Assessing human exposure to phthalates, alternative plasticizers and organophosphate esters

Tuong Thuy Bui

Academic dissertation for the Degree of Doctor of Philosophy in Applied Environmental Science at Stockholm University to be publicly defended on Thursday 1 June 2017 at 13.00 in William-Olssonsalen, Geovetenskapens hus, Svante Arrhenius väg 14.

Abstract

Phthalate esters (PEs) and organophosphate esters (OPEs) are common indoor pollutants frequently detected in environmental (dust, air), personal (hand wipes, diet) and human matrices (urine, serum etc.). In this thesis, mathematical models were used to establish links between intake and body burden for a comprehensive dataset based on a Norwegian study population. Also, the relative importance of different PE uptake pathways was assessed and discussed. Furthermore, the suitability of human nails as an alternative, non-invasive biomonitoring matrix for PEs was investigated. Additionally, information regarding alternative plasticizers to PEs was collected and presented extensively. Results showed that for PEs (paper II), daily intakes based on external exposure media agree with back-calculations using urinary metabolite concentrations, leading to the conclusion that human exposure for the general adult population is well understood and that the most important uptake routes were captured. Overall intake levels are comparable or lower than level presented in recent comprehensive studies and hazard quotients were well below 1 (low risk). As expected, diet was found to be the most important uptake route for all PEs. For lower molecular weight PEs, inhalation becomes a strong contributing pathway whereas for higher molecular weight PEs, dust ingestion was also important. Daily intake based on hand wipes was found to be much lower than the estimated total dermal intake based on air, dust and personal care products, questioning the relevance of hand wipes to represent total dermal exposure. Human nails were found to be unsuitable for replacing urine as a biomonitoring matrix for PEs as internal intake (from blood) cannot explain measured nail concentrations and uptake from air is too slow to reach observed concentrations within a realistic time frame (paper III). Hence, the kinetic links between intake and nail concentrations could not be established. Although exposure to traditional PEs is decreasing, use and body burden of some alternatives are increasing (paper I). Fortunately, most alternative plasticizers have favorable toxicological properties, resulting in low risk for humans. In contrast to PEs, OPEs still remain a group of poorly studied substances in terms of human exposure (paper IV). Due to lack of information regarding human metabolism, reliable links between intake and concentrations in serum and urine could not be established. Modelling results showed that concentrations in serum, and to some extent, urine, were underestimated for 2 compounds. It is likely that a combination of missing intake and suboptimal biomarkers were the cause for this under-prediction. Because of this, further studies regarding human metabolism should be performed for OPEs and potentially more specific biomarkers identified in the future. For PEs, there is a need for more comprehensive datasets to study exposure for high risk groups such as infants and children. Furthermore, dermal uptake remains poorly understood and the uptake of PEs into human nails should be studied in more detail to establish the kinetic links between exposure and body burden.

Keywords: *Human exposure, phthalates, organophosphates, plasticizers, flame retardants, modelling.*

Stockholm 2017
http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-141808

ISBN 978-91-7649-698-5
ISBN 978-91-7649-699-2

Department of Environmental Science and Analytical Chemistry

Stockholm University, 106 91 Stockholm