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KEY PREDICTORS OF HUMAN PBDE BODY BURDEN FOR A NORTH EAST UK COHORT

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Introduction

PBDEs are a group of additive flame retardants that were widely used in the late 20th Century until their association with negative human health effects became apparent. Whether dust or diet is the primary exposure source for PBDEs differs between individuals and over time and may be related to occupational exposure, age and extent of local use, countries, with age and over time. In a recent systematic review of associations between human exposure to PBDEs via diet and indoor dust, and internal dose, we concluded three key factors influenced correlations between external PBDE exposure and human body burden: 1) half-life of individual congeners in the human body; 2) proximity and interaction between PBDE source and study subject; and 3) time of study relative to phase out of PBDE technical products[1].

Penta, Octa and Deca are the three technical PBDE mixes of PBDEs. Production and use of Penta and Octa BDE were restricted from use in the EU in 2004[2], with the use of Deca BDE in electronics and electrical goods essentially ceasing in 2008[3]. PBDEs display a range of half-lives in humans with a general trend of shorter half-lives for the higher brominated compounds. Specifically, while estimates of human half-lives for Deca (BDE-209) are just a few days, for the main congeners of the Penta BDE mixture they are around two to four years[4,5]. The main origins of human body burdens of PBDEs can be expected to change over time away from indoor dust towards diet as BFR containing household goods such as soft furnishings and electronics are replaced with items that do not contain PBDEs[6]. The aims of this study were to determine the relative strength of various dietary and indoor environment PBDE exposure predictors for a UK cohort in the North East of the country.

Materials and methods

Participants were selected using a screening questionnaire to include urban and rural locations, and occupations and diets with expected divergent PBDE exposure. The study was approved by the Durham and Tees Valley Research Ethics Committee.

In 2011, the 10 co-habiting volunteer couples each completed a study week with food frequency and lifestyle questionnaires, food and activity diaries and room contents surveys to evaluate individual's external PBDE exposure. Study participants also provided a 24 hour duplicate diet sample, samples of dust from homes (living areas and bedrooms), workplaces and vehicles, 60 mL blood sample, and 50+ mL breast milk samples where possible (see Figure 1). Serum, milk and duplicate diet samples were extracted and analysed for PBDEs at Fera, York, UK, using previously described methods[7]; with dust samples analysed at the University of Birmingham, UK again using previously described methods[8]. The following PBDE congeners were measured: BDE17, 28, 47, 49, 66, 71, 77, 85, 99, 100, 119, 126, 138, 153, 154, 183 and 209.

Results and discussion

Both dust and diet were found to be important exposure sources, dependent on the individual. Exposure and food frequency questionnaires and room surveys, provided detailed insight into each participant's exposure history, and in conjunction with laboratory data, PBDE bioavailability and half-life information, predictors for the body burdens of individuals were assessed. Comparison of PBDE congener fingerprints for sampled matrices indicated serum and milk samples were influenced by Penta congeners with dust dominated by the Deca product (see Figure 2). Rooms with older soft furnishings and exposed foam, or items imported from the USA, demonstrated greater concentrations of Penta mix BDEs in their dust and consequently in the matched participants' body burdens. Duplicate diet samples were influenced by both Penta-BDE congeners and BDE-209.

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Figure 1: Conceptual Exposure Model/ Study Design

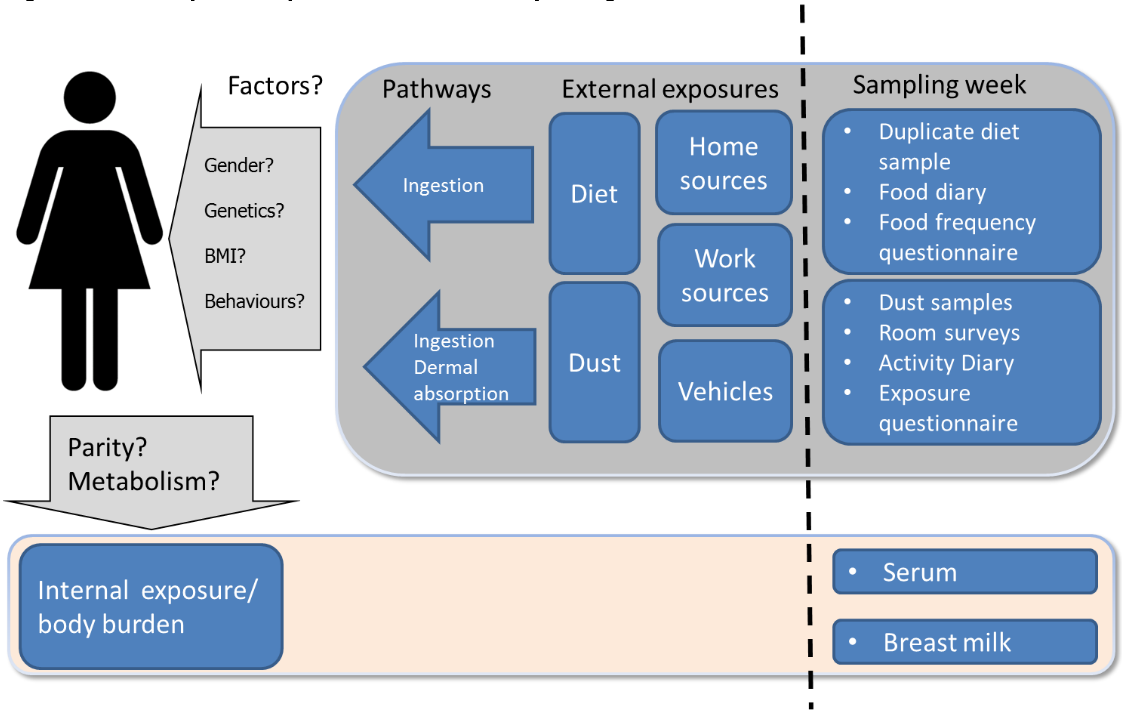

Figure 2: Congener proportions in different matrices for this study and technical mixtures