PCDDs, PCDFs, and PCBs concentrations in breast milk from two areas in Korea : Body burden of mothers and implications for infant feeding.

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Introduction

Infants are exposed to PCDDs/PCDFs and PCBs prenatally and via breast milk(Startin, 1988, US EPA, 1994). With a longer duration of breast-feeding an increasing body burden of these compounds can be expected in the infant, along with a decrease in the maternal body burden. After six to seven months of nursing, the concentrations measured in blood fat of infants were distinctly higher than those of their mothers(Abraham et al, 1998).

In order to assess the maternal body burden based on PCDDs/PCDFs and PCBs concentrations in breast milk and the infant intake rate through breast-feeding, concentrations of these compounds were measured in breast milk samples from 24 mothers living in Korea.

Material and Methods

Twenty-four milk samples were obtained in 1997 from volunteer mothers living in an urban area(Seoul, n=11), and an industrial area(Inchon, n=13) of Korea. The participants in the study were 24-48 years of age, who had lived in the respective areas for at least 5 years. As pretreatment, fat was extracted from samples by the School of Environmental Engineering at Pohang University. PCDDs/PCDFs were analyzed by HRGC-HRMS while PCBs were analyzed by GC-MS at the Fisheries & Oceans Lab. of Canada.

Calculation of PCDDs/PCDFs and PCBs body burden was made according to a maternal weight of 66kg(Average body weight in Korea, 1995) and that maternal body weight was 30% lipid. The equation used for calculating body burden was :

$$\text{Body Burden (TEQ ng)} = C_{milk}(\text{TEQ ng/kg fat}) * BW_{mother}(\text{kg}) * \text{Lipid (\%)}$$

where C_{milk}(TEQ ng/kg fat) : Concentration in maternal milk
BW_{mother}(kg) : Body weight of mother

The daily dioxin intake rate of the mother can be predicted on the basis of the levels in breast milk. Such procedures have been developed by Smith(1987) and Sullivan et al.(1991). The approach assumes that the concentration in breast milk fat is the same as in maternal fat and can be calculated as follows:

$$ADD_{mother}(\text{pg/kg/day}) = (C_{milk}(\text{TEQ pg/kg fat}) * 0.693 f_2) / (h(\text{day}) * f_1)$$

where ADD_{mother}(pg/kg/day) : Average daily dose to the mother
h(day) : Half-life of dioxin in adult
f_1 : Proportion of ingested dioxin that is stored in fat
f_2 : Proportion of mother's weight that is fat(kg maternal fat/kg total body weight)

For the daily dioxin intake rate of the mother, there was assumed to be a 7-year half-life of the dioxin-like compounds, 0.9 for f_1(Smith, 1987) and 0.3 for f_2(Smith, 1987).

Using the estimated PCDDs/PCDFs and PCBs concentration in breast milk, the daily dioxin intake rate of an infant by breast-feeding can be estimated as follows :

$$ADD_{infant}(\text{pg/kg/day}) = (C_{milk}(\text{TEQ pg/kg fat}) * f_3 * f_4 * IR_{milk}(\text{kg/day}) * ED(\text{yr})) / (BW_{infant}(\text{kg}) * AT(\text{yr}))$$

where ADD_{infant}(pg/kg/day) : Average daily dose to the infant
IR_{milk}(kg/day) : Ingestion rate of breast milk
ED(yr) : Exposure duration
AT(yr) : Averaging time
f_3 : Fraction of fat in breast milk
f_4 : Fraction of ingested contaminant that is absorbed

Calculations for infant intake were made on the assumption that an infant consumed 800gr/day, fat comprised 4% of breast milk and 90% of ingested contaminant was absorbed. The concentrations of chemicals decline by 20% within 6 months because of the chemical's excretion into milk(Rogan et al, 1991). The concentration in breast milk after 3 months breast-feeding was adjusted consecutively applying first-order kinetics.

Results and Discussion

PCDDs/PCDFs and PCBs levels in breast milk from mothers living in the urban area were higher

than those in the industrial area. PCDDs/PCDFs and PCBs levels in breast milk from primipara mothers (20.5TEQ pg/g fat, 5.5TEQg/g fat, respectively) were found to be higher than those from multipara mothers(8.5TEQ pg/g fat, 3.0TEQg/g fat, respectively)(Table 1). For PCDDs/PCDFs, 2,3,4,7,8-PeCDD(about 40%) was the predominant congener, and the proportion of 2,3,7,8-TCDD was less than 3%. For PCBs, PCB-126(about 75%) was the predominant congener(Fig. 1). The correlations between PCDDs/PCDFs and PCBs concentrations were positive but they were not significant. The ratio of the PCBs to PCDDs/PCDFs TEQ concentration averaged 0.3 and it was a similar ratio compared to the UK and USA. Maternal body burden levels of PCDDs/PCDFs and PCBs based on their concentrations in breast milk were 268-622 TEQ ng(Fig. 2). These body burden levels were found to be slightly higher than those of mothers in the USA(74-310 TEQ ng). The daily dioxin intakes of mothers were predicted to be 0.78-2.18 TEQ pg/kg/day for PCDDs/PCDFs and 0.34-0.66 TEQ pg/kg/day for PCBs(Fig. 3). The daily intakes of an infant for PCDDs/PCDFs and PCBs are listed in Table 2. The daily intakes of a 0-3-month-old infant were 3.5 times higher than that of a 7-12-month-old infant. For the first year, the body burden of an infant was predicted to be 84 TEQ ng and the daily intake of infant was predicted to be 231 TEQ pg/day, assuming 50^{th} percentile PCDDs/PCDFs concentration(10.63 TEQ pg/ g fat). According to these results, the 50^{th} percentile daily intake for PCDDs/PCDFs in an infant was found to be higher than those of mothers(51-144 TEQ pg/day) and adults in the USA(119 TEQ pg/day).

Acknowledgement

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Table 1. PCDDs, PCDFs and PCBs concentrations in breast milk in Korea

	Urban area						Industrial area					
	Primipara			Multipara			Primipara			Multipara		
	Mean	SD	(n)	Mean	SD	(n)	Mean	SD	(n)	Mean	SD	(n)
PCDDs(pg/g fat)	994	337		-	-		994	337		994	337	
PCDFs(pg/g fat)	260	310	(6)	-	-		260	310	(2)	260	310	(7)
Dioxin(TEQ pg/g fat)	**24.06**	**18.30**		**-**	**-**		**24.06**	**18.30**		**24.06**	**18.30**	
Non-ortho PCBs(pg/g fat)	243	310		499	581		243	310		243	310	
Mono-ortho PCBs(pg/g fat)	10379	4502	(8)	4235	3186	(3)	10379	4502	(4)	10379	4502	(9)
PCBs(TEQ pg/g fat)	**7.79**	**1.95**		**3.72**	**2.75**		**7.79**	**1.95**		**7.79**	**1.95**	

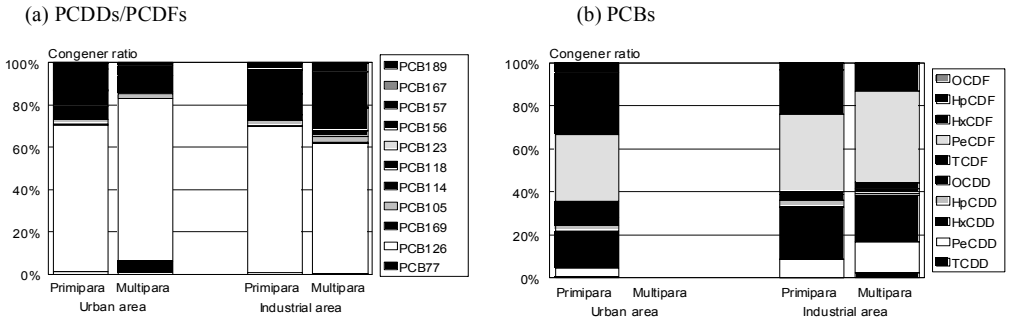
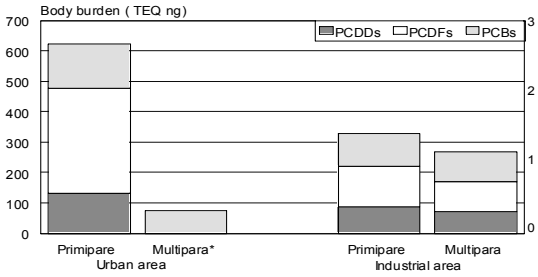
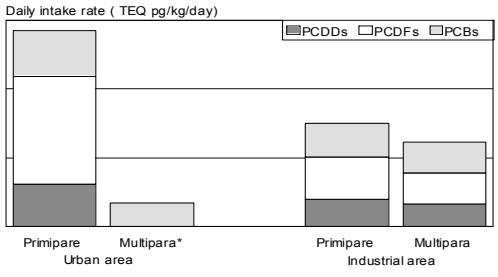


Figure 1. Proportion of PCDDs/PCDFs and PCBs congener in breast milk in Korea



* PCDDs/PCDFs data not available

Figure 2. Comparison of maternal body burden of PCDDs/PCDFs and PCBs based on their concentration in breast milk



* PCDDs/PCDFs data not available

Figure 3. Comparison of maternal daily intake of PCDDs/PCDFs and PCBs based on their concentration in breast milk

Table 2. Infant daily intake rate of PCDDs/PCDFs and PCBs based on their concentration in breast milk in Korea

	Concentration of chemical in breast milk (TEQ pg/g fat)		ADD_{infant} (TEQ pg/kg/day)					
			0 – 3 months (body weight : 5kg)		4 – 6 months (body weight : 7kg)		7 – 12 months (body weight : 11kg)	
	50^{th} percentile	90^{th} percentile	50^{th} percentile	90^{th} percentile	50^{th} percentile	90^{th} percentile	50^{th} percentile	90^{th} percentile
PCDDs	4.35	8.55	25	49	14	28	7	14
PCDFs	6.28	18.56	36	107	21	61	10	31
PCBs	6.89	8.43	40	49	23	28	11	14
Total	17.52	35.45	101	205	57	116	29	59