Exposure to Organophosphorus Flame Retardants (PFRs) through Human Breast Milk Feeding

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Abstract
Organophosphorus flame retardants (PFRs) are added to a wide range of consumer products, including televisions, computers, electrical outlets and household textiles, to reduce the flammability. Since two major brominated flame retardants (BFRs), i.e., polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDs) were listed in the Stockholm Convention on persistent organic pollutants (POPs), the use of PFRs has been increasing. Therefore, environmental contamination and exposure for human are of public concern. However, limited information on human exposure to PFRs is available so far. In the present study, we investigated the levels of PFRs, PBDEs, and HBCDs in human breast milk collected from some Asian countries including Vietnam, the Philippines and Japan. PFRs and PBDEs were detected in most of the analyzed breast milk samples from Asian countries. In Japan, the concentrations were in the order of PFRs = HBCDs > PBDEs and levels of PFRs and HBCDs were higher than those of PCBs. As the result of temporal variation study, PFR and HBCD levels were higher in 2009-2014 than in 1999 while PCBs showed a decreasing trend. Since the estimated daily intake (EDI) values for some PFRs were close to the reference dose, adverse effects of these compounds should be investigated in future.

Conclusions
Accumulation level
• Philippines > Vietnam > Japan
• Exposure level could be affected by e-waste dismantling

Temporal trend
• Levels of PFRs and HBCDs have increased during study period

Recent increase in production and use of PFRs and HBCDs

Exposure assessment
• Some EDI values for TBP, TCEP and TDCIPP were close to RfDs

Health effect on breast feeding infant should be investigated in the future.

Results and Discussion

Fig. 1 Concentration of PFRs in breast milk from Japan, Vietnam and the Philippines.

Fig. 2 Temporal variation of PFRs, HBCDs, PCBs and PBDEs in breast milk from Japan.

Fig. 3 Estimated daily intake (EDI) of PFRs through breast milk ingestion in Japan, Vietnam and the Philippines.

Materials and Methods
Targeted 10 PFRs Compounds

Analytical Method

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