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.

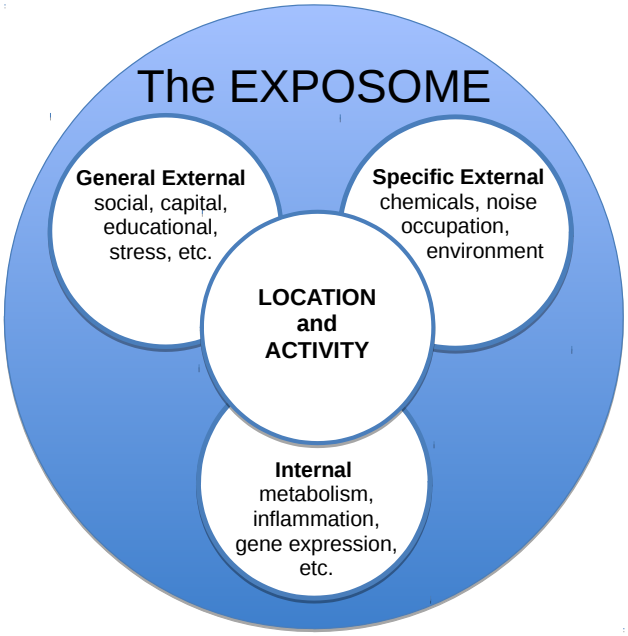
The advent of the exposome paradigm along with the development of mobile technology, low cost environmental sensors, and the "internet-of-things" brings exciting opportunities for exposure monitoring. In particular, the use of smartphone apps and the telecommunication facilities of smartphones to transmit 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*).

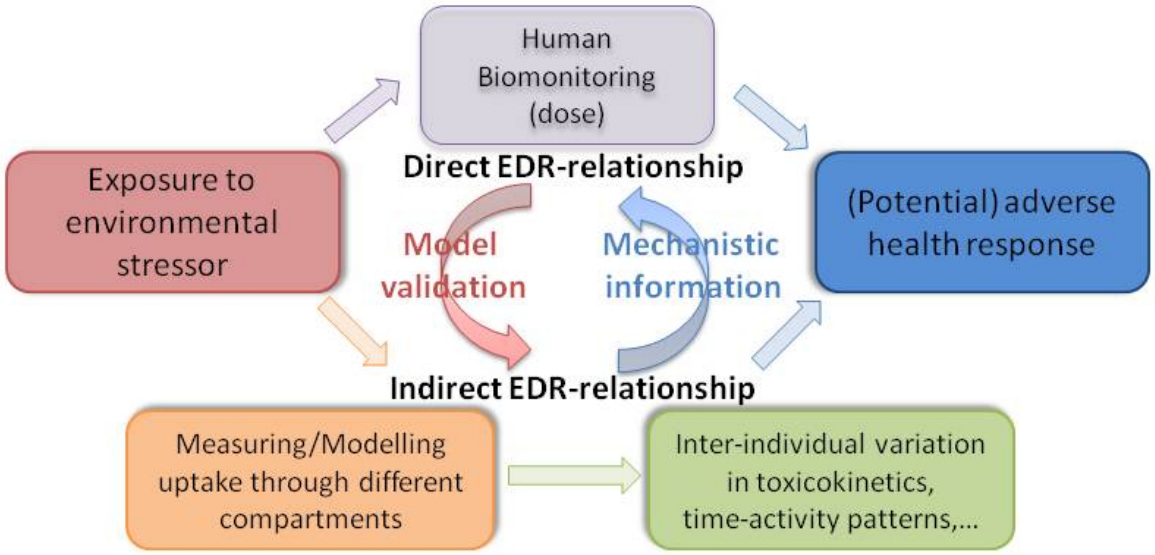


Figure 1: The Exposure-Dose-Response (EDR) Triad to evaluate the potential adverse health effects of exposure to environmental agents (adapted from *Smolders and Schoeters, 2007*)

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.

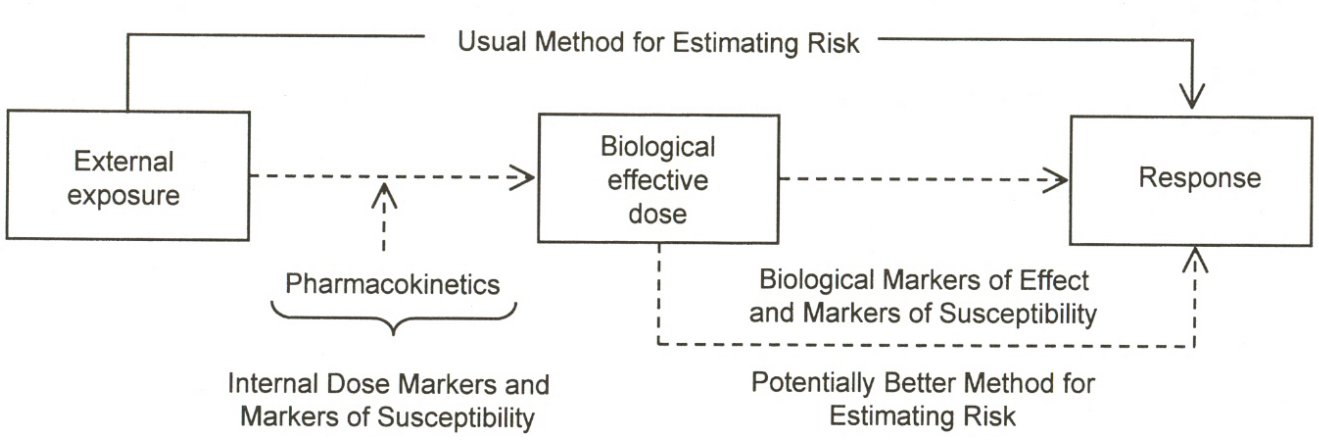


Figure 2: General approach for risk estimation (*WHO–IPCS, 2001*)

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

- **CDC** Third National Report on Human Exposure to Environmental Chemicals. *Atlanta, Georgia: Centers for Disease Control and Prevention; 2005*.
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- **WHO-IPCS** Biomarkers in Risk Assessment: Validity and Validation. *Environmental health criteria 222. Geneva: World Health Organization, International Programme on Chemical Safety; 2001*

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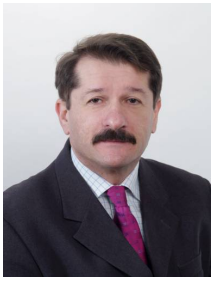

Professor Dr. Sc. **Zdravko Špirić**, Ph.D., is scientific adviser in technical sciences (chemical engineering) and in the interdisciplinary field of science (engineering, public health and health care). He has strong education, professional and scientific background with a proven excellence, skills 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.
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- Jarque S, Quirós L, Grimalt JO, Gallego E, Catalan J, Lackner R and Piña B (2015) Background fish feminization effects in European remote sites. Nature Scientific Reports 5, 11292
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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.

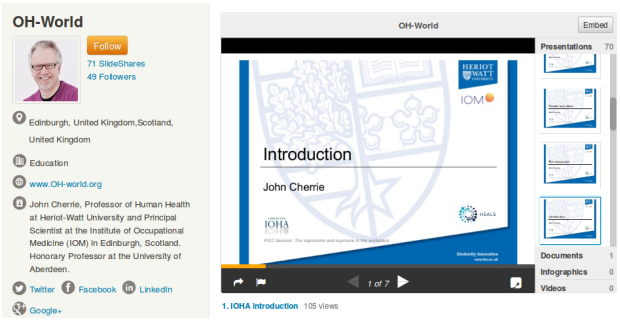
More information at:

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).

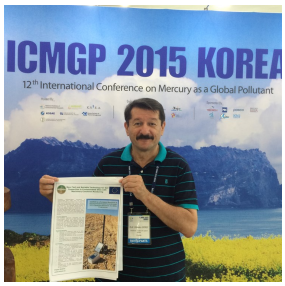
More information at:

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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