MUNI | RECETOX

Comprehensive investigation of indoor chemical exposures

Petra Svobodová, Lisa Emily Melymuk, Simona Rozárka Jílková

Chemical Pollutants and Human Exposure Routes - Environmental Chemistry and Modelling - RECETOX - Faculty of Science, Masaryk University, Kamenice 5, 625 00 Brno, Czech Republic

Introduction

We spend more than 90% of our time indoors, and for this reason it is important to know about the environments in which we spend most of our time. Indoor environments contain a complex mix of chemicals, and these are important sources of chemical exposure to humans. This project will screen indoor environmental matrices (air, dust, consumer products) to assess the mixture of chemicals in residential and other indoor environments and synthesize data from different geographic regions and types of environments to determine key sources of variability, the impact of differing chemical regulations, and prioritize which compounds we should be focusing on for further risk analysis and toxicity evaluation. The project comprises a review of current data combined with targeted analysis and suspect screening of indoor samples to profile the chemical mix indoors, followed by prioritization of the identified chemicals according to regulations, levels, and hazard.

This research falls under the GAČR project: Dust as a major human exposure pathway to endocrine disrupting chemicals in the indoor environment, covering the chemical characterization aspect. The chemical characterization is complemented by bioaccessibility testing to identify the fraction of chemicals from dust that are available in the digestive system, and toxicity tests to assess the toxicity and mechanism of action of dusts, and the substances in dusts, and identify the most important active substances.

The Danger of Dust?

The main exposure pathway for many hazardous chemical through indoor dust. Dust has a presence through our whole lives. We are in contact with it from our first breath to the last. We touch it on every surface. And it is also an uninvited guest in our food. We are exposed to dust continuously, especially young children who play on the floor and have more hand-to-mouth behaviour.

Dust is very complex and heterogenous mixture. Dust consists of e.g. ash, soot, pollen, viruses, bacteria, clay, sand, fibers from carpets and clothes - artificial and natural, animal fur, skin particles, hairs, dander and also particles of consumer and buildings products[1]. Many substances contained in dust have harmful effects on human health, and as has been said, the problem with dust is that it is really everywhere.

How much dust do you eat?

Try to estimate how much dust you have ingested (eaten) over your life. In only the first year of our life we ingest about 10 800 mg of dust.

Age	Mass of eaten dust (mg/day)[2]
0-1 year	30
1-2 year	50
2-12 years	30
>12 years	20

It is average 34 mg/day over the first 12 years.

12 year 34 mg/day → Your age -12 20 mg/day → Your answer ?

For my whole life I eaten around 250 g of dust – it is like two and half chocolate bars.

SOURCES

Analytical strategy

This project focusses on identifying and quantifying the substances in the dust with possible adverse effects on humans. The complexity of dust and the thousands of substances present creates a challenge. In target analysis, it is necessary to know in advance what substances we want to focus on. This strategy is widely used in dust, because many of the chemicals of concern (flame retardants, plasticizers, pesticides, etc.) are well-known[3]. Target analysis is a necessary part of any quantitative analysis of dust. We will focus on substances known to be of concern in dusts due to high levels and hazard properties: polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organochlorine pesticides, per and polyfluoroalkyl substances, polybrominated diphenyl ethers, novel flame retardants, organophosphate esters, phthalate esters, bisphenols, current-use pesticides and trace metals. To understand the key factors driving the distributions of these chemicals in dust, we analyze not only the bulk dust, but separate size fractions with different physical properties (different organic content, surface area-to-mass ratios). We supplement our interpretation with information about the amount of total carbon (inorganic/organic) in the dust matrices.

While target analysis allows us to identify the known chemicals of concern, dust is an ideal matrix to act as an early warning of chemicals of future concern. This is why, to best characterize the possible risk from exposure to indoor dust, we need to supplement targeted analysis with advanced mass spectrometry techniques and data analysis, screening dust according to longer lists of suspected chemicals to identify yet unknown potential hazards.

MICROENVIROMENTS

Microenvironments

Much of the work on dusts has focused on dust from homes. But this gives only a limited picture of our exposures. We focus our research on seven places, microenvironments, where people spend much of their time but can have very different levels. For example, a shop with food should have lower concentration of flame retardants than a shop with electronics, as flame retardants are found at high levels in electronics. We also expect higher organic carbon content in dusts in homes, because there is high contribution of skin particles, also food, hairs and pets fur. Compared to that, in cars and public spaces we expect higher inorganic carbon content because there is higher contribution of soil and road dusts, which is accumulate on our shoes. We see these differences in the comparison of organic carbon content of dusts from different microenvironments (Fig. 1). If differences between microenvironments are not taken into account, it can completely change results about overall levels of chemicals and risks posed by dust exposure.

Our researched microenvironments:

- New houses
- Prefab flats
- Offices
- Public spaces
- Cars
- Schools
- Kindergartens

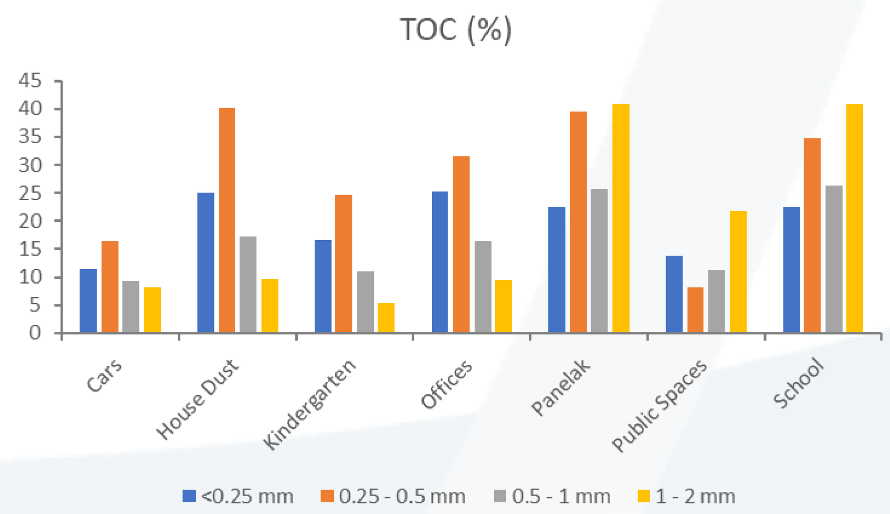

Figure 1: Total organic carbon (TOC) levels in different dust size fractions from different microenvironments in Brno.

Reference

[1] R.M. Maertens, J. Bailey, P.A. White, The mutagenic hazards of settled house dust: a review. Mutation Research/Reviews in Mutation Research. 2004, 567(2-3), 401-425. ISSN 13835742. doi:10.1016/j.mrrev.2004.08.004

[2] U.S. EPA, Exposure Factors Handbook Chapter 5 (Update): Soil and Dust Ingestion. Office of Research and Development, Washington, DC, EPA/600/R-17/384F. 2017, 100, 15.

[3] P. Rostkowski, P. Haglund, R. Aalizadeh, et al., The strength in numbers: comprehensive characterization of house dust using complementary mass spectrometric techniques. Analytical and Bioanalytical Chemistry. 2019, 411(10), 1957-1977. ISSN 1618-2642. doi:10.1007/s00216-019-01615-6

GAČR GRANTOVÁ AGENTURA ČESKÉ REPUBLIKY