

Persistent organic pollutants in human breast milk collected from Dalian and Shenyang, China

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Introduction

During the past few decades, numerous investigations on pollution of persistent organic pollutants (POPs) such as dioxins, PCBs and DDTs in human breast milk have been conducted in various countries with a view to assessing risks for infants. In developed countries, it was found that levels of POPs in human breast milk have decreased in recent decades (1, 2). On the other hand, in some developing and former soviet countries, it is suspected that organochlorine insecticides such as DDT and HCH are still in use, and relatively high levels of these contaminants have been observed in human breast milk (3, 4).

China, which has the largest ground area among Asian countries, produced large quantities of technical HCH and DDT in the past and mainly used these organochlorine insecticides in agricultural fields (5, 6). In fact, high levels of HCHs and DDTs have been detected in seawater, sediment and fish from China (7-9). In addition, relatively high levels of PCBs have been detected in aquatic media along industrialized areas (8, 9). Thus, in China, because of anticipated higher levels of pollution by POPs in the environment, some investigations on pollution by these contaminants in environmental media have been recently conducted. However, no information on human exposure to POPs in northeastern parts of China is available, although a few investigations have been conducted in southeastern parts around Hong Kong.

The present study attempted to elucidate the contamination status of POPs in human breast milk collected from primiparae in Dalian and Shenyang, northeastern China.

Materials and Methods

Human breast milk samples were collected from primiparae in Dalian ($n=20$) and Shenyang ($n=20$), northeastern China during November and December 2002. We obtained informed consent from all the primiparae, who have donated breast milk. Ages of primiparae in Dalian and Shenyang were within 24-34 (mean; 28.0) and 22-40 (mean; 28.5) years, respectively, and no statistically significant difference was observed. In this study, dioxins and related compounds in 5 pooled samples of human breast milk from Dalian ($n=3$) and Shenyang ($n=2$) were also analyzed. Pooled sample was obtained by mixing each 10 ml of milk from 5 primiparae (final volume 50 ml). The five pooled samples belonged to the following age groups, Dalian; 26-27, 28-29, and 30 years, and

Shenyang; 25-28, 29-32 years. Samples were collected in chemically cleaned containers and stored at -20°C until analysis. POPs were analyzed following the method described previously (10). TEQs were calculated using WHO-TEFs (11).

Results and Discussion

POPs were detected in all the samples of human breast milk analyzed in this study (Table 1). DDTs and HCHs were predominant in human breast milk from both Dalian and Shenyang and the levels were 1-2 order of magnitude higher than other POPs. It has been previously reported that DDTs and HCHs were predominant in environmental media and biota including humans along the coastal area around Hong Kong (7, 9, 12). These results indicate that pollution sources of DDTs and HCHs are also present in northeastern regions of China and extend over the wide range of coastal areas in China. Furthermore, concentrations of POPs in human breast milk from Dalian were significantly higher than those from Shenyang (Fig. 1), implying that greater exposure sources of these contaminants are present near coastal areas rather than inland. It was anticipated that intake of seafood in Dalian may be one of main reasons why levels of POPs in human breast milk from Dalian were higher, because of active fishing industry in the area, although we could not obtain details of feeding habits of milk sample donors.

Table 1. Concentrations (arithmetic mean \pm standard deviation) of POPs in human breast milk collected from primiparas in Dalian and Shenyang, China

Location	Lipid (%)	Concentration (ng/g lipid wt.)				
		DDTs	HCHs	HCB	PCBs	CHLs
Dalian	1.4 \pm 0.84	2100 \pm 1200	1400 \pm 1500	81 \pm 46	42 \pm 22	16 \pm 6.8
	(0.35-3.5)	(780-5400)	(140-7200)	(30-220)	(11-91)	(4.7-31)
Shenyang	1.7 \pm 1.1	870 \pm 740	550 \pm 520	56 \pm 30	28 \pm 21	6.7 \pm 3.5
	(0.77-5.2)	(140-3200)	(120-2200)	(25-120)	(8.8-100)	(0.71-17)

Figures in parentheses show the range of concentrations.

To understand the magnitude of contamination in human breast milk from Dalian and Shenyang, levels of POPs were compared to those reported recently in human breast milk from other developed, developing and former soviet countries (1-4, 13-21) (Table 2). Concentrations of HCHs from Dalian were relatively higher compared with other developed, developing and former soviet countries, while the levels were lower than those from Kazakhstan, where recent use of technical HCH in cotton field is suspected (3). In addition, concentrations of DDTs in human breast milk from Dalian were notably higher than those from developed countries where the use of technical DDT was banned in 1960-70s and comparable to those from developing and former soviet countries where use of technical DDT for agricultural and public health purposes even in recent years has been suspected. Furthermore, HCB levels in human breast milk from Dalian were relatively higher compared with other countries. On the other hand, concentrations of PCBs and CHLs in human breast milk from Dalian and Shenyang were relatively lower.

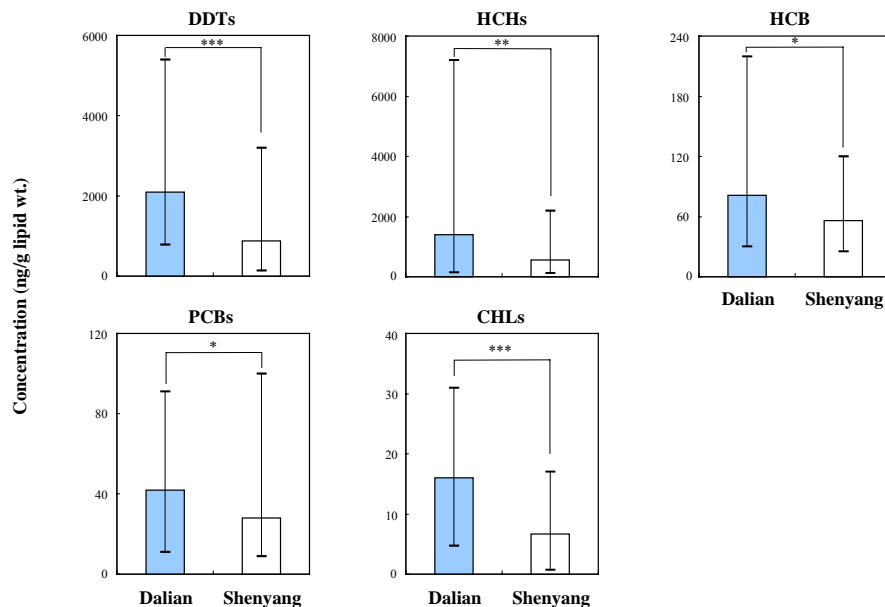


Fig. 1. Comparison of POPs levels in human breast milk collected from primiparae in Dalian and Shenyang.

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 2. International comparison of POPs (ng/g lipid wt.) in human breast milk

Country	Survey year	PCBs	DDTs	HCHs	CHLs	HCB	ref.
Developing and							
<i>former socialist countries</i>							
Dalian	2002	42	2100 ^a	1400 ^e	16 ⁱ	81	Present study
Shenyang	2002	28	870 ^a	550 ^e	6.7 ⁱ	56	Present study
Turkey	1995-96	-	2400 ^b	480 ^e	-	50	(13)
Iran	1991	-	2000 ^b	600 ^e	-	61	(14)
Brazil	1992	150	1700 ^a	280 ^e	-	12	(20)
Mexico	1997-98	-	4700 ^c	60 ^e	-	30	(4)
Kenya	1991	-	470 ^c	96 ^f	-	-	(18)
Kazakhstan	1994	380	2300 ^b	2300 ^f	-	91	(3)
Russia	1996	520	2000 ^b	560 ^j	27 ^j	99	(15)
Developed country							
Japan	1998	200	290 ^b	210 ^g	85 ⁱ	14	(1)
Sweden	1997	320	170 ^b	-	-	12	(2)
Germany	1995-1997	550	240 ^b	40 ^g	-	80	(21)
Canada	1996	250	470 ^d	23 ^e	140 ⁱ	43	(19)
Spain	1991	-	610 ^b	280 ^e	-	0.6	(17)
UK	1997-98	-	470 ^b	100 ^h	-	43	(16)

^a p,p' -DDE + p,p' -DDT + p,p' -DDD. ^b p,p' -DDE + p,p' -DDT. ^c p,p' -DDE + p,p' -DDT + p,p' -DDD + o,p' -DDT. ^d p,p' -DDE + p,p' -DDT + o,p' -DDT. ^e α -HCH + β -HCH + γ -HCH.

^f α -HCH + β -HCH. ^g β -HCH only. ^h β -HCH + γ -HCH. ⁱ oxychlordane + *trans*-nonachlor + *cis*-nonachlor. ^j total.

The present study also determined pollution levels of dioxins and related compounds in pooled samples of human breast milk collected from primiparae in Dalian and Shenyang (Table 3). No significant difference of dioxin concentrations was observed between Dalian and Shenyang, and no clear correlation with mother's age was observed, either. The TEQs in human breast milk from Dalian and Shenyang were notably lower than those from Japan (22), which is the most developed country in Asia, indicating that pollution levels of dioxins and related compounds in the Chinese environment and human exposure to these contaminants are relatively low.

Table 3. Concentrations (pg/g lipid wt.) of dioxins and related compounds in pooled samples ^a of human breast milk from Dalian and Shenyang, China

	Dalian			Shenyang	
	26-27 ^b	28-29 ^b	30 ^b	25-28 ^b	29-32 ^b
Lipid (%)	1.5	1.6	2.1	2.1	2.0
PCDDs	40	41	51	37	21
PCDFs	22	14	20	15	9.4
non-ortho PCBs	47	47	46	31	34
mono-ortho PCBs	4000	5000	4900	3700	5200
PCDDs-TEQs	2.4	1.9	2.3	2.1	1.4
PCDFs-TEQs	3.0	2.6	3.4	3.0	2.1
non-ortho PCBs-TEQs	2.2	2.0	2.3	1.8	2.0
mono-ortho PCBs-TEQs	0.69	0.94	0.86	0.66	0.82

^a 5 samples (10 ml of each sample) were pooled.

^b Range of mother's age

To understand the magnitude of exposure to HCHs and DDTs by infants, we estimated average daily intake (ADI) 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 (3). As expected, ADIs of HCHs and DDTs from Dalian were significantly higher than those from Shenyang, implying that infants in Dalian might be at higher risk by these contaminants.

Acknowledgments

The authors would like to express special gratitude to the doctors and the paramedics in Dalian and Shenyang. This study was supported by Grants-in-Aid for Scientific Research (A) (No.12308030) from Japan Society for the Promotion of Science and for Scientific Research on Priority Areas (A) (No. 13027101) and “21st Century COE Program” from the Ministry of Education, Culture, Sports, Science and Technology, Japan, and by a grant for studies on endocrine disruptors from CREST-JST (Kayama F).

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