HEALS Newsletter

Health and Environment-wide Associations based on Large population Surveys

Project No 603946 of the European Union's Seventh Framework Programme

Contents

Editorial Note

Welcome to the third issue of the HEALS Newsletter!

This issue shows that the HEALS project is reaching cruise velocity after these first 18 months. It starts with an article by the project co-coordinator, Dimosthenis Sarigiannis, who attended the International Workshop on the exposome organized by the US National Institute for Environmental Health Sciences (NIEHS) in Raleigh, North Carolina, USA (January 14–16, 2015).

Fortunately, the concept of exposome is making its way within the scientific community. As we all know, it is linked to many knowledge domains and requires information from a wide diversity of data that must be compiled and integrated in a manageable way for correlation with omics information and health outcomes. All these aspects have been evaluated by Prof. Sarigiannis in his summary article.

Environmental exposure for exposome studies can be measured through "on-line" systems devoted to monitor all activities of individuals during their working, leisure and family lifetime. It can also be measured by off-line methods involving analysis of biomarkers in human tissues or fluids. Both approaches have been considered in deep in within HEALS. In this newsletter we have two interesting summary reports describing the main issues related with the implementation of both approaches. These refer to two achieved deliverables: *The usefulness of sensor technology for the assessment of the external exposome* (Deliverable 1.1) by Miranda Loh and John Cherrie from IOM, and *A synthesis of the guidelines for appropriate biomarker of exposure selection for Environmental Wide Association Studies (EWAS)* (Deliverable 4.2) by Nadine Steckling and Stephan Böse-O'Reilly from LMU, and Alberto Gotti and Dimosthenis Sarigiannis from AUTH.

In this current issue, the *Who is Who* section describes the professional profiles of three research colleagues who are actively involved in the project and participates in different work packages: Zdravko Spiric from OIKON (Croatia), Kinga Polanska from NIOM (Poland) and Clive Sabel from UNIVBRIS (UK). This section also contains the profile of our HEALS Project Manager, Amir Moustafa, from UPMC (France).

The issue ends, as usual, with a list of the scientific publications, public presentations, workshops, conferences and other knowledge-dissemination activities generated by the HEALS researchers since January 2015. Interesting forthcoming events for HEALS partners and exposome researchers are also announced.

Please, do not miss the HEALS Annual Meeting that will be held in Crete, Greece, on 23–25 September 2015.

HEALS Second Annual Meeting
September 23 – 25, 2015
Crete - Greece

HEALS at the international workshop on the Exposome organized by the US NIEHS

Raleigh, North Carolina, USA (14–16 January 2015)

by Dimosthenis Sarigiannis

Aristotle University of Thessaloniki (AUTH)
Thessaloniki, Greece

The US National Institute for Environmental Health Sciences (NIEHS) organized an international expert workshop on exposome science on January 14–16 2015 at its headquarters in Raleigh, NC, USA. It was very successful bringing together all major experts on exposure and exposome science in the USA and Canada, but also a significant number of peers from Europe and Japan.

The goals of the workshop were to develop a framework for implementing the exposome today and in the future as a tool for environmental health sciences. This included:

- Understanding the nature of exposure
- Identifying associations between exposures and human health
- Investigating the mechanisms underlying these associations.

Secondary goals of the meeting were to:

- Define and disseminate the exposome concept
- Discuss challenges and opportunities in implementing the exposome
- Provide recommendations for developing and implementing the exposome concept for the environmental health sciences community.

The meeting was the culmination of the work of workgroups of experts formed in the summer of 2014 – the workgroups were charged with assessing the state of science, gaps and challenges in the exposome today, and providing recommendations for advancing the implementation. The groups dealt with the following topics: external exposure assessment; exposure assessment in biological samples; biological impact and consequences; epidemiology; data, analytical methodologies, and bioinformatics. All groups issued reports on the state of science and gave recommendations on how to best proceed internationally on each of the sub-topics above.

D. Sarigiannis, the HEALS co-PI, participated in the last group focusing on exposome data analytics and bioinformatics. The group was led by Dr. Chirag Patel, from Harvard University Medical School. The recommendations issued on data analytics are as follows:

1. **Catalog** contributions of environmental exposures to disease risk (e.g., susceptibility, variance explained) to strengthen the case for exposome research.
    - Document successes that relate to chronic disease outcomes with the complex phenomenon of exposure (*i.e.*, multiple exposures).
    - Recommend requirements for an exposome-association catalog (analogous to the NHGRI GWAS catalog).
2. Identify high-throughput (*e.g.*, 'omics, sensor-based) technologies and gaps to allow **unbiased** assessment of internal and the external *exposome*.
3. Incentivize other parties (*e.g.*, 'omics investigators in other disciplines, funding institutions, industrial entities) to integrate the *exposome* in their programs. Develop **high-throughput analytics methods** to analyze exposome data.
    - Develop **big data** analytics and visualization tools to accelerate exposome-related research (*e.g.*, **exposome-phenome** association studies).
    - Identify how **existing** 'omics statistical methods can be extended for the exposome research and **gaps** for new method development.
    - Encourage a **shift** in focus from "**one** exposure-**one** phenotype" to building **networks** of exposures, genes, and phenotypes.
    - Develop methods to *link* internal and the external exposome (*e.g.*, via biological inspired modeling)
    - Develop computational methods to incorporate biological/physiological knowledge.
    - Develop methods to support varieties of study designs (*e.g.*, longitudinal studies, Mendelian randomization) to strengthen inference and causality.
4. Identify **data standards** for high-throughput *exposome* research.
    - Develop *data and domain language standards* to encourage re-use in exposome-related research in future data collection, retrospective annotation.
    - Formalize the role **ontologies** play in integration/analysis.
5. Promote **data analytics standards** and **code re-use**.
    - Identify "use-cases" for software libraries and open-source software tools to jump start exposome analyses.
    - Identify partners to extend existing infrastructure to host repositories.
6. **Integrate** measurements, processing, and analyses and global initiatives.

- Identify requirements to support measurement and raw data analysis workflows to measure individual-level exposomes *e.g.*, connect existing **core facilities** to measure the exposome *e.g.*, **integrating** over NIH Commons initiatives (*e.g.*, metabolomics, microbiome).
- Instantiate a **Global Exposome Initiative** bringing together the US, European, and Japanese efforts.
- Determine possibilities for **joint** funding and creation toward robustness of the derived associations between environmental exposures and health status in large populations.

7. Need for data sharing for **reproducible** research.
   - Evaluate *strategies* and *"best practice"* for exposome-related data sharing
   - Need to engage *all players* involved in the research process, incl. journal editors and funders.
8. Provide **educational** and **outreach** opportunities
   - Identify an *example dataset* (*e.g.*, NHANES in the USA or DEMOCOPHES in the EU) for exposome-related methods development that is publically accessible.
   - "Netflix challenge"/Kaggle for the exposome data mining: hackathons and competitions to encourage data scientists to join the research community.
9. Develop exposome-related informatics and data analysis strategies and exposome curriculum and training support akin to NIH Common Fund BD2K K career awards.

At the meeting discussions were held in plenary and in break-out groups. The latter focused on two main topics: (a) how to integrate and prioritize the recommendations issued by the pre-meeting workgroups and (b) how to demonstrate implementation of exposome science in use cases. There was a good debate on what new the exposome concept brings to environmental health sciences, especially when compared with modern exposure science to date. External exposome was considered by several key scientists as simply a modern enunciation of conventional exposure analysis; thus, only the internal exposome brought something new. This was heatedly debated at the workshop in plenary and the final conclusion was that there is scope for considering both the external and internal exposome, including both conventional stressors and factors such as socio-economic status, proximity to green space, psychological condition and stress etc. among the exposome determinants.

Overall, NIEHS sought to obtain a framework for the development of an exposome-dedicated research program across the NIEHS and NIH branches, bringing together the US Federal government and international partners (in particular the EU and Japan) and the broader environmental health sciences community.

The Role of Sensor Technology in the External Exposome

by Miranda Loh and John Cherrie

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A key part of the HEALS project is to develop methods for measuring the external exposome, those environmental factors that may influence future health risks for people throughout their lives. The external exposome encompasses all of the non-endogenous exposures that may be encountered, from environmental pollutants through to our diet and psychological stressors. As part of identifying the HEALS methodology we have undertaken a review to identify to what extent new sensors technology can be used to track the specific external exposome. This review forms one of the early project deliverables and we are now in the process of seeking to publish our findings in the peer-reviewed scientific literature.

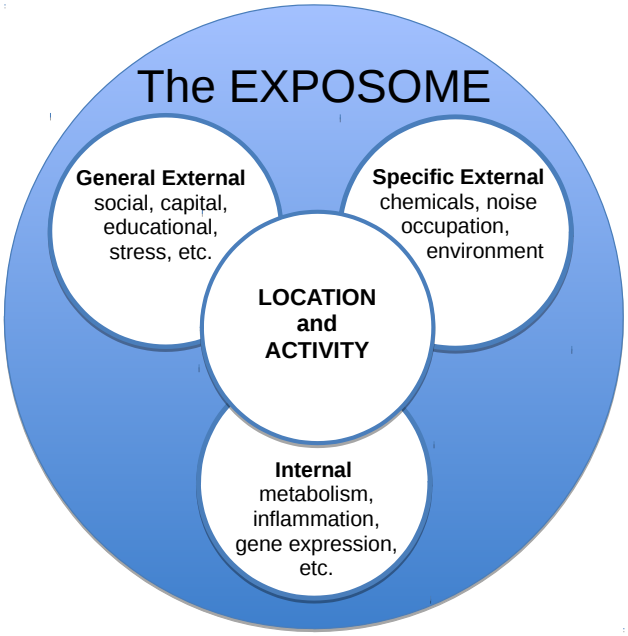
The advent of the exposome paradigm along with the development of mobile technology, low cost environmental sensors, and the "internet-of-things" brings exciting opportunities for exposure monitoring. In particular, the use of smartphone apps and the telecommunication facilities of smartphones to transmit and store data has made it possible to use small sensors to continuously monitor aspects of the external exposome. Also, the ability of phones to locate an individual in time and space provides underlying data that can be used, along with personal sensor data or environmental data from fixed location monitors, to provide reliable estimates of personal exposure. For example, knowing the location of an individual and whether they are inside a building our outside can allow an estimation to be made of exposure to ultraviolet radiation from sunlight using environmental UV levels modeled from satellite data.

We identified a number of innovations that were candidate technologies for inclusion in the HEALS external exposome methodology. We evaluated their usefulness using six criteria:

- Unobtrusive to the user;
- "Low-cost", *i.e.* from less than €100 to around €500 for each sensor;
- Able to collect, store and transmit real-time and high temporal resolution data;
- Useable by a non-scientifically trained person, who should have to minimally engage with the sensor system to collect the data;
- Ability to connect to the internet so that collected data can be remotely stored;

- Meets predefined quality assurance specifications.

The current sensors or other technologies that most fully meet our criteria are mobile phone apps that log and process location along with activity data, plus electronic pedometers that record walking, running and other physical activity. Many other approaches will be useful for HEALS, including periodically logging data about noise levels and recording dietary data with a mobile phone app. However, perhaps most disappointing is that the current state of air pollution sensors is generally not sufficient for deployment for personal monitoring in an exposome study. The technologies are either expensive and technically demanding to use or the sensors lack specificity and are prone to bias from other environmental factors, *e.g.* from abrupt temperature changes as a person goes from an indoor to outdoor environment.



The available technologies for measuring the external exposome are evolving very quickly, and while they provide great promise for advancing our knowledge they are mostly not sufficiently advanced for use in characterizing the external exposome. We conclude that for now the best approach will be to develop techniques for tracking individuals and automatically identifying their activities, and then to use data fusion techniques to estimate the exposome from fixed location environmental sensors, satellite data and other information.

The possibility of accessing an unprecedented amount of individualized exposure data, which would greatly improve our ability to identify associations between environmental exposure and health, also comes with various limitations and challenges. There are practical difficulties in storing and processing these data, particularly if the intention is to preserve the data for many decades. Privacy and ethical considerations are clearly an issue when these technologies are used to assess exposure to environmental stressors, but most particularly the sensitivity of many individuals about logging their location and activity needs to be carefully considered. Issues of data ownership and data protection need to be clarified to allow ubiquitous environmental health monitoring to become an everyday reality.

The future possibilities for monitoring the external exposome are great and HEALS will take a first step towards this goal.

A deliverable on *Can Sensor Technologies Really Define the Exposome?* is available for download on the HEALS website:

http://www.heals-eu.eu/wp-content/uploads/2013/08/HEALS-D1.1.pdf

References

A paper developed from the HEALS deliverable D1.1 has been submitted to the journal *Environment International*.

Loh M, Sarigiannis, D, Gotti A, Karakitsios S, Pronk A, Kuijpers E, Annesi-Maesano I, Baiz N, Madureira J, Oliveira Fernandes E, Jerrett M, Cherrie JW. The Role of Sensor Technology in the External Exposome. *Environment International (submitted)*.

Guidelines for appropriate "biomarker of exposure" selection for environmental-wide association studies

by Nadine Steckling; Stephan Böse-O'Reilly and Alberto Gotti; Dimosthenis A. Sarigiannis

University Hospital Munich (IOCOSEM) Munich, Germany
Aristotle University of Thessaloniki (AUTH) Thessaloniki, Greece

HEALS aims at the derivation of environment-wide association studies (EWAS) between environmental determinants and adverse health outcomes rendering thus operational the exposome concept. The work package (WP) on human biomonitoring builds together with the –omics WP the analytical exposure biology framework for internal exposome characterization. The project has produced guidelines for exposure biomarkers that may be appropriate for EWAS. Deliverable 4.2 provides a brief overview on the state-of-the-art of human biomonitoring, with a focus on the practical application of biomarkers in relation to the needs of HEALS.

Human biomonitoring can be defined as "the method for assessing human exposure to chemicals or its effect by measuring these

chemicals, their metabolites or reaction products in human specimens" (*CDC, 2005*). HBM data provide an integrated overview of the pollutant load any participant is exposed to, and hence serve as an excellent approximation of aggregate and cumulative exposure. However, HBM cannot replace environmental monitoring and modelling data. Most often, environmental monitoring data for different environmental compartments (air, water, food and soil) provide better insight into potential sources, hence allowing the development of more informed and appropriate risk reduction strategies. At the same time, mathematical approaches to describe the pharmacokinetic and toxicokinetic behaviour of environmental agents (generally referred to as Physiologically based Pharmacokinetic [PBPK] models) offer a more mechanistic insight into the behaviour and fate of environmental agents following aggregate and/or cumulative exposure (indirect EDR-relationship in *Figure 1*).

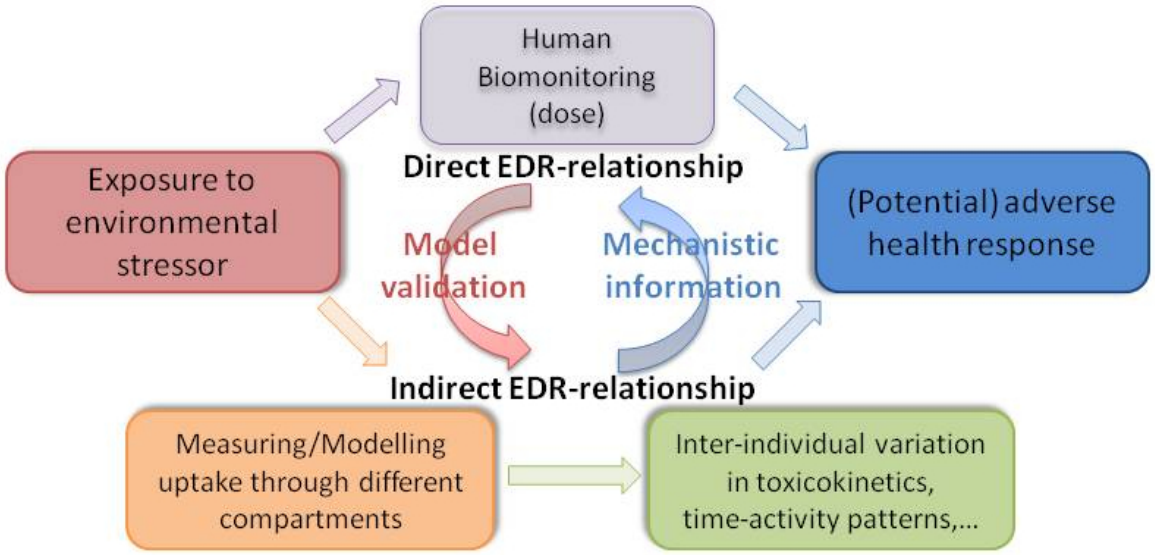


Figure 1: The Exposure-Dose-Response (EDR) Triad to evaluate the potential adverse health effects of exposure to environmental agents (adapted from *Smolders and Schoeters, 2007*)

Biomarkers of exposure (must be differentiated from biomarkers of effect and biomarkers of susceptibility) identify and measure chemical residues in tissue or body fluids, xenobiotic metabolites or physiological outcomes that are effects of exposure, often unrelated to the toxic effect of concern in humans. These data provide information on an individual's total exposure from all sources, preceding the time of the analysis. Overall, the basic rationale for using exposure biomarkers is that they could provide, in some cases, a more accurate method for assessing exposure and, ultimately, risk (*Figure 2*) (*Schulte and Waters, 1999*).

To provide a comprehensive guidance for the selection of appropriate biomarkers of exposure that can support EWAS studies, an extensive list of stressors were examined thoroughly. Fact sheets of 30 stressors belonging to stressor groups including persistent organic pollutants (POPs), other organic pollutants, toxic and potential toxic elements, volatile organic compounds (VOCs), pharmaceuticals in the environment, and smoke were prepared. Additionally to the 30 stressors with mostly existent biomarkers of exposures, fact sheets about 26 categories of stressors with partially defined or non-existent biomarkers of exposures were incorporated. These comprise air pollution, water, noise, nanoparticles (NPs) and ultrafine particles (UFPs), DNA-damaging agents, occupational hazards, and cultural factors. Information about chemistry, biological systems affected, possible exposure routes, absorption, elimination, reference values, and specimens for analysis were included for every stressor, if applicable.

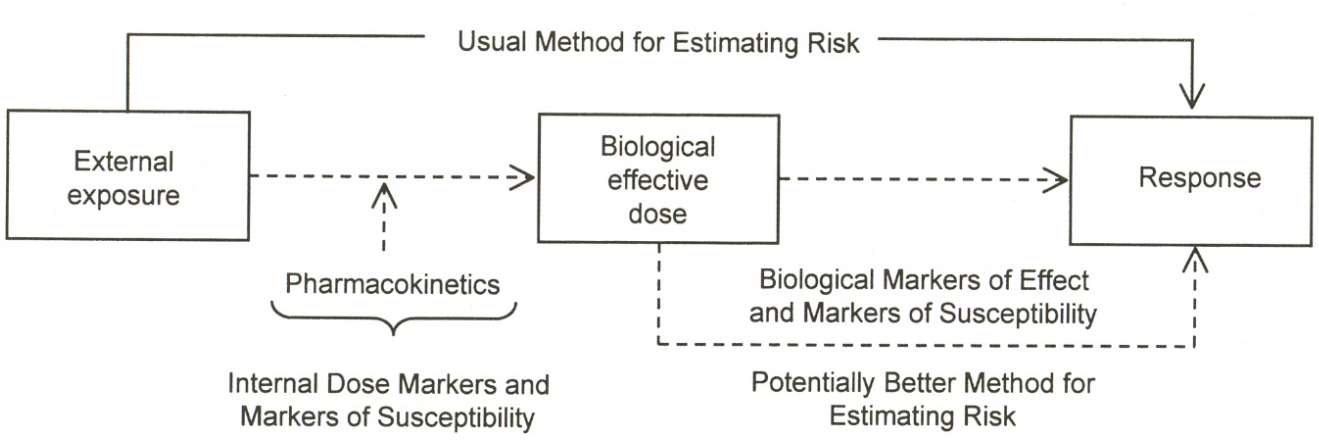


Figure 2: General approach for risk estimation (*WHO–IPCS, 2001*)

In the report many different stressors are listed, most of which are chemicals. But the number of chemicals humans are exposed to is by far greater than any report could make a list of. Beyond, physical, biological, social and psychological stressors influence the health and can contribute to the pathogenesis of diseases. However, for some of these stressors excellent biomarkers of exposure are available and are described in detail in the deliverable. Some examples are lead in blood and bones, mercury in urine, blood, hair or elsewhere, PCBs in blood or breast milk, S-phenyl mercapturic acid (S-PMA) or free, non-metabolized benzene in urine for determining benzene exposure, etc. At the same time some very important stressors have no measurable biomarkers of exposure, *e.g.* air pollutants such as $PM_{2.5}$ or ozone. Whole groups of stressors, such as nanoparticles or UV light do not leave any measurable substances in accessible body specimens. Some stressors cannot be measured directly but their metabolites can be analysed, *e.g.* formaldehyde. However, often these metabolites are not substance-specific and could result from independent metabolic pathways.

In HEALS, internal and external exposome data are used to derive environment-wide associations between exposure and health. Novel mathematical and computational tools are used to explore the association between different environmental, genetic and epigenetic determinants and identified biological perturbations and, eventually, disease phenotypes. In addition, using the HEALS methodology, a plausible pathway towards establishing causality in the observed associations between environmental stressors and health status is tread. The deliverable is the result of a highly collaborative process. The eight institutes involved in WP 4 as well as HEALS partners outside WP 4 prepared fact sheets in accordance to their expertise. An internal review process involving all authors, external colleagues, the WP leader, the HEALS coordinator and co-coordinator provided at least two reviews for every fact sheet which assured a high quality work. More than 800 references were collected and compiled in a reference management system. The collaboration resulted in 265 pages summarising the state of research of biomarkers of exposure from selected stressors.

The deliverable is available for download on the HEALS website:

http://www.heals-eu.eu/wp-content/uploads/2013/08/HEALS_D4.2.pdf

References

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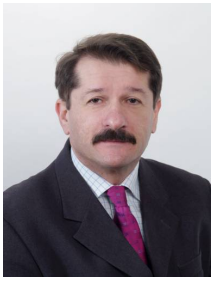

Professor Dr. Sc. **Zdravko Špirić**, Ph.D., is scientific adviser in technical sciences (chemical engineering) and in the interdisciplinary field of science (engineering, public health and health care). He has strong education, professional and scientific background with a proven excellence, skills and experience in environmental technologies – Knowledge triangle: education, research and innovation. He is licensed manager for Technological projects with long experience in the EHS in petroleum industry. Currently he is the scientific director of OIKON, and professor at the Medical school Rijeka, Croatia. Prof. Špirić has more than 20 years of experience and expertise in the energy sector (production, policy, strategy) and in research and process development, specializing in environmental technology (Innovation and business driven research + laboratory and field extensive industrial consulting practice). He has also extensive experience in the implementation/coordination of the EU health studies and projects. He is registered in the EU database as an expert/evaluator FP5/6/7/H2020, since 2002. He is author (sole and co-author) of more than 300 professional/technical and 100 scientific papers published in professional magazines and scientific publications. He has given lectures at local and international congresses. In HEALS, Zdravko Špirić is group leader focused in daily running of studies in HEALS cohort recruitment and support (WP 17) and in dissemination (WPs 18 and 19).

Kinga Polanska, PhD, is an epidemiologist in the Department of Environmental Epidemiology of the Nofer Institute of Occupational Medicine (Lodz, Poland). Her research interests are focused on the impact of a variety of environmental exposures during pregnancy and after delivery on pregnancy outcomes, children's health and their neurodevelopment. Since 2007 she has been the main coordinator of the Polish Mother and Child Cohort Study (www.repropl.com). This prospective cohort comprises of 1,800 mother–child pairs. Kinga Polanska has been collaborating with many researchers conducting birth cohorts in Europe, mainly with MoBa and INMA cohort and the team that has been involved in ENRIECO, CHICOS and HELIX projects. She is the author or co-author of 75 publications in international peer-reviewed journals and has been involved in a number of national and international projects including REPRO_PL, PNRF, ECNIS, IMPASHS and RICHE. In the HEALS project, Kinga Polanska is involved in several Work Packages (WPs 2, 15, 17 and 18) and she is particularly interested in

the impact of environmental exposures on child neurodevelopment. She is also responsible for coordination of the Polish part of the Pilot European Exposure and Health Examination Survey (EXHES).

Prof. Dr. **Clive Sabel** is BSc in Geography from Lancaster University (1990), MSc in GIS from Edinburgh University (1991) and PhD in GIS, Environmental exposure & Health from University of Lancaster (1999). After postdocs at St Andrews University (UK) and Karolinska University (Sweden), and lectureship at the University of Canterbury (New Zealand), he returned to the UK in 2007 to join the Imperial College London's Department of Epidemiology and Public Health. He came back to Geography's fold in 2009 to become Associate Professor, and then Professor, at the University of Exeter. In September 2013, he joined Bristol University as Professor in Quantitative Geography. He has published in both the GIS and public health literatures, notably in the areas of spatial analysis on large complex datasets, individual exposure assessment and of socialeconomic impacts on health. Prof. Clive Sabel is also a regular consultant for the UK Government. In the HEALS project, Clive Sabel is leader of WP 10 and also involved in other Work Packages.

Amir Moustafa is in charge of the management in HEALS, including planning progress survey and follow up of the project achievements. He is giving support to the coordination and communication between Stream and Work Package project teams and the Coordination. He is responsible for the supervision and final elaboration of the HEALS-related documents. Amir Moustafa is in charge of maintaining a regular reporting by all partners of scientific progress and financial reporting. He is also responsible of reporting all deliverables and publications to the European Commission (EC) and the coordination and supervision of the scientific and financial reporting to the EC.

Publications

The scientific contributions of the HEALS Project are hosted on ZENODO, an open digital repository that enables researchers, scientists, EU projects and institutions to share and showcase multidisciplinary research results (data and publications) that are not part of the existing institutional or subject-based repositories of the research communities.

The collection of HEALS scientific papers on ZENODO can be found in the following website:

https://zenodo.org/collection/user-heals

Papers published from January 2015:

- Polanska K, Jurewicz J and Hanke W (2015) Smoking and alcohol drinking during pregnancy as the risk factors for poor child neurodevelopment – A review of epidemiological studies. International Journal of Occupational Medicine and Environmental Health 28(3): 419–443.
- Den Hond E, Govarts E, Hanny W, Horvat M, Mazek D, Tratnik JS *et al.* (2015) First steps toward harmonized human biomonitoring in Europe: demonstration project to perform human biomonitoring of a European scale. Environmental Health Perspectives 123(3): 255–263.
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Presentations at International Meetings and Workshops

Dissemination and networking activities since January 2015 included the participation of several HEALS members at international workshops, conferences and scientific events hereinafter summarised:

- **Zdravko Špirić (OIKON)** *Mercury concentrations in mosses in Croatia* (lecture). 28th Task Force Meeting. International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation). Rome, Italy. 3rd February 2015.
- **Denis Sarigiannis (AUTH)** *Application of "omics" in Studying the Exposome: Health and Environment-wide Associations based on Large Population Surveys* (lecture). Environmental Exposure Science Symposium. London, UK. 6th March 2015.
- **Joaquín de Lapuente (CERETOX)** *An approach in product regulation and substances in nanotechnologies* (oral presentation). ImagineNano 2015: 3rd European Event in Nanoscience & Nanotechnology. Bilbao, Spain. 10-13th April 2015.
- **John Cherrie (IOM)** *Assessing external exposure in a large European survey of children and their parents* (poster presentation). 3rd UK & Ireland Exposure Science meeting. London, UK. 24th April 2015.
- **Miranda Loh (IOM)** *Using a physical activity monitor and smartphone app to determine time-use and location information for exposure studies* (oral presentation). 3rd UK & Ireland Exposure Science meeting. London, UK. 24th April 2015.
- **John Cherrie (IOM)** *The Exposome and Exposure in the Workplace* (lectures on exposome). Professional Development Courses (PDC) in the 10th International Scientific Conference of the International Occupational Hygiene Association (IOHA). London, UK. 25th April 2015.
- **Spyros P. Karakitsios (AUTH)** *Multiscale connectivity – a high dimension biology approach to unravel the exposome* (platform presentation) and *Development of a personal exposure model based on Agent Based Modelling* (poster presentation). SETAC Europe 25th Annual Meeting. Barcelona, Catalonia, Spain. 4th May 2015.
- **Mercè Garí (CSIC)** *Patterns of accumulation of persistent organic pollutants in a representative sample of the population of Catalonia* (platform presentation) and *Influence of socio-demographic and diet determinants on the levels of mercury in preschool children from a Mediterranean island* (poster). SETAC Europe 25th Annual Meeting. Barcelona, Catalonia, Spain. 7th May 2015.
- **Marta Fort (CSIC)** *Incorporation of antimony and copper in pregnant women from traffic pollution* (platform presentation). SETAC Europe 25th Annual Meeting. Barcelona, Catalonia, Spain. 7th May 2015.
- **Joan O. Grimalt (CSIC)** *Highlights from Environmental Chemistry* (Closing Session). SETAC Europe 25th Annual Meeting. Barcelona, Catalonia, Spain. 7th May 2015.
- **Robert Barouki (UPD)** *Exposome concept and its exploration* (oral presentation). Annual meeting of the association "France Nature Environnement". Paris, France. 6th June 2015.
- **Robert Barouki (UPD)** *The exposome* (lecture). Inaugural day of the "Health-Work Institute" at the Université Paris Est. Créteil, France. 10th June 2015.
- **Adrian Charlton and Mike Dickinson (FERA)** *Exposing the Exposome: Metabolomics and Environmental Toxicology* (oral presentation introducing the HEALS concept along with provisional data for "adductomics" method development). 3rd International Fresenius Conference on Human Health Hazard, Exposure and Risk Assessment for Agrochemicals, Biocides and REACh Chemicals. Dusseldorf, Germany. 11th June 2015.
- **Janja Snoj Tratnik, Darja Mazej, Ingrid Falnoga, Milena Horvat (JSI) and Zdravko Špirić (OIKON)** *Evaluation of methyl mercury exposure, susceptibility and health effects in the Mediterranean population* (oral presentation) 12th International Conference on Mercury as a Global Pollutant. Jeju, Korea. 15th June 2015.
- **Zdravko Špirić, Trajče Stafilov and Inava Vučković (OIKON)** *Moss biomonitoring as a tool for mercury air pollution control in Croatia* (poster presentation). 12th International Conference on Mercury as a Global Pollutant. Jeju, Korea. 15th June 2015.
- **Robert Barouki (UPD)** *Why research about health and environment must be interdisciplinary to broach climate change?* (lecture). Conference on "Climate, Health, Inequalities. Which Solutions?" at the Ministry of Social Affairs, Health and Women Health. Paris, France. 18th June 2015.
- **Robert Barouki (UPD)** *The exposome concept and the cocktail effect* (lecture). Workshop SPTC-PRINCEPS on "Current approaches to assess chemical contaminant mixture effects and regulatory implications". Paris, France. 19th June 2015.
- **Robert Barouki (UPD)** *Climate change and health in the context of the exposome* (lecture). Symposium on "Current and Future Research trends on Climate Change and Health", a side event of the conference "Our Common Future Under Climate Change". Paris, France. 6th July 2015.

Other dissemination activities

- **OIKON (Croatia)**. During *Open Education Week 2015*, in order to celebrate and actively contribute with their efforts to the global Open Education Movement, Croatian students join to raise awareness about open education and its impact on teaching and learning. Namely, within the university course *Health and Environment safety*, led by Prof. Dr. **Zdravko Špirić**, students of the Medical School University of Rijeka, Croatia, on 10th March 2015, publicly presented some of their research papers in the field of health and environmental risks – with special emphasis on sustainable development.

  Students Branežac Katarina, Brusić Iva, Bulić Sara, Gačić Ivona, Jurčić Martina, Marinović Mihaela, Trbović Anamaria and Biskupović Toni presented their seminar papers focused primarily on health and environment (EU FP7 HEALS project), and especially on the importance of education for sustainable development. Interesting discussion followed that successfully highlighted current and future sustainable development challenges seen through the prism of youth generation.

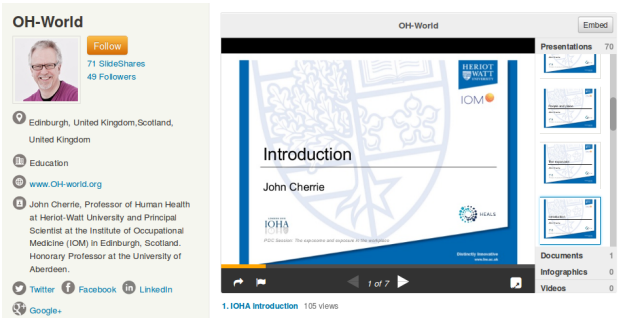
More information at:

http://www.openeducationweek.org/language/croatian/

- **IOM (UK)**. Professor **John Cherrie**, Research Director of the Institute of Occupational Medicine (IOM), gave a Professional Development Course (PDC) on *The Exposome and Exposure in the Workplace* at the 10th International Scientific Conference of the International Occupational Hygiene Association (IOHA) (25–30 April 2015, London, UK).

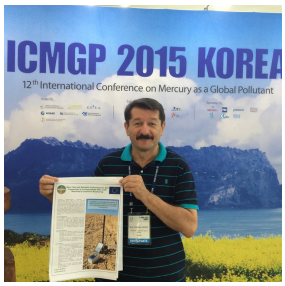
More information at:

http://www.slideshare.net/JohnCherrie/1-ioha-introduction



- **OIKON (Croatia)**. Prof. Dr. **Zdravko Špirić**, Scientific Director of OIKON Ltd, participated in the 12th International Conference on Mercury as a Global Pollutant (14–19 June 2015, Jeju, Korea).

The participants of the conference were informed and invited to discuss the HEALS project objectives, methods and goals and possible co-operation on mercury actions. HEALS brochures were made available and distributed to conference participants.



- **UPD (France)**. Professor **Robert Barouki**, Director of Inserm Unit 1124 (Toxicology, Pharmacology and Cellular Signaling) at the Inserm/Université Paris Descartes, was interviewed by the Inserm Press Room in relation to the Symposium on *Current and Future Research trends on Climate Change and Health* (6th July 2015, Paris, France).

More information at:

http://presse-inserm.fr/en/climate-change-and-health-what-are-the-implications/19829/

- **HEALS Project** has been recently linked to EU Cordis:

http://cordis.europa.eu/project/rcn/110918_en.html

Forthcoming Events

HEALS meetings

- **HEALS Annual Meeting**
  23–25 September 2015, Crete (Greece)
  www.heals-eu.eu

Other related meetings

- **35th International Symposium on Halogenated Persistent Organic Pollutants (DIOXIN 2015)**
  23–28 August 2015, Sao Paulo (Brazil)
  http://www.dioxin20xx.org
- **27th Conference of the International Society for Environmental Epidemiology (ISEE 2015): *Addressing Environmental Health Inequalities***
  30 August – 3 September 2015, Sao Paulo (Brazil)
  http://www.isee2015.org/
- **51st Congress of the European Societies of Toxicology (Eurotox 2015): *Bridging Sciences for Safety.***
  13–16 September 2015, Porto (Portugal)
  http://www.eurotox2015.com
- **European Academy of Paediatrics. Congress and Master-Course 2015**
  17–20 September 2015, Oslo (Norway)
  http://www.eapcongress.com
- **18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP): *Sustainable Resource Use and Impact on Health and Well-being***
  26–30 September 2015, Crete (Greece)
  http://www.mesaep.org
- **25th Annual ISES Conference. International Society of Exposure Science: *Exposures in an Evolving Environment.***
  18–22 October 2015, Henderson, Nevada (USA)
  http://www.ises2015.org
- **SETAC Europe 26th Annual Meeting: *Environmental contaminants from land to sea: Continuities and interface in environmental toxicology and chemistry***
  22–26 May 2016, Nantes (France)
  http://nantes.setac.eu
- **28th Conference of the International Society of Environmental Epidemiology (ISEE-2016): *Old and New Risks: Challenges for Environmental Epidemiology***
  1–4 September 2016, Rome (Italy)
  http://www.iseepi.org/Conferences/future.htm

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HEALS Newsletter

Health and Environment-wide Associations based on Large population Surveys

Project No 603946 of the European Union's Seventh Framework Programme

Contents

Editorial Note

Welcome to the fourth issue of the HEALS Newsletter!

In this issue we are starting with an article that reports the methodologies for the assessment of the indoor air quality in dwellings which constitute a substantial part of the **EXHES Pilot Study**. In this article, Prof. Eduardo de Oliveira Fernandes from the Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI, Portugal) describes the protocols and techniques for auditing homes in the context of the HEALS project. Moreover, the article includes a note on the training activity held in the last HEALS Annual Meeting (Crete, Greece, September 2015) and the views of some participants.

Two achieved Deliverables are also described in the newsletter: D1.3 "Socioeconomic health differences with a particular focus on the exposome" that is summarized by Rosemary Hiscock, from the University of Bristol (UNIBRIS, UK), and D8.2 "Design and implementation of the Environmental data management system (EDMS)", that is summed up by Panagiotis Karagiannis, Evangelos I. Tolis and John G. Bartzis, from the University of Western Macedonia (UOWM, Greece).

The *Who is Who* section describes the professional profiles of two research colleagues who are actively involved in the project and participate in different work packages: Mike Dickinson from Fera Science Ltd (UK) and Rob Stierum from TNO (The Netherlands). As usual the issue ends with a list of the main scientific publications, public presentations, workshops, conferences and other knowledge-dissemination activities generated by the HEALS researchers since January 2015.

We take advantage of this editorial note to inform that HEALS is co-organizing the **8th International Network on Children's Health, Environment and Safety (INCHES) Conference**, which will be held in Barcelona, Catalonia, Spain, on the 14–16th September 2016.

HEALS contribution towards the enhancement of the EC methodologies on the assessment of the indoor air quality in dwellings (EXHES Pilot Study – WP-17)

by Eduardo de Oliveira Fernandes

Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI)
Porto, Portugal

The improvement of the indoor air quality (IAQ) in Europe requires the enhancement of the methodologies and techniques to assess the IAQ status and thus, the impact of policies in reducing the burden of disease associated with exposure to indoor air pollution. This could lead to a better understanding of the role of environmental risk factors in respiratory diseases and other chronic pathologies, ultimately resulting in better primary prevention strategies.

The Indoor Monit is an EC project comprehending a harmonised framework of criteria, protocols and techniques to monitor the IAQ status generating five audit typologies/objectives for specific circumstances*(Figure 1), where the sixth one, at project design phase, is a promise towards the future. The protocol and techniques for auditing homes in the HEALS project refers to the 'survey' type audit which objective is to characterize the indoor air conditions in general.

For the HEALS survey an electronic tool was elaborated including information regarding outdoor environment, building construction, age and size, number of floors, number of occupants, finishing materials, heating and ventilation systems, past occurrences and current visible problems and potential indoor sources. This a totally innovative tool accompanied of an explanatory video, having both products a high potential for replication.

**PILOT INDOOR AIR MONIT project, coordinated by the Joint Research Centre on behalf of DG SANCO.*

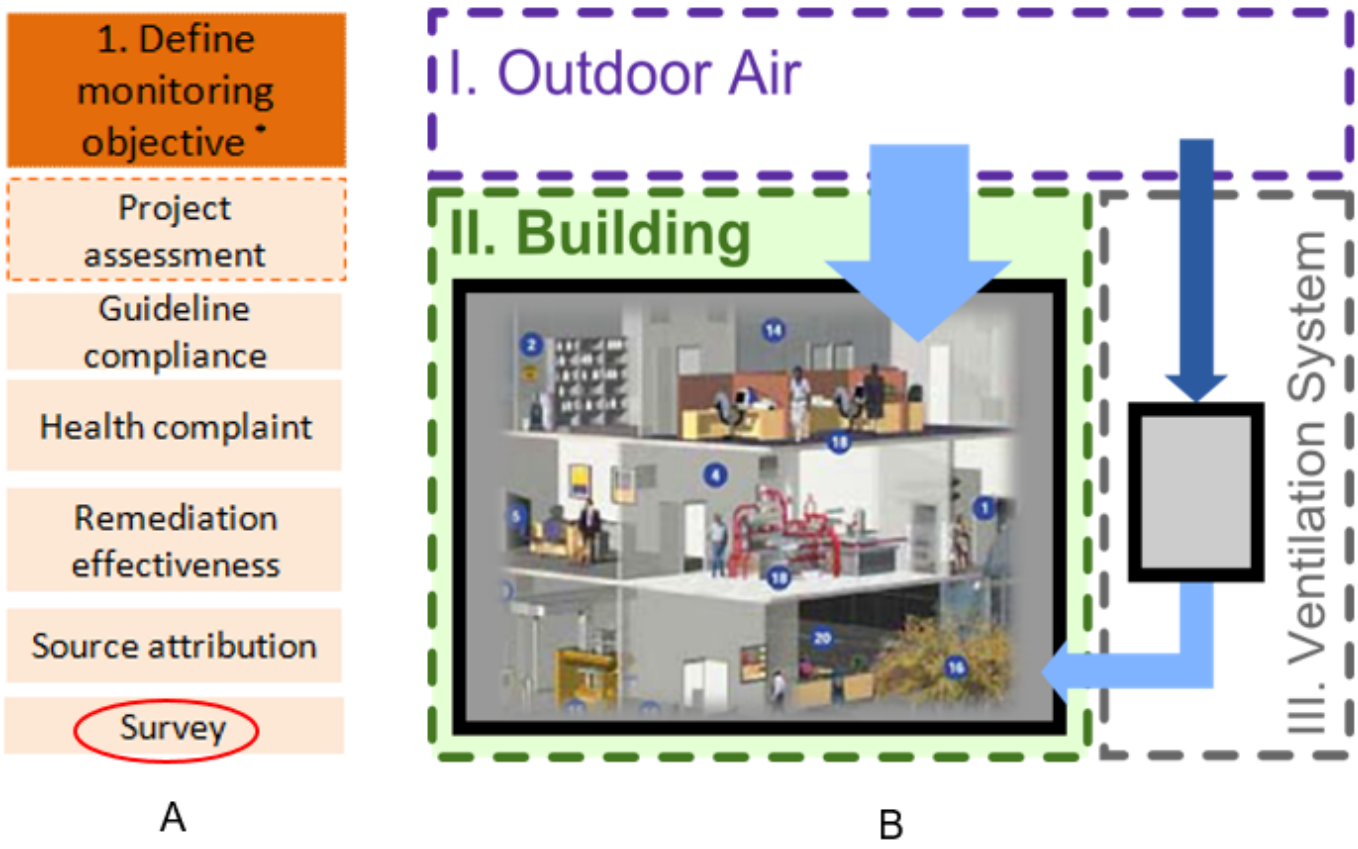

Figure 1. A. IAQ audit typologies. B. The building as an air system imaged in the outdoor air.
*Differ in the amount and specificity of the requirements.

Training on field activities focussed on indoor air quality in the EXHES IAQ audit (protocol B)

A training exercise on IAQ auditing was held on September 24, 2015 in Crete, Greece, aimed at providing expertise to the 10 project partners on how to conduct the EXHES IAQ field studies, including methodologies to fill in checklists and perform measurements and use specific equipment (Figure 2).

The training was directed by a INEGI/UP' team coordinated by Eduardo de Oliveira Fernandes and comprising Joana Madureira, Inês Paciência, João Rufo and Raquel Sousa.

Selected answers to the questionnaire administered to the participants in the training

Some partners involved in the training shared their impressions; among them, Nour Baïz (UPMC, France), Kinga Polanska (NIOM, Poland), Asimina Stamatelopoulou (NCSRD, Greece), Darja Mazej (JSI, Slovenia), Zdravko Špirić (OIKON, Croatia), Edward Johnstone (UM, UK) and Joaquim Rovira (URV, Spain)

Question 1 *How efficient was the IAQ audit training session?*

Joaquim Rovira IAQ audit training gave me the overall view of what is and how to perform these surveys. For me this was the goal of training session.The materials (presentation and supporting material) were very useful.

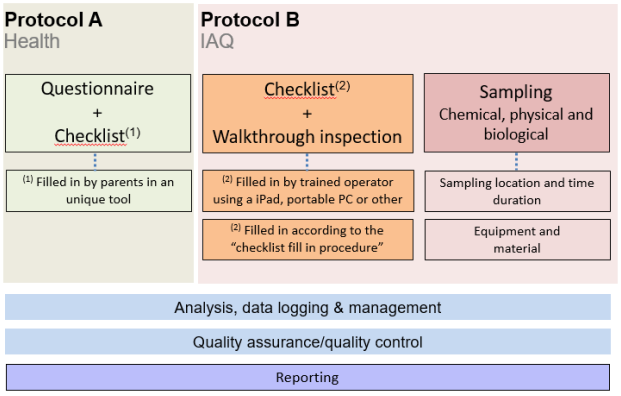

Figure 2. EXHES data collection (A. Health Questionnaire; B. Environmental Survey).

Question 2 *What were your impressions regarding the IAQ audit training session?*

Darja Mazej It was a step forward to do IAQ assessment in more harmonized way in HEALS. Maybe it would be helpful to do some practical measurements and do some intercomparisons.

Question 3 *Do you think it was a good idea to have videos and other support material during the training session?*

Asimina Stamatelopoulou Videos and other support material during the training session contributed to make the presentation more descriptive and schematic. It was easier for us to understand how measurements should be done in practice.

Environmental data management system (EDMS)

by Panagiotis Karagiannis, Evangelos I. Tolis and John G. Bartzis

University of Western Macedonia (UOWM)
Konzani, Greece

Introduction

The design and implementation of the Environmental Data Management System or EDMS is one of the three specific tasks in WP 8 under the title "Environmental Data Mining" and is in straight relation to the other two tasks, namely Data Collection and Data Quality and Assessment. The EDMS has been created in order to gather environmental data from other information sources, as well as those produced throughout the project. In short, the EDMS has to be a solid and robust application in order to host the data processed or pre-processed by the aforementioned tasks.

Pre-processing involves Environmental Data Source Identification that is suitable for Environment-wide application studies in specific areas. This task is carried out through detailed review of past and ongoing research and survey projects. Moreover, this data have to be gathered and possibly stored in its existing format before they are stored in the EDMS. This means that primary data, when available, will come in a wide variety of forms as long as its structure and file format is concerned.

Ultimately, since the collected data will serve other WPs, any given dataset, after having been evaluated in terms of quality and applicability, will have to be transformed in a standard format, compliant with the INSPIRE Directive.

The first approach on creating the EDMS had three alternatives:

- Link to existing databases
- Incorporate these application to the environmental management system
- Extract datasets and import them to the environmental management system

System requirements and implementation

On top of the already referred cross – task issues, the EDMS has been designed and implemented following certain procedures

and standards. The main issue here was that the HEALS database should be able to retrieve data from existing databases.

Additionally, the database design sees that,

a) All data are geo-referenced, by specifying the geographic coordinates of each single observation, both for point-form and for polygonal spatial information and

b) All data are univocally coupled to a time reference (instant, hour, day, month, etc.) and as such they are ready to be investigated, by using time series based statistics.

Furthermore, the EDMS is in compliance with the INSPIRE Directive. The Directive 2007/2/EC of the European Parliament aims to create a European Union (EU) spatial data infrastructure. It is addresses 34 spatial data themes which are based on the following common principles:

1. Data should be collected only once
2. Combine seamless spatial information
3. Should be possible for information collected to be shared
4. Geographic information readily available
5. Geographic information easy to find
6. Implementing Rules (IR) on
   - Metadata
   - Data Specifications
   - Network Services
   - Data and Service Sharing
7. The Implementing Rules are adopted as Commission Decisions or Regulations and are binding in their entirety.

Building the EDMS is perceived as a 4 step process. First, the web framework and application architecture is defined. In general, the application consists of a web component, various application programming interfaces for interacting with databases and the database itself. Then, the appropriate Database Management System is chosen as well as the relational model or models. Secondly, EDMS is populated via a commonly accepted template for entering data sets. The third step was to establish links to existing data bases or more appropriately to their web interfaces in order to provide a head start for the steps to come. At the same time there was work toward connecting to other databases for automatic updating, importing or exporting data, as well as making specific selections or grouping records. The last step involves data which come in formats that require further processing.

Data Collection Entry

The EDMS of HEALS project contains data on the following environmental categories of interest (***Data class***):

- Land use/Land cover
- Meteorological Data
- Comfort data indoors (temperature-relative humidity)
- Air emission data
- Air emission data – materials/products
- Pollutant concentration data in indoor air, outdoor air, in vehicle air, soil, dust, water and drinking water
- Food concentration data
- Population data (age/gender/etc.)
- Noise data
- Building characteristic data
- Heat Stress Data
- Pharmaceutical Data
- EMF Data

Under the ***environmental stressor*** the EDMS includes the priority pollutants of the HEALS project or other environmental parameter relative to humans which are:

- PM10, PM2.5
- VOCs
- Phthalates
- Toxic metals
- Organic compounds
- Organohalogens
- Dust mites
- Pesticides
- Endocrine disruptors
- POPs
- NO2
- O3
- Mold
- Pollen
- Noise

Figure 1. Data search options.

The EDMS currently stores more than 100 detailed data sets, a considerable number of which (more than 60) also contain data files that have been uploaded in various formats (*eg*. csv, mmz, zip, pdf), apart from a great number of URLs leading to external data sources. These numbers will change because uploading data is an ongoing process. The URL in order to visit the EDMS is:

https://heals.uowm.gr

Data search and presentation

After entering the EDMS, data retrieval involves selection queries bases on three categories (Figure 1):

1. Data Class
2. Country
3. Pollutant / Stressor

The search produces the available data sets (Figure 2). Each set, upon selection is presented providing the categories used to collect the data in tabbed format (Figure 3).

The Present Status and the way forward

EDMS can be perceived as a solid and detailed environmental data repository accessible via the web.

The EDMS currently stores more than 100 detailed data sets, while these numbers will change because uploading data is an on-going process. The efforts will continue with new environmental data giving emphasis on the areas of EXHES study (WP17) and WP9 pilot studies and the requirements of external exposure modeling (WP11).

In addition there is an ongoing effort to link EDMS as a module to HEALS Geodatabase system in collaboration with WP12 partners.

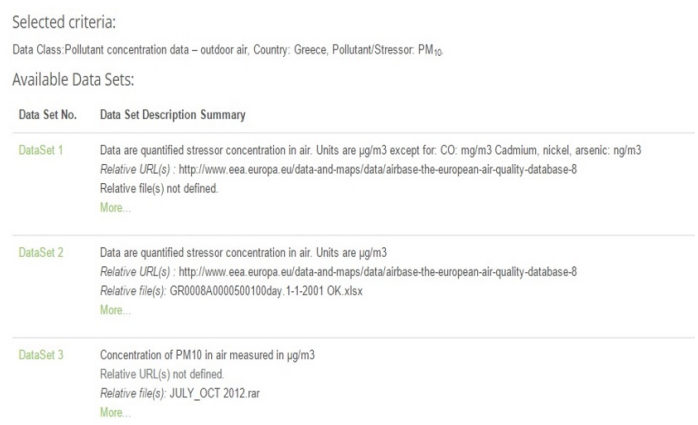

Figure 2. Available data sets after search.

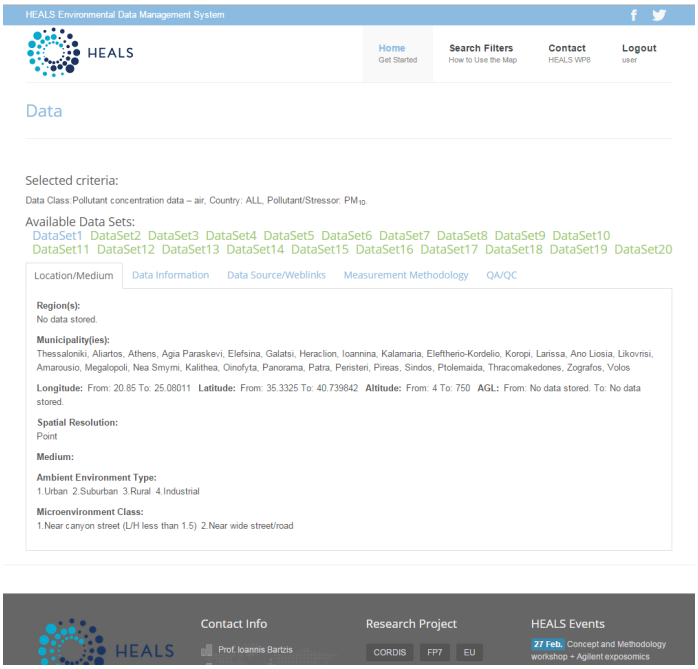

Figure 3. Data presentation.

Socioeconomic health differences: a particular focus on exposome differences

by Rosemary Hiscock

University of Bristol (UNIBRIS)
Bristol, UK

There is no single definition of socioeconomic status (SES) [1] but it can be said to embody an array of social and economic resources: material capital such as money and goods, human capital such as skills, knowledge, prestige or power, and social capital – beneficial social connections [2–5]. These resources can be deployed in order to protect and promote health. Disease, disability and premature death are higher for lower socioeconomic groups, two or three times higher in the EU [6].

The exposome is likely to play a dominant role in the SES and health relationship because in general the genome appears to play a small part in disease development: possessing a genetic variant associated with a particular disease only increases the risk of disease

occurring by 10 to 30% [7]. However no studies were found which contrasted genetic and environmental causes of the association between SES and health. Many studies have considered one pathway between SES and health but few have contrasted multiple pathways empirically. Even those that have compared multiple pathways have only considered a small number of options within a single study. These studies have not found stable pathways – rather pathways vary with different health outcomes. Thus it is not possible with the current state of the literature to estimate what proportion of SES differences in health is due to the exposome. However it is possible to describe some of the possible pathways between the exposome, SES and health.

SES differences in health may be the results of firstly demographic differences – some population groups such as ethnic minorities, women and children and older people have less access to health promoting and maintaining resources, secondly differences in world view through cognitive and personality differences and health knowledge and thirdly, at least partly as a result of the above, low SES groups may be less likely to engage in healthy behaviours such as following a good diet, not smoking and vaccinating children. However the extent to which low SES becomes health endangering will depend on the social environment: on parenting, on supportive relationships, on government provision of health care, welfare, education and housing, on the physical environment: infrastructure, noise levels and air pollution. An adverse social environment can lead to stress causing internal changes and an adverse physical environment can lead to build up of some pollutants in the body.

We examined relationships between SES and pollution, occupation and physical activity in particular detail. We found that in general low SES groups are more exposed to air pollution but there are exceptions (*i.e.* there are high status neighbourhoods in central areas of some cities). They may be more exposed to contaminants through diet in particularly in developing countries and to infections. There are many features of low SES occupations which may compromise health such as low control over work and high physical demands. Other possibilities include exposure to chemicals, job security and low occupational prestige. However physical strength required for, or developed from, jobs often filled by low SES people and lack of mental strain may be health. Low SES people in poor health are less likely to be able to continue to work – the physical demands of low SES jobs require good physical health. Our findings on exposure to physical activity suggested that low SES people may undertake less leisure time physical activity but they may be at least as physically active in other domains (*e.g.* occupation, active travel).

Our review also leads to some methodological recommendations. Firstly a composite SES measure may be preferable to a multitude of SES measures due to multicollinearity. The exception would be a study that aims to explore the meaning of measures in which case it would be important to recruit large numbers of unusual subjects (*e.g.* highly educated but low income or low education but high income). Secondly it is not possible to tell from previous studies whether ethnic differences are due to SES, culture or genetics. Ethnic group differences thus need to be understood in context. Finally if an aim of a research project is to examine exposure to pollution as a mediator between SES and health it is necessary to design the study and analysis carefully in order to do so. The methodologies used in several studies were not fit for purpose.

The literature would suggest that a study seeking to account for SES differences in health should include the external exposome differences detailed in table 4.1 and the genome differences detailed in table 4.2. An important factor that does not really fit in either of these tables is age. Lifecourse models suggest that SES differences in health can start in utero and occur throughout our lives.

Table 4.1 Exposome pathways between SES and health

Pathway	Subcategories/description
Health behaviour	
Health service use	Vaccinations, dental, screening
Obesity/diet	BMI related/nutrition, diet related contaminants
Physical activities	Leisure, occupational, for transport
Smoking	
Other	Sunbed use, alcohol, sleep
Supportive environment	
Parenting	Skill acquisition, children at risk
Relationships	Social network/support
Government provision	Access to health services, education for disadvantage groups
Stigma	Due to age, gender, ethnicity, disability, etc.
Physical environment	
Exposure to socially stress producing situations	Violence, residential mobility, family turmoil and conflict, lack of routine
Housing conditions	Damp, temperature, building materials, ventilation, infestations, hygiene, food preparation facilities
Neighbourhood conditions	Abandoned lots, graffiti, noise, advertisements, design, traffic
Access	Municipal services, places for physical exercise, purchasing points for healthy food and unhealthy substances (*e.g.* tobacco, alcohol)
Exposure to chemicals	Toxins and hazardous wastes, ambient pollutants, lead, tobacco smoke
Exposure to nature	Recreation and food growing opportunities

Table 4.2 Differences created by the genome that may explain associations between SES and health

Pathway	Subcategories/description
Tangible	
Demographic#	sex
Physical differences*	height, potential for poor health
Worldview	
Psychological*	personality
Cognitive*	IQ

Race is not included here because current research suggests that genetic susceptibility is a minor predictor of poor health and is not strongly patterned by race [8]. * In addition to their genetic component these are also impacted by the exposome.

To conclude, there are many explanations with support from previous literature for the relationship between SES and health. However very few studies were encountered that empirically contrasted different pathways. Thus on the basis of the collated literature, we have much to learn in this area.

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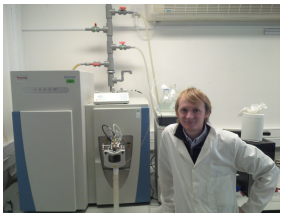
This is an edited version of **R. Hiscock**, **C. Schieberle**, **N. Li**, **M. Garí** & **J.O. Grimalt** (2015). HEALS Deliverable 1.3: *A critical review of how much of the difference in disease between socioeconomic and other social groups can be explained by the differences in the "group" exposome*. Retrieved from:

http://www.heals-eu.eu/wp-content/uploads/2013/08/HEALS_D1.3.pdf

WHO is WHO

HEALS 'WP5 Omics and epigenetics analyses' coordinator, **Rob Stierum**, is a Senior Researcher and European Registered Toxicologist at The Netherlands Organization for Applied Scientific Research TNO. After obtaining his PhD at Maastricht University (Maastricht, The Netherlands) on poly(ADP-ribosylation), Rob was further trained in mitochondrial DNA repair during a fellowship at the National Institutes on Aging (Baltimore, USA) for which he was awarded the NIH Fellows Award for Research Excellence. Currently, Rob heads the risk assessment and toxicology group, including systems toxicology and toxicoinformatics activities, at TNO. His drive is to aim for improvement of toxicology and exposure assessment, via the integration with omics and bioinformatics technologies. He has obtained/coordinated various research grants in this area. As such, he coordinated the bioinformatics for the European Nutrigenomics Organisation (NuGO), The Netherlands Toxicogenomics Centre (NTC) and EU FP6 Carcinogenomics. Further, he is the coordinator of several CEFIC long range initiative projects AIMT-2, AIMT-3 and AIMT-4 to explore the value of data mining, chemical grouping and toxicogenomics for toxicological risk assessment in the chemical industry. He also heads large national projects funded by ZonMw aiming at the integration of human disease mechanistic data for exploration of (in vitro) systems toxicology data. This task is currently expanded towards the inclusion of PBPK data to allow for in vivo potency estimation based upon in vitro toxicogenomics. Within the recent H2020 caLIBRAte project (Performance testing, calibration and implementation of a next generation system-of-systems Risk Governance Framework for nanomaterials), Rob has started to coordinate the workpackage on human risk assessment, in which the inclusion of omics and other innovative testing data for nanoparticle safety is evaluated. Rob has >60 publications/bookchapters in the areas of genomics and bioinformatics applied to toxicology and nutrition, exposure assessment and DNA repair. He presented at, and organized, several scientific meetings, and serves as a frequent reviewer on scientific journals. Finally, he serves as a guest researcher in bioinformatics for the exposome at IRAS, Utrecht University.



Mike Dickinson works as a Research LCMS specialist at Fera Science Ltd (previously the Food and Environment Research Agency). Graduating from the University of York in 2003 he has over 10 years of experience in analytical chemistry and over 4 years experience in high resolution mass spectrometry applications. Mike's current work involves non targeted analysis of food, plant and clinical samples for various international industrial and research partners. He has published several articles in the field of high resolution mass spectrometry. In addition to HEALS he is currently participating in the EU project Abstress, in which he studies metabolomics of legumes in order to understand the mechanisms of resistance to combined abiotic and biotic stress. Within HEALS, Mike Dickinson is working on the metabolomic profiling of biological samples (blood, urine, umbilical tissue, etc.) by both high resolution MS and NMR (using other colleagues expertise at Fera). This involves setting up and validating the non-targeted analytical methodologies in preparation for the analysis of existing cohort samples. He is involved in WPs 5, 15, 19 and 20.

Publications

The scientific contributions of the HEALS Project are hosted on ZENODO, an open digital repository that enables researchers, scientists, EU projects and institutions to share and showcase multidisciplinary research results (data and publications) that are not part of the existing institutional or subject-based repositories of the research communities.

The collection of HEALS scientific papers on ZENODO can be found in the following website:

https://zenodo.org/collection/user-heals

Papers published from July 2015 include:

- Polanska K, Jurewicz J and Hanke W (2015) Smoking and alcohol drinking during pregnancy as the risk factors for poor child neurodevelopment – A review of epidemiological studies. International Journal of Occupational Medicine and Environmental Health 28(3): 419–443.
- Den Hond E, Govarts E, Hanny W, Horvat M, Mazek D, Tratnik JS *et al.* (2015) First steps toward harmonized human biomonitoring in Europe: demonstration project to perform human biomonitoring of a European scale. Environmental Health Perspectives 123(3): 255–263.
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Presentations at International Meetings and Workshops

Dissemination and networking activities since July 2015 included the participation of several HEALS members at international workshops, conferences and scientific events hereinafter summarised:

- **I. Annesi-Maesano (UPMC)** *The burden of meteorological factors to allergic and respiratory health and risk factors* (lecture). Symposium on "Current and Future Research trends on Climate Change and Health", a side event of the conference "Our Common Future Under Climate Change". Paris, France. 6th July 2015.
- **R. Barouki (UPD)** *Climate change and health in the context of the exposome* (lecture). Symposium on "Current and Future Research trends on Climate Change and Health", a side event of the conference "Our Common Future Under Climate Change". Paris, France. 6th July 2015.
- **M. Mari *et al.* (URV & CSIC)** *Human Exposure and risk assessment of PAHs bound to three PM fractions (10, 2.5 and 1) in an area influenced by a cement plant* (lecture). 35th International Symposium on Halogenated Persistent Organic Pollutants (Dioxin2015). São Paulo, Brazil. 23–28th August 2015.
- **M. Marquès *et al.* (URV)** *Long term study on the levels of PCDD/Fs and other organic substances in workers of a hazardous waste incinerator* (poster presentation). 35th International Symposium on Halogenated Persistent Organic Pollutants (Dioxin2015). São Paulo, Brazil. 23–28th August 2015.
- **F. Sánchez-Soberón *et al.* (URV & CSIC)** *Cancer risk assessment of PM1-bound PAHs nerby a cement plant using a respiratory tract model* (poster presentation). International Symposium on Polycyclic Aromatic Compounds conference (ISPAC 2015). Bordeaux, France. 13–17th September 2015.
- **R. Barouki (UPD)** *The Ah Receptor system regulation: Implications for environment and health risk assessment* (lecture). 18th International Symposium MESAEP. Crete, Greece. 26th September 2015.
- **S. Augusto *et al.* (URV)** *Using lichens to monitor PAHs in a multisource industrial and urban area* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **F. Sánchez-Soberón *et al.* (URV & CSIC)** *Human exposure and risk assessment of three pm fractions (10, 2.5 and 1) in an urban-industrial area of Barcelona* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **M. Schuhmacher *et al.* (URV)** *Climate change impact on photodegradation and ecotoxicity of PAHs in Mediterranean soils* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **D.A. Sarigiannis, I. Annesi-Maesano, J. Cherrie *et al.* (HEALS partners)** *The HEALS approach to health and environment-wide associations* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **V. Karri *et al.* (URV)** *Improving interaction mechanism of metal mixtures (Pb, Cd, Hg, As, Cr) in Generalized Physiological Toxicokinetic Model (PBTK)* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **N.I. Pitaraki *et al.* (HEALS partners)** *Estimating individual exposure by human monitoring* (poster presentation). 18th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP). Crete, Greece. 26–30th September 2015.
- **R. Barouki (UPD)** *The Aryl hydrocarbon Receptor system* (lecture). CS-DC 15 e-conference: From Molecules to Organisms and Ecosystems. Integrative Ecotoxicology. Paris, France. 1st October 2015.
- **R. Barouki (UPD)** *The "exposome" – a new concept unifying social and environmental non-genetic determinants of health across the life course* (lecture). Workshop on "Innovation in research and teaching in planetary health". World Health Summit. Berlin, Germany. 13th October 2015.
- **R. Barouki (UPD)** *Changement climatique et impact sur la santé humaine vus sous l'angle de l'exposome* (Séminaire scientifique annuel). Maison de la Chimie. Paris, France. 15th October 2015.
- **R. Barouki (UPD)** *Changement climatique et Santé*. Bordeaux, France. 22nd October 2015.
- **R. Barouki (UPD)** *Changement climatique et Santé a l'ère de l'exposome*. Journée des médecins de santé publique. Paris, France. 22nd October 2015.
- **R. Barouki (UPD)** *OMICS!* OPAL-Francopa 2015. 4th November 2015.
- **R. Barouki (UPD)** *Changement Climatique et Santé* (Table ronde Generali). Le Bourget, France. 1st December 2015.
- **R. Barouki (UPD)** *Climate change impact on humans as a part of affected ecosystem* (lecture). Workshop COP21 Responding to Health and Data Challenges. Case for Climate Change and Atmospheric Pollution. Paris, France. 4th December 2015.
- **A. Leblanc *et al.* (UPD)** *Carbohydrate metabolism is disrupted by a combination of persistent organic pollutants in the human hepatic cell line HepaRG* (poster presentation). 2nd Paris Workshop on Endocrine Disruptors Effects on Wildlife and Human Health". Paris, France. 21–22 January 2016.

Other dissemination activities

- **Kinga Polanska (NIOM) and Gemma Calamandrei (ISS)** gave a joint presentation of the HEALS project during the LIFE PERSUADED (an EU funded project on Phthalates and bisphenol A biomonitoring in Italian mother child pairs) workshop, held at the Istituto Superiore Sanità in Rome (Italy) on December 17th 2015. The workshop was finalized at dissemination among stakeholders, researchers and personnel of the National Health System of research initiative on the theme of children's environmental health. It represented an occasion of networking with other LIFE projects.

- **Gemma Calamandrei (ISS)** was invited to present the HEALS project in the WHO International Meeting "Eastern Mediterranean Country Resources for children and adolescents with Autism Spectrum Disorder", November 16–18th 2015, organized by Instituto Superiore di Sanità, Rome (Italy). The presentation was focused on the role that environmental factors may play in the aetiopathogenesis of Autism Spectrum Disorders. The audience was composed by a selected group of Pediatricians, Psychologists and Neuropsychiatrists from Eastern and Southern Mediterranean Countries working in the field of Autism and other Neurodevelopmental Disorders.

Forthcoming Events

- **2nd Conference on Occupational Medicine and Endemiology (COME 2016)**
  2–4 March 2016, Beijing (China)
  http://www.engii.org/ws2016/Home.aspx?ID=696

- **Society of Toxicology 55th Annual Meeting and ToxExpo**
  13–17 March 2016, New Orleans (Louisiana, USA)
  http://www.toxicology.org/events/am/AM2016/

- **10th Network Conference on Persistent Organic Pollutants**
  13–14 April 2016, Birmingham (UK)
  http://www.birmingham.ac.uk/schools/gees/research/projects/nercpops/conferences/10th-conference.aspx

- **The International Conference on Environmental Pollution and Public Health (EPPH 2016)**
  13–15 April 2016, Suzhou (China)
  http://www.engii.org/epph2016/

- **2nd International Conference on Human Biomonitoring**
  17–19 April 2016, Berlin (Germany)
  http://www.umweltbundesamt.de/en/2nd-international-conference-on-human-biomonitoring

- **SETAC Europe 26th Annual Meeting**
  22–26 May 2016, Nantes (France)
  http://nantes.setac.eu

- **11th European Pesticide Residue Workshop**
  24–27 May 2016, Limassol (Cyprus)
  http://eprw2016.com/

- **2nd International Conference on Atmospheric Dust (DUST 2016)**
  12–17 June 2016, Taranto (Italy)
  http://www.scientevents.com/dust2016/

- **8th International Congress on Environmental Modelling and Software (iEMSs 2016): *Supporting a sustainable future***
  10–14 July 2016, Toulouse (France)
  http://www.iemss.org/sites/iemss2016/

- **36th International Symposium on Halogenated Persistent Organic Pollutants (DIOXIN 2016)**
  28 August – 2 September 2016, Firenze (Italy)
  http://dioxin2016firenze.org/

- **8th International Network on Children Health, Environment and Safety Conference (INCHES 2016)**
  14–16 September 2016, Barcelona (Catalonia, Spain)
  http://inchesnetwork.net/upcoming-conferences/

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