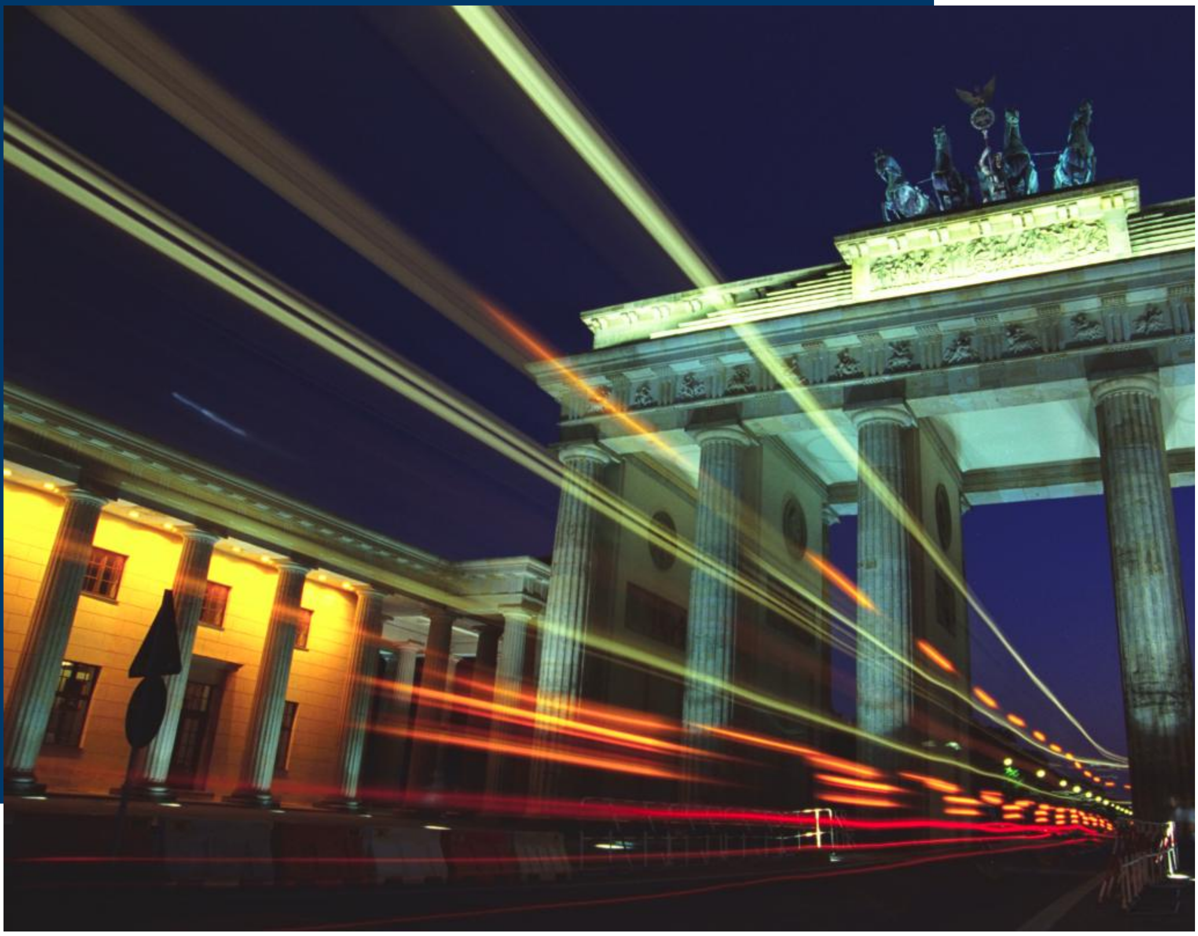
Abstracts



Advancing Exposure Science in Europe – today's results for a safer future

International Society of Exposure Science – Europe Chapter Workshop

19–21 March 2024, Berlin

German Federal Institute for Risk Assessment

Preface

Dear guests and experts in the field of exposure science, related disciplines and regulatory areas,

It is an honour to welcome you at the German Federal Institute for Risk Assessment in Berlin, hosting the ISES Europe Workshop “Advancing Exposure Science in Europe – today’s results for a safer future”. Let me begin by expressing my appreciation to the Scientific Committee for their enthusiasm and commitment in making this workshop possible.

The world around us is full of hazards. As mankind we have developed strategies for dealing with hazards that occur in our daily lives such as potentially harmful chemicals, bacteria, viruses and also physical hazards like radiation. I do not need to emphasise to this audience that most of these approaches for dealing with hazards are related in one way or another to controlling exposure.

A purely hazard-based approach is currently being discussed in some regulatory areas. However, we must emphasise that the dose and circumstances of exposure are key determinants of any risk. Exposure information and exposure science support are needed in regulatory and non-regulatory areas related to chemical safety, food safety, product safety, environmental health and occupational health. For this purpose, high quality exposure data is of utmost importance. Our work at the BfR can illustrate this point. The experts in our exposure department specialise in finding solutions to identified data gaps and scientific challenges in the field of exposure as input into our risk assessments in close cooperation with the experts from toxicology-oriented departments.

We need to work together to tackle some of the most difficult challenges in risk assessment and risk management. In response to the UN Sustainable Development Goals and the EU Green Deal, a "European Exposure Science Strategy 2020–2030" has been developed and some of the authors are among the participants of this workshop. “Aggregated Exposure”, “One Health” and “One Substance, One Assessment” are other highly relevant and upcoming topics for exposure science. Given the complex challenges related to societal changes such as climate change, crisis preparedness, increasing industrialisation and technological innovations, including those related to artificial intelligence, we need to bring together experts from all areas of exposure science.

I am very confident that this workshop will provide a good opportunity to discuss the appropriateness of new and existing concepts, approaches, methods and priorities. So far, there is no substitute for high-level meetings like this workshop, where science, practice, pragmatism and vision intermingle.

Also on behalf of the Scientific Committee, I would like to thank all authors, speakers, panellists and all participants for their contributions that will make this workshop a success. I hope that the venue and the vibrant city of Berlin will inspire you to build bridges and push boundaries in the important field of exposure science and dissemination. I wish you a fruitful conference and an enjoyable time with your colleagues.

Professor Dr Dr Dr h.c. Andreas Hensel
President of the German Federal Institute for Risk Assessment (BfR)

Dear exposure scientists,

With an excellent preparation of the workshop and the hospitality of BfR we have a great opportunity to meet and discuss the further development of exposure science in Europe.

The workshop programme offers a great variety of contributions with much time for discussion in interactive sessions. On site participation will also provide opportunities for social interaction and building your personal network. With these activities we shape ISES Europe to be(come) a strong community of researchers that will contribute to the ambitions to further develop exposure science in Europe and globally.

Current key developments in science relate to further improvement of approaches in exposure assessment, also in the context of new developments such as the exposome initiative. For the society we will continue to work on a safe and healthy environment for all. This will be done in the wider perspective of climate change that will have a substantial impact on health and the environment for generations to come.

Last but not least, ISES Europe also hopes to support you in your personal ambitions as current or future scientist in this field. We will discuss how to organise good quality curriculum to support exposure science training and certification. I hope that you will feel welcome to share your ideas regarding your own role and contribution during this meeting. This will ensure that we use this meeting to verify if we are on the right track regarding the implementation of the Exposure Science Strategy 2020–2030 and the roadmap to achieve our goals for the years to come. During this meeting we will also take some time to organise ourselves as a society chapter in the business meeting.
I hope that many of you will be actively involved in one of the working groups of the ISES Europe.

I wish you a pleasant meeting and stay in Berlin.

Paul Scheepers
President of ISES Europe

Advancing Exposure Science in Europe – today‘s results for a safer future

Exposure science is essential to assess possible health or environmental risks in the different regulatory and non-regulatory frameworks. As all parts of our lives, exposure science has also been challenged in the recent years, e.g. by climate change, by growing industrialisation or by technical enhancements, especially connected to artificial intelligence. The 2024 annual workshop of ISES Europe will bring together scientists from all fields of exposure science (dietary exposure, occupational exposure, environmental exposure, consumer exposure, radiation exposure) to share new approaches and results addressing those challenges and contributing to today‘s results for a safer future.

Scientific Committee

Gerald Bachler
DuPont de Nemours (Belgium) B.V.B.A., BE

Alison Connolly
University College Dublin, IE

Marlene Dietz
Federal Institute for Occupational Safety and Health, DE

Darragh Doherty
University College Dublin, IE

Karen Galea
Institute of Occupational Medicine, GB

Henri Heussen
Cosanta BV - Stoffenmanager®, NL

Anna Jäger
German Federal Institute for Risk Assessment, DE

Anna Kolbaum
German Federal Institute for Risk Assessment, DE

Oliver Lindtner
German Federal Institute for Risk Assessment, DE

Urs Schlüter
Federal Institute for Occupational Safety and Health, DE

Andrea Spinazzè
University of Insubria, IT

Susana Viegas
NOVA University of Lisbon, PT

Maryam Zare Jeddi
Shell Nederland B.V., NL

Contents

1 Programme

Tuesday, 19 March 2024	
11:00–12:00	Registration, coffee morning for students and new researchers
12:00–12:30	**Welcome** Matthias Greiner, head of the department Exposure, German Federal Institute for Risk Assessment (BfR), DE Urs Schlüter, Europe Regional Chapter of the International Society of Exposure Science (ISES Europe), Federal Institute for Occupational Safety and Health, DE
12:30–13:15	Chair: Urs Schlüter, Federal Institute for Occupational Safety and Health, DE **Exposure science in a circular economy. What are we circulating?** Paul Scheepers, President of ISES Europe, Radboud University, NL
13:15–13:45	Poster viewing and coffee break
13:45–15:00	Chair: Urs Schlüter, Federal Institute for Occupational Safety and Health, DE **The establishment of ISES Europe to future advancements I** **1. Advancing exposure science for integrated EU chemicals policies: a framework for efficiency** Yuri Bruinen de Bruin, German Federal Institute for Risk Assessment, DE **2. Data repositories and analytics** Marissa Kosnik, Eawag Swiss Federal Institute of Aquatic Science and Technology, CH **3. ECETOC workshop to elevate exposure science in chemical safety assessment: outcomes and follow-up** Jan Urbanus, on behalf of ECETOC
15:00–15:30	Poster viewing and coffee break
15:30–16:30	Chair: Oliver Lindtner, German Federal Institute for Risk Assessment, DE **The establishment of ISES Europe to future advancements II** **4. Human biomonitoring** Maryam Zare Jeddi, Shell Global Solution B.V., NL **5. Exposure models** Urs Schlüter, Federal Institute for Occupational Safety and Health, DE **6. Education, training and communication** Alison Connolly, University College Dublin, IE
16:30–17:00	Chair: Karen Galea, Institute of Occupational Medicine, GB **Panel session – ISES Europe Q&A**
17:00 onwards	Get-together with snacks and drinks
17:30 onwards	Student and New Researchers event (walking tour in Berlin City Centre; meeting point: canteen entrance)

Wednesday, 20 March 2024	
09:00–10:00	Chair: Gerald Bachler, DuPont de Nemours (Belgium) B.V., BE **Keynote: Consumer exposure research for a targeted European chemicals regulation (REACH)** Astrid Heiland, German Federal Institute for Risk Assessment, DE
10:00–11:00	**Parallel guided poster tours** P1: Food and dietary exposure and other exposure related topics P2: Innovative technologies and monitoring P3: Workplace, public spaces, airborne exposure **Parallel breakout sessions: ISES working groups (WGs), open to all** WG Exposure models Chair: Urs Schlüter, Federal Institute for Occupational Safety and Health, DE Room: Lecture theatre WG Integrated Frameworks and Policy Efficiency Chair: Jos Bessems, VITO Health N.V., BE Room: D146
11:00–11:30	Poster viewing and coffee break
11:30–12:30	**Parallel oral presentations** O1: Advances in exposure modelling I Chair: Urs Schlüter, Federal Institute for Occupational Safety and Health, DE Room: Lecture theatre O2: New developments for mixture exposure assessment Chair: Maryam Zare Jeddi, Shell International B.V., NL Room: D146 O3: Progress in data generation for refined exposure assessments – Pesticides Chair: Karen Galea, Institute of Occupational Medicine, GB Room: D145
12:30–13:30	Lunch break and group photo
13:30–14:30	**Parallel guided poster tours** P4: Food and dietary exposure P5: Advances in exposure modelling I **Parallel breakout sessions: ISES working groups (WGs), open to all** WG Human Biomonitoring Chair: Maryam Zare Jeddi, Shell International B.V., NL Room: Lecture theatre WG Data repositories and analytics Chair: Marissa Kosnik, Eawag Swiss Federal Institute of Aquatic Science and Technology, CH Room: D146

14:30–15:00	**ISES Europe Membership meeting, open to all** Chair: Paul Scheepers, President of ISES Europe, Radboud University, NL The board of ISES Europe will present the work of the last years focusing on the new bylaws of ISES Europe (presented during a virtual membership meeting on January 24th 2024), the outcome for the board election (mid-January to beginning of February 2024) and the new board members.
15:00–16:00	**Parallel guided poster tours** P6: Progress in data generation for refined exposure assessments P7: Advances in exposure modelling II and New developments for mixture exposure assessment **ISES working group (WG) breakout session, open to all** WG Education, Training and Communication Chair: Alison Connolly, University College Dublin, IE Room: Lecture theatre
16:00–16:30	Poster viewing and coffee break
16:30–17:30	**Parallel oral presentations** O4: Advances in exposure modelling II Chair: Henri Heussen, Cosanta B.V. – Stoffenmanager, NL Room: Lecture theatre O5: Progress in data generation for refined exposure assessments – food and dietary exposure Chair: Oliver Lindtner, German Federal Institute for Risk Assessment, DE Room: D146 O6: Other exposure related topics Chair: Gerald Bachler, DuPont de Nemours (Belgium) B.V, BE Room: D145
17:30–18:30	**Parallel oral presentations** O7: Advances in exposure modelling III Chair: Andrea Spinazzè, University of Insubria, IT Room: Lecture theatre O8: Human biomonitoring I – Data generation Chair: Alison Connolly, University College Dublin, IE Room: D146 O9: Exposure at school and public spaces Chair: Susana Viegas, NOVA University of Lisbon, PT Room: D145
19:00 onwards	Conference dinner Participants will be picked up by buses. After a sight-seeing tour on the bus, everyone will be taken to the restaurant for dinner. Participants can also come to the restaurant on their own from 20:30. Restaurant: Dieselhaus, Forum an der Museumsinsel 10, 10117 Berlin

Thursday, 21 March 2024	
08:30–09:30	Chair: Henri Heussen, Cosanta B.V. – Stoffenmanager, NL **Keynote: Assessing biological exposures in the omics era** Lidwien Smit, Professor of One Health and Environmental Epidemiology, Institute for Risk Assessment Sciences (IRAS), Utrecht University, NL
09:30–10:30	**Parallel oral presentations** O10: Workplace exposure Chair: Karen Galea, Institute of Occupational Medicine, GB Room: Lecture theatre O11: Human biomonitoring II – Data generation Chair: Maryam Zare Jeddi, Shell International B.V., NL Room: D146 O12: Steps forward to reach informed aggregated exposure assessments Chair: Christian Jung, German Federal Institute for Risk Assessment, DE Room: D145
10:30–11:30	Poster viewing and coffee break **In parallel starting 10:45, open to all** **ISES working groups extending boundaries for exposure science: collaboration for collective progress** Chair: Paul Scheepers, President of ISES Europe, Radboud University, NL Room: Lecture theatre
11:30–12:10	Chair: Matthias Greiner, German Federal Institute for Risk Assessment, DE **Keynote: Strengthening data quality and exploring new data streams to face future challenges in exposure assessment** Bruno Dujardin, European Food Safety Authority (EFSA), IT
12:10–13:10	Chair: Matthias Greiner, German Federal Institute for Risk Assessment, DE **Panel: Strengthening exposure science in legislation and policy** – Katleen Baert, European Commission’s DG for Health and Food Safety, BE – Bruno Dujardin, Scientific officer for regulatory risk assessment of chemicals at European Food Safety Authority (EFSA), IT – Natalie von Götz, Swiss Federal Office of Public Health, project leader Swiss Health Study, CH – Alejandro Rodarte, FoodDrinkEurope, senior manager Food Safety, Research & Innovation, BE – NGO (TBC)
13:10–13:30	**Announcement of poster award winners for students and new researchers** **Closing statements from BfR and ISES Europe**

2 Abstracts – oral presentations

2.1 Exposure science in a circular economy. What are we circulating?

Paul Scheepers

Radboud University, Nijmegen, NL

The concept of circular economy is one of the corner stones of the plan to achieve the sustainability goals. This policy is implemented by circulation of materials to secure an efficient use, reducing waste streams. This would lead to a more efficient use of natural resources and a reduced reliance on non-renewable feedstocks. From economy perspective this increases efficiency.

The concept of circularity has gained traction triggering innovative technology solutions. The public embraces this concept as a principle observed in nature itself and individuals become engaged and apply this it to their own households, communities and businesses.

In this contribution the focus will be on materials that are labelled as hazardous to humans and the environment. Most of these materials are now increasingly being re-used in an attempt to close the circle by reducing waste streams of these chemicals.

Some examples illustrate how difficult it can be to achieve true circularity for some hazardous materials such as in mining of metals and fossil fuels. Loose ends with emissions to the environment may become a potential threat to humans and the environment if operations are not well engineered and supervision by authorities is not adequate. An attempt will be made to identify the challenges for exposure science, related to production, use and reuse of hazardous chemicals. The needs from science and society will be discussed and how exposure science can be part of the solution.

2.2 Advancing exposure science for integrated EU chemicals policies: a framework for efficiency

Yuri Bruinen de Bruin

German Federal Institute for Risk Assessment, Berlin, DE

Background

A robust scientific framework in exposure science is imperative for optimising the use of exposure knowledge across diverse EU chemicals-related policies. Such a framework contributes to improving risk assessment, risk management, and communication within the realms of chemical safety, security, and sustainability.

Objective

This study aims to catalyse collaboration among public and private stakeholders, fostering the harmonised adoption of exposure assessment data, methodologies, and tools across EU legislation.

Methods

As part of the European Strategy of Exposure science 2020–2030, through a comprehensive mapping and analysis of the EU regulatory landscape utilising exposure information, this work identifies policy and research challenges. Key areas of action were then translated into opportunities to enhance both policy and scientific efficiency.

Results

The identified key action areas involved the creation of a unified scientific exposure assessment framework. Supported by baseline acceptance criteria and a shared knowledge base, this framework promotes the exchange and acceptance of exposure knowledge within and across EU chemicals-related policies. It is poised to enhance communication and management across chemical safety, security, and sustainability policies, spanning sourcing, manufacturing, global trade, product use and waste management. Integration of this framework into policy and industry practices is anticipated to contribute to systemic improvements in regulatory risk assessment and management.

2.3 Data repositories and analytics

Marissa Kosnik

Eawag Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, CH

High-quality and comprehensive exposure data are critical for different decision contexts, including human health monitoring and chemical risk assessment and management. However, exposure-related data are frequently of unclear quality and structure, not readily accessible, and stored in disconnected data repositories and the literature, making effective data usage challenging. In support of the European Exposure Science Strategy, the data repositories and analytics ISES Europe Working Group was established in 2020 to help guide an integrated European exposure data production and management framework for use in science and policy.

To meet this goal, the data repositories and analytics working group mapped the existing exposure data landscape to requirements for data analytics and repositories across European policies and regulations, and needs and ways forward for improving data generation, sharing, and use were identified. These needs were then translated into an action plan as a framework for European and global advancement in the generation, analysis, and sharing of exposure data relevant to EU policies and regulations. Identified key areas of action are to (1) develop consistent exposure data standards and vocabularies for data production, reporting, and analysis, (2) increase data transparency and availability, (3) enhance data storage and related infrastructure, (4) increase automation in data management, (5) increase data integration, and (6) advance tools for innovative data analysis. An overview of these strategic objectives identified by the data repositories and analytics working group and the action plan to overcome challenges and advance exposure data generation and uptake into EU chemical policies will be presented.

2.4 ECETOC workshop to elevate exposure science in chemical safety assessment: outcomes and follow-up

Jan Urbanus

on behalf of the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)

As a not-for-profit organisation seeking to advance the science of chemical safety assessment in Europe via a collaborative approach involving industry, academia and regulatory agencies, ECETOC recognises the fundamental importance of exposure science under the risk assessment paradigm. Therefore, building on its prior contributions to the implementation of REACH and on the 2020–2030 strategy of ISES-Europe, ECETOC recently convened a workshop to further elevate the role of exposure science from its current status of being somewhat subordinate to hazard assessment. Recommendations to stakeholders were developed in the subject areas of exposure data generation and use, models, capacity building, and exposure from new circular and sustainable chemical processes. Based on these recommendations, ECETOC is currently looking to establish a new overarching programme focused on exposure science, with clear objectives related to human health and environment; to initiate associated expert work groups for the subject areas considered most essential to its objectives, including exposure-informed next-generation risk assessment; and to participate in existing ISES-Europe working groups in other areas. Calls for nominations to the coordination group of the new ECETOC programme, and to the new expert work groups evolving from it, will be published and contributions from all stakeholders are encouraged. The presentation will outline the current progress and plans.

2.5 Human biomonitoring

Maryam Zare Jeddi[1,2]

[1] Shell Global Solution B.V., NL
[2] Life science Intelligence consulting, NL

Human biomonitoring (HBM), is a crucial approach for evaluating human exposure to environmental chemicals, often considered the “gold standard” of exposure characterisation. Its role in identifying real-life exposures and assessing risks related to chemical mixtures is increasingly recognised. In 2018, the decision to establish the European Chapter of the International Society of Exposure Science (ISES Europe), “Exposure Data Production: Human Biomonitoring (HBM)” Working Group (ISES Europe HBM Working Group) was motivated by a strategic recognition of the need to strengthening the role of human biomonitoring in exposure science, enhancing public health protection, and supporting regulatory decision-making across Europe. This initiative was underpinned by several key objectives, each aimed at enhancing our understanding, assessment, and management of chemical exposures to protect public health and support regulatory frameworks.

The working group mission focuses on generating high quality HBM data and metadata, with the strategic vision of enhancing the application of HBM data in the regulatory risk assessment process, industrial practices, and bridging knowledge gaps between chemical exposures and health outcomes. Outlining key benefits of HBM, six strategic objectives are defined: 1) Further development of sampling strategies and standardised protocols for data collection, use and storage, 2) Improved sampling methods and chemical-analytical HBM methods, 3) Harmonise processes and FAIR Principles implementation, 4) Enhanced quality control and assurance (chemical-analytical as well as statistical), 5) Sustained funding and legislative support, and 6) Targeted communication with stakeholders.

The HBM Working Group’s foundational principles encompass advancing scientific excellence, inform and influence policy, foster collaborative research and innovation and building capacity and expertise. This working group has formed four subgroups, HBM for Regulatory Excellence, Occupational Biomonitoring, Communication and Stakeholder Engagement and FAIR Exposure Data, all working together to achieve these objectives.

2.6 Exposure models

Urs Schlüter[1,2]

[1] Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE
[2] International Society of Exposure Science – Europe Chapter (ISES Europe)

Exposure models are essential in many contexts for exposure science. To address the numerous challenges and gaps that exist, exposure modelling is one of the priority areas of the European Exposure Science Strategy developed by ISES Europe. This strategy was developed for the priority area of exposure modelling in Europe with four strategic objectives. These objectives are

(1) enhancement of models and tools,
(2) development of new methodologies and support for understudied areas,
(3) improvement of model use and
(4) regulatory needs for modelling.

In a bottom-up approach, exposure modellers from different European countries and institutions who are active in the fields of occupational, population and environmental exposure science pooled their expertise in the ISES Europe Working Group on exposure models. This working group assessed the state-of-the-art of exposure modelling in Europe by developing an inventory of exposure models used in Europe and reviewing the existing literature on pitfalls for exposure modelling, in order to identify crucial modelling-related strategy elements.

Decisive actions were defined for ISES Europe stakeholders, including collecting available models and accompanying information in a living document curated and published by ISES Europe, as well as a long-term goal of developing a best practice in exposure modelling.

Additionally, to the four strategic objectives, the working group developed an action plan and roadmap for the implementation of the European Exposure Science Strategy for exposure modelling. This strategic plan will foster a common understanding of modelling-related methodology, terminology and future research in Europe.

2.7 Education, training and communication

Alison Connolly

University College Dublin, IE

Exposure science plays a pivotal role in understanding human interaction with various stressors and evaluating associated health risks. However, Europe currently lacks dedicated education and training programmes in exposure science. To address this gap, the European Chapter of the International Society of Exposure Science (ISES) formulated the European Exposure Science Strategy, with one of the primary objectives to establish exposure science in education.

The ISES Europe Education, Training, and Communication working group, established in 2018, has made significant strides towards this goal. Key achievements include the development of a harmonised glossary of terms for exposure science, ensuring consistent interpretation across publications. Additionally, the working group has initiated the development of a curriculum framework for exposure science education, with harmonised learning outcomes categorised by knowledge, skill, and competence.

Future ambitions include the creation of educational courses and programmes, certification processes for course recognition, and professional accreditation for exposure scientists. These initiatives aim to produce well-trained graduates with clearly defined career pathways, enhancing the credibility of exposure science professionals.

Overall, the efforts of the ISES Europe Education, Training, and Communication working group mark significant progress in anchoring exposure science in academic research and education. The establishment of formal education and training programmes, along with harmonised terminology and curriculum, will contribute to advancing exposure science expertise in Europe and beyond.

2.8 Keynote: Consumer exposure research for a targeted European chemicals regulation (REACH)

Astrid Heiland

German Federal Institute for Risk Assessment, Berlin, DE

Consumer behaviour surveys are suitable for determining exposure parameters such as use frequency, amount of product used, and exposure/application time. They are also essential to gather information surrounding of the application, the specific habits of consumers, the awareness of use instructions and safety measures implemented by manufacturer. However, it is challenging to enquire the information in a way, that reliable results are obtained. Therefore, a feasibility study of consumer behaviour was initiated in 2016 [1] to assess the usefulness of different survey methods depending on six sentinel consumer product types. Taking these results into account, the BfR conducted further studies on consumer pattern especially in the DIY sector as there is a particular lack of data in this area. The data makes it possible to update the current exposure defaults in fact sheets [2] and exposure modelling tools, to define new exposure scenarios for consumer products conquering the market, e.g. with new (advanced) materials or compositions, to review the efficiency of already implemented risk management measures, and tailored regulatory actions. Examples will be given in the presentation.

[1] Schneider et al. 2019. Consumer behaviour survey for assessing exposure from consumer products: a feasibility study. Journal of Exposure Science and Environmental Epidemiology, 29 (1), 2019, 83–94. https://doi.org/10.1038/s41370-018-0040-2

[2] Do-It-Yourself Products Fact Sheet. Default parameters for estimating consumer exposure – Updated version 2022. https://doi.org/10.21945/RIVM-2022-0208

2.9 ISES working group: Exposure models

Chair: Urs Schlüter

Federal Institute for Occupational Safety and Health, DE

Exposure models are essential in many contexts for exposure science and one of the priority areas of the European Exposure Science Strategy developed by ISES Europe. Therefore, the **Exposure Models** Working Group, established by ISES Europe, has the overarching aim to establish within the exposure science scientific and regulatory community a common understanding of use, documentation, validity and limitations of the models and tools for exposure assessment. This working group addresses the need to have guidance to enhance transparency of choices made in the selection of models, tools and exposure-related input parameters, and to better understanding the quality aspects of model results.

Additionally, to the four strategic objectives (1. enhancement of models and tools,
2. development of new methodologies and support for understudied areas,
3. improvement of model use and 4. regulatory needs for modelling), the working group developed an action plan and roadmap for the implementation of the European Exposure Science Strategy for exposure modelling. Therefore, sub-working groups were established addressing the evaluation of models and tools, the standardisation of modelling and the education and training for model users.

Results and plans of the working groups and the sub-groups will be discussed during the meeting of the **Exposure Models** Working Group. The collaboration of this working group with the other ISES Europe working groups will be discussed. The results will be brought to the session that is intended to discuss collaboration activities between the working groups.

2.10 ISES working group: Integrated Frameworks and Policy Efficiency

Chair: Jos Bessems[1], Yuri Bruinen de Bruin[2]

[1] VITO – Flemish Institute for Technological Research, Mol, BE
[2] German Federal Institute for Risk Assessment, Berlin, DE

The European Chapter of the International Society of Exposure Science (ISES Europe) developed the European Exposure Science Strategy 2020–2030, including a strategic objective to address barriers and challenges in broader uptake of exposure science in regulatory frameworks mainly on chemicals in Europe. Since the establishment of the ISES Europe 'Integrated Frameworks and Policy Efficiency' Working Group in 2018, various scientists in the chemicals policy or the policy-supporting domains have collaborated to contribute to the overall Exposure Science Strategy 2020-2030 as well as to enhance the use of exposure science across EU chemical policies as part of this European Exposure Science Strategy.

In this respect, two key areas of action were identified: (1) to develop a common scientific exposure assessment framework, supported by baseline acceptance criteria and (2) to develop a shared knowledge base enhancing exchangeability and acceptability of exposure knowledge within and across EU chemicals-related policies. Such framework will improve communication and management across EU chemical safety, security and sustainability policies comprising sourcing, manufacturing and global trade of goods, product use and waste management. In support of building such a common framework and its effective use in policy and industry, exposure science innovation needs to be better embedded along the whole policymaking cycle and be integrated into companies' safety and sustainability management systems. This will help to systemically improve regulatory risk assessment and management practices.

This workshop will briefly recap achievements so far and discuss the way forward. An important element will be a brief evaluation of the roadmap developed and to discuss the action needs up to 2030 and set priority objectives for the short (2–3 years), medium (4–7 years) and more long-term (starting 2030) goals.

Furthermore, to deliberate on future aspirations regarding the establishment of formal education and training programmes, curriculum development, and their role in advancing exposure science expertise within Europe and globally.

2.11 ISES working group: Human Biomonitoring

Chair: Maryam Zare Jeddi, Karen S. Galea[3], Nancy Hopf[4], Susana Viegas[5]

[1] Shell Global Solution B.V., NL
[2] Life science Intelligence consulting, NL
[3] Institute of Occupational Medicine (IOM), Edinburgh, UK
[4] University of Lausanne, Lausanne, CH
[5] NOVA National School of Public Health, Lisbon, PT

The ISES Europe Human Biomonitoring (HBM) Working Group is grounded in fundamental principles aimed at advancing scientific excellence, informing and influencing policy, fostering collaborative research and innovation, and building capacity and expertise. This group is dedicated to proactively pursuing impactful scientific contributions, supporting the development and application of guidelines and tools that elevate human biomonitoring practices, and promoting connectivity across scientific disciplines. A key objective is to cultivate a global pool of talent, enriching the field with experts in human biomonitoring as well as providing mentoring and training opportunities.

Moreover, the group is committed to increasing member recognition and visibility, leveraging their expertise and networks to enhance dialogue among stakeholders. Through interactive discussions among current and potential members, we prioritise our activities and explore future directions, aiming to review our efforts regularly to assess the group’s performance and broaden the involvement of our experts.

Furthermore, our ambition is to establish the ISES Europe HBM Working Group as a sustainable and recognised leader in the field of biomonitoring. We are aware of the potential that our experts and the participating organisations possess in contributing to the growth and enhanced visibility of our group. By harnessing this potential and through strategic collaboration and engagement, we aim to foster an environment where the collective expertise and resources of our members are fully utilised for the advancement of biomonitoring practices and to drive innovation, share knowledge, and address the complex challenges of human and environmental health. We invite experts to join our HBM Working Group as a recognised hub of expertise in Europe, moving towards the sustainability of our collective work in human biomonitoring.

2.12 ISES working group: Data repositories and analytics

Chair: Marissa Kosnik

Eawag Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, CH

The ISES Europe data repositories and analytics working group was established in 2020 to support the goals of the European Exposure Science Strategy. Through the working group, a collaboration of stakeholders from academia, government, and the private sector aim to guide an integrated European exposure data production and management framework for use in science and policy.

The working group discussions identified several needs to enhance the uptake of exposure data in European policies and regulations. These needs were then translated into an action plan as a framework for European and global advancement in the generation, analysis, and sharing of exposure data. Identified key areas of action are to (1) develop consistent exposure data standards and vocabularies for data production, reporting, and analysis, (2) increase data transparency and availability, (3) enhance data storage and related infrastructure, (4) increase automation in data management, (5) increase data integration, and (6) advance tools for innovative data analysis.

This workshop aims to bring new members in to the ISES Europe data repositories and analytics working group and discuss next steps to meet the goals of the developed action plan. Priority objectives will be identified, and potential future directions for the working group will be explored.

2.13 ISES working group: Education, Training and Communication

Chair: Alison Connolly[1], Gerald Bachler[2]

[1] University College Dublin, IE
[2] DuPont de Nemours (Belgium) B.V.B.A., Mechelen, BE

The European Chapter of the International Society of Exposure Science (ISES) created the European Exposure Science Strategy which included a strategic objective to address the gaps that exist in training and education for exposure science. Since the establishment of the ISES Europe Education, Training, and Communication working group, in 2018, stakeholders across sectors collaborated to create a framework for the advancement of exposure science education, which included four key strategic objectives.

Expert discussions identified several imperative requirements to propel exposure science education forward, including enhancing global recognition of exposure science as an independent discipline, establishing a centralised platform for disseminating relevant information, standardising terminology and educational methodologies within the field, and introducing a system for accreditation of exposure science courses and certified professionals.

To address these needs, the working group is divided into several sub-groups. One of the primary focuses is standardising terminology among exposure scientists, with the initial glossary published in 2022 and a further iteration is underway. The group is identifying the need to create and develop relevant learning materials and to provide a systematic process for certification and accreditation of exposure science courses and professionals.

This workshop will evaluate the advances made, and the priority objectives for the short, medium, and long-term goals of the group. Furthermore, to deliberate on future aspirations regarding the establishment of formal education and training programmes, curriculum development, and their role in advancing exposure science expertise within Europe and globally.

2.14 Keynote: Assessing biological exposures in the omics era

Lidwien Smit

Utrecht University, Utrecht, NL

Traditionally, the environmental and occupational health field has placed emphasis on chemical pollutants and the risk of non-communicable diseases, such as cancer and non-malignant respiratory diseases. Despite the significant public health impact of exposure to both infectious and non-infectious biological agents in residential, school, and work environments, the exposure science and occupational safety and health communities have devoted relatively little attention to the biological exposome. However, several developments are changing the landscape. The COVID-19 pandemic has reinforced the need to protect individuals from exposure to bioaerosols, while another major development in the field is the increasing use of molecular methods to assess the microbiome and virome in human and environmental samples.

Evaluating bioaerosol exposure risks is a complex task due to the dynamic and diverse nature of bioaerosols, limitations of available measurement methods, and the absence of environmental and occupational exposure limits. In this lecture, I will discuss several recent examples of studies, showcasing innovative bioaerosol measurement and modelling techniques and their application in exposure assessment and epidemiological studies. I will also address differences and similarities between chemical and biological exposure assessment. Ultimately, biological exposome research should help to elucidate exposure-response relationships, leading to improved risk assessment and prevention.

2.15 ISES working groups: Cross-collaborative working-group meeting

Alison Connolly[1], Susana Viegas[2], Karen S. Galea[3], Jos Bessems[4], Gerald Bachler[5], Maryam Zare Jeddi[6], Urs Schlüter[7]

1 University College Dublin, IE
2 NOVA University of Lisbon, PT
3 Institute of Occupational Medicine, GB
4 VITO Health N.V., BE
5 DuPont de Nemours (Belgium) B.V.B.A., Mechelen, BE
6 Shell International B.V., NL
7 Federal Institute for Occupational Safety and Health, DE

Exposure science serves as a cornerstone for ensuring environmental safety, mitigating human health risks, and fostering sustainable practices. The European Chapter of the International Society for Exposure Science (ISES Europe) is actively pursuing the objectives outlined in the 'European Exposure Science Strategy 2020–2030' roadmap.

As the exposure science field is a multi/trans-disciplinary field, six key thematic areas were identified: (1) Exposure science education, training, and communication; (2) Exposure assessment methods and tools; (3) Exposure data production and monitoring; (4) Data repositories and analytics; and (5) Regulatory exposure assessment science and (6) Building partnerships & collaboration. To advance on these thematic areas, dedicated working groups were established with accompanying aims, and with identifying the key needs and building blocks required to achieve it.

Amidst the working groups' process and advancements, a compelling trend has emerged highlighting the necessity for cross-collaborative dialogue, as none of the thematic areas exists in isolation. Specifically, there is a need for European networks, that contribute to the exposure science domain, to; enhance collaboration to streamline funding identification, standardising exposure assessment methodologies and terminologies, and seek input from diverse expertise and stakeholders in the development of education and training material to advance the discipline.

This workshop will be the platform to discuss how the working groups can formalise the cross-collaboration, identify the common areas of interest, and to prioritise the activities currently outlined in the strategy, as well as a call for further contributors from the wider exposure science community.

2.16 Keynote: Strengthening data quality and exploring new data streams to face future challenges in exposure assessment

Bruno Dujardin

European Food Safety Authority (EFSA), IT

Since its establishment in 2002, EFSA has acquired robust expertise in the field of dietary exposure, one of the key components of chemical risk assessment in food. This has resulted in the building of the Comprehensive European Food Consumption Database and a wealth of chemical monitoring data in food have been collected for a wide range of chemical compounds. These advancements have played a crucial role in building the risk assessment capacity in the EU, but continuous improvements are needed to address new social and scientific challenges.

There is an increasing demand for scientific risk assessment that is faster and more accurate, while ensuring a high level of consumer protection. Depending on the chemical domain, concerns may be raised for subpopulations with specific dietary needs, e.g. in the area of nutrition and food additives, or risk managers may also call for increased level of protection, e.g. exposure estimates covering up to 99.9 % of the population for the risk assessment of pesticides (as opposed to 95 % in other chemical domains). To address these challenges, a continuous improvement of the data quality will be key, and several activities in this remit are already ongoing. Furthermore, there will be a need to explore new data streams that will complement the data already collected by EFSA. A project investigating new opportunities regarding monitoring and surveillance data for chemicals has therefore been recently initiated.

This oral presentation will provide an overview of the main challenges and ongoing activities within this remit.

3 Abstracts – parallel oral presentations

3.1 O1: Advances in exposure modelling I

3.1.1 Evaluation of the ConsExpo Exposure to vapour – evaporation model

Sebastiaan L. Zoutendijk, Christiaan Delmaar, Wouter ter Burg

National Institute for Public Health and the Environment (RIVM), Bilthoven, NL

The freely available consumer exposure assessment tool ConsExpo Web integrates several exposure models into a single web application. The Exposure to vapour – Evaporation model is a physical model of the evaporation of a substance from a liquid matrix, such as paint or a cleaning product, into indoor air. The full physics of the evaporation of liquid mixtures and their interaction with substrates is complex, therefore several simplifying assumptions have been made. It is desirable to test whether the simplified model is adequate to describe real-life scenarios.

We present an evaluation of the ConsExpo Exposure to vapour – Evaporation model based on the reproduction of experimental data from the scientific literature. We have searched for reproducible experiments with air concentration measurements of volatile organic chemicals from paints, lacquers, personal care products, and household cleaning products. We make recommendations for estimating physico-chemical model parameters and their uncertainties. We model the experiments with ConsExpo Web and compare the model results with the experimental results. We find that the model performs well for aqueous solutions on impermeable substrates. For porous substrates, the comparisons show an overestimation of the short-term emissions. The model performs less well for non-aqueous solutions, likely due to lacking availability of appropriate physico-chemical parameters.

This evaluation of the ConsExpo Exposure to vapour – Evaporation model provides important information regarding the reliability and interpretation of model results and the optimal choice of input parameters. We will furthermore use the evaluation results to assess whether the model needs improvement.

3.1.2 Functional requirements to develop a new risk assessment tool: the first step – a new inhalation model to assess the exposure to bioaerosols

Carlota Alejandre Colomo[1], Geneviève Marchand[2], Carla Viegas[3,4], Rudolf van der Haar[5], Cristina Bercero Antiller[5], Remko Houba[6], Anne Mette Madsen[7], Hicham Zilaout[1], Henri Heussen[1]

1 Stoffenmanager® - Cosanta B.V., Amstelveen, NL
2 Institut de recherche Robert-Sauvé en santé et en sécurité du travail, Quebec, CA
3 Health & Technology Research Center, ESTeSL – Escola Superior de Tecnologia e Saúde, Instituto Politécnico de Lisboa, PT
4 NOVA National School of Public Health, Public Health Research Centre, Comprehensive Health Research Center, CHRC, NOVA University Lisbon, Lisbon, PT
5 MC Mutual, Barcelona, ES
6 NECORD, Utrecht, NL
7 National Research Centre for the Working Environment, Copenhagen, DK

Within Occupational Hygiene, risk assessment due to exposure to biological agents has received less emphasis compared to risks associated with other hazardous substances. Thus, the tools for hazard inventory, risk assessment, and implementation of control measures for biological agents remain scarce.

The COVID-19 pandemic raised awareness on the magnitude of potential health consequences linked to exposure to biological agents also in workplace environments. But concerns should not be limited to infectious biological agents. Non-infectious microorganisms might also impact in workers' health due to their sensitising, toxic and even carcinogenic effects. Workers in various sectors may be exposed through aerosols or contact with infected persons or materials that are contaminated with microorganisms presenting clinical relevance and/or toxicological potential.

Different qualitative risk assessment tools for biological agents have been developed over the last decades with differences in their scope, parameters used and results obtained. In order to propose a functional design for the development of a new risk assessment tool related to biological agents, four existing tools were compared to better understand their strengths, limitations and applicability.

Based on this comparison, a general structure for a complete new tool was proposed with some key requirements for determining occupational exposure to biological agents. Furthermore, we developed a new qualitative risk assessment model for bioaerosol inhalation created from a source-receptor conceptual model where scores for each parameter were assigned based on literature and experts support. The current model has been applied to seven different sectors and tested in more than 120 real workplace scenarios. Results will be presented.

3.1.3 The new ECETOC TRA worker tool 3.2: utilising workplace measurements to evaluate and improve exposure predictions of the screening tool

Joost G.M. van Rooij[1], Gerald Bachler[2], Athanasios Gkrillas[3], Oliver Henschel[4], Qiang Li[5], Jan Urbanus[6], Matthias Wormuth[7]

[1] Caesar Consult, Chemrade Software B.V., Nijmegen, NL
[2] DuPont de Nemours (Belgium) BV, BE
[3] Dow Belgium BV, BE
[4] BASF SE, DE
[5] Clariant Produkte (Deutschland) GmbH, DE
[6] Belgian Shell NV, BE
[7] Syngenta Crop Protection AG, CH

The ECETOC TRA worker tool is widely used as a conservative screening tool to estimate inhalation and dermal occupational exposure in the risk assessment of chemicals.

Since the publication of the TRA tool, several studies were published which evaluated the ECETOC TRA worker tool v2.0, v3.0 and v3.1 exposure predictions against workplace exposure measurements. In some instances, these publications reported that the occupational exposure was underestimated by the TRA tool. To gain more clarity about these reported underestimations and to identify possible improvements to the TRA tool, an ECETOC TRA working group carried out a systematic evaluation of all validation studies published since 2010. To this end, a protocol was developed to define minimum quality criteria for occupational exposure measurements and to delineate the comparison of measurements with the ECETOC TRA worker tool v3.1 exposure estimates.

Overall, 249 exposure scenarios (ES) comprising approximately 4,500 data points were utilised to evaluate short-term and long-term inhalation, and dermal exposure predictions. For the majority of ES, the TRA tool provides sufficiently conservative predictions. The underestimations observed for inhalation exposure to liquids (in 19 % of the ES) and dermal exposure (in 18 % of the ES) are largely associated with a limited set of process categories (PROCs).

Based on these findings, the TRA tool has been updated to provide more conservative exposure predictions for the identified PROCs. The improved ECETOC TRA worker tool v3.2 was made available in October 2023 on the ECETOC website.

Further improvements to the ECETOC TRA worker tool are currently discussed.

3.1.4 Generic quantitative models for prediction of occupational exposure to respirable dust and respirable quartz within the formulating, metal manufacturing and construction industries

Hicham Zilaout[1], Dorothea Koppisch[2], Carlota Alejandre Colomo[1], Mario Arnone[2], Henri Heussen[1]

1 Stoffenmanager® - Cosanta B.V., Amstelveen, NL
2 Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), DE

The current version of Stoffenmanager@ is not applicable to all areas of activity with solids in which respirable dust and respirable quartz are used or may arise. Therefore three novel generic models to quantitatively predict exposure to respirable dust and quartz are developed, aiming to protect workers from associated health risks within formulating, metal manufacturing and construction industries.

Personal exposure data including comprehensive contextual information were extracted from the IFA exposure database MEGA. Stoffenmanager® scores were calculated for the measurement values. For each quantitative model exposure data were segregated into calibration and validation datasets. Subsequently, mixed effect models were performed to derive quantitative regression equations. Spearman correlation coefficients were calculated to study the relation between concentrations estimated with use of new regression equations and measured exposure concentrations.

A total of approximately 8000 good quality exposure measurements were extracted for all three models. Stoffenmanager® scores were compared with exposure measurements and the calculated spearman coefficients showed a positive relationship for all algorithms. The results indicated a moderate to strong relationship between observed and estimated exposures. Proportions of measurements above 50th and 90th percentile were calculated, as a measure for conservatism of the models. They varied around 50 % and 10 % respectively. These results will be presented alongside examples of workplace scenarios including new local controls implemented in the models.

The substantial amount of personal exposure data, the good correlation and the level of conservatism indicate that the innovative models are sufficient to be implemented in Stoffenmanager® to expand its applicability domain.

3.2 O2: New developments for mixture exposure assessment

3.2.1 Exposure assessment of PFAS mixtures present in human biomonitoring data

Bas Bokkers[1], Wieneke Bil[1], Jacob van Klaveren[1], Clémence Fillol[2], Madeline Carsique[3], Amélie Crépet[3]

1 National Institute for Public Health and the Environment (RIVM), Bilthoven, NL
2 Santé Publique France, Saint-Maurice Cedex, FR
3 Agency for Food, Environmental and Occupational Health & Safety (ANSES), Maisons-Alfort Cedex, FR

Human biomonitoring (HBM) data, reflecting real-life exposure to chemicals, commonly shows that individuals are exposed to more than one per- and polyfluoroalkyl substance (PFAS) simultaneously. In the real-life mixture project in PARC (https://www.eu-parc.eu/) we developed a method to assess the presence of various PFAS in human blood. HBM data are available from studies performed by PARC partners on an individual level. The PFAS concentrations in blood of individuals can be summed and expressed as PFOA equivalents. This procedure is similar to the toxic equivalency factor (TEF) approach applied in the risk assessment of dioxins, and makes use of a relative potency factor for each PFAS. These factors express the toxicological potency of a PFAS compared to the potency of PFOA. Summed PFOA equivalents can subsequently be compared to a HBM guidance value of PFOA.

In this research we apply the derived relative potency factors for immunotoxicity derived at internal (blood) level. Furthermore, it will be illustrated how these factors can be applied to the individual PFAS HBM data from the French ESTEBAN study to determine the mixture exposure to various PFAS. The traditional approach towards chemical exposure and risk assessment is performed on a substance-by-substance basis, consequently underestimating the risk from exposure to PFAS mixtures with similar adverse health effects. The approach presented here allows the mixture exposure and risk assessment of up to 10 PFAS, which reduces the possibility of underestimating the risk of real-life exposure to PFAS mixtures.

3.2.2 OECD Activities using relevant effect biomarkers and AOPs for assessing known and unknown mixture risks

Radu Corneliu Duca[1], Nancy B. Hopf[2], Susana Viegas[3], Dan Villeneuve[4], Maryam Zare Jeddi[5], Rex FitzGerald[6], Martin Wilks[7], Kaspar Schmid[8], Naoko Moritani[9], Patience Browne[9], Robert Pasanen-Kase[8]

1 National Health Laboratory (LNS), Dudelange, LU
2 Unisanté, CH
3 ENSP/UNL, PT
4 US-EPA, US
5 Shell, NL
6 University of Basel and Geneva, CH
7 SCAHT, CH
8 SECO, CH
9 OECD, FR

The OECD Occupational Biomonitoring Guidance Document (www.oecd.org/chemicalsafety/risk-assessment/occupational-biomonitoring-guidance-document.pdf) was published in 2022 as a joint activity under the Working Parties on Exposure and Hazard Assessment involving more than 40 institutes/organisations. The Guidance Document presents current regulatory and scientific approaches to derive occupational biomonitoring values and provides practical guidance on how to use them for risk assessment. In the OECD Guidance Document, the derived health-based human exposure biomarker assessment values are referred to as Occupational Biomonitoring Levels (OBLs) which are suitable for use in risk assessment and risk management. The methods described in the Guidance Document pave the way for high quality and globally harmonised occupational risk assessment, but are also limited to the availability of data sets, analytical capacities and speed of regulatory processes.

To be able to cope with these challenges, a new OECD effect-biomonitoring project using Adverse Outcome Pathways (AOPs) for mixture assessment was initiated in October 2022 for the following reasons:

(i) Effect-biomarkers are the only option to assess known & unknown exposures and mixtures in an integrative way.
(ii) Validated effect biomarkers can be used to address relevant health effect endpoints and Mode of Actions (MoAs) in humans and other organisms and can be linked to adverse effects using the developing Adverse Outcome Pathway (AOP) concept.
(iii) A systematic understanding of the relevance and interpretation of effect-biomarker data will lead to increased protection options for workers and environmental organisms.

The project includes around 80 experts from 20 countries and the work is divided among five drafting groups providing examples related to Endocrine Disruption, (Developmental)-Neurotoxicity, Genotoxicity & Oxidative Stress, Reproduction Toxicity and Exposure Assessment Quality Principles for effect-biomonitoring. The drafting group work is currently applied to already characterised effect-biomarkers and related case studies. The final project outcome will be practice-oriented guiding principles, including mixture threshold derivation concepts for relevant effect-biomarkers. With these practice-oriented mixture assessments, occupational and environmental exposures to chemical mixtures health effects can be addressed. These concepts are intended to be used for existing and future effect-biomarkers which can provide meaningful and robust links to adverse outcomes for an integrative risk assessment.

3.3 O3: Progress in data generation for refined exposure assessments – Pesticides

3.3.1 Robust regulatory tools for European non-dietary risk assessment: plant protection industry's data collection initiative

Neil Morgan[1], Sarah Adham[2], Edgars Felkers[3], Felix M. Kluxen[4], Christian J. Kuster[3], Christiane Wiemann[5]

[1] Syngenta Ltd, Jealott's Hill International Research Centre, Bracknell, UK
[2] Corteva Agriscience, Abingdon, UK
[3] Bayer AG, Crop Science Division, Monheim am Rhein, DE
[4] ADAMA Deutschland GmbH, Cologne, DE
[5] BASF Oesterreich GmbH, Vienna, AU

Plant protection products (PPPs) undergo rigorous safety assessments. In Europe, non-dietary risk assessments for operators, workers, bystanders and residents are highly conservative as this area of exposure science has historically been relatively data poor. The European agricultural chemistry industry, mostly represented by CropLife Europe (CLE), has been engaged in collaborative activities to generate new data and pool existing data from individual companies to refine the approaches prescribed by the European Food Safety Authority (EFSA) guidance on non-dietary exposure (2022).

Here we describe the initiative's key activities, beginning with the development of the Agricultural Operator Exposure Model (AOEM) (an integral part of the EFSA risk assessment model) and covers the projects which refine current approaches to bystander, resident and re-entry worker assessment, including the Bystander Resident Orchards Vineyards (BROV) project, improvements to the Bystander and Resident Exposure Assessment Model (BREAM) (spray drift), proposals for refined vapour inhalation assessments, and a meta-analysis of Dislodgeable Foliar Residue (DFR) data for re-entry exposure. A study to quantify the benefits of using closed transfer systems (CTS) and an appraisal of the inherent compounded conservatism in the current risk assessment paradigm are introduced. Related activities under the umbrella initiative comprise seed treatment exposure estimation and dermal absorption assumptions and approaches to determine systemic exposure.

Non-dietary exposure now features prominently on the critical pathway to registration for PPPs. We show the industry's ongoing commitment to advancing the science that allows farmers access safe and sustainable crop protection solutions needed to maintain viable food production in Europe.

3.3.2 How can exposure assessment for pesticides in epidemiological studies be improved? Insights from the IMPRESS project

Karen S. Galea[1], William Mueller[1], Samuel Fuhrimann[2,3,4], Kate Jones[5], Johan Ohlander[2], Ioannis Basinas[6], Andrew Povey[6], Martie van Tongeren[6], Hans Kromhout[2]

[1] Institute of Occupational Medicine (IOM), Edinburgh, UK
[2] Utrecht University, Utrecht, NL
[3] Swiss Tropical and Public Health Institute (Swiss TPH), Allschwil, CH
[4] University of Basel, Basel, CH
[5] Health and Safety Executive, Buxton, UK
[6] University of Manchester, Manchester, UK

The authors have not given permission to publish the abstract.

3.3.3 DermExpoDB – a database to share occupational dermal data

Jessica Meyer[1], Suzanne Spaan[2], Henk Goede[2], Daniel Vetter[3], Violaine Verougstraete[4], Sandra Lohmann[1], Dag Rother[1]

1 Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE
2 Dutch Organization for Applied Scientific Research (TNO), NL
3 EBRC Consulting GmbH, DE
4 European Association of Metals (Eurometaux) BE

In databases such as MEGA, SUVA database, CWED or COLCHIC measurement data on occupational inhalation exposure has been collected for quite some time. There have also been a few attempts to systematically collect data on workplace skin exposure in the past, such as RISKOFDERM, BEAT or DERMDAT. The latter data collections are no longer maintained or updated. For this reason, several institutes (BAuA, EBRC/Eurometaux and TNO) have joined forces to create a new online database structure to collate and exchange occupational dermal data and make this data sustainably available for research and development purposes. The corresponding database software will be developed, operated and sustained by BAuA.

The collated dermal exposure data will enable, amongst others, to evaluate and/or (further) develop dermal exposure models, to gain a better understanding of specific exposure situations and to identify research needs in terms of for instance sampling methodology and dermal exposure mechanisms. As such, this DermExpo database (DermExpoDB) depends on active contribution and commitment of the consortium partners. DermExpoDB is unique in that it is web-based and that the ownership rights of the data sets stored in the database remain with the data owners. Two different types of data can be included in DermExpoDB: individual measurement data as well as summary statistics (e.g., arithmetic mean and standard deviation) of a specific dataset.

The developed web-based database structure as well as the technical implementation of the software will be presented. In addition, possibilities for contributing to the database and an overview of the data currently available in DermExpoDB will be given.

3.4 O4: Advances in exposure modelling II

3.4.1 New hand-held operator exposure model for agricultural and non-agricultural scenarios

Sabine Martin[1], Claudia Großkopf[1], Christian Küster[2], Matthew Crowley[3], Christiane Wiemann[4], Christian-Tobias Willenbockel[1], Arpad Szarka[5], Mark Best[6], Anugrah Shaw[7]

[1] German Federal Institute for Risk Assessment (BfR), Berlin, DE
[2] Bayer AG, Monheim am Rhein, DE
[3] US EPA, Washington DC, US
[4] BASF Oesterreich GmbH, AT
[5] Syngenta Crop Protection, LLC, Greensboro, US
[6] Syngenta Crop Protection, Ltd., Bracknell, UK
[7] University of Maryland Eastern Shore, US

Determining operator safety when handling pesticides is an important aspect of the approval of these products. A risk-based approach assessing safe uses is usually carried out in countries with a regulatory infrastructure that supports a relatively complex process of risk assessment While risk assessment models for vehicle-mounted application are well-developed and supported by sufficiently large datasets, data for agricultural hand-held sprayers are rather limited in European and US models as hand-held applications have a lower relevance.

However, hand-held applications are still commonly used in many regions of the world [1]. A global database was collated to develop new models for hand-held applications to address the need for exposure assessments for relevant scenarios in these countries. Hand-held studies that are part of the two models referenced in the FAO Toolkit are included within the dataset [2]. Additional studies, many conducted by member companies of CropLife International, were evaluated by a Working Group that includes regulators, industry experts, and observers from FAO and WHO. Criteria provided by FAO for referencing new model(s) in the FAO Toolkit are addressed in this initiative [3].

The dataset primarily includes outdoor and greenhouse agricultural applications. Statistical analysis for the model is conducted by an independent company with subject matter expertise provided by the Working Group. Preliminary analysis supported by expert knowledge was used to identify impact factors for model development. Quantile regression analysis will be used to develop the model. A comprehensive project report with relevant data and information will be published for transparency.

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3.4.2 ICPPE risk assessment & mitigation tool: facilitating pesticide risk evaluation for operators using hand-held spray equipment

Christian Küster[1], Olivier Sanvido[2], Claudia Großkopf[3], Anugrah Shaw[4]

[1] Bayer AG, Monheim, DE
[2] State Secretariat for Economic Affairs, CH
[3] German Federal Institute for Risk Assessment, DE
[4] University of Maryland Eastern Shore, US

Pesticides, regulated for sale and use, usually undergo a rigorous registration process in countries all over the world. This includes assessing whether the product can be used by operators within acceptable risk under local agronomic conditions with realistic risk mitigation. While regulatory authorities in countries with established risk assessment procedures routinely evaluate operator risks, many countries particularly in Asia, Africa and Latin America often face challenges in conducting thorough assessments due to limited resources and expertise.

In September 2021, a global meeting of regulators, industry experts, and academics was convened to discuss the development of a user-friendly risk assessment and mitigation tool. This tool, focusing on operators using handheld equipment, should be based on a global exposure database/exposure model and replace existing exposure models lacking sound data for handheld equipment.

Developing this tool involves balancing simplicity and accuracy in operator risk assessments by considering input from a variety of stakeholders, including regulators, industry and academia. While sophisticated methods are accurate, they can be complex to implement and interpret. Conversely, overly simple methods, like hazard-based approaches, may lack precision.

The tool aims to address operator safety by setting default input parameters that affect exposure, such as dermal absorption rates, treatment area, equipment used, and PPE mitigation measures to balance protection and comfort. It provides a simple interface and clear output to help national regulators make informed, risk-based decisions and suggest mitigation strategies, including the selection of appropriate PPE.

3.4.3 Protection by ordinary light clothing against pesticide spray drift for bystanders and residents

Edgars Felkers[1], Christian J. Kuster[1], Sarah Adham[2], Felix M. Kluxen[3]

[1] Bayer AG, Monheim, DE
[2] Corteva Agriscience, Abingdon, UK
[3] ADAMA Deutschland GmbH, Cologne, DE

There are stringent EU regulatory requirements to assess pesticide exposure to bystanders and residents to direct spray drift. A “light clothing” adjustment factor (AF) of 0.82 is applied in the exposure assessment, based on simple assumptions for covered body surface and penetration through clothing. To assess the appropriateness of the AF, we collated data from 32 field studies. The mean % reduction from ordinary light clothing (“reduction %”) in children and adults for all crops and standard and drift-reducing nozzles was 42.7 %, resulting in AF of 0.573. Sources of variation were investigated, e.g., crop type, leaf coverage, buffer, spray pressure, and nozzle type, which indicated that reduction % could be impacted by several conditions. The reduction % is similar between crops; therefore, a single AF value covering all crops can be derived. One exception was for early-stage vineyard scenarios (the reduction % is lower (27 %) than late stage (42–47 %)) and could be considered individually to avoid unnecessary conservatism for the other scenarios. This evaluation demonstrates the current AF to be overly precautionary, and a more realistic, exposure scenario-relevant value could be applied for bystander/resident risk assessments.

3.4.4 Advances in modelling of inhalation exposure for droplet and foam spraying applications

Stefan Hahn[1], Jessica Meyer[2], Katharina Schwarz[1], Monika Krug[2], Wolfgang Koch[1]

[1] Fraunhofer Institute for Toxicology and Experimental Medicine (ITEM), Hannover, DE
[2] Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE

Spray and foam applications can be found at workplaces as well as in consumer environments. Thereby spraying has several advantages but is also often prone to high inhalation burden. Foaming is often considered as an alternative to reduce inhalable aerosol concentration. Mechanistic model approaches with different degree of complexity are available to predict the inhalable exposure for spraying activities. However, all these model approaches have some limitations. On the one hand, there are modelling approaches available that use very simple mass balance considerations or simple empirical models, which deliver very conservative results. On the other hand, more sophisticated mass-balance models are published, which result in more accurate estimates, but which require more detailed information on processes and scenarios. The latter are often not immediately available.

In the presentation we report on a modelling approach for inhalation exposure caused by spray and foam applications. The basic model is a 2-box mass balance model using a minimum of input data. Although droplet evaporation, settling, and wall deposition is not considered in the first instance, the model output can be refined accordingly by introducing correction factors based on two key parameters, the droplet size class and the vapor pressure class of the solvent. Alternatively, experimentally determined airborne release fractions can be used that relate to the used spray equipment. Such release fractions have also been derived for foam applications. The presentation will contain a description of the model, derivation of the release fractions, and a comparison with measured data.

3.5 O5: Progress in data generation for refined exposure assessments – food and dietary exposure

3.5.1 What's in our food: first results of the BfR MEAL Study

Irmela Sarvan, Oliver Lindtner, Matthias Greiner

German Federal Institute for Risk Assessment (BfR), Berlin, DE

Data for dietary exposure assessment of substances in prepared foods are for many substances lacking or inadequate. To improve the knowledge of substance levels in foods, the first German total diet study (TDS) called BfR MEAL Study (meals for exposure assessment and analytics in foods), was initiated. A TDS is a cost-effective and reliable method used worldwide for the analysis of substances in foods for dietary exposure assessment. Foods are prepared as typically consumed and analysed for a broad spectrum of substances.

356 MEAL foods, representing at least 90 % of the German diet were investigated and analysed for over 300 substances. The MEAL food list was developed based on available food consumption data and market data. Foods were purchased at retail level in different shops and were stratified by production type, type of packaging and storage condition and/or origin, if relevant. Foods were representatively prepared as eaten. Prior to substance-specific analysis, similar foods were homogenised and pooled.

The influence of food preparation and sampling by region, season or type of production will be discussed. Food preparation might cause varying levels of substances in foods e.g., by reduction of vitamins or formation of acrylamide after heat treatment. Furthermore, levels of potassium in potatoes were shown to vary depending on the type of processing. Foods with reduced water content caused by drying, contained high substance levels such as cadmium and lead in cocoa powder and spices.

The BfR MEAL Study provides levels of substances in foods typically consumed by the German population and provides an expanded data set for exposure assessment. This will enable the confirmation of recommendations in dietary guidelines, and closing gaps in the knowledge of substance levels in foods. The data will be combined with national consumption data to estimate total dietary exposure to increase consumer safety.

3.5.2 The contribution of air to risks and transfers associated with PAH in urban agriculture: calculation of new bioconcentration factors in edible plants

Karen Perronnet[1], Etienne Catry[1], Roseline Bonnard[1], Anne Barbillon[2]

[1] French National Institute for Industrial Environment and Risks (Ineris), Verneuil-en-Halatte, FR
[2] AgroParistech Innovation, FR

The French CARTHAGE project is the acronym for "The contribution of air to Risks and Transfers associated with PAH in Urban Agriculture: Management and Assessment". It is based on experiments on three urban community farms around Paris (France) in order to assess the contribution of air pollution to plant PAHs contamination, by distinguishing different transfer mechanisms such as leaf and root transfers.

The CARTHAGE project therefore helps to determine whether urban air pollution is an obstacle to the development of agricultural practices in urban areas. Two types of Bioconcentration factors (BCF) were calculated for 24 PAHs in four edible vegetables (carrots, salads, zucchini and parsley): BCF soil-plant and BCF air-plant as air quality in PAHs was characterised during plant growth. In total 48 BCF soil-vegetable and 28 BCF air-vegetable were provided, filling in missing data in models needed for transfer prediction.

Main results showed that both air and soil contribute at different levels to the plants contamination with PAHs, depending on species, even for carrots as air contribution was initially considered to be zero.

Concentrations in plants were also compared to those obtained through modelling, based on physicochemical properties of substances and including specific pathways as dust re-flight, particles air deposits, gas absorption. Modelled concentrations in plants were globally similar and often higher than experimental, leading to a conservative approach for human health risk assessment.

The 4-years project proposed adequate management measures to prevent or reduce the exposure and risks associated with the presence of PAHs in urban areas.

3.5.3 Consumer exposure to pesticide residues from food – an exploratory study of duplicate food portions (DFP) intake and urinary metabolite excretion

Nina Wieland[1], Neus González[2], Hans Mol[3], Jonatan Dias[3], Paul T. J. Scheepers[1]

1 Radboud University, Nijmegen, NL
2 Centre de Tecnologia Ambiental, Alimentària i Toxicològica (TECNATOX), Barcelona, ES
3 Wageningen University & Research, Wageningen, NL

Food safety in the EU relies on restrictions of pesticide residues in food items from the internal market and in those products imported into the EU. Food residue data published by the European Food Safety Agency (EFSA) can be used to estimate dietary pesticide uptake, for example by using the computational PRIMo model from EFSA. This model uses processing factors to determine the influence of food preparation and processing, however experimental verification/examination of this approach is needed.

In the European Sustainable Plant Protection Transition (SPRINT) study, dietary uptake of pesticides was studied in human volunteers. Forty-three participants were asked to collect a duplicate portion of food and beverages (DFP) consumed for 24 hours. On the day of the DFP collection, urine was also collected for 36 hours. DFP and urine samples were analysed for pesticide residues and pesticide biomarkers of exposure (mostly metabolites), respectively, using LC-MS/MS and GC-MS/MS. Glyphosate and AMPA were analysed separately by dedicated methods.

Out of 183 PPPs, 86 were detected in the DFPs. The highest detected frequencies (%) were metalaxyl (100 %), pirimiphos-methyl (77 %) and tebuconazole (70 %). Piperonyl-butoxide, a synergist, was detected in almost all portions. Biomarkers found most frequently in urine were 3-PBA (81 %) (non-specific metabolite of many pyrethroid-based products), DCCA (63 %) (metabolite of cypermethrin, cyfluthrin, permethrin), TCPy (84 %) (chlorpyrifos/chlorpyrifos-methyl) and DEAMPY (74 %) (pirimiphos-methyl). Glyphosate and AMPA were detected in 42 % and 30 % of all urine samples, respectively. The highest concentrations measured, were 136 µg/L for the pyrimethanil metabolite M605F002, 18 µg/L for hydroxy-tebuconazole, and 14 µg/L for DEAMPY.

Collection and analysis of DFP provides insight into dietary intake of pesticides in consumers.

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3.5.4 Probabilistic dietary exposure assessment of the Italian population to 3-monochloropropane-1,2-diol, 2-monochloropropane-1,3-diol and glycidol

Simone Stefano, Alessia Lanno, Sofia Ghironi, Alice Passoni, Renzo Bagnati, Alessandra Roncaglioni, Enrico Davoli, Elena Fattore

Istituto di Ricerche Farmacologiche Mario Negri, Milan, IT

3-Monochloropropane-1,2-diol (3-MCPD), 2-Monochloropropane-1,3-diol (2-MCPD) and glycidol and their esters are food-borne process contaminants generated under refinement of vegetable oils. In its latest guidelines, the European Food Safety Authority (EFSA) established a Tolerable Daily Intake (TDI) of 2 µg/kg bw/day for 3-MCPD, and identified a threshold for Margin of Exposure (MoE) of 25,000 for glycidol. However, it is still unclear whether such thresholds may be exceeded – especially by the younger population –, and whether 2-MCPD may pose a potential health concern. Our study aims at estimating the exposure of the Italian population to these contaminants. To this aim, the Observed Individual Means methodology was employed. Probabilistic exposure assessment was performed by stratifying the sample of consumers by age class. Disaggregated consumption data were retrieved from the "INRAN SCAI 2005-2006" dietary survey. Occurrence data were obtained using an in-house analytical method. Ninety food samples, including vegetable oils, bread, biscuits, potato chips and other sweet and salty snacks were analysed using gas chromatography coupled with mass spectrometry to quantify the total content of contaminants. 2-MCPD was detected in only a few samples, suggesting overall lower health concern in comparison to 3-MCPD and glycidol. With respect to the adult population, exposure to 3-MCPD was below the TDI, whereas the MoE for glycidol indicated health concern, even for the less exposed age groups. These preliminary findings will be integrated with occurrence data in infant formulas, which are expected to drive the exposure for the younger population.

3.6 O6: Other exposure related topics

3.6.1 A pilot study on low-carbon intervention among motorcycle commuters in Taipei

Man-Ni Wang, Kang Lo, Chang-Fu Wu

National Taiwan University, Taipeh, TW

Urban centres are affected by PM2.5 and carbon emissions from traffic and industry, contributing to climate change. Encouraging low-carbon transport like cycling and electric vehicles is vital, as these approaches provide benefits in reducing both pollution and carbon emissions. This study aims to evaluate the impact of transportation interventions on carbon emissions and PM2.5 exposures at the National Taiwan University campus. In this pilot study, 11 students who regularly commuted by fuel motorcycles were recruited for a two-stage intervention involving cycling and electric scooter usage. In the first stage, participants were asked to ride bicycles during commuting periods on weekdays for two weeks and wore low-cost PM2.5 sensors to gather exposure monitoring data. In the second stage, also for two weeks, their willingness of switching to using shared electric scooters were surveyed and daily usages of commuting tools were tracked. Carbon emissions were then compared across both stages, with questionnaires administered before, during, and after the study.

Following the intervention, 92 % of participants shifted to electric motorcycles, yielding a 31 % reduction in transport carbon emissions. More than half showed a willingness to modify commuting behaviours, contributing to a 46 % reduction in carbon emissions, while the unwilling group saw a 15 % decrease. Distance from school was a decisive factor, with willing participants living closer on average (3.7 km vs. 4.8 km). Additionally, PM2.5 exposure ranged from 5.27 to 26.14 ug/m3 in the first stage, with apparent contrast between different commuting routes. The study results showed that incentives for green commuting might be needed and tools for selecting low-exposure commuting routes also should be developed.

3.6.2 Exploring the landscape of 5G NR EMF exposure sensing technologies: a narrative review

Erdal Korkmaz[1], Sam Aerts[1], Richard Coesoij[2], Chhavi Raj Bhatt[3], Maarten Velghe[4], Loek Colussie[5], Derek Land[1], Marco Spirito[2], John Bolte[1,4]

[1] The Hague University of Applied Sciences, The Haag, NL
[2] Delft University of Technology, Department of Microelectronics, Delft, NL
[3] Australian Radiation Protection and Nuclear Safety Agency, AU
[4] National Institute for Public Health and the Environment, NL
[5] Dutch Authority for Digital Infrastructure, NL

With the global rollout of 5G New Radio (NR) networks, which introduces new frequency bands (e.g., 3.5 GHz and 26 GHz in Europe) and dynamic, user-following traffic beams, understanding and monitoring radiofrequency electromagnetic field (RF-EMF) exposure levels are crucial to ensure public safety and address potential health-related concerns. In this work, we identified the current gaps in RF-EMF exposure assessment tools, especially with respect to the innovations brought by 5G, as well as the requirements for next-generation instruments and methods.

Through a comprehensive search of relevant literature, we evaluated the entire range of state-of-the-art RF-EMF assessment tools, including high-end spectrum analysers, field meters, stationary nodes or area monitors, and lab-developed sensors. Additionally, the growing application of mobile apps for personal exposure data collection in 5G NR networks is highlighted. Furthermore, we examined both standardised and non-standardised measurement protocols, gathering insights into the diversity of the methodologies.

Our review revealed that, although there is a significant demand for affordable and durable sensors – whether for personal exposure measurements, mobile (vehicle-integrated) measurements, or use in distributed sensor networks – there is a general lack of comprehensive information regarding current custom-developed RF-EMF measurement tools, particularly concerning measurement uncertainty. Moreover, real-time, fast-sampling solutions are necessary to provide sufficient insight into the highly irregular temporal variability of the EMF distribution in next-generation networks. Finally, because of the diversity of tools and methods, a thorough comparison across them is essential in order to identify which statistical tools are required for aggregating the available measurement data.

3.6.3 Establishing a framework for exposure science certification: enhancing professional competencies and strengthening exposure science identity

Gerald Bachler[1], Alison Connolly[2], Natalie von Goetz[3], Steven Verpaele[4], Maryam Zare Jeddi[5]

1 DuPont de Nemours (Belgium) B.V., Mechelen, BE
2 University College Dublin, IE
3 Swiss Federal Office of Public Health, CH
4 Nickel Institute
5 Shell International BV

The European Exposure Science Strategy 2020–2030 has set a strategic objective to develop a certification framework for exposure science courses and professionals. This initiative is driven by multiple factors: (i) to establish exposure science as a recognised profession and support its unique identity, (ii) to standardise the roles and the profiles of practising exposure scientists, (iii) to harmonise educational and practical experiences, thereby facilitating clear career paths for graduates, and (vi) to enhance the competency of exposure scientist through ongoing education and advancements within the field.

Within the ISES Europe Education, Training and Communication (ETC) Working Group a subgroup has been formed to focus on this framework. The framework is established based on current best practices developed by professional organisations in related fields, such as toxicology, industrial hygiene, and environmental science.

The foundation of the framework lies in the identified Domains of Expertise (DoE) for exposure science. Based on the DoE, two career pathways are proposed for qualification in exposure science: professional qualification for practising exposure scientists and certification of exposure science courses. Both qualification pathways emphasise continuous education and regular re-qualification.

At the upcoming ISES Europe workshop in Berlin 2024, the subgroup dedicated to this certification framework will present its preliminary structure and solicit valuable feedback. Following the workshop, the subgroup plans to begin implementing this framework within the ISES Europe community.

3.6.4 Wearables for occupational exposure monitoring: the role of EU occupational health and safety legislation

Stefania Marassi[1,2], John Bolte[1]

[1] The Hague University of Applied Sciences, Delft, NL
[2] Leiden University, Leiden, NL

Wearable technology is emerging as a promising solution for measuring and monitoring workers' occupational exposure to chemical and physical agents. Compared to traditional methods and instruments to measure and calculate occupational exposure (e.g. personal air sampling), these devices offer several opportunities to protect workers' health and safety: they allow for real-time and continuous monitoring thanks to the integration of different sensors capable of measuring and real-time reporting a wide range of physical and chemical environmental parameters (e.g. noise, vibrations, particulate matter, gases) and occasionally physiological ones. When necessary, continuous monitoring may lead to prompt occupational health and safety (OHS) interventions, such as when the noise exposure levels reach a certain threshold. Therefore, one may contend that wearables are useful instruments to incorporate into the risk assessment process that an employer is mandated to perform under current national and European legislation (see, e.g., Directive 89/391/EEC). By continuous monitoring with wearables hotspots in time and place, high exposure activities, and work protocol improvement, it may be possible to decrease health risks; however, information on the employee's behaviour, work rhythm, and productivity can be derived from the same data. With that in mind, from a legal standpoint, one of the core questions that emerges is whether or not the existing European OSH regulatory framework is equipped to address the use of wearables for monitoring occupational exposure, and to what extent such framework does, or should, allow for the integration of this sensing technology in the risk assessment process.

3.7 O7: Advances in exposure modelling III

3.7.1 Systematic review and meta-analyses on the relevance of occupational oral exposure

Marlene Dietz[1,2], Wiebke Ella Schnieder[1,3], Urs Schlüter[1], Anke Kahl[2]

[1] Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE
[2] University of Wuppertal, Wuppertal, DE
[3] Hamm-Lippstadt University of Applied Sciences, DE

A comprehensive assessment of all contributing exposure pathways is essential for the overall protection of workers. Ingestion can also potentially contribute to the overall exposure, but the perspectives on this pathway are conflicting.

REACH guidance R.14 states that a quantitative assessment is not required. Several scientific studies suggest a contribution from oral exposure based on comparisons of the level of external dermal and inhalation exposure and biomonitoring.

Therefore, this study systematically examines documented evidence for the relevance of oral exposure in occupational contexts. Five electronic databases and nine institutional websites were searched to identify relevant publications and studies.

A total of 147 studies were identified. Of these, nine publications consider occupational oral exposure to be generally irrelevant. 123 studies consider this exposure pathway as potentially relevant and 80 studies consider it explicitly relevant. These conclusions are based on modelling or measurements in 78 and 94 cases, respectively.

Other indoor workplaces, other industrial workplaces or recycling workplaces are most frequently identified as (potentially) relevant for oral exposure. Metals, dusts and powders or pesticides are the most frequently mentioned substance groups for which occupational oral exposure is (potentially) relevant.

Thus, the database shows that oral exposure may be relevant for the assessment of total occupational exposure. There is a further need for the identification of relevant workplaces and substance groups and therefore for simpler and improved modelling and measurement approaches.

3.7.2 Exposure to pyrethroids of French children from the ELFE cohort: using physiology-based pharmacokinetic modeling (PBPK) in a refined risk assessment approach

Ophélia Gestin[1], Elisa Thépaut[1,2], Michèle Bisson[1], Brice M.R. Appenzeller[3], Linda R. Macheka[3], Paul Palazzi[3], Alba Iglesias-González[3], Cécile Zaros[4], Cleo Tebby[1], Florence Zeman[1,2]

[1] French National Institute for Industrial Environment and Risks (INERIS), Verneuil-en-Halatte, FR
[2] Université de Picardie Jules Verne, Amiens, FR
[3] Luxembourg Institute of Health, Strassen, LU
[4] INED French Institute for Demographic Studies, Aubervilliers CEDEX, FR

Pyrethroids are widely used pesticides that are suspected to affect children's neurological development. Biomonitoring of human populations is carried out, among other things, by monitoring metabolites in urine. Some metabolites, such as F-PBA, CFMP and DBCA, are specifically produced from one compound: cyfluthrin, cyhalothrin and deltamethrin respectively, while others, such as 3-PBA and DCCA, are common to several parent pyrethroids sharing similar structural properties and metabolic pathways. Not all molecules have the same toxicokinetics and/or toxicodynamics. The aim of the present work was to determine the respective contribution of several parent pyrethroids to total exposure, to refine children risk assessment in children. To this end, urinary concentrations of pyrethroid metabolites (i.e. 3-PBA, F-PBA, DCCA, DBCA and CFMP) obtained in 220 children aged 3.5 years from the ELFE cohort were computed in a physiologically-based pharmacokinetic (PBPK) model previously developed for a mixture of pyrethroids. Daily dietary intake estimated from reverse dosimetry based on a Bayesian framework was compared with toxicological reference values (TRVs) specifically developed for children. Our results show that the levels of 3-PBA measured exceeded the human biomonitoring guidance value (i.e. 3.25 µg.L-1 in urine) for 0.01 % children. In addition, daily doses predicted by the PBPK model for parent pyrethroids exceeded the TRV for neurodevelopmental effects in some of the children considered in our study. By providing a better understanding of pyrethroid toxicokinetics and the contribution of each molecule to exposure, our study has demonstrated how PBPK modelling can help refine risk assessment in sensitive populations such as children.

3.8 O8: Human biomonitoring I – Data generation

3.8.1 Development of a human biomonitoring method for assessing the exposure to 2,4,7,9-Tetramethyl-5-decyne-4,7-diol (TMDD) in the general population

Carmen Tiwald, Nadine Rögner, Gerhard Scherer, Nikola Pluym, Max Scherer

Analytisch-Biologisches Forschungslabor (ABF) GmbH, Planegg, DE

Human Biomonitoring (HBM) of emerging chemicals has received increasing attention within the EU in recent years. We developed and validated a new bioanalytical method for the exposure assessment of 2,4,7,9-Tetramethyl-5-decyne-4,7-diol (TMDD), a non-ionic surfactant used as an adjuvant in various industrial sectors. Due to its widespread use, a high prevalence in the environment is expected. As a first step, we conducted a metabolism study with 4 volunteers receiving an oral dose of 75 µg TMDD/kg body weight and a dermal dose of 750 µg/kg body weight. Using UPLC-Q-Orbitrap-MS we identified terminal methyl-hydroxylated TMDD (1-OH-TMDD) as the major urinary metabolite of TMDD, for which a targeted, quantitative LC-MS/MS method was developed and validated. Using this method, we determined the toxicokinetic parameters of 1-OH-TMDD as a biomarker of exposure following oral and dermal administration of TMDD. The results showed an effective metabolism as well as a rapid oral and substantial dermal resorption of TMDD. After oral administration, an almost complete elimination of 1-OH-TMDD was achieved after 12 h (mean t_{max} 1.7 h). As expected, excretion was delayed after dermal exposure with complete excretion occurring after approximately 48 h (mean t_{max} 12 h). Finally, the method was applied to 50 urine samples from non-occupationally exposed volunteers. The quantification rate of 1-OH-TMDD in these samples was 90 %, with an average concentration of 0.19 ng/mL (0.97 nmol/g creatinine), demonstrating that 1-OH-TMDD is a suitable biomarker of exposure to TMDD in the general population.

3.8.2 Development of an indexed score to identify the most suitable biological material to assess SARS-CoV-2

Marina Almeida-Silva[1,2], Renata Cervantes[1], Ana Marques-Ramos[1], Edna Ribeiro[1]

[1] Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
[2] OSEAN-Outermost Regions Sustainable Ecosystem for Entrepreneurship and Innovation, Funchal, PT

The rapidly contagious process that is happening with COVID-19 makes it urgent to multiply testing for SARS-CoV-2 diagnostic, to identify the active viral shedding cases and decrease the risk of transmission to other patients and health care professionals, including transmission from asymptomatic people. Although nasopharyngeal swabs (NPS) is the most common specimen type used for COVID-19 diagnosis, it requires supervision by a professional and there is a concern about exposure of healthcare staff, difficulty in collection, and discomfort of patients during collection. This study has the purpose to provide updated information about the most suitable biological material to diagnose SARS-CoV-2, considering the risk assessment, specialisation needed, test cost, complexity of the collection and sample treatment associated with the different types of specimens.

An extensive search of scientific review articles was made, to collect information about the biological specimens to identify SARS-CoV-2 which are urine, sputum, nasopharyngeal, oropharyngeal, bronchoalveolar (BLF), saliva, faeces and blood. For this purpose, an index score was developed based on seven categories: Materials and Equipment; Infection Risk for the Health Professional; Infection Risk for the Patient; Collection; Cost; Specialised HR; RNA Extraction Type – and each criterion from the index score was quoted from 1.0 to 5.0 and then a sum was made to classify which specimen is the better choice to diagnose SARS-CoV-2, according to the chosen parameters.

Blood is the only specimen that did not achieve the maximum score in any parameter and Urine, Sputum and Feaces did not reach the maximum score due to RNA Extraction Type Criteria. Among all the specimens of the respiratory system, Sputum has the highest rate according to the index score. BLF score indicates that this specimen is the worst for SARS-CoV-2 diagnosis and the score of Saliva demonstrates that it is the best specimen to perform SARS-CoV-2 diagnosis.

3.8.3 Identification of use-specific hemoglobin adduct patterns for different tobacco/nicotine product user groups by non-targeted GC-MS/MS analysis

Max Scherer, Fabian Pilz, Therese Burkhardt, Gerhard Scherer, Nikola Pluym

Analytisch-Biologisches Forschungslabor (ABF) GmbH, Planegg, DE

Tobacco smoke contains several electrophilic constituents which are capable of forming adducts with nucleophilic sites in DNA and proteins like hemoglobin (Hb) and albumin. New nicotine and tobacco products are discussed as less harmful forms of tobacco use compared to smoking combustible cigarettes due to reduced exposure to harmful constituents.

Here, we present a novel non-targeted screening strategy using GC-MS/MS for Hb adducts based on the analysis of the respective derivatised N-terminal valine adducts after Edman degradation. We analysed blood samples from a clinical study with habitual users of combustible cigarettes, electronic cigarettes, heated tobacco products, oral tobacco, nicotine replacement therapy products and non-users of any tobacco/nicotine products. Our non-targeted approach revealed significant differences in the Hb adduct profiles of the investigated tobacco/nicotine product user groups. Several Hb adduct forming chemicals could be identified: methylating and ethylating agents, ethylene oxide, acrylonitrile, acrylamide, glycidamide and 4-hydroxybenzaldehyde. Levels were elevated in smokers compared to all other groups for Hb adducts from methylating agents, ethylene oxide, acrylonitrile, acrylamide and glycidamide. Our approach revealed higher concentrations of Hb adducts formed by ethylation, acrylamide and glycidamide in users of HTP compared to non-users, however, still less for the latter two than in smokers. Due to their long half-lives, Hb adducts related to acrylonitrile, acrylamide (glycidamide), and ethylene oxide exposure may be useful for the biochemical verification of subjects' compliance in longitudinal and cross-sectional studies with respect to smoking and HTP use/abstinence.

3.8.4 Detection of the reprotoxic metabolite mono-n-hexyl phthalate (MnHexP) in urine of young children: data from the KITA-study NRW Germany

Yvonni Chovolou[1], Holger M. Koch[2], Sonja Wrobel[2], Silvia Sievering[1], Jennifer Engelmann[1], Thomas Brüning[2], Barbara Köllner[1], Martin Kraft[1]

1 North Rhine-Westphalia Office for Nature, Environment and Consumer Protection, Recklinghausen, DE
2 Ruhr-Universität Bochum, Bochum, DE

Phthalates are mainly used as plasticisers. Phthalates classified as toxic to reproduction are subject to extensive restrictions and bans in the EU resulting in a continuously decreasing exposure. To our surprise, we identified mono-n-hexyl phthalate (MnHexP) in recently collected samples, a metabolite of the highly potent phthalate di-n-hexyl phthalate (DnHexP).

The results shown here are part of the HBM survey of the state of North Rhine-Westphalia, Germany (KITA-study NRW) which investigates the exposure of children to pollutants at regular intervals of 3 years in order to identify exposure trends. MnHexP was measured in 503 spot urine specimens obtained from preschool children aged 2–6 years by isotope-dilution mass-spectrometry coupled to high performance liquid chromatography (HPLC-MS/MS). The collection took place between October 2017 – Mai 2018 (Cycle 3) and July 2020 – July 2021 (Cycle 4).

MnHexP was found in concentrations above the limit of quantification (LoQ; 0.2 µg/L) in 26 % of the samples from 2017/18 and in 61 % in 2020/21. Median MnHexP concentration was < 0.2 µg/L in 2017/18 and increased to 0.56 µg/L in 2020/21. The 95th percentile was 0.81 µg/L in 2017/18 and 8.73 µg/L in 2020/21. This corresponds to a significant increase in exposure by a factor of 10. No significant differences were found between sexes or the degree of urbanisation.

The reasons for the increasing exposure of children to MnHexP are currently unclear. The primary objective will therefore be to clarify the source of the increasing exposure to MnHexP to enable measures for its timely reduction.

3.9 O9: Exposure at school and public spaces

3.9.1 Airborne virus exposure mitigation by advancing respiratory protective equipment testing with a fluorescent tracer

Kirsten Lassing[1,2], Heiman Wertheim[1], Nayandra Verzaal[2], Henk Jan Holterman[3], Paul T. J. Scheepers[2]

[1] Radboud University Medical Center, Nijmegen, NL
[2] Radboud University, Nijmegen, NL
[3] Wageningen University & Research, Wageningen, NL

During the COVID-19 pandemic, it became clear that crowded poorly ventilated indoor environments represent a significant risk for aerogenic virus transmissions. Better understanding of the role of aerosols may lead to more effective exposure mitigation strategies. In this study we focused on respiratory protective equipment (RPE) by introducing a ‘stress test’ based on the use of a fluorescent tracer. The rationale behind this set-up is based on the droplets with a virus load that depends on the type of body fluid and characteristics of the infected host.

A medical nebuliser was used to generate inhalable water droplets with a particle size ranging from 6.5 to 14.8 µm containing 1 % fluorescein sprayed at 10 cm distance in the direction of a facemask placed on a mannequin head. We assessed the sum of filter penetration and face seal leakage by determining the recovery of the fluorescent tracer on a membrane filter placed in the mouth opening of the mannequin head.

Preliminary results reveal a 58 % higher leakage in surgical masks compared to FFP2 respirators, translating to overall efficiencies of 97 % and 98 %, respectively. Our study shows that the use of a fluorescent tracer may be considered as a new approach to test RPE for virus protection efficacy. We expect this novel approach to be further developed for quantitative assessment of RPE performance testing as well as diagnostics of face seal leakage. Moving forwards, we plan to refine and expand this concept through testing on human volunteers.

3.9.2 One Health approach in "Do It Yourself" stores to tackle fungal contamination

Marta Dias[1,2], Bianca Gomes[2,3], Pedro Pena[1,2], Renata Cervantes[1,2], Susana Viegas[1,2], Carla Viegas[1,2]

1 Universidade NOVA de Lisboa, Lisbon, PT
2 Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
3 Universidade de Lisboa, Lisbon, PT

Wood dust contamination by fungi poses health risks due to exposure by inhalation. This study aimed to assess the exposure of woodworking employees and customers to fungal load in 13 "Do It Yourself" (DIY) stores in the Lisbon metropolitan area (Portugal). An active sampling method (MAS-100 air sampler) was applied in different store areas, collecting 200 L at a flow rate of 140 L/min. Regarding the occupational exposure assessment and considering the threshold suggested by the WHO of 150 CFU.m-3, the cutting area and the wood display surpass this limit in all the stores included. As for the threshold suggested by OSHA for fungi in non-industrial workplaces (1.0 x 101-1.0 x 104 CFU/m^3), all the sampling sites from all the stores are within the limit, although indoor/outdoor ratio showed a higher indoor load compared to the outdoor counts in most of the stores. Regarding the Portuguese Indoor Air Quality legal framework, although the ratio I/O complied in two out of 13 stores, it was possible to identify in one of these two toxigenic species with a quantitative cut-off above the legal frame. The results of this assessment raise health concerns regarding workers' and customers' safety and support the need to implement measures to prevent exposure and protect workers' and customers' health. Additionally, it is known that wood dust and shavings from DIY stores may be used in animal bedding and agriculture, promoting fungal contamination in other settings. This highlights the need for a One Health approach.

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3.9.3 First insights of Portuguese primary schools' fungal assessment – is indoor air quality complying with Portuguese legal framework?

Pedro Pena[1,2], Renata Cervantes[1,2], Bianca Gomes[1,3], Marta Dias[1,2], Carla Viegas[1,2]

[1] Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
[2] Universidade NOVA de Lisboa, Lisbon, PT
[3] Universidade de Lisboa, Lisbon, PT

The assessment of Microbial Indoor Air Quality in elementary schools is essential to create healthier school environments and improve children's health outcomes. Portugal only established protection thresholds for microbial exposure, in commercial and service buildings through Portaria nº 138-G/2021 (1), leaving schools neglected for such parameters. Since this legislation has already been proven insufficient for fungal parameters (based on indoor/outdoor ratio) in other critical environments such as healthcare centers (2), this study aims to assess fungal load compliance in different sites of schools located in Lisbon area. An active sampling method was applied by collecting air through a MAS-100 device collecting 200 L at a flow rate of 100 L/min. Of the 10 schools assessed in a summer campaign, 9 did not comply with the Portuguese legal framework in at least one site (8 out of 10 in the classrooms, 5 out of 7 in the bathroom, 4 out of 9 in the canteen, 4 out of 6 in the gymnasiums, and 3 out of 8 in the library). A critical assessment was performed to identify fungal species listed in this legislation. Although one school complies with the quantitative cut-off (I/O), critical species such as Aspergillus section Circumdati (Aspergillus ochraceus), and Aspergillus section Fumigati (Aspergillus fumigatus) present in this school do not meet the toxigenic species quantitative cut-off. The risk of exposure to pathogenic fungi poses a major public health threat for school-age children impacting not only treatable fungal infections but also students' learning conditions and outcomes (3).

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3.9.4 Assessing the impact of climate change on indoor fungal contamination in Lisbon metropolitan area primary schools: a comprehensive study

Renata Cervantes[1,2], Pedro Pena[1,2], Marta Dias[1,2], Bianca Gomes[1,3], Carla Viegas[1,2]

[1] Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
[2] Universidade NOVA de Lisboa, Lisbon, PT
[3] Universidade de Lisboa, Lisbon, PT

The occurrence of severe weather events caused by global climate change raises concerns about indoor fungi [1,2], which can potentially alter fungal communities and intensify mycotoxin production, posing a health risk [3]. In educational settings, inadequate ventilation and high moisture levels amplify indoor fungal growth and mycotoxin contamination, contributing to respiratory illnesses and allergic reactions in children and school staff [4,5,6]. Our research explores the relationship between climate change and fungal diseases, focusing on temperature and moisture as drivers of exposure, specifically in primary schools in the Lisbon metropolitan area. A comprehensive investigation was carried out to examine the presence of contamination, in schools. This involved using both passive sampling techniques and collecting materials from the institutions, true air samples with MAS-100, for 400 l at 200 l/min, and with Anderson six-stage, for 200 l at 28.3 l/min, and samples of mops and surface swabs, as well as samples of settled dust through vacuuming and EDC. The samples will be analysed by culture-based methods, through the inoculation onto two different culture media: malt extract agar (MEA) supplemented with chloramphenicol (0.05 %) incubated at 27 ºC and dichloran-glycerol agar (DG18), incubated at 27 ºC and 37 ºC for 6 days. We will also be preforming molecular detection of the selected fungal sections (Aspergillus sections Circumdati, Flavi, Fumigati and Nidulantes). The purpose of sharing the findings is to offer insights, into the practice of actively sampling air. This aims to support the development of risk management strategies that protect both students and individuals from the increasing risks associated with fungi.

3.10 O10: Workplace exposure

3.10.1 From generic REACH information to concrete protective measures at the workplace

Melanie Berghaus

Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE

People responsible for safety and health in enterprises receive information via (extended) Safety Data Sheets (SDS), which might include exposure scenarios. They use this as a basis for a risk assessment according to OSH-legislation. However, this information is generic and it can be quite challenging to adapt the parameters to a real workplace. This is especially true for small and medium sized enterprises.

In Germany, the Hazardous Substance Ordinance (GefStoffV) transposes the Chemical Agents Directive (CAD) to national law. How to use REACH-Information for a risk assessment is further concretised in the Recommendation on Hazardous Substances (EmpfGS) 409. Furthermore, the EMKG Workplace & Chemicals is a control banding tool designed by BAuA to help especially small and medium sized enterprises to fulfil the requirements of the GefStoffV regarding the risk assessment with hazardous substances. It starts with simple parameters from the SDS and on-site visits of the actual workplace. It is based on the guidance to the CAD. The results are concrete protective measures described in control guidance sheets. They also reflect the tiered approach of the CAD and the GefStoffV. In research projects such as F2440 MapS – Measures for Control Guidance Sheets or investigations on the dissemination channels of the multipliers of the EMKG Workplace & Chemicals we aim to adapt this guidance even more to the needs of the users. This presentation is supposed to point out what people responsible for safety and health need to use information from the SDS successfully for their workplace risk assessment.

3.10.2 Advancing agricultural safety: comprehensive analysis of closed transfer systems in reducing operator and environmental exposure in Europe

Juan Sasturain[1], Christian Küster[2], Tirso Oteyza[3], Udo Blaschke[1], Michal Kicinski[4]

[1] BASF SE, Limburgerhof, DE
[2] Bayer AG, DE
[3] Syngenta Crop Protection AG
[4] CropLife Europe

Our research examines the effectiveness of three Closed Transfer Systems (CTS) types in mitigating operator exposure to plant protection products during mixing and loading, and the impact on environmental exposure reduction.

In the operator exposure study, data for gloves, hands, head, inner, and outer body were collected across four European countries, involving 12 operators and using different products to cover a broad range of European practices. This data was compared against the benchmarks set by the Agricultural Operator Exposure Model (AOEM), referencing EFSA Guidance for open pour loading. Additionally, we conducted separate studies comparing traditional sprayer filling methods with CTS, focusing on their impact on ground exposure and container rinsing.

All three CTS types demonstrated a substantial reduction in operator exposure. The tested inverted systems (easyFlow M, easyconnect) provided similar levels of protection, allowing for data amalgamation, and showed more than 95 % reduction in both potential and actual exposure. GoatThroat®, while slightly less effective, still offered significant protection of > 70 % exposure reduction. The environmental study further revealed that CTS use drastically reduces exposure potential to the ground and improves container rinsing compared to traditional methods.

The integration of CTS in European agricultural practices significantly diminishes both operator and environmental exposure to PPPs. The GLP report of the operator exposure study, containing all relevant raw data, has been submitted to EFSA for an independent evaluation. The dual focus on operator safety and environmental protection is a crucial step forward in sustainable agriculture, fostering safer pesticide handling and bolstering farmer confidence.

3.10.3 Occupational inhalation exposure during surface disinfection – exposure assessment based on exposure models compared with measurement data

Lea Anhäuser[1], Benedikt Piorr[2], Mario Arnone[3], Wolfgang Wegscheider[1], Johannes Gerding[1]

[1] German Social Accident Insurance Institution for the Health and Welfare Services (BGW), Cologne, DE
[2] Federal Institute for Occupational Safety and Health (BAuA), Dortmund, De
[3] German Social Accident Insurance (DGUV), Sankt Augustin, DE

For healthcare workers, surface disinfections are daily routine tasks. An assessment of the inhalation exposure to hazardous substances, in this case the disinfectant's active ingredients, is necessary to ensure workers safety. However, deciding which exposure model is best for exposure assessment remains difficult.

The aim of the study was to evaluate the applicability of different exposure models for disinfection of small surfaces in healthcare settings.

Measurements of the air concentration of active ingredients in disinfectants (ethanol, formaldehyde, glutaraldehyde, hydrogen peroxide, peroxyacetic acid) together with other exposure parameters were recorded in a test chamber. The measurements were performed using personal and stationary air sampling. In addition, exposure modelling was performed using three deterministic models (unsteady 1-zone, ConsExpo and 2-component) and one modifying-factor model (Stoffenmanager®). Their estimates were compared with the measured values using various methods to assess model quality (like accuracy and level of conservatism).

The deterministic models showed overestimation predominantly in the range of two- to fivefold relative to the measured data and high conservatism for all active ingredients of disinfectants with the exception of ethanol. With Stoffenmanager® an exposure distribution was estimated for ethanol, which was in good accordance with the measured data.

The three deterministic models and Stoffenmanager® have provided good to acceptable estimates for the defined specific exposure scenario and seem suitable for the assessment of inhalation exposure during surface disinfection.

Reference:

L. Anhäuser, B. Piorr, M. Arnone, W. Wegscheider, J. Gerding, Occupational inhalation exposure during surface disinfection – exposure assessment based on exposure models compared with measurement data, J. Exposure Sci. Environ. Epidemiol., provisionally accepted manuscript.

3.10.4 Operator safety – assessing operator exposure during drone application of pesticides

Maxie Kohler[1], Thomas Anft[1], Lirong Chen[1], Christian Timmermann[1], Georg Hamacher[2], Edgars Felkers[1], Christian Küster[1]

[1] Bayer AG, Monheim, DE
[2] AGREXIS AG, Basel, CH

Drones gain increasing relevance in pesticide applications and their use is expected to improve operator safety significantly, especially when they are used as a replacement for hand-held applications.

An operator exposure study was performed in accordance with OECD guidance No. 9 [1,2] to allow for drone-specific exposure assessment. A tracer dye (food colorant, Brilliant Blue) was applied to an 8 ha paddy rice field (representing ½ working day) with drones (DJI MG-1S and –1P, 10 L tank, 20 L/ha). Two persons (1 pilot, 1 mixing, loading, cleaning) operated the drone and samples (12 replicates; inner and outer dosimeters, gloves, face and neck wipes, hand washes) were analysed using a validated LC-MS/MS method.

The results show that the major part of the exposure occurs during mixing and loading while exposure of the pilot is significantly lower. For mixing and loading, exposure was reduced by > 98 % wearing one layer of clothes and gloves. Comparison of the drone study data of the pilot with the handheld application exposure models showed that the exposure of the applicator is reduced by 90–99 % when spraying by drones. These results and additional study data for refinement of the distribution of exposure during mixing and loading and will serve as a basis for model development regarding operator exposure from drone applications around the world [3].

[1] Guidance Document No. 9, OECD/GD (97)148
[2] Kuster JK et.al., Pesticide exposure of operators from drone application, ACS Agric Sci Technol 2023, doi.org/10.1021/acsagscitech.3c00253
[3] Bayer Operator Safety Standard, March 2021: www.bayer.com/sites/default/files/210323_Bayer-Operator_Safety_Standard-FINAL_2.pdf

3.11 O11: Human biomonitoring II – Data generation

3.11.1 Regulatory implementation of mixture risk assessment using human biomonitoring data

Jacob van Klaveren[1], Anne Zwartsen[1], Amélie Crépet[2]

[1] National Institute for Public Health and the Environment (RIVM), Bilthoven, NL
[2] Agency for Food, Environmental and Occupational Health & Safety (ANSES), Maisons-Alfort Cedex, FR

There is growing societal and political concern about the risk of combined exposure to multiple chemicals. To characterise the total risk, mixture risk assessment should be performed instead of substance-by-substance assessments which may consequently underestimate the risk. The European Commission and 27 Member States are funding the Partnership for the Assessment of Risks from Chemicals (PARC; https://www.eu-parc.eu/) which aims to develop next-generation chemical risk assessment to protect human health and the environment. The partnership will develop a FAIR model platform able to perform e.g. exposure assessments and run kinetic models, and train interested parties on how to use this PARC model toolbox. The PARC project Real-life mixtures specifically aims to support regulatory risk assessment by providing methods, models and approaches for human risk assessment of mixtures using data from human biomonitoring (HBM) studies. Thirty-five institutes from 18 Member States are joining forces to improve mixture risk assessment using HBM data by sharing exposure data and uploading data into the Monte Carlo Risk Assessment (MCRA) toolbox.

A process of harmonising the data from these partner studies is initiated. Hazard data (including grouping into effect and toxicokinetic information) are being collected and organised. In 2023–2024, statistical analysis (such as mixture identification) will be performed in a harmonised way using the MCRA toolbox. Analysis is first carried out on prioritised chemical families (e.g. pesticides, heavy metals and per- and polyfluoroalkyl substances) associated with specific health effects of concern (e.g. neurotoxicity, nephrotoxicity and/or immunotoxicity). Training materials will become available for stakeholders.

3.11.2 Paradigm shift in chemical risk assessment: NAMs and the changing landscape of exposure data collection

Nancy Hopf[1], Maryam Zare Jeddi[2], Peter Bos[3], Karen S. Galea[4], Eva Govarts[5], Hubert Dirven[6], Karine Audouze[7], Michael Bader[8], Gerald Bachler[9], Robert Pasanen-Kase[10], Radu Duca[11], Imran Ali[12], Susana Viegas[13], Tiina Santonen[14]

[1] University of Lausanne, Lausanne, CH
[2] Life science intelligence consulting, NL
[3] National Institute for Public Health and the Environment (RIVM), Bilthoven, NL
[4] Institute of Occupational Medicine (IOM), UK
[5] VITO Health N.V., BE
[6] Norwegian Institute of Public Health, Oslo, NO
[7] Université Paris Cité, FR
[8] BASF SE, DE
[9] DuPont de Nemours (Belgium) BV, BE
[10] State Secretariat for Economic Affairs SECO, CH
[11] National Health Laboratory (LNS), Dudelange, LU
[12] KEMI- Swedish Chemicals Agency, SE
[13] NOVA National School of Public Health, Lisbon, PT
[14] FIOH- Finnish Institute of Occupational Health, FI

Implementing New Approach Methodologies (NAMs) in exposure science is a paradigm shift moving from integrating traditional animal-based models to innovative methods. We investigated the progressive integration of NAMs such as high-throughput screening, omics, and artificial intelligence in exposure science to understand how these would enhance relevance, accuracy, and comprehensiveness in environmental and occupational exposure assessments. We demonstrate the application of NAMs and adverse outcome pathways (AOP) in exposure assessments within the Next-Generation Risk Assessment (NGRA) framework. This integration fits within existing legal structures and extends beyond because it also provides comprehensive internal exposure data. A key aspect of this shift is the incorporation of human biomonitoring (HBM) within NAMs, bridging the gap between external and internal exposure data. HBM data respecting the FAIR principles (Findable, Accessible, Interoperable and Reusable) refine existing risk assessments by using human exposure data. To leverage HBM effectively across a chemical's life cycle, a suite of tools and methodologies is required. These include advanced analytical techniques for detecting low exposures, data integration platforms for correlating external exposure with internal biomarkers, and modelling tools for extrapolating HBM data to broader populations. This integration is needed to aligning exposure data with biological responses offering a deeper understanding of health risks and thereby assuring safe and sustainable across their entire life cycle. At the upcoming ISES Europe workshop in Berlin 2024, our subgroup dedicated to NAMs will present our initial framework seeking valuable insights and feedback from the scientific community.

3.11.3 Minimum information requirements for Human Biomonitoring (HBM) in environmental health studies

Maryam Zare Jeddi[1,2], Karen S. Galea[3], Nancy Hopf[4], Susana Viegas[5], Tiina Santonen[6], Ruben Peeters[7], Eva Govarts[7], Jos Bessems[7], Vicente Mustieles[8], Mariana F. Fernandez[8], Hubert Dirven[9], Henriqueta Louro[10], Manosij Ghosh[11], Robert Pasanen-Kase[12], Andre Conrad[13], An van Nieuwenhuyse[14], Radu Duca[14], Paul Scheepers[15], Ovnair Sepai[16], Imran Ali[17], Maria Dusinska[18], Alena Bartonova[18], Ana Virgolino[19], Giovanna Tranfo[20], Carla Costa[21], Karine Audouze[22], Michael Bader[23], Alison Colony[24], Kyriaki Machera[25], Barbara Magagna[26], Judy LaKind[27], Shoji Nakayama[28], Tyler Pollock[29], Devika Poddalgoda[29], Joao Paulo Teixeira[30], Eva Kumar[31], Sebastien Denys[32], Loïc Rambaud[32], Clémence Fillol[32], Arthur David[33], Holger M. Koch[34], Kate Jones[35]

1 Life Science intelligence consulting, NL
2 ISES Europe HBM working group, NL
3 Institute of Occupational Medicine (IOM), Edinburgh, UK
4 University of Lausanne, Lausanne, CH
5 NOVA National School of Public Health, Lisbon, PT
6 Finnish Institute of Occupational Health, Helsinki, FI
7 VITO Health, Flemish Institute for Technologcal Research (VITO), Mol, BE
8 University of Granada, ES
9 Norwegian Institute of Public Health, Oslo, NO
10 National Institute of Health Dr. Ricardo Jorge, Lisbon, PT and Universidade NOVA de Lisboa, Lisbon, PT
11 Environment and Health, Leuven, BE
12 State Secretariat for Economic Affairs SECO, CH
13 German Environment Agency (Umweltbundesamt), Dessau-Roßlau/Berlin, DE
14 National Health Laboratory (LNS), Dudelange, LU
15 Radboud University, Nijmegen, NL
16 UK Health Security Agency, UK
17 KEMI- Swedish Chemicals Agency, SE
18 The Climate and Environmental Research Institute NILU, NO
19 Universidade de Lisboa, Lisboa, PT
20 Italian Institute against accidents at work (INAIL), IT
21 National Institute of Health Dr. Ricardo Jorge, Porto, PT and Universidade do Porto, Porto, PT
22 Université Paris Cité, Paris, FR
23 BASF SE, DE
24 University College Dublin, IE
25 Benaki Phytopathological Institute, Athens, GR
26 GO FAIR Foundation, Leiden, NL
27 LaKind Associates, LLC, US
28 National Institute for Environmental Studies, JP
29 Health Canada, Ottawa, CA
30 National Institute of Health, PT
31 Finnish Institute for Health and Welfare, Kuopio, FI
32 Santé Publique France, Saint-Maurice Cedex, FR
33 Univ Rennes, Inserm, EHESP, Irset (Institut de Recherche en Santé, Environnement et Travail), FR
34 Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Institute of the Ruhr University Bochum (IPA), DE
35 HSE - Health and Safety Executive, Harpur Hill, UK

Human biomonitoring (HBM) is used as valuable approach in environmental health studies, to determine human exposure to chemicals and potentially associated (early) health effects. Despite the wealth of data generated over the last decades, the reusability of this information is currently limited and time-consuming to process, primarily due to the lack of standardised guidelines, data and metadata harmonisation. Reusability and comparability not only depend on standardised sampling, analysis and data preparation methods but also on well-defined metadata concepts to describe the contextual data related to the dataset. Only this can facilitate interoperability, integrative and interdisciplinary analysis of the different datasets.

The ISES Europe HBM working group is developing minimum information requirement guidelines, and guidance on study evaluation for reporting for both general population and occupational HBM studies. This initiative provides a community-agreed FAIR (Findable Accessible, Interoperable, Reusable) metadata schema enriched by controlled vocabularies as an essential part of the FAIR Environmental Health Registry (FAIREHR) development. Along with unique and persistent identifiers, metadata collection and storage formats are the cornerstone of the FAIR principles, guiding scientific data management and stewardship. Minimum information requirements are sets of guidelines specifications that define the structure of the minimum metadata attributes in terms of semantics, syntax and optionality to support harmonisation, findability and reusability of HBM datasets across the dedicated scientific communities. A metadata template allows an investigator to describe all the “data about the data” needed to understand the nature of a study, its motivation, and how the study was executed. Furthermore, it can assist in assessing and ensuring the accuracy and reliability of data. FAIREHR ensures that generated HBM data and metadata are compatible with existing data repositories such as IPCHEM and the Monte Carlo Risk Assessment (MCRA) platform to allow using HBM data in risk assessment process.

In this work ISES Europe HBM working group is collaborating with several organisations and initiatives such as the Partnership for the Assessment of Risks form Chemicals (PARC).

Our subgroup dedicated to FAIREHR development will present its preliminary set of minimum information requirement for HBM studies, seeking valuable feedback from workshop delegates to push the state of the art in scientific data dissemination, and ensuring generation of high quality HBM data.

3.11.4 Towards FAIR human biomonitoring (HBM) data: development of a tool to enhance HBM data harmonisation

Ruben Peeters, Fen Zhang, Hanny Willems, Laura Rodriguez Martin, Liese Gilles, Jan Theunis, Jos Bessems, Caio Mescouto Terra de Souza, Dirk Devriendt, Eva Govarts

VITO Health, Flemish Institute for Technological Research (VITO), Mol, BE

Background

Harmonisation and aggregation of heterogeneous data in Human Biomonitoring (HBM) studies is critical to enhance conclusion validation and move towards FAIR (i.e., Findable, Accessible, Interoperable, Reusable) data.

Objective

We aimed to introduce an HBM tool with the goals of (1) optimising harmonisation, and enabling future FAIRification, (2) using flexible templating, (3) ensuring data integrity, (4) facilitating the creation of derived variables and (5) conducting summary statistics, while ensuring data confidentiality.

Method

Excel files were used to configure templates, aligning with standards and formats as specified under the HBM4EU (hbm4eu.eu) and the PARC (eu-parc.eu) projects. A Python package was used to interpret the templates, making validation and transformation possible. Pyodide and WebAssembly were used to ensure data confidentiality and availability through a web interface.

Results

A tool was created and made available for stakeholders (https://hbm.vito.be/tools). The tool allows harmonised data storage in the Personal Exposure and Health (PEH)data platform. Standards were defined and relevant HBM data was validated, before uploading to the platform or for further use. Moreover, the formatted and validated HBM data were compatible with the Monte Carlo Risk Assessment (MCRA) platform to allow using HBM data in the context of risk assessment. The tool also allows users to calculate derived variables (e.g., imputed censored data, standardisation) and conduct summary statistics (e.g., geometric mean, percentiles) for visualisation in the European HBM dashboard.

Conclusion

The current tool proves effective in advancing data quality, harmonisation, and aggregation in HBM studies. With local execution, user-friendly codebooks, and standardised schemas, it supports a unified framework that enables consistent analysis and interpretation across diverse studies and datasets.

3.12 O12: Steps forward to reach informed aggregated exposure assessments

3.12.1 Aggregate exposure assessment for PFAS using environmental data and human biomonitoring

Arno Vanderbeke, Mirja Van Holderbeke, Kaatje Touchant, Katleen De Brouwere, Ann Colles

VITO Health, Flemish Institute for Technological Research (VITO), Mol, BE

A 2019 PFAS action plan in Flanders accelerated when ground works revealed per- and polyfluoroalkyl substances (PFAS) contamination in soil around the 3M plant in Zwijndrecht, Belgium. A human biomonitoring study was started where the goal was to investigate to what extent adolescents (n = 303, 12–17 y) were exposed to PFAS, map the routes of exposure and how this was related to their health. Participants were recruited from the area within 5 km from the 3M plant. Blood and environmental samples from their living environment were collected. 21 PFAS compounds were measured in all the blood samples, as well as in the environmental samples. The different types of environmental samples were soil, compost, rainwater, vegetables, fruit, nuts and eggs. House dust samples were collected as well. Our approach to modelling human exposure is twofold, first the aggregated external exposure is modelled, after which this modelled external exposure is used to model the internal exposure. The focus is on the oral exposure route, as this route in general is the dominant exposure route for PFAS. For the exposure modelling we focused on the six compounds that were > LOQ in ≥ 60 % of the serum samples: PFOSt, PFOAt, PFNA, PFHxSt, PFBA and PFDA. External aggregate exposure modelling revealed local eggs as a major source of PFOS and PFOA, and local vegetables as a major source for PFHxS, PFBA and PFDA. Despite high concentrations in house dust, the contribution to the total oral exposure was limited due to low intake in this age group.

3.12.2 Aggregate consumer exposure assessment – enhancements of the PACEM tool

Christiaan Delmaar, Jordi Minnema, Roel Schreurs, Bas Bokkers, Bas Zoutendijk

National Institute for Public Health and the Environment (RIVM), Bilthoven, NL

Chemicals may be released from multiple sources and expose humans in a population via different pathways and routes. To assess the potential impact on human health from the exposure to such a chemical the total, or aggregate, exposure needs to be determined. Determining this exposure requires careful consideration of how exposures from different sources should be combined. To support aggregate exposure assessment, a tiered approach was proposed.

For the special case of exposure to a chemical substance via multiple consumer products, the freely available Probabilistic Aggregate Consumer Exposure Model (PACEM) was developed. PACEM combines survey information on product usage with realistic representations of product composition to estimate aggregate exposure at an individual level in the population that arises from the combined use of multiple products. Recently, PACEM has been extended with new functionalities including enhanced probabilistic modelling and a novel method to assess the contribution of specific products to the population exposure. This allows for better risk management by evaluating the impact of lowering acceptable levels of substances in specific products.

In addition, a method was developed to facilitate integration of PACEM with other exposure data and support the use of the tiered approach in the aggregation of exposure from consumer products with additional sources such as dietary, occupational and environmental exposure data or models. This integration method was implemented and used first to establish a tighter integration with the consumer exposure assessment tool ConsExpo to assess the exposure via products not included in PACEM.

3.12.3 Dietary and non-dietary external exposure versus aggregated internal exposure: results from the SPRINT project

Daniel Figueiredo[1], Hans Mol[2], Anke Huss[1], Neus González[4], Nina Wieland[3], Nicoleta Suciu[5], Marco Trevisan[5], Paul Scheepers[3]

[1] Utrecht University, Utrecht, NL
[2] Wageningen Food Safety Research, Wageningen, NL
[3] Radboud University, Nijmegen, NL
[4] Universitat Rovira i Virgili, Reus, ES
[5] Università Cattolica del Sacro Cuore, Milan, IT

Individuals are frequently exposed to pesticides via different routes, which can have an impact on human health, hence there is a growing need for aggregated pesticide exposure estimates across the population.

553 participants were recruited across 10 European countries. For 54 pesticides, which metabolites were measured in urine, we calculated dietary exposure using EU monitoring data, food frequency questionnaires and processing factors. Non-dietary exposure (inhalation, dermal and dust ingestion) was estimated using available models and by monitoring data through silicone wristbands. Contribution of each exposure route was calculated. Combined external exposure was compared with aggregated internal exposure through measurement of urinary biomarkers. For this, we built multivariable models for pesticides for which > 30 % of values were above the limit of quantification (N = 14).

For 40 % of the pesticides, dietary exposure was the sole (or primary) contributor for total exposure. However, for some pesticides, like boscalid and glyphosate, route contribution varied among participants, with inhalation and/or dermal contributing more than diet. For 6 out of 14 pesticides, we observed that dietary exposure was a statistically significant predictor for variability in urinary excretion concentrations of (metabolites of) chlorpyrifos-methyl, boscalid, glyphosate, AMPA and tebuconazole. Wristband concentrations also turned out to be significant predictors for chlorpyrifos-methyl, tebuconazole, 2,4D and MCPA.

Our results emphasise that for several pesticides the environmental exposure route should be considered in aggregate exposure assessment. Current dietary and non-dietary models need improvement, especially regarding the quality of input parameters, such as the factors for food preparation and processing.

3.12.4 Aggregate exposure to parabens in personal care products and toys

Femke Affourtit, Jordi Minnema, Walter Brand, Bas Bokkers, Susan Wijnhoven

National Institute for Public Health and the Environment (RIVM), Bilthoven, NL

Parabens are a type of preservative. In Europe, four parabens have been approved for use in personal care products and fingerpaint. Use of a single product containing these parabens poses no health risk. However, using more than one product containing parabens leads to higher exposure levels. RIVM calculated the aggregate exposure to parabens for both adults and children after using different products.

Measurement data of parabens in various personal care products and toys from the Netherlands Food and Consumer Product Safety Authority (NVWA) are used as a basis for the calculations. For exposure calculations, exposure models PACEM and ConsExpo are used. Preferably PACEM is used because this model provides a more realistic exposure estimate. However, for several products, subpopulations (children) and exposure scenarios, use surveys are not available or not implemented in PACEM. In such cases ConsExpo is applied to derive an exposure estimate. In certain cases, also exposure calculations through ConsExpo are not possible, and additional methods are used.

The results of both models and additional calculations differ in their level of conservatism and may not be directly comparable. Comparisons of the parabens exposures associated with each source are made as far as reasonably possible. Keeping these considerations in mind, the aggregate exposure was estimated and compared among the four parabens.

4 Abstracts – parallel poster presentations

4.1 P1: Food and dietary exposure and other exposure related topics

4.1.1 A reference library for suspect screening of environmental toxicants using nontargeted ion mobility spectrometry-mass spectrometry analyses

Devin Teri[1], Noor A. Aly[1], James N. Dodds[2], Alexandra C. Cordova[1], Erin S. Baker[1,2], Ivan Rusyn[1]

[1] Texas A&M University, Texas, US
[2] University of North Carolina, Chapel Hill, US

Exposure assessment traditionally relies on time-intensive extraction and analytical methods to evaluate < 40 chemicals, which is infeasible for mixture analyses. Ion mobility spectrometry-mass spectrometry (IMS-MS) is a rapid post-ionisation separation technique, applicable to targeted and non-target analyses of chemicals and mixtures. IMS-MS separates compounds based on mass-to-charge ratio (m/z) and size specific drift time (DT), enabling the calculation of collisional cross section (CCS) values crucial for molecular and isomeric distinctions in complex samples. In this project, we utilised 4,000+ diverse chemicals from the ToxCast Program to establish a comprehensive CCS database for future IMS-MS-enabled exposomic studies. Classified into 13 categories, chemicals were prepared at 10 µM in a 50:50 water/methanol solution and analysed via IMS-MS using electrospray ionisation (ESI, positive and negative modes) and atmospheric pressure chemical ionisation (APCI, positive mode). The Agilent IM-MS Browser was then used to calculate CCS values followed by manual verification of each ion envelop across all detected compounds. Approximately 50 % of all ToxCast compounds were detected in at least one of the ionisation modes, with CCS reproducibility within +/-1 % $Å^2$. Of the 50 % of chemicals detected, ~65 % were detected with ESI+, ~60 % with ESI-, and ~35 % with APCI+. Approximately 25 % of the tested compounds were exclusively detected in ESI+, 30 % in ESI-, and 5 % in APCI+. These numbers showcase the need for diverse ionisation modes in suspect screening. In summary, this database will be a pivotal tool for high-throughput suspect screening of environmental contaminants, enabling rapid exposure and risk assessments of complex environmental samples.

4.1.2 Naturally occuring radionuclides in food: participation in Germany's first total diet study (BfR MEAL Study)

Michaela Achatz[1], Peggy Hofmann[1], Anna Kolbaum[2], Irmela Sarvan[2], Oliver Lindtner[2]

[1] Bundesamt für Strahlenschutz (BfS), Berlin, DE
[2] German Federal Institute for Risk Assessment (BfR), Berlin, DE

Total Diet Studies (TDS) are used to determine concentrations of nutrients and pollutants in the diet. Headed by the Federal Institute for Risk Assessment, the first German TDS started as "BfR MEAL Study" in 2015. Foods were systematically and representatively prepared in a ready-to-eat-state and analysed for different substance groups. The Federal Office for Radiation Protection (BfS) participated in this study by determining the specific activity of naturally occurring radionuclides (uranium-234/238, radium-226/-228 and lead-210) and a resulting dose assessment.

To determine these radionuclides, the BfS received a total of 206 MEAL samples, 2 kg each, from the BfR, which mainly included the 9 food groups grains, vegetables, fruits, nuts/legumes, milk products, fish, meat and eggs, sweets and baby food. The samples were dried, combusted and solubilised by using microwave digestion. After digestion, chemical separation was made prior to the measurement of the alpha or beta radiation of the corresponding radionuclides and/or their daughter nuclides.

Overall up to 204 meal samples were analysed. The specific activities in the food groups vary and depend on the radionuclide. Ra-226 and Ra-228 are relevant for dose contribution in all food groups, Pb-210 in some foods, whereas U-234 and U-238 play a minor role. Additionally, some individual foods were identified that showed higher activity levels.

From these results, it is possible to estimate the annual intake through food for the population in Germany and to identify foods that cause a higher dose contribution than previously assumed. A risk assessment for food can be derived.

4.1.3 Results of the first German total diet study – levels of acrylamide in typically consumed foods

Sara Perestrelo, Oliver Lindtner, Matthias Greiner, Irmela Sarvan

German Federal Institute for Risk Assessment (BfR), Berlin, DE

Acrylamide (AA) is a process contaminant formed when foods containing asparagine and reducing sugars are prepared at high temperatures. In the first German Total Diet Study, 230 foods were analysed on AA. Total Diet Studies are a design to generate occurrence data of foods in pooled samples, for later exposure assessment. The highest levels of AA were found in vegetable crisps, followed by potato patties and pan-fried potatoes. Other potato-based products such as "Bauernfrühstück" (omelette with bacon and potatoes), potato crisps, sweet potato fries and oven crisps also showed high levels of AA. Surprisingly, coffee contained low levels of AA, with instant coffee having the highest levels of AA amongst coffee samples. Different browning degrees of the foods and various cooking methods were tested in some foods. French fries cooked to a browning degree of 3 in all cooking methods contained AA levels above the benchmark set by the European Union. Lowest levels of AA were observed in French fries prepared in the oven and in sweet potatoes prepared in the air fryer. Other foods such as popcorn, salty sticks and dark chocolate were also relevant in their AA content. Levels of AA found in our study can support future dietary exposure and food safety assessments.

4.1.4 Climate change impact on chemicals and toxins exposure

Susana Viegas[1,2]

[1] Universidade NOVA de Lisboa, Lisbon, PT
[2] Comprehensive Health Research Center (CHRC), Lisbon, PT

Climate change (CC) and the consequent changes of the environmental conditions bring several challenges to public health such as identifying the possible changes on the human exposure patterns to chemicals and toxins.

An extensive search was performed to identify scientific papers available in Pubmed discussing the influence that CC have in the human exposure to chemicals and toxins. The general search was done using the following key-words in combination: chemicals, toxins, biotoxins, CC and human exposure. The filters used in Pubmed were i) papers published between 2013 and December 2023; ii) only articles written in English; and iii) only full texts.

53 781 papers were found with an increase of 1.5 times between the 1st year (2013) and the last year (2023). A more refined search was done aiming to focus on specific groups of chemicals and toxins such as metals, biotoxins, mycotoxins, pesticides, ozone and particulate matter with metals presenting the higher number of results followed by particulate matter and pesticides.

There is a growing awareness on the CC impacts on chemicals and toxins exposure. However, there is still a need for extensive research to unveil relevant aspects such as the influence on contaminant behaviour in the different environmental compartments and toxicity due to the altered distribution and degradation that results in differences in the human exposure pattern. In this context, exposure science will play an important role providing relevant information on CC direct and indirect effects, such as the changing exposure pattern to chemicals and toxins.

Reference:

Susana Viegas; Exposure Science in a Climate Change Scenario. Port J Public Health 25 April 2022; 40 (1): 1–2. https://doi.org/10.1159/000522593

4.2 P2: Innovative technologies and monitoring

4.2.1 How to get away with monitoring: lessons learned from conceptualisation and construction of a low-cost device for monitoring particulate matter

Giacomo Fanti[1], Francesca Borghi[2], Emanuele Cauda[3], Cody Wolfe[3], Justin Patts[3], Carlo Dossi[4], Andrea Cattaneo[1], Andrea Spinazzè[1], Domenico M. Cavallo[1]

[1] University of Insubria, Como, IT
[2] University of Bologna, Bologna, IT
[3] National Institute for Occupational Safety and Health, Pittsburgh, US
[4] University of Insubria, Varese, IT

Introduction

The aim of this presentation is to discuss the process of the conceptualisation, implementation, and testing of a low-cost (about €120) portable monitoring device for airborne fine particulate matter (PM2.5), based on miniaturised sensors and components.

Methodology

The hardware and software of the sensor device (called “P.ALP” – Ph.D. Air quality Low-cost Project) will be briefly presented. The devices were tested using a calm air aerosol chamber under several exposure conditions, to assess the precision and the accuracy of the prototype.

Results

A monitoring device for PM2.5, based on low-cost sensors and technologies was successfully conceptualised, designed, implemented, and tested. The findings show that the P.ALP can follow the concentration profiles with reasonable accuracy but the performance needs to be improved through calibration factors. Further tests and analyses are in progress to elucidate the P.ALP’s performances even in different exposure scenarios in real environments.

Conclusions

The P.ALP monitoring system was designed and developed to be a simple device, which can be further customised and implemented using the wide range of low-cost sensors available on the market. The P.ALP can be involved and adapted to a wide range of applications because of the inexpensive nature of the components, the small dimensions, and the high data storage capacity. Thanks to a very low cost per unit, P.ALP can be improved and adopted in a very wide range of applications and study designs. Some of the main benefits of the P.ALP are the reduced form factor, the low power consumption, and cost.

4.2.2 Human and farm animal exposure to pesticides – silicone wristbands to study non-dietary routes of exposure

Daniel Figueiredo[1], Hans Mol[2], Anke Huss[1], Martien Graumans[3], Hongyu Mu[4], Rima Osman[4], Paul Scheepers[3]

[1] Utrecht University, Utrecht, NL
[2] Wageningen Food Safety Research, Wagening, NL
[3] Radboud University, Nijmegen, NL
[4] Wageningen University & Research, Wagening, NL

Silicone wristbands have emerged as a suitable passive sampler for evaluating exposures. Until now they have been deployed to assess a limited number of pesticides across some species.

We measured 177 pesticides in wristbands worn by 715 humans, 152 farm-animals (including 21 farm cats), across 10 countries in Europe and Argentina, in close proximity to both conventional and organic farming activities. Analyses were done via LC-MS/MS. For humans, we collected information on possible exposure determinants, such as frequency of house cleaning and use of pesticides. Multivariable models were used to study determinants of wristband concentrations.

We detected 171 out of the 177 pesticides. A mixture of fludioxonil, boscalid, fipronil, azoxystrobin and piperonyl butoxide was detected in 30 % of the human wristbands. In animals, pendimethalin paired with piperonyl butoxide in > 30 %wristbands. The average concentrations ranged from 0.5 to 117 ng/g in humans and 0.2 to 487 ng/g in farm-animals and cats. Concentrations in wristbands worn from participants living close to conventional farms were higher in comparison to those living close to organic farms. Having pets increased significantly the fipronil concentrations. For other pesticides, reporting spraying or working in agricultural sector turned out to be the main predictors of elevated concentrations.

Wristbands proved to be a good proxy for environmental exposure assessment. Multiple pesticides were captured in both wristbands worn by humans and animals, which allowed to look at exposure contrasts within and between species. In future studies, wristbands can be used to prioritise in internal exposure studies (human biomonitoring).

4.2.3 Establishing and sustaining a real-time indoor sensing network to evaluate indoor air pollutant exposure in Dublin, Ireland’s school pilots programme

Jiayao Chen, Francesco Pilla

University College Dublin, Dublin, IE

The World Health Organization indicated both outdoor and indoor exposure to air pollutants pose adverse health effects on human health. People spend over 90 % of their time indoors, and the significance of indoor exposure is paramount. For the susceptible demographics, ensuring optimal indoor air quality (IAQ) for school children is crucial for their physical comfort, well-being, productivity, and overall health. Smart city projects advocate for real-time monitoring systems for assessing, enhancing, and maintaining indoor air quality and supporting scientific research and citizen science endeavours.

This study establishes a real-time monitoring network of school classrooms, teachers’ common rooms, and office buildings across Dublin, Ireland. Leveraging a set of Smart Citizen Kit and PurpleAir, the monitoring system monitors particle matter concentrations in different sizes, equivalent carbon dioxide, and total volatile organic compounds, carbon dioxide, formaldehyde, noise, as well as temperature and relative humidity. Specifically, employing low-cost sensors with WIFI communication facilitated real-time data collection, management, processing, and visualisation. Supplementary data encompassed building and classroom characteristics, occupants’ features, and outdoor parameters were collected. Precampaign procedures addressed inter-sensor and intra-sensor variabilities to ensure data consistency and data accuracy. Protocols were established for obtaining high-quality data from low-cost sensors. Spatial and temporal analyses were conducted to evaluate variations in IAQ. The developed real-time IAQ rating tool aims to furnish short-term (i.e., hourly) data updates to enable time interventions, mitigating school-hour exposure to air pollutants and exposure over a 24-hour cycle. Moreover, the network exhibits the potential to be implied for IAQ modelling and forecasting.

4.2.4 Watch the power! Monitoring of magnetic fields from high-voltage power lines

Kenneth Deprez, Tom van de Steene, Leen Verloock, Emmeric Tanghe, David Plets, Wout Joseph

Ghent University / IMEC-WAVES, Ghent, BE

An increasing demand for electrification will influence the intensity and distribution of the current high-voltage lines. However, an increase in the power running through these lines could lead to a higher exposure to electromagnetic fields at (extremely) low frequencies. A plethora of studies, starting as early as 1885 but still ongoing, have explored the correlation between potential health effects and prolonged exposure to magnetic fields.

The current measurement methods include spot measurements, which entail a single measurement of the magnetic field strength under a high-voltage power line. Hence, the result is influenced by the moment of measurement. A personal exposimeter could be used as well. However, the result is influenced by the individual wearing the exposimeter and is limited in time. Accordingly, these methods could not monitor the exposure of these magnetic fields continuously, whilst this is essential for understanding long-term exposure levels and to ensure compliance with established safety standards.

We developed a low-cost monitoring sensor that could measure electromagnetic fields at 50 or 60 Hz accurately, thus enabling this continuous monitoring. The sensors response to the magnetic field was equal to that of the expensive control measurement system. Furthermore, when compared to publicly available data concerning the load of the high-voltage line under which the sensor was placed, an identical pattern is observed. In conclusion, by analysing the data from these sensors, spatial and temporal variations of magnetic fields can be recorded, contributing to a better understanding of their potential impact on the environment.

4.3 P3: Workplace, public spaces, airborne exposure

4.3.1 Exposure assessment to air pollutants: a WFH (working from home) case study

Francesca Borghi[1,2], Andrea Spinazzè[2], Giacomo Fanti[2], Angelica Albareda[2], Jacopo Ghiraldini[2], Davide Campagnolo[2], Alessio Carminati[2], Marta Keller[2], Sabrina Rovelli[2], Carolina Zellino[2], De Vito Giovanni[3], Andrea Cattaneo[2], Domenico Maria Cavallo[2]

[1] University of Bologna, Bologna, IT
[2] University of Insubria, Como, IT
[3] University of Insubria, Varese, IT

Introduction

Working From Home (WFH) is becoming increasingly common, necessitating a careful evaluation of the health of WFH workers during this mode of work. For this reason, this study aims to assess one of the potential risk factors present in indoor environments, namely exposure to air pollutants.

Methodology

Two monitoring campaigns were performed: a long-term and a short-term campaign, both focused on the measurement of personal exposure to size-fractionated PM (Particulate Matter) in WFH and WFO (Working From Office) conditions, through a paired-sample study design.

Results

The results indicate that specific activities performed by the investigated subjects may contribute to a higher exposure (up to 4 times) in the WFH setting compared to the typical office work mode.

Conclusions

In consideration of the aforementioned, organisations should assess indoor environmental quality (IEQ), along with other risk factors, and implement mitigation measures as needed to address and manage health risks for WFH employees. To achieve this goal, organisations could rely, for example, on the use of low-cost sensor networks, at least for a preliminary assessment of exposure to various risk factors. These low-cost sensor networks can indeed collect real-time data on various parameters, such as temperature, lighting, noise levels and air quality. By analysing these information, potential issues can be identified, and targeted interventions can be implemented to optimise the working environment.

4.3.2 Assessing microbial contamination and particulate matter exposure in Portuguese poultry facilities

Bianca Gomes[1,2], Marta Dias[2,3], Renata Cervantes[2,3], Pedro Pena[2,3], Carla Viegas[2,3]

[1] Universidade de Lisboa, Lisbon, PT
[2] Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
[3] NOVA University Lisbon, Lisbon, PT

The prevalent airborne microorganisms in animal production facilities are poorly described in terms of quantity, composition, and risk category. This study intends to characterise microbial contamination in poultry pavilions through a multi-approach protocol for sampling and analyses. Samples will be gathered from each poultry pavilion following three growth stages of poultries (Early-, Middle-, and Late- Flock) during two seasons (Summer and Winter). Indoor air samples will be collected at the central point of the poultry pavilion by impaction method. A composite sample of bedding material will be collected from various parts of each pavilion. In addition to one composite sample of feed. A surface swab will be performed on the pavilion walls. In addition, electrostatic dust collectors (EDC) will be placed about 150 cm above the ground in a horizontal surface for approximately 7–10 days. Particle concentration measurement and environmental parameters (temperature and relative humidity) will be registered. To assess environmental impact outdoor samples will be collected at 1 m away. To evaluate the microbial contamination, samples will be inoculated onto different culture media for fungi and bacteria characterisation. The fungal contamination will be also characterised through molecular detection of toxigenic species, antifungal resistance, and mycotoxins profile. Cytotoxicity assessment will be included to recognise the possible health effects. The sampling campaign is currently under way and preliminary results will be presented.

The expected results will enable to determine possible sources of microbial contamination characterise the risk associated with the exposure and identify priority areas for action to mitigate microbial exposure.

4.3.3 Identifying the gaps regarding exposure to aeroallergens in schools: systematic review

Carla Viegas[1,2], Inês Paciência[3], Pedro Pena[1,2], Renata Cervantes[1,2], Iisa Antola[3], Drew Henderson[4], Aino-K. Rantala[3], Timo Hugg[3], Maritta S. Jaakkola[3], André Moreira[5], Cláudia Viegas[2], Robert Ferguson[4], Jouni J.K. Jaakkola[3,6]

1 Escola Superior de Tecnologia e Saúde (ESTeSL), Lisbon, PT
2 Universidade NOVA de Lisboa, Lisbon, PT
3 University of Oulu, FI
4 University of Essex, Colchester, UK
5 Universidade do Porto, Porto, PT
6 Finnish Meteorological Institute, Helsinki, FI

Allergic diseases are a major concern in high income countries, and their occurrence continues to increase worldwide[1]. Despite previous studies reporting the health effects of exposure to both chemical and (micro)biological agents[2,3], aeroallergens have been less well studied. Most studies have focused on exposure to indoor allergens in the home. However, exposure can happen in other environments, including in schools where children spend much of their time.

A systematic review is being conducted to summarise evidence regarding the exposure to indoor allergens at schools and the effect of this exposure on asthma, allergic sensitisation, and other allergic diseases. The study questions are: What are the most common indoor allergens in schools?; What methods (sampling and assays) are applied to measure the levels of indoor allergens in schools?; What are the levels of indoor allergens in schools?; What are the determinants of indoor allergens in schools?; and, What are the effects of exposure to indoor allergens on asthma, asthma-like symptoms, asthma control, allergic sensitisation, and allergic diseases?. We will search on SciVerse Scopus, PubMed MEDLINE, and Web of Science databases. The results will be exported to Covidence Systematic Review Software.

Preliminary results will be presented and discussed to identify the roadmap regarding surveillance and/or mitigation of aeroallergens exposure at schools.

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4.3.4 Efficiency of personal protective equipment in reducing operator exposure to pesticides

Christian Küster[1], Felix Kluxen[2], Edgars Felkers[1], Neil Morgan[3], Julien Durand-Reville[4]

[1] Bayer AG, Monheim, DE
[2] ADAMA Germany GmbH, DE
[3] Syngenta, Jealott's Hill International Research Centre
[4] Phyteis, French plant protection association, FR

Personal Protective Equipment (PPE) is used to reduce exposure when working with chemicals. For pesticides, exposure scenarios comprise mixing and loading (M&L) and application by operators. The exposure prediction model recommended by European regulatory agencies for operator risk assessments – the Agricultural Operator Exposure Model (AOEM) – is based on 48 operator exposure studies involving over 500 professional operators (from 10 European countries) in typical working situations to assess exposure under realistic field conditions. We used the same AOEM data to assess the efficiency of exposure reduction from chemical-resistant nitrile gloves and working coveralls during M&L (tank and backpack sprayer), applications using groundboom and airblast spraying as well as outdoor and indoor (greenhouse) applications using handheld sprayers. All studies indicate consistent and high exposure reduction > 90 % for gloves and coveralls across all investigated scenarios. Exceptions were almost exclusively observed when an operator incorrectly used the PPE. The mean exposure reduction from all operators, including those that used PPE incorrectly, was 95.0 % for gloves and 96.4 % for polyester/cotton working coveralls during M&L, and 91.1 % for gloves and 94.9 % for coveralls during all application scenarios. This analysis confirms the essential role of PPE in reducing operator exposure to pesticides. Outliers indicate that operators need to be properly trained and adhere to label instructions to apply pesticides according to good agricultural practices.

4.3.5 Exposing students to particulate matter sensors

Derek Land, Sam Aerts, John Bolt

The Hague University of Applied Sciences, Delft, NL

Wearable technology developed for personal and environmental exposure and health monitoring is rapidly becoming more accessible and affordable. Priced within a range of a few dozen euros, these devices are now inexpensive enough to be used in educational settings, allowing entire classrooms of students to engage with them.

At The Hague University of Applied Sciences (THUAS), students are using the Sensirion SPS-30 and Nova SDS011 low-cost particulate matter (PM) sensors to measure the air quality in their own everyday environment. Their tasks involve developing a research design for PM exposure assessment and comparing their findings against legal limits (or recommendations). The goal is to not only teach scientifically sound measurement techniques, with an emphasis on the repeatability of the experiments and the reliability of the collected data, but also increases the students' awareness of their environmental conditions.

This active learning approach has now been extended to a collaborative project with a local secondary school. Here, about eighty 14-year-olds, with the help of PM sensors, learn how to program, control hardware, and collect and analyse data. While conducting environmental exposure research, the pupils enhance their technical skills and develop a deeper appreciation for air quality and other environmental issues. Furthermore, they are contributing to a collective 'young citizen science' dataset, which provides insights into the PM exposure of young people and may improve overall awareness of air quality and the importance of limiting exposure.

4.4 P4: Food and dietary exposure

4.4.1 Triazole derivative metabolites in the BfR MEAL Study: occurrence in plant-based foods and dietary exposure estimation

Anna Jäger, Johannes Diederich, Sophia Schendel, Christian Jung, Christian Sieke, Irmela Sarvan, Oliver Lindtner

German Federal Institute for Risk Assessment (BfR), Berlin, DE

Triazoles are a common chemical moiety in pesticides that have been used in agriculture for decades. Residues of triazoles and their metabolites can be taken up with foods. Triazole derivative metabolites (TDM) are of particular concern, because little is known about their occurrence in foods and related dietary exposure. In the BfR MEAL Study, the first German total diet study, triazole alanine, triazole acetic acid and triazole lactic acid were measured in a set of 207 representative plant-based food pools produced by conventional farming. Highest overall residues were found in almonds for triazole alanine. Highest triazole lactic acid and triazole acetic acid values were found in mango and rye-wheat bread, respectively. Considering the limited storage stability, 1,2,4 triazole was analysed in 50 food pools only, among which almonds showed highest residues. In 42 % of all foods analysed at least one TDM showed concentrations above detection limits. To assess long-term exposures, consumption data of the KiESEL Study (children 0.5–5 years) and the NVS II Study (adolescents and adults 14–80 years) were matched to the occurrence data at appropriate levels of food aggregation. In order to cover a wider range of foods consumed, additional foods were included by mapping using appropriate processing factors and agreed extrapolation rules. Consumption of animal products was disregarded as relevant TDM source. The highest median exposure by bodyweight was estimated for children aged 0.5–1 years to triazole alanine among all age groups and substances. Overall, TDM exposures did not exceed respective acceptable daily intakes.

4.4.2 FoodMagnifier App – contaminants & nutrients in food

Anna Elena Kolbaum[1], Kerstin Paschko[1], Joanna Czach[2], Anna Zolynia[2], Karl Presser[2], Oliver Lindtner[1]

[1] German Federal Institute for Risk Assessment (BfR), Berlin, DE
[2] Premotec GmbH, Winterthur, CH

Many apps provide the public with information on food nutrients. However, there is a lack of apps that address the presence of potentially undesirable substances. These pose a challenge due to their complexity, especially in risk communication. The FoodMagnifier app was developed as part of the FNS Cloud project (www.fns-cloud.eu). Data from the German pilot Total Diet Study (TDS) (TDS-Exposure Project; www.tds-exposure.eu) on the occurrence of aluminium, lead, copper, manganese and mercury in foods on the German market served as the basis for structuring the app, creating its visual presentation and providing background information and help functions. During the development phase, usability tests were conducted in 2022 with project partners (N = 14) and in 2023 with lay people from the German population and experts in risk communication and risk management (N = 42). The results of these tests provided valuable insights for improving the technical and content aspects of the app. As a result, the app offers search functions for substances or foods, as well as options for comparative presentation. It also provides background information on the substances and their health relevance. In-app assistance and an interactive tutorial provide essential guidance on understanding and using the app. A demo version of the app is available at www.foodmagnifier.eu. In conclusion, an app has been developed that presents information on substances in food in an appropriate and understandable way in the context of communicating potential risks.

4.4.3 An overview of exposure assessment at Food Standards Agency

Emma French, Rhoda Aminu, Joseph Shavila, Amy Neill

Food Standards Agency, London, UK

The exposure assessment team (EAT) use dietary data to inform risk assessment, which in turn informs risk management, policy development and consumer advice for food and feed safety.

The primary source of food consumption data is from the National Diet and Nutrition Survey (NDNS). This is a cross-sectional survey conducted on a rolling basis and is designed to collect detailed, quantitative information on food consumption, nutrient intake and nutritional status of the general population aged 1.5 years and over living in private households in the UK. The survey covers a representative sample of around 1000 people per year and uses an online collection method called Intake24. The dietary exposure assessments conducted are supported by information from a recipe database containing ingredient information for more than 5000 recipes. This maximises the inclusion of multiple food sources that contribute to exposure to food chemicals. The recipe database supports refinements of exposure assessments and allows the prioritisation of foods for surveillance and monitoring purposes. EAT has developed its expertise to provide exposure assessments using the best available science to inform assessments of chemicals ranging from heavy metals, pesticides and veterinary medicines, naturally occurring contaminants, micro-organisms, allergens, and trade risk assessments.

EAT’s regulatory functions have extended to assessing exposure as part of Scientific Advisory Committee work (e.g. Committee on Toxicity) and for evaluating applications submitted for a range of regulated products. The team have worked with other Government Departments on approaches relating to the assessment of chronic dietary exposure conducted by different UK authorities.

4.4.4 Exposure assessment for dioxin and dioxin-like PCBs in Germany based on the BfR MEAL Study

Katrin Blume, Mandy Stadion, David M. Schumacher, Oliver Lindtner

German Federal Institute for Risk Assessment (BfR), Berlin, DE

The BfR MEAL Study is the first Total Diet Study in Germany measuring more than 300 substances in foods as eaten that represent usual consumption behaviour. Dioxin (PCDD/Fs) and dioxin-like PCBs (dl-PCBs) have been analysed in 645 pools each consisting of 15–20 individual foods considering different brands, shopping locations and preparation methods. They have been analysed in all food groups except fruit and vegetable juices, water and water-based drinks.

Average exposure (P50) for the sum of dioxin and dl-PCBs (WHO-PCDD/F-PCB-TEQ (WHO-TEF 2005) for adolescents and adults between 14–80 years ranges from 0.17–0.30 (lb-ub) pg WHO2005-TEQ/kg bw per day in case of consumption of mainly conventional foods. For children between 0.5–< 6 years average exposure is 0.47–0.80 (lb-ub) pg WHO2005-TEQ/kg bw per day assuming preference for conventional foods. In case of consuming mainly organic foods, dietary exposure (P50) is higher for adolescents and adults namely 0.22–0.35 (lb-ub) pg WHO2005-TEQ/kg bw per day and for children 0.55–0.92 (lb-ub) pg WHO2005-TEQ/kg bw per day.

When conventional foods are preferred “grains and grain-based products” are the highest contributor to total dietary exposure for adolescents and adults, followed by “milk and dairy products” and “animal and vegetable fats/oils”. In case of organic foods ranking is changed to first “milk and dairy products” and second “animal and vegetable fats/oils”. Regarding children consumption of “milk and dairy products” represents the main contributor for dioxin and dl-PCB exposure, followed by “grain and grain-based products” and “composite dishes” both for conventional and organic foods.

4.5 P5: Advances in exposure modelling I

4.5.1 Establishing a Go-To Hub: the development of a repository of guidance and standard documents in support of good modelling practice in exposure science

Gerald Bachler[1], Angelika Derler[2], Natalie von Goetz[3], Stefan Hahn[4], Alicia Paini[5], Steven Verpaele[6], Maryam Zare Jeddi[7]

[1] DuPont de Nemours (Belgium) B.V., Mechelen, BE
[2] Environment Agency Austria, AT
[3] Swiss Federal Office of Public Health, CH
[4] Fraunhofer Institute for Toxicology and Experimental Medicine, DE
[5] esqLABS GmbH
[6] Nickel Institute
[7] Shell International BV

The European Exposure Science Strategy 2020–2030 seeks to enhance the effective use of computational exposure models, a crucial objective requiring the provision of pertinent resources to model users. These resources encompass product use information, (regulatory) guidance documents, risk management measure efficiencies, among others.

Within the Exposure Models Working Group of the International Society of Exposure Science (ISES) Europe Chapter, a dedicated subgroup emerged to facilitate access to such resources, fostering good modelling practice (GMP) in exposure science. As outlined by the subgroup, this includes the identification of suitable model input parameters, optimal exposure model selection and usage, appropriate result and model evaluation, and effective interpretation and communication of results (to each stakeholder).

To fortify these endeavours, the subgroup developed a Repository of guidance and standard documents, scientific publications, databases, and similar references. This Repository is strategically organised into five themes, ensuring a seamless provision of resources throughout the modelling process. The thematic divisions include (1) Substance Parameters, (2) Exposure Factors, (3) Exposure Modelling, (4) Model Evaluation, and (5) Result Communication. Geared specifically towards Europe, the Repository is currently curated by the ISES Europe society.

Seeking to enrich the concept of the Repository, the subgroup welcomes input at the ISES Europe workshop in Berlin. Post-workshop, the subgroup aims to publish the Repository on the ISES Europe website, solidifying its role as a vital hub for advancing exposure modelling practices in the European landscape.

4.5.2 Evaluation of Korean workers' exposure characteristics to lead: comparison of MEASE estimates with exposure measurements

Dohee Lee, Naroo Lee

Korea Occupational Safety and Health Agency (KOSHA), Ulsan, KR

The objective of this study was to identify exposure categories that present a high risk of lead exposure in Korea and assess the applicability of the Metals' Estimation and Assessment of Substance Exposure (MEASE) by comparing its estimates with actual measured value.

Lead exposure data, acquired from the Korean government, underwent analysis adhering to NIOSH7302. Contextual data was inputted into MEASE for estimation. Statistical analysis, using SPSS25, encompassed Pearson correlation and One-wayANOVA. Both measured and MEASE-estimated values were compared to occupational exposure limit (OEL).

A total of 182 measurements were analysed, focusing on hot metallurgical processes ($n = 103$), metal abrasion ($n = 46$), and powder handling ($n = 33$). MEASE predicted notably higher exposure levels for metal abrasion and powder handling as opposed to hot metallurgical processes, with an F-value of 16.82. Although measured values mirrored this trend, the difference was statistically insignificant. Excluding three outliers (1.6 %), measured values generally fell below estimates. Correlation analysis revealed a weak association between estimates and actual measurements for hot metallurgical processes ($r = 0.463$) and powder handling ($r = 0.471$), but none for metal abrasion. Particularly, 21 % of measured values and 78 % of estimated values exceeded the OEL (0.05 mg/m^3), despite the usage of local exhaust ventilation (LEV).

The study concludes that metal abrasion, powder handling, and hot metallurgical processes potentially pose high lead exposure risks. Moreover, MEASE tends to overestimate exposure levels. Considering Korea's stringent OEL and compulsory LEV, it is inferred that the underlying levels of lead exposure are comparatively low. Therefore, employing tier 2 models or direct measurements is advised for more accurate lead exposure assessments.

4.5.3 Reflection on the landscape of education in the area of exposure modelling

K. S. Galea[1], A. Paini[2], G. Bachler[3], C. Alejandre-Colomo[4], P. Fantke[5], W. Fransman[6], C. Jung[7], A. Van Nieuwenhuyse[8], N. von Goetz[9,10], A. Connolly[11]

[1] Institute of Occupational Medicine (IOM), Edinburgh, UK
[2] esqLABS GmbH, Saterland, DE
[3] DuPont de Nemours (Belgium) BV, Mechelen, BE
[4] Stoffenmanager® - Cosanta B.V., Amstelveen, NL
[5] Technical University of Denmark, Lyngby, DK
[6] Risk Analysis for Products in Development, TNO, NL
[7] German Federal Institute for Risk Assessment (BfR), Berlin, DE
[8] Laboratoire National de Santé, Dudelange, LU
[9] Federal Office of Public Health, Bern, CH
[10] ETH Zurich, Zürich, CJ
[11] University College Dublin, Dublin, IE

The authors have not given permission to publish the abstract.

4.5.4 Deriving dermal absorption default values for use in global operator exposure models for agricultural and non-agricultural scenarios

Neil Morgan[1], Matthew Crowley[2], Philip Fisher[3], Marcela Giachini[4], Felix Kluxen[5], Yueh Yi Lee[6], Sabine Martin[7], Steve McEuen[8], Thiago Santana dos Santos[9], Anugrah Shaw[10], Githaiga Wagate[11], Korinna Wend[7]

[1] Syngenta Ltd, Jealott's Hill International Research Centre, Bracknell, UK
[2] US EPA, Washington DC, US
[3] Bayer CropScience France, Sophia Antipolis, FR
[4] Corteva Agriscience, Sao Paolo, BR
[5] BASF SE, Limburgerhof, DE
[6] Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Taichung, TW
[7] German Federal Institute for Risk Assessment (BfR), Berlin, DE
[8] FMC Corporation, Stine Research Center, Newark, US
[9] Agência Nacional de Vigilância Sanitária, Brasilia, BR
[10] University of Maryland Eastern Shore, Princess Anne, US
[11] University of Cape Town, KE

Risk assessments for pesticides are vital in ensuring that use patterns do not lead to unacceptable exposures for operators applying plant protection products. In some countries, the use of handheld equipment is still prevalent yet there is no globally applicable model to estimate exposures associated with this equipment. A consortium of experts including regulators, academics and industry was assembled to consider available data and develop such a model.

A key parameter in determining systemic dose for operators is dermal absorption as the skin is the primary route of exposure. Dermal absorption is well studied and influential factors include formulation type and composition, concentration of the test substance (thus dose per unit area) and the physico-chemical properties of the active ingredient. Assessment of dermal absorption is an integral part of the risk assessment. Regulatory default values < 100 % have been derived for some regions when no specific data are available (EFSA 2017[1], NZ EPA 2022[2]). No such agreed defaults are available for use globally.

To derive defaults with universal application, including the new model, a substantial and diverse database of over 400 dermal absorption studies was made available by CropLife Europe. Experts in the Working Group agreed on the key parameters and independent statistical analysis was carried out to determine which of these can be used to determine appropriate defaults. These defaults will prove crucial as specific data may be less available in countries where the new model will be of most use. A comprehensive project report will be published for transparency.

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4.5.5 Innovative design of a tired approach through ranking of different workplace exposure models

Raffaella Papagna, Jessica Meyer, Urs Schlüter

Federal Institute for Occupational Safety and Health (BAuA), Dortmund, DE

Exposure assessment plays a central role in risk management to ensure the best possible protection for workers handling hazardous substances. As workplace monitoring data are often not available, modelling tools are needed to estimate exposure. However, most of the existing models are available on different platforms, making it difficult for users to find the right tool. In order to facilitate both the access and the usability of estimation models, a platform (toolbox) is currently being developed in an ongoing BAuA project. Since the exposure estimate of different models is not equal in terms of accuracy, the toolbox will offer the possibility to perform a tired approach. A tiered approach refers to a procedure in which the exposure assessment systematically progresses from a relatively simple to a more complex assessment. After entering simple parameters (substance name, physical state, type of scenario…), the tool will offer tier 1 models first. If a more detailed exposure assessment is required, the user will be guided to a higher tier model which will be more suitable for the investigated scenario. In order to classify the models as objectively as possible into specific tiers, various evaluation studies have been analysed. The criteria for determining the model performance will then be used as a basis for ranking the models from simple screening to more sophisticated and accurate models. Since the tired approach is barely implemented in workplace exposure models, the current BAuA project makes an important and innovative contribution to workplace exposure assessment.

4.5.6 Shiny rrisk – a web application for transparent stochastic quantitative risk and exposure modeling

Robert Opitz, Thomas Selhorst

German Federal Institute for Risk Assessment (BfR), Berlin, DE

The web application shiny rrisk is a tool for quantitative stochastic risk and exposure modelling. This tool is being developed at the Federal Institute for Risk Assessment to meet the need for transparent and efficient risk and exposure modelling. Its graphical user interface allows fast and low-error development and documentation of even very complex models. In addition, automated reports can be generated for exchanges between modellers and policy makers.

We expect to meet direct users of the application at the conference and familiarise them with the tool. We would like to present the application as a poster, and if possible, also directly via an electronic device (e.g. notebook, pad), at the conference.

4.6 P6: Progress in data generation for refined exposure assessments

4.6.1 Consumer behaviour survey on the use of adhesives (universal glue and wall-paper glue)

Adrian Cieszynski, Christian Jung

German Federal Institute for Risk Assessment (BfR), Berlin, DE

The consumer exposure assessment is often part of the chemical safety assessment under the chemical regulation REACH. High quality data is needed to model exposure and obtain reliable results especially in the area of consumer behaviour. Therefore, a consumer survey with focus on selected types of adhesives (all-purpose adhesive and wallpaper glue) for Do-It-Yourself tasks was conducted.

In the first work package (WP 1), telephone interviews were used to determine retrospectively the frequency of application, the reading and following of application instructions, the use of aids, other people present during the task and the protective measures applied. In the second work package (WP 2), through the use of protocols (self-administered activity report), more specific parameters were documented during the adhesive use. This includes the applied product quantity and duration of use as well as detailed product information.

Of the 1,335 participants of WP 1, all-purpose adhesives were used by 68.6 % and wallpaper glue by 12.7 % within the last 12 months. 38.9 % (all-purpose adhesive) and 1.7 % (wallpaper glue) of the respondents used the adhesive more than once per month.

As exemplary results of WP 2 (N = 55) the product amount used and the duration of use are given here. The 75th percentiles are:

- For all-purpose adhesives: 6 grams and 36 minutes
- For wallpaper glue: 250 grams and 446.5 minutes (including mixing and loading)

In conclusion, to obtain reliable use parameters, the presented combination of two methods, i.e. telephone interviews and use of protocols is useful and the results are suitable to derive robust default values for the exposure assessment.

4.6.2 How to measure dermal hand exposure in occupational exposure studies? – New methodology to assess applicability of hand-wash method and cotton gloves

Christiane Wiemann[1], Eric Fabian[2], Sina Wolf[2], Christina Rieken[2], Natascha Gärtner[2], Philip Fisher[3], Felix M. Kluxen[4], Steve McEuen[5]

[1] BASF Oesterreich GmbH, Vienna, AT
[2] BASF SE, Ludwigshafen, DE
[3] Bayer Crop Science, Sophia-Antipolis, FR
[4] ADAMA Deutschland GmbH, Cologne, DE
[5] FMC Corporation, Philadelphia, US

Assessment of agricultural worker exposure to pesticides comprises measurement of external dermal exposure to plant surface residues and inhalation exposure. Measurement of dermal exposure using working-clothing as outer and cotton underwear as inner dosimeter is well established but different methodologies are used to assess actual hand exposure. Either standardised hand-washes are conducted after the work task or cotton gloves are worn throughout the task.

To compare these two dosimeters a modified in vitro dermal absorption study (1) was developed. Dried residues from spray solutions were transferred (2) either to the surface of skin membranes or to the glove surface mounted on top of these membranes in the penetration chamber. The surface was wetted with artificial sweat prior to residue transfer. Transfer efficiency, absorption through the skin as well as compartment distribution after the different exposure regimens were compared.

Application of dried residues via stamp transfer resulted in significant lower mean absorption 0.23 % of applied dose as compared to liquid spray application (4.94 %). Mean dried residue transfer efficiency ranged from 45 % to 88 % and were higher to cotton than to skin. In another study mean absorption from dried residue for uncovered skin was 0.06 % versus 1.82 % of applied dose for cotton covered skin (30-fold). Thus, both residue transfer and absorption were higher for cotton covered skin.

The data generated with this new methodology emphasise the need to adequately understand the impact of the selected dosimeter type both for the retained residues on the dosimeter as well as for the actual exposure.

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4.6.3 Characterising exposures to neonicotinoid insecticides in Ireland

Darragh M. Doherty[1], Sonja A. Wrobel[2], Holger M. Koch[2], Heiko-Udo Käfferlein[2], Daniel Bury[2], Craig Slattery[1], Alison Connolly[1]

[1] University College Dublin, Dublin, IE
[2] German Social Accident Insurance, Institute of the Ruhr-Universität, Bochum (IPA), Bochum, DE

Neonicotinoid insecticides and neonicotinoid-like insecticides (NNIs) are the most widely used insecticides worldwide, accounting for nearly a quarter of the insecticide market in 2018. In recent years, NNIs have gained notoriety due to their adverse effects on pollinators, resulting in many restrictions of NNIs in the European Union. NNIs have also been indicated as potential human health hazards and therefore are listed on chemical priority lists throughout the world. Despite growing concern about the hazardous properties of NNIs, there is a dearth of large-scale studies of human exposure to NNIs in the European Union.

The EIRE 'nEonicotinoid Insecticide exposuREs' project aims to characterise exposures to NNIs among the Irish population using a human biomonitoring strategy. Between 2019 and 2020, 226 first-morning void urine samples were collected from members of 14 farm families and 54 non-farm families to assess glyphosate exposures in Ireland. In 2023, these urine samples were reanalysed for seven major NNIs (imidacloprid, acetamiprid, thiacloprid, thiamethoxam, clothianidin, flupyradifurone, and sulfoxaflor) and nine of their metabolites using a previously validated method involving liquid chromatography–mass spectrometry coupled to online solid-phase extraction.

The EIRE project has indicated widespread exposure to NNIs among the general Irish population, with 76 % of the study population exposed to at least one NNI. Study results from this human biomonitoring study of NNIs in the Irish population will be presented at the conference, along with discussions of future studies involved in the EIRE project.

4.6.4 Exposure of consumers in Germany to Do-It-Yourself and crafting products with intended skin contact

Eva Rogasch, Adrian Cieszynski, Stefanie Klenow

German Federal Institute for Risk Assessment (BfR), Berlin, DE

When hands serve as tools using products, skin comes into contact with chemicals that e.g. potentially cause skin irritation or allergies. While skin contact is expected with household products such as dishwashing liquid, skin contact in the DIY and crafting sector has so far received little attention in the literature. Therefore, a representative telephone survey with 1000 consumers (male: 46 %, female: 54 %) was conducted in Germany to analyse in what extend certain DIY and crafting products were used with skin contact during the last 12 months, how often they used them and for what purpose. The products in the survey included among others sealants, adhesives, chalk, putty, fingerpaints, play slime and modelling clay. The results showed that adhesives (38.8 %), chalk (24.6 %) and silicone sealants (23.5 %) were the most commonly used products in contact with skin. Frequency of use varies depending on product type, with variations ranging between minimum one use per year (putty) and use on every day during the last 12 months (adhesives). Fingerpaints ($p < 0.001$), chalk ($p = 0.007$) and adhesives ($p = 0.02$) were used on significantly more days per year by female than by male contestants.

In conclusion, the survey gave valuable information about consumer use patterns of products with intendent skin contact. On this basis, particularity relevant products can be identified for further investigation and a more in-depth risk assessment can be carried out.

4.6.5 The application of the mobile application for the assessment of cleaning workers' exposure to cleaning products: a pilot study

Sewon Lee, Andrew Povey, Martie van Tongeren

University of Manchester, Manchester, UK

The authors have not given permission to publish the abstract.

4.7 P7: Advances in exposure modelling II and new developments for mixture exposure assessment

4.7.1 Handling of left- and interval-censored arsenic data from BfR MEAL study for dietary exposure assessment

Annett Martin, Irmela Sarvan, Christine Müller-Graf, Matthias Greiner

German Federal Institute for Risk Assessment (BfR), Berlin, DE

A difficult step in dietary exposure assessment is the handling of concentration data reported as left- (below limit of detection – LOD) and interval-censored (between LOD and limit of quantification – LOQ). Using the example of arsenic concentration (approx. 39 % censoring) in the BfR Meal study, the average contamination of food should be determined and differences tested between conventional and organically produced food from different regions in Germany. Two approaches (modified lower bound [mLB] and upper bound [UB]) were used to substitute censored observations. The simple substitution assumes that all values < LOD/< LOQ have the same value. This can lead to biased estimators. Statistical methods for censored data are therefore used to take into account the uncertainty of the values between the two limits. Here, estimates for quantiles and mean values as well as statistical tests based on the observed uncensored values and the percentage censored of values. Bootstrap methods and two-dimensional Monte-Carlo simulation make it possible to model the uncertainty and variability of the parameters (quantiles, median, mean, 95 % credible intervals) and to transfer this information into a quantitative exposure (risk) assessment model.

A total of 16 main food groups with 210 measurements (food pools) per production type and region were included. On average, the estimated median values were between the mLB and UB approach. In Region 4, a difference in arsenic concentrations was observed between organic and conventional foods.

Analysing the arsenic data with a mixture of left- and interval censored methods proved to be an advantage over simple replacement methods.

4.7.2 Children are exposed to multiple sweeteners in non-alcoholic soft drinks

Christian Jung, Anna Jäger, Sebastian Ptok, Julika Lietzow, Oliver Lindtner

German Federal Institute for Risk Assessment (BfR), Berlin, DE

Simultaneous exposure to multiple chemicals is a topic with increasing relevance. Due to their combined use in several soft drinks and limited data regarding effects upon combined exposure to humans, artificial sweeteners are an important topic in that area. Furthermore, the German National Reduction and Innovation Strategy for Sugar, Fats and Salt in Processed Foods may lead to an increased use of artificial sweeteners in multiple foods including soft drinks associated with higher exposure in the future.

Data from the BfR MEAL Study was used to evaluate present occurrence levels of artificial sweeteners in soft drinks. Data on seven frequently used sweeteners (Acesulfame K, Aspartame, Saccharin, Cyclamate, Sucralose, Steviol glycosides [Stevioside and Rebaudioside A]) in 92 energy-reduced soft drinks were collected. In almost all (n = 87) of the soft drinks more than one sweetener was used with an average of 2.8 sweeteners per drink.

Subsequently, the (combined) exposure to those sweeteners was estimated for children (aged from 0.5 to 5 years) using data from the KiESEL nutritional survey. Exposure levels ranged up to 3.8 mg / (kg d) in case of Cyclamate but did not exceed the respective acceptable daily intake (ADI) levels. However, the simultaneous exposure to multiple sweeteners was clearly demonstrated. Future research is needed to assess potential risks from combination of sweeteners.

4.7.3 ImproRisk model as an open access risk assessment tool

Demetris Kafouris, Aspasia Sarandi, Georgios Stavroulakis,
Christophoros Papachrysostomou

Ministry of Health, Nicosia, CY

ImproRisk is an open-access Risk Assessment model, developed in Cyprus, which contributes to the harmonisation, standardisation and transparency of the Dietary Exposure Assessment methodologies across Europe. It is a simple and transparent tool, built in R, for conducting accurate dietary exposure assessments to chemical substances. Aiming to be established as a standardised Risk Assessment tool at European level, the model has been designed to accept occurrence and consumption data, coded according to the EFSA's food classification and description system version 2 (FoodEx2). ImproRisk users are able to estimate dietary exposure to a chemical substance under study at any level of the EFSA's FoodEx2, considering the FoodEx2 base term and the Process facet (F28). Dietary exposure is estimated at individual level for different population groups and exposure estimates are stratified by different demographic characteristics. In this context, ImproRisk is considered a tool for facilitating decision making, since it provides information regarding the percentage of the population exceeding the health-based guidance value for a specific chemical substance. The objective of this study is to present the model's Risk Assessment outputs from the estimation of the Dietary Exposure to lead, cadmium and mercury of the Cyprus population.

4.7.4 A comparison between field measurements of vapour concentrations of plant protection products and predictions by the BROWSE model

Edgars Felkers[1], Sarah Adham[2], Anne-Kim Vinck[3], Kathrin Bürling[4], Neil Morgan[5], M. Clare Butler Ellis[6]

1 Bayer AG, Monheim, DE
2 Corteva Agriscience, Abingdon, UK
3 Bayer SAS, Lyon, FR
4 Corteva Agriscience Germany GmbH, Munich, DE
5 Syngenta, Bracknell, UK
6 Silsoe Spray Applications Unit Ltd, Bedford, UK

A database of field measurements of air concentrations of pesticide active ingredients has been compiled by CropLife Europe with an aim to revise the default air concentration values and assumptions applied in assessing vapour exposure in the risk assessment of bystanders and residents. The BROWSE model, released in 2014, which is a regulatory risk assessment model that includes the exposure of residents and bystanders has a component relating to post-application vapour inhalation. Predictions of concentration deduced from exposures obtained using the BROWSE model were compared with field measurements of 24-h and 7-day average concentrations. The methodology for obtaining concentration estimates from the BROWSE model is described, and the criteria for including field studies in the comparison are given. The field data were adjusted to account for differences between the field experiment and the BROWSE scenario using factors derived from a separate plume dispersion model. This showed that BROWSE provides a satisfactory level of conservatism in determining potential exposures of residents and bystanders to vapour and could be a reliable alternative to replace the current EFSA approach for predicting vapour inhalation exposures for pesticides where no compound-specific data are available.

4.7.5 Fruit and vegetable intake plays a key role in pesticide exposure of Latvian citizens

Lasma Akulova, Evita Veipa, Linda Matisane, Zanna Martinsone, Juris Breidaks, Ieva Strele, Anita Seile[1], Kristiana Venzega[1], Linda Paegle[1], Inese Martinsone[1]

Rīga Stradiņš University, Rīga, LV

Diet is one of the sources of pesticide exposure. To assess the role of intake of fruit and vegetables on pesticide exposure in Latvia, in 2020, 402 urine samples from children and their parents were gathered and analysed in association with 24 h food diaries prior to urine sample collection. A suspect screening approach with full-scan High-Resolution Mass Spectrometry was used to detect pesticide mixtures in the samples. Fieldwork was done in two seasons (winter/early spring of 2020 and summer of 2020) to evaluate the impact of agricultural activities. Chlorpropham was the most frequently detected pesticide in children's urine samples (children, who live less than 250 m from agricultural lands – in winter – 38.0 %, n = 19, in summer – 46.0 %, n = 23 vs. children, who live more than 500 m from the fields – in winter, 37.3 %, n = 19, in summer – 41.2 %, n = 21). No statistically significant differences were observed between the groups, indicating that diet impacts pesticide exposure. Additional results show that the proportion of pyrimethanil (detected/not detected) is statistically significantly different among children reporting eating apples (26.8/73.2 %) 24 h prior to urine sample collection compared to not eating apples (11.1 %/88.9 %), X2 (1) = 5.50, p = 0.019, Cramer's V = 0.2. In adult urine samples the differences of acetamiprid (detected/not detected) were statistically significant between those having apples (50.0 %/50.0 %) and not (23.4 %/76.6 %), X2 (1) = 12.5, p < 0.001, Cramer's V = 0.264. Being systemic substances, both pesticides can penetrate the apple skin further into pulp and its removal might not be effective. Therefore the use of self-grown or biological produce consumption should be encouraged to lessen the exposure to pesticides.

4.7.6 Plume modelling of outgassing from fumigated cargo

Anna Gierak, Stefan Sander

German Federal Institute for Risk Assessment (BfR), Berlin, DE

Residues of fumigants in food and feed transported in bulk on barges may pose a risk to the crew and bystanders. This is particularly the case if the documents do not mention that the cargo has been fumigated. Several cases of outgassing and poisoning in barges caused by phosphine have been reported in recent years. Current risk management measures do not appear to be sufficient. The Gaussian plume model from the ALOHA (Areal Locations of Hazardous Atmospheres) hazard modelling software of the US Environmental Protection Agency (EPA) was used to estimate potential risk for the specific conditions on barges. Incident and literature data were used to develop the model. The impact of key model parameters on the output concentration values was evaluated. The modelling visualises the spatial extent of the potential plume and the concentration of the substance in it. This leads to an exposure, which exceeds the EU toxicological reference values of 0.1–0.2 ppm for workers and bystanders by several orders of magnitude. In conclusion, further protective measures are needed. These may include gas measurements, a plan of emergency and making the crew aware of the possibility of transporting hazardous cargo. If necessary, ventilation is the main option to get rid of the fumigants. Besides its scientific importance, the project may have practical applications in supporting experts in the decision-making process.

5 Index of Authors

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Max-Dohrn-Straße 8-10
10589 Berlin, Germany
T +49 30 18412-0
F +49 30 18412-99099
bfr@bfr.bund.de
bfr.bund.de

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