Persistent Organic Pollutants in Human Breast Milk Collected around the Open Dumping Site in Kolkata, India

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Introduction

During the past few decades, numerous investigations on pollution of persistent organic pollutants (POPs) such as polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs), biphenyls (PCBs) and organochlorine insecticides in human breast milk have been conducted in various countries with a view to assessing risks for infants. As a result, in developed countries, it was found that levels of POPs in human breast milk have decreased in recent decades (*1, 2*). In Asian developing countries, however, information on POPs, especially dioxins and related compounds such as PCDDs, PCDFs, and coplanar PCBs (Co-PCBs), in human breast milk is still limited.

Our study group conducted investigations on POPs pollution in human breast milk from the open dumping sites of municipal wastes and control sites in Asian developing countries such as India, Cambodia, Vietnam, and the Philippines and demonstrated that levels of dioxins and related compounds in human breast milk from Indian dumping site were significantly higher than those in other countries and Indian control site (*3*). This result indicates that significant pollution sources of dioxins and related compounds, which are probably formed by spontaneous combustion or intentional incineration of municipal wastes, are present in Indian dumping site and residents around there have been exposed to relatively high levels of these contaminants. However, our study focused only on the dumping site in Chennai, which is located on southern India, and so it is unknown whether the residents in other regions are exposed to high levels of dioxins and related compounds and other POPs.

Hence, the present study attempted to elucidate the contamination status of POPs in human breast milk collected from the dumping and control sites in Kolkata, northeastern India.

Materials and Methods

Human breast milk samples (n=18) were collected from mothers living near the open dumping site of municipal wastes in Kolkata, northeastern India during 2004-2005. Samples (n=14) were also

collected from mothers in a location 30 km away from the dumping site (control site). We obtained informed consent from all the donors of milk samples. Samples were collected in chemically cleaned containers and stored in Environmental Specimen Bank (*es-BANK*) for Global Monitoring of Ehime University at –20 °C until analysis. POPs were measured following the method described previously (*3, 4*). TEQs were calculated using WHO-TEFs (*5*). Statistical analyses were conducted by using Mann-Whitney *U* test and Spearman's rank correlation coefficient.

Results and Discussion

POPs were detected in all the samples of human breast milk analyzed in this study (Table 1). No significant difference was observed between concentrations of POPs in primiparae and multiparae. Generally, concentrations of POPs in primipara milk are higher than those in multipara (*3, 4*) due to elimination of POPs in multipara via the past lactation. Considering these observations, concentrations of POPs in multiparae of Kolkata may supposedly attain similar levels as in primiparae soon after weaning of the child because of continuous exposure to these contaminants.

Table 1. Concentrations of POPs in human breast milk collected from Kolkata, India.

Compound	Dumping site		Control site	
	Primipara (*n* =12)	Multipara (*n* =6)	Primipara (*n* =8)	Multipara (*n* =6)
	Mean ±SD (Range)	Mean ±SD (Range)	Mean ±SD (Range)	Mean ±SD (Range)
Lipid (%)	2.6 ±0.87 (0.92-3.6)	2.5 ±1.4 (1.4-5.1)	2.4 ±0.81 (1.7-4.0)	1.8 ±0.90 (0.88-3.4)
PCDDs [a]	710 ±270 (350-1300)	560 ±440 (240-1300)	920 ±590 (290-1800)	1400 ±1000 (220-3200)
PCDFs [a]	44 ±17 (27-87)	39 ±23 (17-65)	56 ±35 (21-120)	58 ±38 (6.8-120)
Non-*ortho* PCBs [a]	350 ±250 (74-890) [c *]	410 ±260 (110-850)	110 ±68 (19-220)	92 ±35 (61-160)
Mono-*ortho* PCBs [b]	100 ±84 (16-290) [c **]	100 ±62 (34-170)	15 ±9.6 (4.4-33)	15 ±6.2 (5.8-24)
TEQs [a]	62 ±34 (27-150) [c *]	51 ±28 (20-90)	34 ±19 (17-73)	35 ±17 (7.9-58)
PCBs [b]	240 ±150 (43-520) [c **]	220 ±140 (110-490)	43 ±26 (16-99)	37 ±21 (20-74)
HCHs [b]	350 ±210 (81-650)	180 ±120 (60-380)	880 ±540 (74-1900) [d *]	670 ±600 (81-1700)
DDTs [b]	870 ±620 (130-2500)	370 ±250 (200-860)	1000 ±680 (240-2400)	1300 ±900 (350-2800)
CHLs [b]	6.6 ±2.2 (3.6-11) [c **]	3.8 ±4.1 (1.8-12)	3.1 ±2.3 (0.58-7.0)	3.4 ±2.7 (0.40-7.3)
HCB [b]	2.2 ±0.92 (1.3-4.6)	2.0 ±1.3 (0.77-4.4)	4.5 ±1.8 (2.4-8.4) [d *]	4.8 ±2.5 (2.0-9.3)

[a] pg/g lipid wt.
[b] ng/g lipid wt.
[c] Concentrations of dumping site were significantly higher than those of control site.
[d] Concentrations of control site were significantly higher than those of dumping site.
* $p < 0.05$, ** $p < 0.01$

Concentrations of non- and mono-*ortho* PCBs in human breast milk from the dumping site were significantly higher than those from control site, whereas no different levels were found for PCDDs and PCDFs (Table 1). In addition, significant higher concentrations of total PCBs were also observed in dumping site milk than control site. These results indicate that pollution sources of PCBs are present in Kolkata dumping site, possibly which leach out from dumped electric equipments with old transformers and capacitors, and hence the residents around there have been exposed to relatively high levels of PCBs. Interestingly, concentrations of total and dioxin-like PCBs in dumping site milk significantly increased with the number of years living there (Fig. 1), supporting exposure to these contaminants derived from the dumping site. Furthermore,

concentrations of chlordane compounds (CHLs) in dumping site milk were higher than those in control site milk, implying possible sporadic usage for public health purposes. On the other hand, concentrations of HCHs and HCB were higher in control site than dumping site milk (Table 1). The control site investigated in this study was an active agricultural area, and so these organochlorine insecticides may be presumed as still being used in this region.

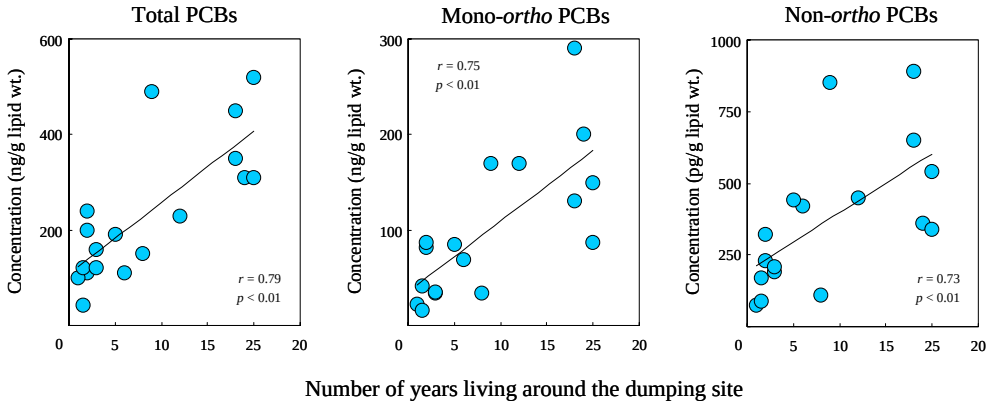

Fig. 1. Relationship between the number of years living around the dumping site and concentrations of dioxin-like and total PCBs in human breast milk from Kolkata dumping site.

Previously, we conducted investigations on POPs pollution in human breast milk from the open dumping sites of municipal wastes in Chennai, southern India, and showed that mean concentrations of TEQs and PCBs were 38 pg/g and 110 ng/g lipid wt., respectively (*3*, *6*). Levels of TEQs and PCBs in dumping site milk from Kolkata were notably higher than those from Chennai, indicating that the magnitude of pollution by these contaminants in Indian dumping sites could be different domestically. Furthermore, levels of TEQs and PCBs in Kolkata milk were also higher than in Japanese milk reported recently (*7*) (Fig. 2). This result implies that the residents around Kolkata dumping site have been exposed to relatively higher levels of dioxins and related compounds and PCBs compared with general public in developed countries. In developed countries, it is reported that residue levels of dioxins and related compounds and PCBs in human breast milk have been decreasing (*1*, *2*) because of the installation of highly efficient incinerators and strict regulations on the production and usage of various chemicals. On the other hand, in India, it can be anticipated that the pollution caused by dioxins and related compounds and PCBs may increase further and hence levels of these contaminants in human breast milk, especially the residents around the dumping sites, may also increase in the future, because the release of dioxins and related compounds and PCBs is not at all controlled even now.

To understand the magnitude of exposure to TEQs and PCBs by infants, daily intake (DI) was estimated from the levels of these contaminants in human breast milk observed in this study, based

on the assumption that an infant ingests 700ml milk per day and the weight of an infant is 5kg. Not only DIs of TEQs in all the milk but also DIs of PCBs in some dumping site samples exceeded the TDI proposed by WHO and Health Canada, implying that infants in Kolkata might be at higher risk by these contaminants.

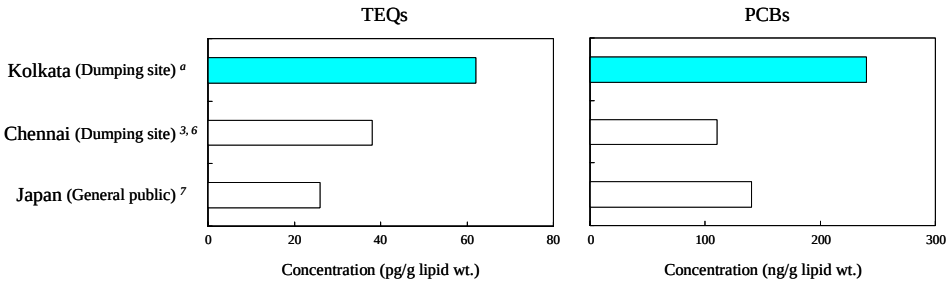

Fig. 2. Comparison of TEQs and PCBs levels in human breast milk collected from the residents around dumping sites in Kolkata and Chennai, and from the general public in Japan. [a] This study, [3, 6, 7] References cited.

Acknowledgments

This study was supported by "21st Century COE Program" from the Ministry of Education, Culture, Sports, Science and Technology, Japan, and the Toyota Foundation.

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