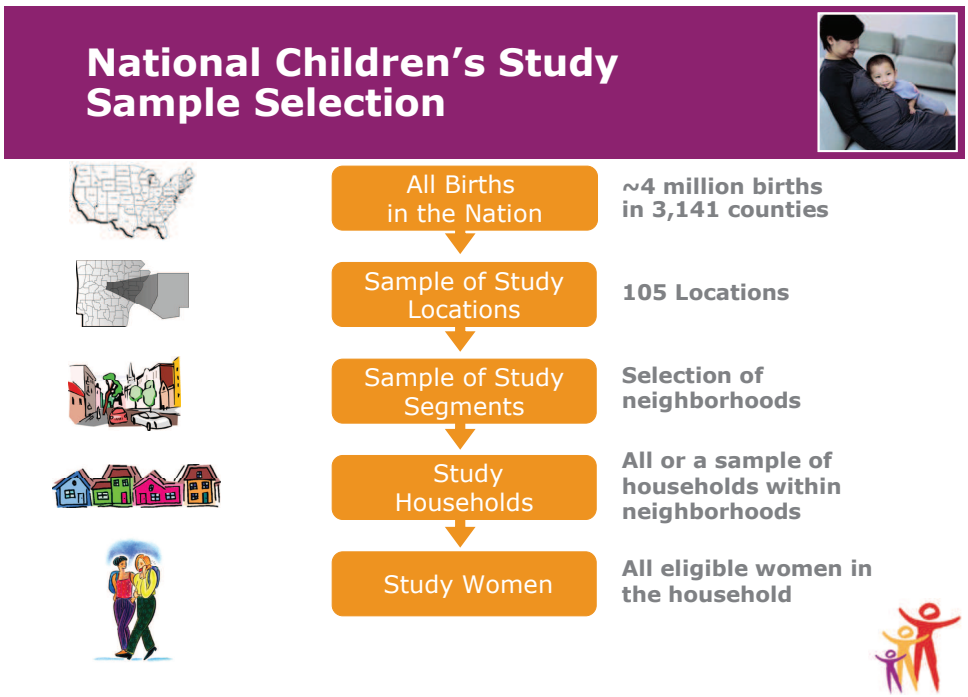
Presentations

1. Use of Biomarkers as Exposure Measures in the National Children's Study
2. Human Biomonitoring as a Tool to Explore Exposure Pathways
3. Chances and Limitations of Integrating Data from Human and Environmental Monitoring at a National Level
4. Chances and Limitations of Integrating Data from Human and Environmental Monitoring at the EU Level
5. From Science to Policy: Translation of Human Biomonitoring Results into Policy Measures in Flanders
6. Human Environmental Biomonitoring as a Policy Lever: A Case Study of Mercury and Pesticide Exposures in New York City
7. The Added Value of HBM for Human Health Protection: From Science to Industry Action
8. Using Biomonitoring to Raise Awareness for Policy Change – Public Interest Campaigns
9. Communication and Ethics in Human Biomonitoring
10. Environmental Justice and Interpretation of Human Biomonitoring Results

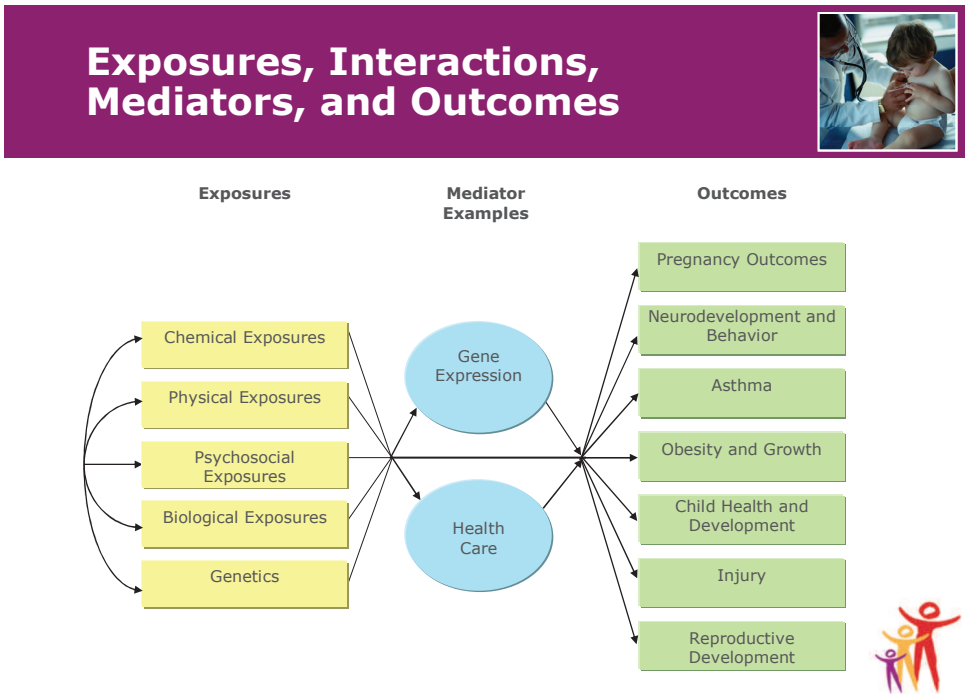
Use of Biomarkers as Exposure Measures in the National Children's Study

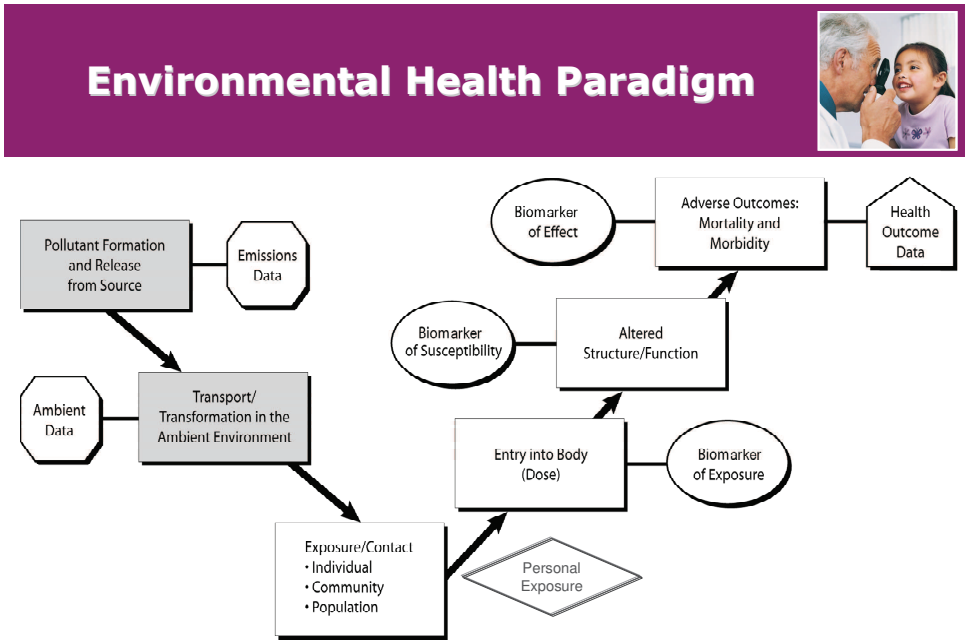
Michael DELLARCO
National Institute of Child Health and Human Development, USA

The National Children's Study was authorised by the Children's Health Act in 2000 and is the largest long-term study of children's health and development ever conducted in the United States. A cohort study of approximately 100,000 children and their families, it is designed to evaluate environmental consequences on children's health and development, from before birth to age 21. It investigates the basic mechanisms of environmental factors, adverse and protective, that influence health and development processes. The selected sample of locations and neighbourhoods ensures that the exposure-outcome relationships identified are representative of all of the children in the US.



The investigation places an emphasis on scheduling visits during periods of preconception, early pregnancy, and early childhood.





Source: Danelle T. Lobdell, US EPA, NHEERL

Environmental exposures are defined broadly to include all physical, chemical, biological, genetic, and psychosocial factors. The various health outcomes under investigation include pregnancy effects, neurodevelopment and behaviour, asthma, obesity and growth, injury, and reproductive development.

Biomarkers of exposure are essential in providing as much information as possible about the consequences of exposure in terms of both cause and result. Analysis offers reliable and reproducible estimates of chemical contaminates at reasonable cost and can provide insight into sources and routes of exposure.

The National Children's Study protocol defines the Biomonitoring sampling from both the mothers and children in terms of sampling points, biological sources, and sampling events and they rely on various observation methods such as questionnaires and diaries. When biological measurements are unavailable, they focus on environmental measurements, sampling indoor and outdoor air, water, house dust, surface wipes, food, and soil. The environmental sampling poses challenges in terms of collection time, cost, and long-term storage.

Biomarkers meet most chemical exposure measurement needs at a reasonable cost compared to environmental measurements. They therefore have many advantages in the effort to estimate the wide range of exposures that occur in the National Children's Study.

NCS Sample Collection Costs

Chemical Contaminants	Biological Media	Cost ($)	Collection Time	Environmental Media	Cost ($)	Collection Time
Metals As, Cd, Hg, Pb	Blood	90-250	11 min	Air (filters)	~100	days
Pesticides organochlorines carbamates pyrethroids	Spot Urine	~120	7 min	Dust wipe	~225	15 min

Human Biomonitoring as a Tool to Explore Exposure Pathways

Ursel HEUDORF
Public Health Department, City of Frankfurt, Germany

Usefulness of HBM for Exploring Exposure Pathways

Human Biomonitoring considers the total exposure of individuals or populations to environmental pollutants, irrespective of the source (food, drinking water, air, consumer products, etc.) or the pathways (ingestion, inhalation, or absorption). Nonetheless, in two specific situations it is necessary to explore the exposure pathways.

Internal Exposure Known, Source Unknown

In the first case, an increase in internal exposure is observed, but the source of contamination is unknown. This scenario sometimes occurs in individual cases in children. Without biomonitoring, it would be impossible to find the source of contamination.

Source Known, Risk Unknown

In the second case, the source of exposure is known, but the risk is unknown, as in studies of the impact of breathing in a contaminated area or of eating local grown produce. Another example of this situation is the determination of the tolerable exposure level of polychlorinated biphenyls (PCBs) in schools. PCBs had been banned in Germany in 1989. Before the application of biomonitoring techniques, unnecessary redevelopment measures were undertaken. After new calculations based on HBM and ambient data, a new PCB redevelopment guideline was set up in 1993. Other exposure assessments based on ambient monitoring and biomonitoring of unknown risks have been undertaken for parquet glue. As a result, expensive redevelopment measures were avoided.

Conclusions

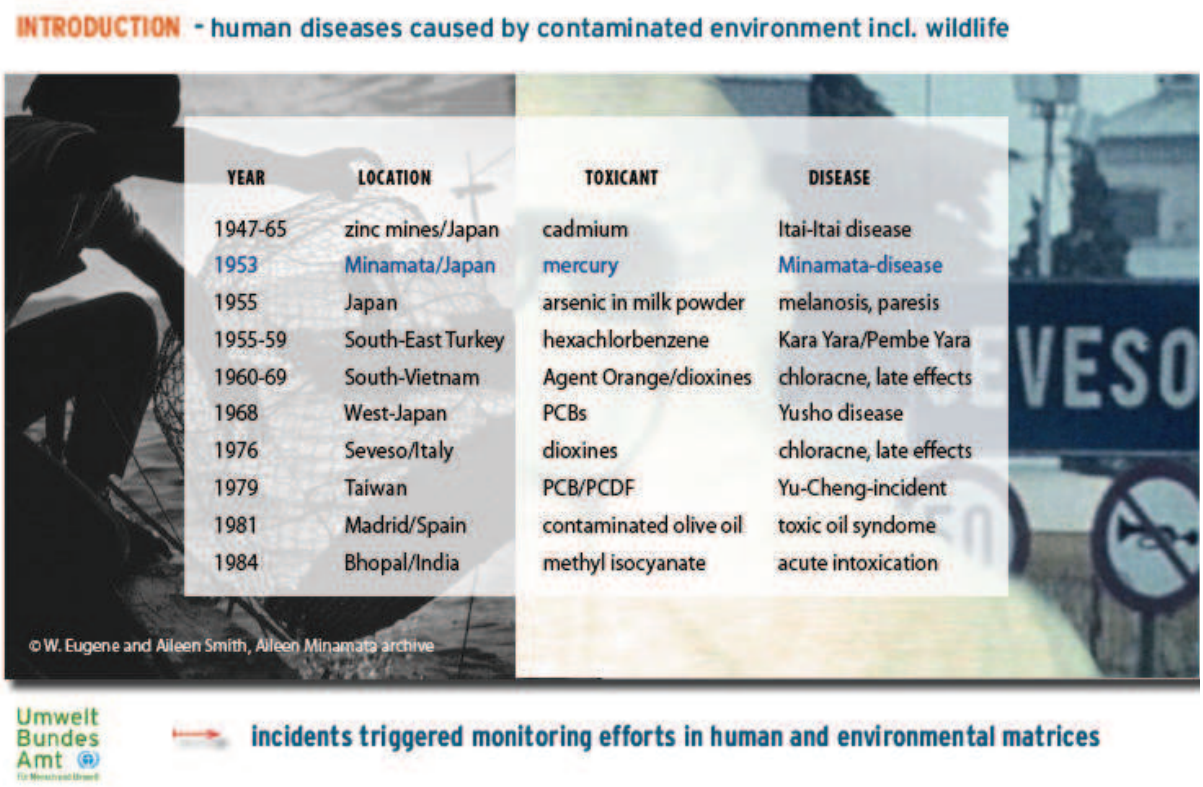
Human Biomonitoring is a valuable and useful tool to explore exposure pathways in individuals and groups when the only preliminary available data is either of the internal exposure or of the source of contamination. Environmental surveys are necessary to assess HBM data of individuals and groups. HBM is necessary, realistic and reasonable exposure and risk assessment, as basis for valid measures to reduce exposure and risk of the population at a reasonable cost.

Chances and Limitations of Integrating Data from Human: and Environmental Monitoring at a National Level

Jan KOSCHORRECK
Federal Environment Agency (UBA), Germany

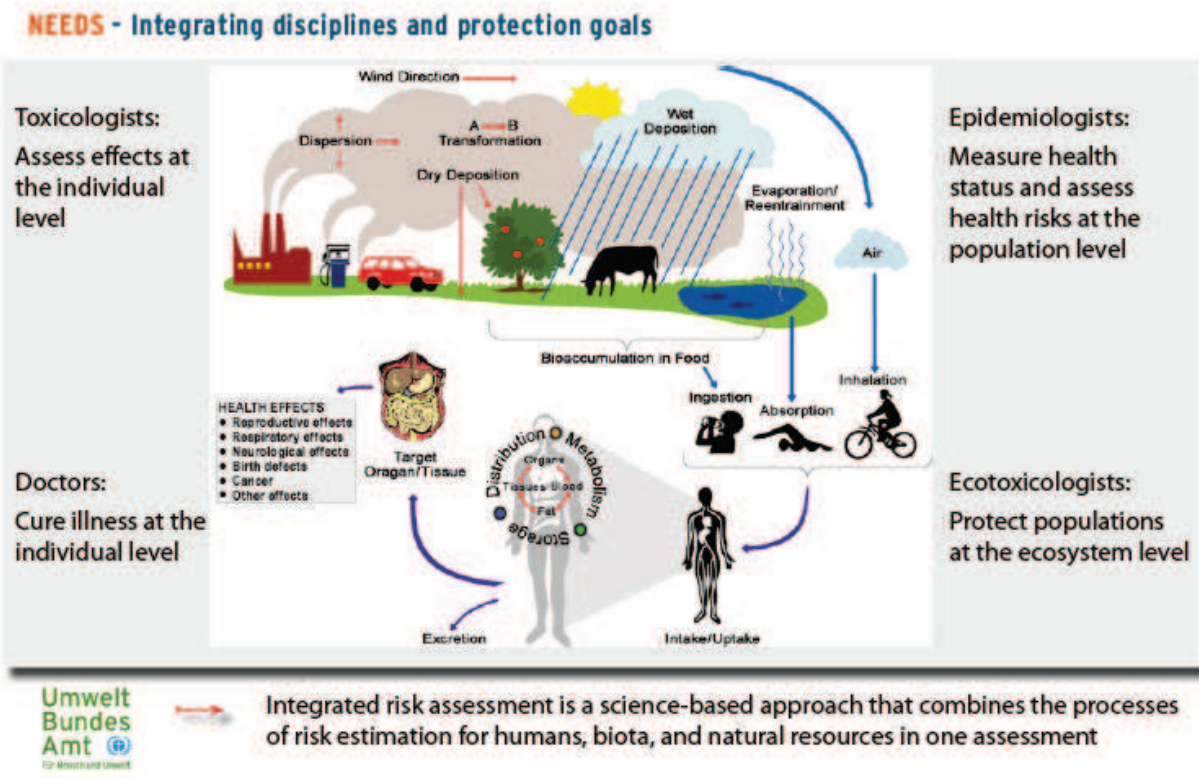
Background

A contaminated environment has caused numerous human diseases. Worldwide, large-scale incidents have triggered monitoring efforts in human and environmental matrices.



Definition of Integrated Risk Assessment

Environmental monitoring involves the integration of various areas and protection goals. The principle players involved are physicians, toxicologists, epidemiologists, and ecotoxicologists. These four actors have found a common definition for integrated risk assessment: It is a science-based approach that combines the processes of risk estimation for humans, biota, and natural resources in one assessment.



Chances of an Integrated Approach

A sustainable approach integrating data from human and environmental monitoring:

- Takes account of human exposure via all environmental compartments
- Can be used by regulation, e.g. exposure assessment of existing substances
- May deliver improved exposure models for prospective risk assessments of new substances
- May provide a safety net for PBT and vPvB substances, where exposure in space and time is unpredictable

Limitations of an Integrated Approach

If we want to integrate data from environmental and human biomonitoring we have to make sure that we can:

- Find a destination for the outcome of the assessment
- Agree on a common standards for sampling and analysing
- Clarify exposure pathways : only a few concrete examples are available at the present time
- Agree on criteria to prioritise monitoring of chemicals in both man and environment

The German Environmental Specimen Bank (ESB)

At the beginning of the 1980s, the German government launched the German Environmental Specimen Bank (ESB), a national tool for the integrated monitoring of chemicals. Since the 1990s, the ESB systematically collects and stores samples of living organisms as indicators of the chemical contamination from air, water, soil, and food web kinetics. Over 215,000 environmental sub-samples and 190,000 individual human samples enable screening and time trends. Significant retrospective analyses of perfluorinated chemicals (PFCs), lead, and polybrominated dyphenylethers (PBDEs) have been undertaken.

The Outlook for 2009

In 2009, the ESB intends to complete the food web analysis for PFCs and PBDEs, screen samples for emerging contaminants based on regulatory criteria and experimental approaches, explore use of blood samples from the umbilical cord in the ESB monitoring routine, become connected to explore the use of existing ESB data for food web modelling and integrated exposure assessment.

Conclusion

Developing integrated exposure models can be a starter for integrated risk assessment.

Chances and Limitations of Integrating Data from Human and Environmental Monitoring at the EU Level

Roel SMOLDERS
Environmental Toxicology Group (VITO), Belgium

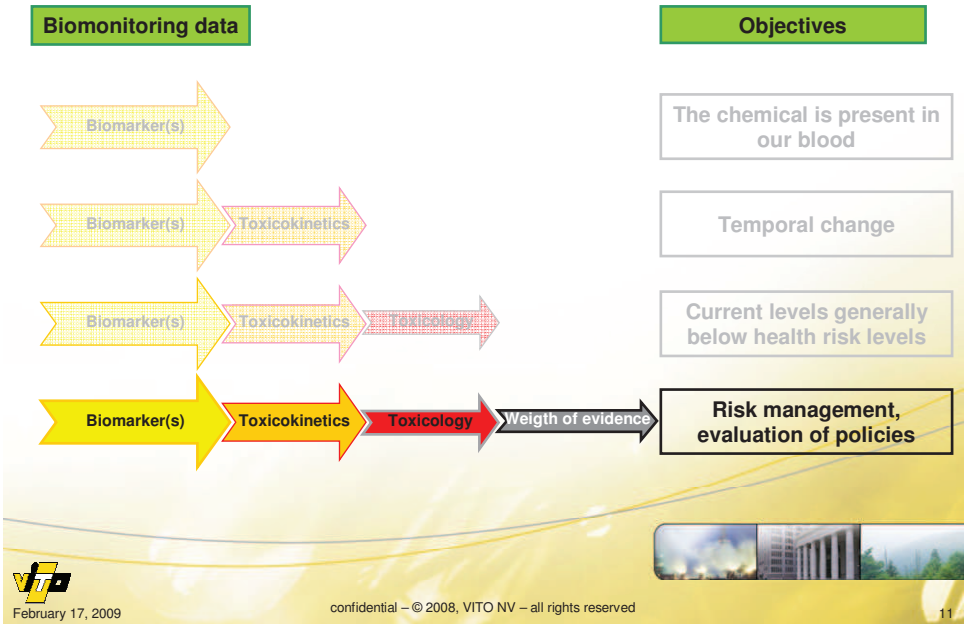
Introduction

After observing the strengths and limitations of biomonitoring, we realise that the integration of environmental data into policymaking is essential. Unfortunately, there is no such thing as 400,000 bio bank samples at the EU level. It is therefore even more difficult to come up with relevant data on how to integrate environmental data.

Why Integration Is Important

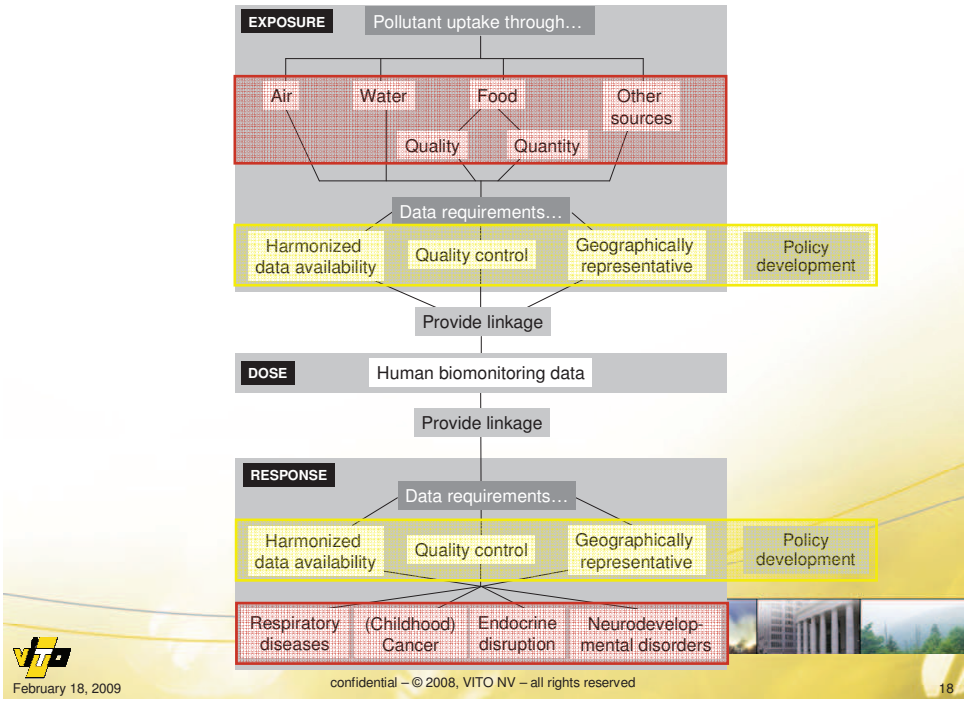
Biomonitoring data in itself tells us the about the presence in the body of a given contaminant. For a population, we can see the trends in concentrations over a period of time and through toxicokinetic literature, we can explain these temporal changes. Unfortunately, this information is insufficient for designing policy.

If we include toxicological information, we can see which health effects are associated with the concentrations of the given contaminant in blood. This enables us to carry out risk assessment. If we find the correlation between emissions of pollutants and concentrations in blood, we can demonstrate the evidence of the source. It is thereby possible to manage risks and evaluate policies.
Integration of HBM and policy-making involves multidisciplinary research, including the disciplines of chemistry, statistics, epidemiology, toxicology, risk assessment, communication, sociology, and politics.



Why We Need an EU Approach

Pollution does not stop at borders. With a European approach, we can manage the trans-boundary aspects, create a harmonised approach, compare data, and set up European legislation. We can also address the wide variations in the Member States in exposures, lifestyles, socio-economic situations, and climate.



Availability of Environment and Health Data in Europe

Information was gathered on the routes and health effects of exposure. They mapped concentrations of pollutants in air, water, and topsoil across Europe and the geographical frequencies of diseases. Within the framework of ESBIO, and identified challenges and opportunities to establish an exposure-dose-response triad for Europe.

Availability of E&H data

Information on routes of exposure

	Availability	Geographical context	Harmonization	Quality control	Policy developments
Air emission	☺	☺	☺	☺	☺
Air imission	☺	☺	☺	☺	☺
Water emission	☺	☺	☺	☺	☹
Water imission	😐	😐	😐	☺	☹
Food quality	😐	😐	☺	☺	😐
Food quantity	☺	☺	😐	😐	😐

Availability of E&H data

Information on health effects

	Availability	Geographical context	Harmonization	Quality control	Policy developments
Cancer (mortality)	☺	☺	☺	☺	☺
Cancer (incidence)	😐	😐	☺	😐	☺
Asthma	☺	😐	😐	☺	☺
Neurodevelopment	😐	☹	☹	☹	☺
Endocrine disruption	☹	☹	☹	☹	☺

Linkage Methods

It is necessary to create a structured method to connect the various data and bring it all together under one banner.

The main problem being faced is that the data was not designed to be used in integrated environmental health assessment. However, all the available information is available in the form of maps, which should help in creating links. Geographic Information Systems (GIS) may offer a flexible platform for integration of Human Biomonitoring and Environment and Health data in Europe.

Linkage Methods

GIS-based integration platform

- Opportunities for 'data-rich' substances
- Inter- and extrapolation
- Spatial and temporal evolution
- Links with research and (EU) policy making (INSPIRE directive)
- Incompatibilities among E&H databases require a degree of generalisation
- Privacy issues

Privacy Issues

- Privacy issues
  - No individual data
  - Some type of aggregation
    - Administrative boundaries
    - Topic related (e.g. distance from source)
    - Land-use (urban, semi-urban, rural)
  - Flexibility needed (≠ spatial scales)

Conclusions

- HBM is not a stand-alone tool
- First priority: get the numbers right
- Where is it coming from and what is it doing?
- Differences in data availability for E&H data
- GIS may offer a flexible platform for integration of HBM and E&H data in Europe
- Integration and interpretation go hand in hand

From Science to Policy: Translation of Human Biomonitoring Results into Policy Measures in Flanders

Caroline TEUGHELS
Department of Environment, Nature and Energy, Flemish Government, Belgium

The Flemish Human Biomonitoring Program was commissioned, financed, and steered by the Flemish government in 2002 as a five-year phased action plan for the development of Environment and Health. The program covered approximately one-fifth of both the territory and population of Flanders. It studied eight different geographical areas in Flanders, each one different in nature from the others. In each region, the program focused on three different age groups: newborns, adolescents, and adults. In each group a selection of pollutants and health effects were measured and all participants completed a questionnaire on lifestyle, food habits, and health effects.

Data Collection and Results

Researchers collected a variety of biomarkers of exposure and effect. As a reference value, they used the average of all of the results in each category. All of the groups were compared to the reference levels. It was found that some groups were significantly higher and others were significantly lower than the reference values. Complex mixtures of results were observed and they needed to choose the biomarker anomalies, which were relevant to public environmental health policies, and to determine the policy measures, which would have to be taken.

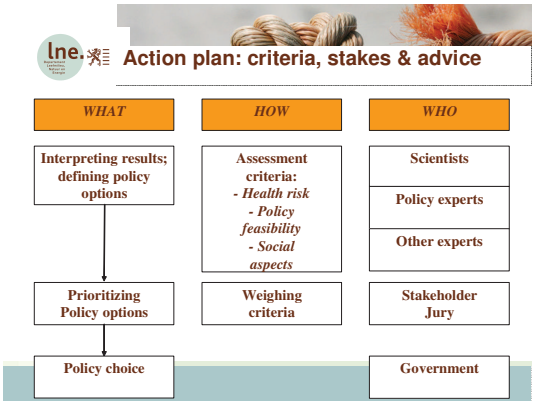
Translation of Results into Policy

The translation of results into policy was challenging due to the fragmentation of specialised knowledge, the scientific complications, the social complexity, and the inexistence of an expert able to draw conclusions for policy. They also wanted to include scientific and social criteria by means of a close collaboration between scientists, policy experts, stakeholders, and a jury.

The Action Plan

A three-stage action plan, preceded by a "pre-phase", was developed for creating policy measures:

- **Pre-phase:** a pre-selection of cases determined by the differences from the reference values.
- **Phase I:** Interpretation of results. Evaluation of the seriousness of anomalies. Assessment of priorities for policy-making: health risks, policy feasibility, social aspects.
- **Phase II:** Evaluation of the underlying reasons for the results. Weighing criteria. Identification of sources of pollution.
- **Phase III:** Proposal of concrete policy measures. Government decision.



A panel of experts and a jury made up of local stakeholders and authorities leads the phases. The Action Plan is currently being carried out for two different cases: the increased levels of persistent organic pollutants (POPs) in rural areas of Flanders and the increase in asthma and allergy incidences in Flemish urban areas. The Action Plan should lead to concrete policy action by the end of 2008.

Lessons Learned

- The boundary work between different scientific disciplines and between scientists and policymakers is very fruitful but should not be underestimated in complexity - Learning by doing and negotiating…
- The participation of stakeholders in the policy process should be well defined and focussed
- Open communication of human biomonitoring results and of the resulting policy response are essential key elements in raising awareness and broadening the social basis for a broad environment and health policy.

Human Environmental Biomonitoring as a Policy Lever: A Case Study of Mercury and Pesticide Exposures in New York City

Daniel KASS
New York City Department of Health, USA

Description of the Program

The New York City (NYC) Environmental Biomonitoring Program was modelled after the Center for Disease Control's (CDC) National Health and Nutrition Examination Survey (NHANES). It was a population-based sampling of non-institutionalized NYC residents aged 20+ years. Samples were collected between June – December 2004 and it was a combination of interview and physical exam (blood and urine samples from 1811 participants) . They examined and surveyed approximately 2,000 people representing the adult non-institutionalized population of NYC. We collected urine and whole blood from just over 1800 of these subjects.

The work focused on heavy and toxic metals, cotinine as a marker of tobacco exposure, and pesticides. They chose these subjects out of a scientifically informed belief that exposures may be higher in NYC by virtue of urbanicity or the population, and out of an intention to act on the results. One focus was on mercury – both inorganic and organic -- and pesticides. They chose to examine exposures to mercury and to organophosphate and pyrethroid pesticides due to the fact that the exposures to these contaminants are considerably higher among New York City residents than in the United States as a whole.

Key Findings

Significant disparities in exposure among certain New York City sub-populations were found. Examples include:

- Inorganic mercury levels – measured in urine - on average were low in NYC and not overall the subject of health concerns.
- Inorganic mercury exposure among women was highest for foreign-born Dominicans.
- Organic mercury exposure was three times higher in New York City than in the overall US population. In New York City, it was highest among Asians as a whole, and within this group, it was highest among foreign-born Chinese. There was a strong relationship between fish and seafood consumption and mercury levels.
- Organophosphate and pyrethroid pesticide exposure was significantly higher in New York City than in the US as a whole. In New York City, it was significantly higher in females and in people whose homes had recently been visited by a pest control professional.

They conducted follow up interviews and home visits to many of these subjects . We determined that each of the cases we were able to interview were attributable to the use of mercury salt-containing illegally imported skin lightening creams manufactured principally in the Dominican Republic. While the number of research subjects with significantly elevated inorganic mercury was small, they represented perhaps as many as 25,000 New Yorkers with unsafe mercury levels attributable to the use of these products.

Policy Changes Resulting from NYC's Biomonitoring for inorganic mercury

Following the discovery of the skin lightening creams, inspectors were sent to more than 400 stores in neighbourhoods with the greatest number of people from the Dominican Republic. They discovered 13 products and embargoed them at more than a hundred stores. Orders were issued requiring the posting of warning signs in stores that sold products for six months. Given the relative frequency with which contaminated imported products are discovered, they created a unit within the lead poisoning prevention group to undertake store inspections and interdictions, as well as public outreach. With the Pan American Health Association, they reached out to the Dominican Republic's Ministry of Health, which in turn conducted inspections of the laboratories and ordered cessation of production in at least some. Finally, a great deal of outreach around these products to the public was undertaken including the dedication of NYC Health Dept resources for public education.

Policy Changes Resulting from NYC's Biomonitoring for organic mercury

Concerning the organic mercury and fish findings, they created a working group with federal and state regulators of commercial fish, both of which stepped up fish sampling in New York City. Biomonitoring effectively made the case that these agencies' prior emphasis on contamination in recreational fish was inadequate to address the population sources of exposure to mercury; namely commercial market fish. NYC itself completed sampling 280 fish representing 20 species commonly sold in Asian markets but not elsewhere. They issued clinical notices using a Health Alert Network to provide guidance to physicians to encourage education, but also to discourage testing. They created a new educational campaign that has circulated nearly 200,000 fish consumption guides to "Eat Fish, Choose Wisely".

Policy Changes Resulting from NYC's Biomonitoring for pesticides

In 2005, NYC became the largest City in the US to restrict local governmental use of pesticides. NYC went a step farther, and requires electronic reporting and public disclosure of pesticide use and trends, in part to drive demand for safer pest control. They have presented the findings to US EPA and to the New York State pesticide regulatory agencies, leading to a greater recognition that urban exposures are significant and indeed rival that among agricultural communities. For example, NYC is now represented on EPA's advisory committee on pesticides. Lastly, they have recently succeeded in convincing the State of New York to prohibit the use of some of the worst products; total release figures; from sale to the public. New York City local laws were adopted that restrict governmental pesticide use. In addition, a New York City Health Department public education program was launched on safer pest control.

A Framework for Biomonitoring as a Policy Lever

Policy is a course of actions intended to influence and determine decisions and other actions. It may be formulated and implemented in the governmental, non-governmental and private sectors. Policies are made in the context of a policy subsystem and involve a variety of key policy actors, including local and state governments and health organisations. External events, such as the media coverage of biomonitoring findings, matter. They bring in additional policy actors, such as advocacy coalitions and health organisations not yet involved in policy formation. Biomonitoring influences the normative beliefs and the relative priority of values of the policy actors concerning the protection of commerce and public health.

The greatest potential of Biomonitoring to influence policy is around how a problem is defined:

- Increased knowledge may accelerate the influence of external events. In addition, the consistency of the findings that urban exposures are higher has made state and federal agencies more sensitive to the concerns. Biomonitoring results also create occurrences outside existing policy systems that can create disequilibrium in the status quo. For example, the media is only an occasional player, but its inherent interest in things "new", "unjust", "scary" and "medical" has disproportionate impact on more traditional policy actors.
- Biomonitoring can also engage new actors in the policy system:
    - In NYC, these included, in case of mercury; Hispanic service organizations in particular, Dominican service organizations.
    - In case of fish; Chinese healthcare providers and business associations in the three NYC Chinatowns
    - Around pesticides, local government, which had been largely absent from policy discussions because most regulation occurs at state and federal levels. Similarly, purchasers of pest control services have been forced to consider how their decisions influence the potential for exposure.

Why is biomonitoring so compelling

Biomonitoring can have profound impacts on a variety of beliefs, in the case of pesticides; a common belief among regulators is that the registration and approval process itself ensures that exposure will be minimal. Similarly, that the proper use of a product ensures its safety.

Biomonitoring can redefine the scope of problem. The findings show that exposures in cities are different than the nation as a whole, and that has changed the assumptions made by many policy actors. The finding that pesticide exposures in NYC are closer to those of an agricultural worker in the Central Valley of California, than they are to the United States overall refocuses attention.

Biomonitoring can influence the relative priority of different values. The value of free commerce is implicit in the sale of consumer products, commercial fish and pesticide products. In addition, in the United States, the agencies charged with their regulation have dual roles; protection of commerce and protection of the public. Human exposure data offers a counterweight to such values.

The results altered perceptions of disparity and equity. For example, by identifying foreign-born Chinese as having the highest mercury levels, NYC began an outreach program to a population largely missing from the radar.

Biomonitoring may influence peoples' beliefs that a problem is susceptible to change. By quantifying a problem and demonstrating disparate impact, biomonitoring demonstrates the potential to influence exposure, paving the way for policy actors to consider ways in which their own actions can influence the potential for, or against, exposure.

Finally, biomonitoring changes beliefs in the efficacy of governmental action. Whether comparing baseline levels to a standard, or tracking levels over time, exposure data can be used to evaluate the effect of governmental actions intended to influence exposure, and in a shorter timeframe than health outcome data, especially for exposures associated with chronic disease. In addition, greater potential to show efficacy can influence our willingness to consider policy changes.

Conclusion

The successes of the NYC program may be related to the fact that the biomonitoring program was population-based, that its subjects were chosen specifically mindful of our potential to interpret and at on our findings, and that our findings are typically presented to policy actors alongside other data that strengthen the case for risk and for action, making it difficult to tease out the precise impact of biomonitoring alone.

Environmental biomonitoring can supplement more commonly available health and mirror public concerns by implicitly emphasizing primary prevention. It can also identify populations at greater risk of exposure and illness and readily influence policy by modifying assumptions, creating disequilibrium between competing assumptions regarding risk, engaging new policy stakeholders, and by modifying the beliefs of key policy actors.

The Added Value of HBM for Human Health Protection: From Science to Industry Action

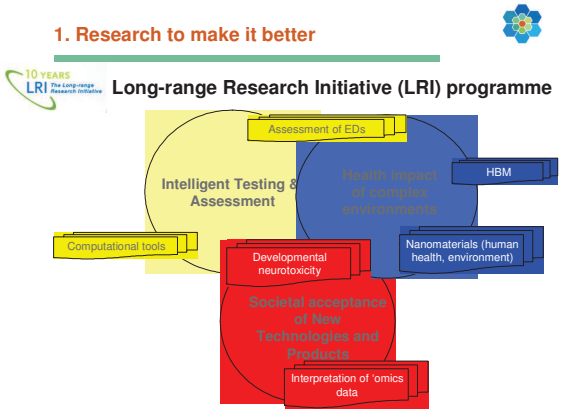
Loredana GHINEA
European Chemical Industry Council (CEFIC)

Use of Human Biomonitoring in the Chemical Industry

Science, societal, and regulatory drivers conduct the behaviour of the chemical industry of which the health-related drivers are the most important. The industry relies on HBM for product development and improvement needs, as it enables early warnings of potential impacts, the creation of assessment schemes, and an analysis of real-life behaviour. In the industrial context, HBM is an established and scientifically based tool that has been used for many years in occupational safety to control the success of risk-management measures and in occupational medicine to examine the chemicals absorbed into human body fluids. HBM has become particularly topical for several reasons. It gives important information about exposure. Through HBM, advancements in analytical methods have enabled the detection of trace amounts of chemicals, which may be used for early warnings. Furthermore, progress has made HBM less costly and more accurate. An enthusiastic perspective for improvements in HBM lies ahead, with continual progress in risk assessment, medical surveillance, data quantity, and diagnosis and treatment. It is expected that improvements in risk management will result.

The Long-Range Research Initiative (LRI)

In order to ensure the increased value of HBM, the European Chemical Industry Council (CEFIC) launched the Long-range Research Initiative (LRI) program in 1998. The program sponsors projects and workshops with organisations such as the European Commission, the United States Environmental Protection Agency, and universities. The LRI strategy is to combine three main areas: the health impact of complex environments; intelligent testing and assessment; and the societal acceptance of technologies and products. The program conducts research for improvement of biomonitoring as well as capacity building endeavours.



Research for Biomonitoring Improvement

The LRI research for improvement of the Human Biomonitoring tool aims to find the following:

- Ways of obtaining a better understanding of effect pathways,
- Ways of establishing a sound interpretation of data
- The further needs for adapting Human Biomonitoring to real-life contexts,
- Ways of balancing the opportunities and limitations of Human Biomonitoring with its operability
- The gaps needed to be filled through further investigation.

Capacity building

CEFIC has also launched a capacity-building programme and the second plan is to look into science policy, coordination, and communication. They have set up four ICCA global workshops for the period 2005–2009, with participants from the European Commission, the United States Environmental Commission, universities, Member States, industry and NGOs. They will continue going forward, by building a network of expertise, committing to communication activities, and involving stakeholders.

Using Biomonitoring to Raise Awareness for Policy Change: Public Interest Campaigns

Lisette van VLIET
Health and Environment Alliance (HEAL), Belgium

Sharlye PATTON
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Why Public Interest Organisations Are Conducting Human Biomonitoring

Human Biomonitoring shows us our internal environment and makes the contaminants inside us visible, and indicates trends and the changes in chemical usage. It also identifies disproportionate exposures, identifying vulnerable groups and HBM enables us to refocus scientific enquiry and to examine the effectiveness of regulations concerning public health. Through its methods, we can link exposure and health outcomes and HBM can help improve consumer choices and product design. Additionally, it can raise awareness in the general public about toxic use, and thereby contribute to the development of social agreements and changes in norms and values.

A European Example: The WWF Detox Campaign

The WWF Detox Campaign tested the chemicals in the blood of numerous groups around Europe, including three generations of families in 12 countries, European Ministers and Members of the European Parliament. The results revealed that all those tested had a cocktail of persistent bio-accumulative and toxic substances in them.

Examples of Public Interest Campaigns in the USA

Biomonitoring data has been used to create policy reform and influence corporate decision-making in the United States.

- The Commonweal and Environmental Working Group tested 11 people for 210 chemicals and subsequently developed a project on how people would feel if they found out their personal body burden.
- In another study, they tested 12 people in California known for their commitment to public well-being and then made the results public. The purpose of the project was to raise awareness of the need for a California Biomonitoring program. As a result, legislation for the "Taking It All In" program was passed in 2006.
- Other legislation was passed further to our actions, including the Kids Safe Chemical Act, related to pollution in newborns. Following another study in seven states, legislation was passed in all seven states banning the chemicals of concern.
- In collaboration with WHO, the Moms and Pops Project (MaPP) was launched. It will test for POPs in breast milk in 30 countries, so that breast milk monitoring will lower POPs levels in our bodies, rather than the number of women who breastfeed.
- In the United States, it is apparent that climate change is becoming more and present in national consciousness and its effects chemical emissions and on human health. We issue reports on the rising number of chemicals in people's bodies and the relationship to climate change. This will be important in creating public health policy and in working corporations for corporate policies as well.

Communication and Ethics in Human Biomonitoring

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Communication and ethics in Human Biomonitoring and the importance of authentic informed consent and on the various aspects of high quality communication was presented by way of a didactic video, which illustrated the effective and appropriate manner to communicate with possible study participants.

Informed Consent

Legislation: To speak of ethics in Human Biomonitoring we are compelled to broach the legal framework, consisting of documents and international conventions. At the heart of all of the legislation is "individual informed consent". Two of the principle legislations related to ethics are the European Privacy Directive, which implemented international law into the Member States, and the Oviedo Convention, which made its recommendations.

Possible Pitfalls

We strive for authentic individual informed consent. However, there may be pitfalls in the process of obtaining authenticity in the consent. For example, the accuracy of the information may be limited, the authenticity of the form for consent may be questionable, or there may be an incorrect understanding of the information.

Good communication

Good communication is crucial in obtaining authentic informed consent and is at the heart of ethical practices. It is essential for the recruitment of volunteers, as well as for the dissemination of research results on the individual, societal and policy level.

Communication between a research participant and a researcher must be adapted to every situation and always represents a complex interaction of personalities. We have prepared a didactic video on informed consent practices, intended for young PhD students. It illustrates several interviewing approaches between a physician and a potential participant in Biomonitoring, as well as one responsible, empathetic approach.

Environmental Justice and Interpretation of Human Biomonitoring Results

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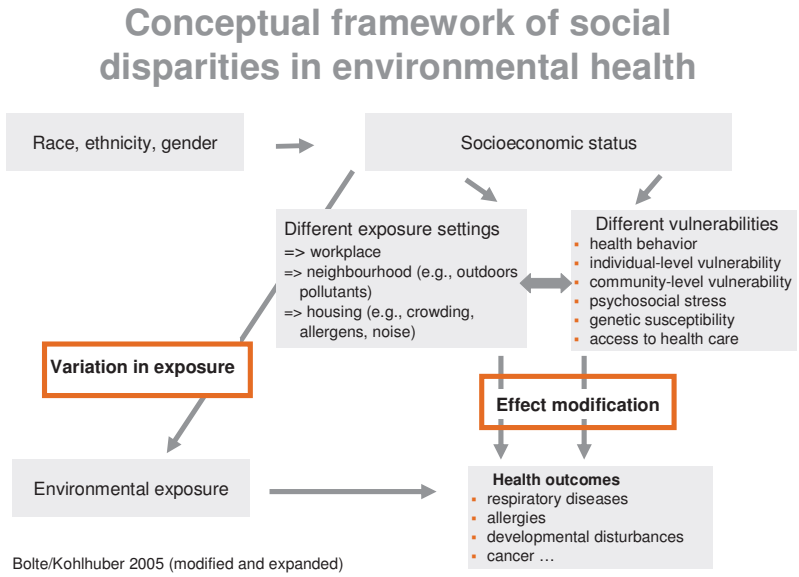
Environmental justice seeks the practice of biomonitoring applications with a far more equitable distribution of resources and assessment of manmade environmental hazards, taking account of relevance to different socioeconomic groups. The environmental justice movement began in the US in the 1980s when grass roots organisations joined to address the disproportionate number of hazardous pollution sources in minority neighbourhoods and low-income communities. Environmental justice has been defined as:

> "Environmental justice seeks the equitable treatment and involvement of every person – regardless of race, colour, national origin, educational level or income – in the development, implementation and enforcement of environmental programs, laws, rules and policies on a distributive, procedural and precautionary level" (Environment Protection Agency).

Basic Principle

The basic principle of environmental justice is that every person is entitled to healthy environment and that environmental health issues cannot be addressed without considering social issues. Environmental justice debate revolves mainly around the question of which population groups are at risk due to exposure to toxins, leading to the question of what kind of social, economic, and psychological consequences result and how fairer distribution of proper measures would look. Environmental justice conceives two major hypotheses: First, that people of lower economic status are likely to be more exposed to environmental hazards, and second, that such populations may be more susceptible to adverse effects of environmental hazards than those in higher socioeconomic groups, due to limited access to adequate health care, lack of material resources, or poorer nutrition.



Bolte/Kohlhuber 2005 (modified and expanded)

The EU PINCHE Study

The Policy Interpretation Network for Children's Health and Environment (PINCHE), funded by the European Union, conducted a study to analyse and interpret existing research on the impact of socioeconomic factors on exposure to environmental hazards. The study reported its key results in 2005, concluding that in most cases there is an inverse social gradient with increased burden of exposures and health effects in children of lower social status.

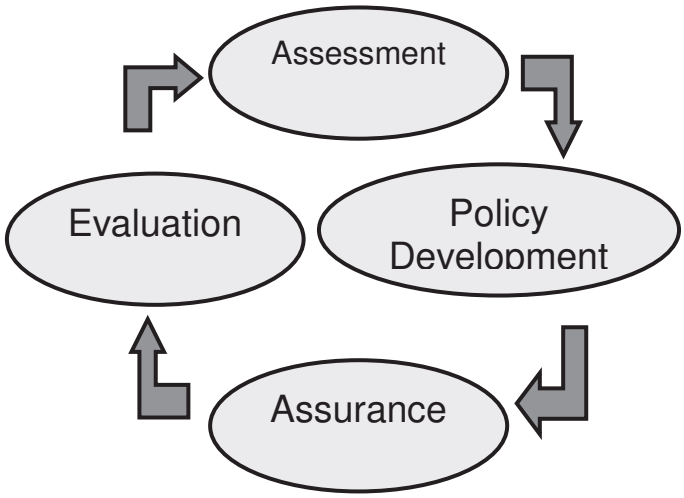
The German Environmental Survey for Children (GerES IV)

Revelations of Environmental Injustice: The German Environmental Survey for Children (GerES IV) revealed evidence of current environmental injustice across Germany. Human Biomonitoring studies had been taking place in North Rhine-Westphalia, a region of heavy industries, for many years, but the distribution of the environmental burden between social groups and its health impact was neglected. Moreover, reanalysing the results of a "hot spot study" revealed that, in agreement with other studies, clear correlations were found between individual indicators of social position, external burden factors, and several health outcomes.

Biomonitoring Needs

The GerES study concludes that HBM studies are essential for risk assessment in the public health action cycle (PHAC): http://www.henet.ch/ebph/bilder/publichealtactioncycle_grafik.gif

- To support research on the correlation between the social differences in exposures to multiple environmental stressors and health outcomes,
- For risk analysis as well as preventive measures, public health promotion, and recommendation for policy intended to address social and environmental factors.



Human Biomonitoring and environmental justice research maybe useful for:

- Developing an integrated conceptual research framework on the correlations between biological markers and pathways of exposure as well as their social dimensions;
- Improving exposure assessment in diverse populations and specific study groups;
- Improving demographic and/or geographic comparisons and trends in environmental exposure and health disparities over time and regional differences;
- Setting priorities for surveillance and exposure reduction;
- Improving the understanding of environmental health disparities both at the individual and at the population level;
- Evaluating environmental policy measures.

Human Biomonitoring in Synergy with Environmental Justice Research

Human Biomonitoring alone is insufficient for making public policies. It is important to coordinate Human Biomonitoring with environmental justice research and to use the synergisms between social and environmental epidemiology. This synergy can be used for:

- getting more information about the purpose of socio-economic factors and social conditions as effect modifiers;
- generating more representative data on the distribution, association and contamination routes of environmental exposure and health outcomes in different subpopulations;
- better understanding social differences in vulnerability and susceptibility characteristics;
- answering methodological challenges posed by the simultaneous occurrence of different types of exposure
    - to multiple environmental hazards modified by socially adverse conditions,
    - at different spatial scales (e.g., individual and community level).

In so doing, issues of "justice" and "fairness" in developing research concepts and projects would be considered.