# Integrated Exposure for Risk Assessment in Indoor Environments (INTERA): The use of case studies to test INTERA tools

Karen Galea[1], Arja Asikainen[2], Spyros Karakitsios[3], Denis A. Sarigiannis[3], Katleen De Brouwere[4], Araceli Sanchez-Jimenez[1], A lberto Gotti[3], Sean Semple[5], Matti Jantunen[2]

## INTRODUCTION

The INTERA (Integrated Exposure for Risk Assessment in Indoor Environments) project, aims to develop a comprehensive indoor air exposure methodology. The main objective of INTERA is to define methodologies for predictive modelling of indoor exposures to chemical contaminants. The final product is a full chain mechanistic approach from source to exposure including internal dosimetry modelling. The work has been divided into 6 linked work packages (Fig. 1).

Three case studies are being undertaken to test the developed integrated methodology (WP1 to 4); suggest any refining to the data tools; identify data gaps; and report on the overall indoor exposure in Europe providing exposure distributions for households in the EU.

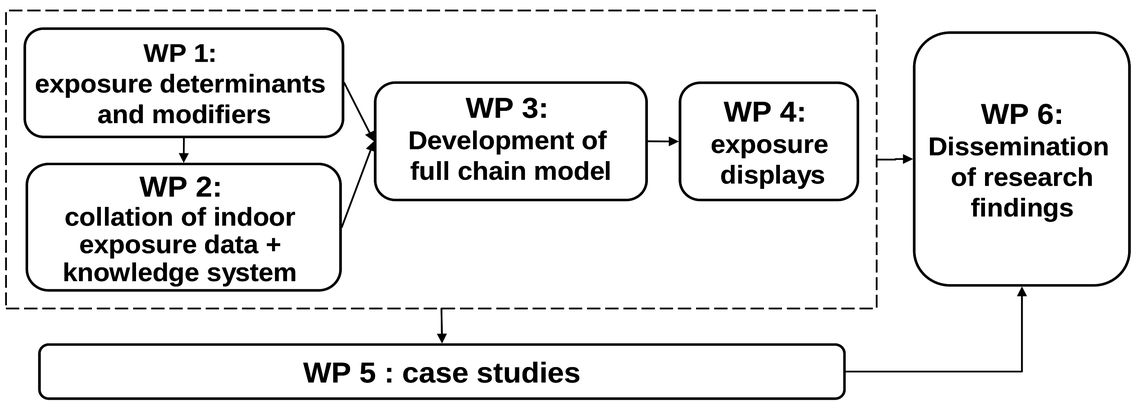


*Fig. 1: Links among the INTERA WPs*

## METHODS

Threes case studies are being undertaken (Table 1). A common framework will be used, which includes the following steps:

1. Defining the scope of the case study
2. Preliminary data collection step (information fed into INTERA tools)
3. Identify the (main) household emission sources / strengths
4. Collate data on patterns of use of these household sources
5. Measurements (modeling) of indoor / personal exposure of EU population
6. Estimation of internal doses to pollutants of interest
7. Develop estimates of exposure across all sources and pathways using a probabilistic exposure approach
8. Comparison/verifying results of the INTERA computational platform with exposure assessment found in literature

**Table 1. The scope of the three case studies**

| Pollutant | Source inc. | Exposure routes | Main health effects |
|---|---|---|---|
| Dimethylfumarate (DMF) | Shoes, furniture | Dermal | Skin sensitization<br>Allergic contact dermatitis |
| Phthalates (DEHP, BBzP, DIDP, DINP) | Flooring materials, clothing, cables and wires, footwear, clothes, bath mats, (toys) etc. | Inhalation, ingestion, dermal | Developmental and reproductive effects,<br>asthma, rhinitis and eczema (children) |
| BTEX (benzene, toluene, ethylbenzene, xylenes) | Many for example, rubbers, lubricants, paints, dyes, tobacco smoke, detergents etc. | Inhalation | Benzene: Cancer (acute myeloid leukemia)<br>BTEX: neurological impairment |

## RESULTS

**DMF**

- There is a limited data on DMF exposure in Europe.
- Estimated concentrations of DMF in products are 0.01 mg $kg^{-1}$ in furniture and 1 mg $kg^{-1}$ in footwear.
- Average exposure periods were 90 days in the case of a sofa and 2-12hrs for footwear.
- Estimated EU population exposed: UK (3,000), Spain (300), France (128), Finland (35), less than 10 cases reported in Germany, Italy, Netherlands, Denmark.

**Phthalates**

- Main indoor exposure pathways/sources for the adult population in Europe are; 1) for BBzP: inhalation (infrequent uses of spray paints), 2) for DINP & DIDP: inhalation (spray paints and indoor air), dermal contact with gloves and ingestion of dust, and 3) for DEHP: inhalation of air; (though for DEHP: exposure is dominated by non-indoor related sources, namely dietary exposure) (Wormuth et al., 2006).
- Infants showed a > 10 fold higher daily exposure (relative to body weight) to DINP, DIDP and DEHP than adults (Wormuth et al., 2006), mainly attributable to ingestion of dust (DEHP and BBzP) and mouthing of toys (for DINP and DIDP); the latter contribution is expected to decrease since the EU ban /restrictions of those 4 phthalates in toys / childcare articles since 2007.

**BTEX**

- There is a wide distribution of BTEX concentrations within different types of indoor settings across EU, linked to the relative strength between indoor sources and outdoor interactions (Fig. 2).

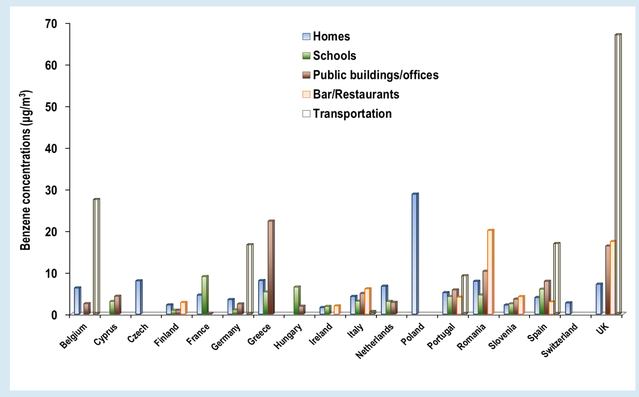


*Fig. 2: Concentration of benzene in different indoor settings in EU*

•Realistic exposure assessment to benzene requires assessment of internal exposure to toxic metabolites and how this is affected by co-exposure to TEX through a mechanistic approach based on PBPK modelling (Fig. 3).

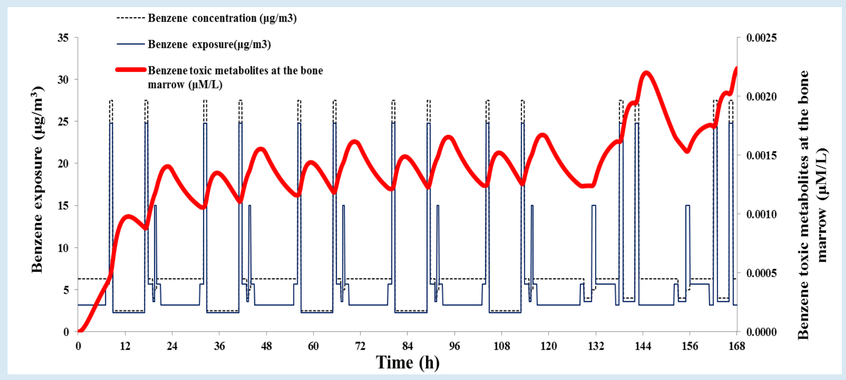


*Fig. 3: Typical weekly benzene external and internal exposure profiles for a male adult in Belgium*

## Discussion

Work on the INTERA case studies continues. The computational platform will be used to provide estimated of exposure for the pollutants. Consideration will also be given to the validation of the computational platform. Updates on the progress of the project will be available on the INTERA website[6].

References: Wormuth et al. (2006) What are the sources of exposure to eight frequently used phthalic acid esters in Europeans. Ris Analyiss Vol 26, 3; 803- 824

1. Institute of Occupational Medicine (IOM), Edinburgh, United Kingdom
2.National Institute for Health and Welfare (THL), Kuopio, Finland
3. Centre for Research and Technology Hellas (CE.R.T.H.) Thessaloniki, Greece
4. Flemish Institute for Technological Research (VITO), Mol, Belgium
5 University of Aberdeen, Aberdeen, United Kingdom
6. http://www.intera-home.eu