Urinary biomonitoring of organophosphate flame retardants in Japanese children and correlations with house dust concentrations

Bastiaensen M[1], Van den Eede N[1], Araki A[2], Ait Bamai Y[2], Kishi R[2], Covaci A[1]

1-Toxicological Center, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
2-Center for Environmental and Health Sciences, Hokkaido University, Kita 12, Nishi 7, Kita-ku, Sapporo 060-0812, Japan

Organophosphate flame retardants (OPFRs) are commonly used as additives in consumer products such as textile, PVC, furniture, electronic devices and foams to meet fire safety standards (1). In recent years, there has been growing concern over the potential health effects of OPFR exposure including carcinogenicity and endocrine disruption, especially in high-risk groups such as children (2). Japanese homes exhibit several phosphate flame retardants in dust samples, some of them in remarkably higher concentrations then elsewhere (1). After exposure OPFRs are readily metabolized by humans and several metabolites have been used for biomonitoring in the general population (2). The objectives of the present study were to monitor the urinary concentrations of OPFR metabolites in Japanese elementary school children, to investigate the relationship between concentrations in house dust and urine adjusted for personal and housing characteristics and to estimate intake to OPFRs.

In this study, we investigated the indoor environment and human exposure of 128 children residing in Sapporo, Japan. We collected dust samples, morning spot urine samples and questionnaires in October and November of 2009 and 2010. Results of OPFR dust levels were reported earlier (1). To complement these results, we measured thirteen urinary OPFR metabolites: bis(2-butoxyethyl) phosphate (BBOEP), dibutyl phosphate (DNBP), bis(2-butoxyethyl) 2-hydroxyethyl phosphate (BBOEHEP), bis(1-chloro-2-propyl) phosphate (BCIPP), bis(1-chloro-2-propyl) 1-hydroxy-2- propyl phosphate (BCIPHIPP), bis(1,3-dichloro-2-propyl) phosphate (BDCIPP), diphenyl phosphate (DPHP), 4-hydroxyphenyl diphenyl phosphate (4-HO-DPHP), bis(2-butoxyethyl) 3′-hydroxy-2-butoxyethyl phosphate (TBOEP-OH), 4-hydroxyphenyl diphenyl phosphate (4-HO-TPHP), 3-hydroxyphenyl diphenyl phosphate (3-HO-TPHP), 5-hydroxy-2-ethylhexyl diphenyl phosphate (5HO-EHDPHP) and tris(2-chloroethyl) phosphate (TCEP). Analyses were performed according to the method described by Xu et al (3). Correlations coefficients were calculated for parents-metabolites and among metabolites when there at least 50% simultaneous detects. Preliminary results show strong correlation between several urinary metabolites, indicating common exposure sources. BBOEP, BBOEHEP and TBOEP-OH all correlate mutually and with the concentration of their parent compound tris(2-butoxyethyl) phosphate (TBOEP, for which remarkably high concentrations were measured in dust. Correlations were also used to assess associations between urinary OPFR metabolite concentrations and demographic and housing characteristics. Next to that, we conducted linear regression model with urinary concentrations as response variable and with dust and creatinine concentrations as explanatory concentrations, adjusted for potential determinants of exposure. Estimations of intake doses were calculated for OPFRs with established health-based reference values based on urinary excretion of metabolites.

References:

1. Tajima S, Araki A, Kawai T, Tsuboi T, Bamai YA, Yoshioka E, Kishi R (2014) *Science of the Total Environment*. **478**, 190-199.
2. Van den Eede N, Heffernan AL, Aylward LL, Hobson P, Neels H, Mueller JF, Covaci A (2015). *Environment International*. **74**, 1-8.
3. Xu F, Van den Eede N, Neels H, Covaci A (2017). *Analytical and Bioanalytical Chemistry*, in review.