Cumulative indoor exposures to Semi-Volatile Organic Compounds (SVOCs) in France: the ECOS project.

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Philippe Glorennec[1,2*], Fabien Mercier[1], Olivier Blanchard[1], Nathalie Bonvallot[1,2], Olivier Ramalho[3], Corinne Mandin[3], Barbara Le Bot[1].

[1]EHESP-School of Public Health/IRSET-Research institute for environmental and occupational health, Rennes, France.
[2]INSERM/U625-National Institute for health and medical research, Research Unit 625
[3]University of Paris Est /Technical building center (CSTB), Marne la Vallée, France.

[*]*Corresponding email: philippe.glorennec@ehesp.fr*

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1 Introduction

Semivolatile organic compounds (SVOCs) are widely used indoor as plasticizers, flame retardants, or pesticides. They are present in indoor environments both in air (as gas and suspended particles) and settled dust. Thus exposition to possibly harmful agents: (phthalates, polybromodiphenylethers, organophosphorous compounds) occurs (Mitchell et al. 2007;Wu et al. 2007). Here is presented the framework of the ECOS project, which objective is to assess domestic cumulative exposure to these substances and associated health risks.

2 Materials/Methods

The steps of the project are:

- Selection of compounds;
- Analytical methods development;
- Nationwide samples collection (settled dust and suspended particulate matter (PM)) in dwellings;
- Chemical analyses;
- Gas-phase concentration modelling;
- Exposure assessment;
- Risk assessment.

Selection of compounds. The first stage of the project consisted in selecting targeted SVOCs on the basis of a literature survey. 254 Pollutants were ranked on the basis of their toxicity and indoor concentration. 66 could be prioritized (Bonvallot et al. 2010). Several compounds are likely to be toxic for reproduction or development, and most of them are suspected to be endocrine disrupters. Most can be analyzed by gas chromatography and mass spectrometry (GS/MS) and constitute our list of compounds of interest (N=59): polycyclic aromatic hydrocarbons (PAHs), polychlorobiphenyls (PCBs), polybromodiphenylethers (PBDEs), phthalates, pesticides and musk fragrances.

Analytical methods development. A multi-residue method was developed and validated for the great majority of the top-ranked substances, for dust samples collected by vacuum cleaner and wipe. (Mercier F. et al. 2010a) Analytes are extracted from dust samples by sonication with dichloromethane (wipe samples) or pressurized liquid extraction (vacuum cleaner samples). After a cleaning process, extracts are analyzed by gas chromatography coupled with tandem mass spectrometry (GC/MS/MS). Another method was developed for suspended particulate matter collected on filters using thermodesorption coupled with chromatography (TD/GC/MS) (Mercier F. et al. 2010b).

Samples collection and analyses. PM_{10} and $PM_{2.5}$ (N=297 pairs) filters have been collected (2003-2005) during a national survey representative of French dwellings, by French Indoor Air Quality Observatory (OQAI). Settled dust were collected with wipes (N=477) and vacuum cleaner (N=311) during another national survey (2008-2009), representative of French dwellings occupied by six months to six years old children. Samples are currently stored at -18°C, before analysis. Conservation of SVOCs in dust samples during storage is currently being assessed with a reference sample that is regularly measured.

Gas-phase concentration modelling. Simultaneous measurements of SVOCs in settled dust and air (PM and gas-phase separately) are performed in 30 dwellings. Equilibrium equations between SVOCs

concentrations in settled dust, PM and gas will be assessed, as Weschler et al. did for phthalates (Weschler et al. 2008). They will allow calculating gas-phase concentration from either PM or dust measured concentrations.

Exposure assessment. Indoor exposure will be assessed by adding inhalation (SVOCs in gas-phase and PM) and ingestion route (SVOCs in settled dust) for children and adults regarding health effects. The exposure assessment will use measured dust and PM SVOCs concentrations, and modelled air concentrations, combined with daily dust ingestion rate and inhalation rate retrieved from literature, and French time-activity patterns (time spent at home).

Risk assessment. Cumulative Risk assessment will use toxicity reference values from toxicological databases. Pollutants with similar toxic mode of action (e.g. anti-androgenic) will be simultaneously studied to take into account additive or synergistic effects.

3 Results

66 SVOCs have been ranked on the basis of expected health risks; many show neurotoxic and reprotoxic effects. For 59 of them, multiresidue analytical methods (GS/MS) have been developed in air and dust samples. Other expected results of this ongoing project are:

- An equilibrium model between dust and air, with gas and PM assessed separately;
- Better knowledge of SVOCs contamination in French dwellings;
- The assessment of indoor exposure, compared to other exposures (diet);
- The identification of the most problematic compounds and their main exposure route;
- The risk assessment for children development, taking into account cumulative exposure to low doses.

4 Conclusions

Assessing risks due to SVOCs will help targeting prevention measures by identifying compounds, and exposure media that leads to a greater risk. It is important in a public health perspective to adopt prevention measures even before epidemiologic confirmation, with established causality, as it could have been done in the past, for example with lead (Lanphear 2007). The originality of this project is that targeted compounds were selected on the basis of their potential for health effects, and afterwards corresponding measurements methods were developed.

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