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Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans in Breast Milk from Chinese Schistosomiasis Areas

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PCDD/Fs are globally distributed toxic chemicals in the environment and were first identified in human milk from general population in the 1980s (Vartianen 1997). Food is the main source of PCDD/Fs and PCBs of human. The concern about effects of these compounds to health of breast-fed infants is rising worldwide (Hashimoto 1995). WHO/EURO has coordinated two rounds of follow-up studies on levels of PCDD/Fs and PCBs in human milk. Data concerning the levels of PCDD/Fs in human milk are being stored year by year, but very limited data are available in China.

In China, schistosomiasis prevailed in the middle and lower valleys of the Yangtze River for a long time and technical sodium pentachlorophenate (Na-PCP) has been sprayed since the 1960s to control the spread of snailborne schistosomiasis. As one of the by-products of Na-PCP, PCDD/Fs distribute in the environment and may accumulate in food link. Schecter et al. (1996) compared PCDD/Fs levels in blood and milk in agricultural workers and others following Na-PCP exposure in a region in the Jiangxi Province, China. But their data of dioxin contents in human milk were from a mixed milk sample (n = 50). This research was in an ongoing study on chlorinated contaminants in environmental samples in Lake-D (Zheng 1997), a region where schistosomiasis continues to be a public health problem and Na-PCP had been sprayed until the end of 1990s. To assess exposure to PCDD/Fs, the human milk was obtained from 33 primiparous mothers living in the region near the Lake-D in 2000.

MATERIALS AND METHODS

Selection criteria for breast milk donors were primiparae living in the region at least 5 years and infants were less than 2 weeks of age before collecting breast milk. Table 1 shows the demographic characteristics of 33 primiparae and infants from Lake-D.

Twenty-four of 33 infants in this study were male. In fact the participants were random volunteers. There was no evidence for selection bias for male infants in the study.

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The exposure assessment questionnaire determined the health status and breast-feeding pattern of the infant; the health status, food frequency pattern, smoking status, medication use, and residential history of the mother; and work history of the mother and father. All the mothers lived and worked in the villages around the Na-PCP sprayed lake since they were born. All the infants were breast-fed.

Table 1. Demographic characteristics of primiparae and infants

	Maternal					Infant
	Age	Resid. History	Height (cm)	Weight (kg)	Milk (day)*	Weight (kg)
Mean	26.3	26.3	158.3	50.1	----	3.78
Range	22 - 33	22 - 33	153 - 165	41 - 60	3 - 12	2.5 – 4.9

*The time to collect milk after delivery.

Breast milk samples (150-200ml) were collected in November 2000 and frozen immediately. Then they were stored at –20℃ until analysis were performed.

The thawed milk samples were homogenized and then ^{13}C-labelled internal standards for 15 2,3,7,8-substituted PCDD/Fs were added to 100 ml of milk. The steps of extraction and cleanup were according to previously described methods (Amirova 1999). Before GC/MS analysis, two ^{13}C-labelled PCDD/Fs were added as the recovery standards.

All analyses were carried out by Agilent 6890 GC/5973 MS using a 60m DB-5 fused-silica column. Quantification was performed in selected-ion monitoring mode. Laboratory reagent and equipment blanks were analyzed prior to a series of samples to test for the presence of background contamination.

The lipid in 10 ml breast milk of each sample was extracted by acetone / hexane (1:1). Lipid contents were determined by accurate weighing after the organic extract vaporized to a constant weight.

RESULTS AND DISCUSSION

The 2,3,7,8-substituted PCDD/Fs were measured in breast milk samples from 33 donors. PCDD/Fs were below the detection limits in 5 samples. Results of the concentration of PCDD/Fs in other samples are shown in table 2. PCDD/Fs levels expressed in International toxic equivalents (I-TEQs) and WHO-TEQs in table 2 were calculated respectively by using the International equivalency factors (I – TEFs) and WHO-TEFs. Detection limits for PCDD/Fs congeners were 9 pg/g fat. Recoveries for internal standards were over 70%.

From table 2, it can be seen that the lipid content of breast milk varied (1.431 – 4.918 g/100 ml), but no significant relationships were found between lipid content and maternal or infant demographics, or PCDD/Fs contaminant concentrations.

Table 2. Concentration of 2,3,7,8-substitute PCDD/Fs in breast milk samples

Sample	Fat (g/100ml)	1,2,3,4,6,7,8 -H_7CDD (pg/g fat)	OCDD (pg/g fat)	OCDF (pg/g fat)	Σ I-TEQs (pg/g fat)	Σ WHO-TEQs (pg/g fat)
1	2.306	ND	132	ND	0.13	0.01
2	2.469	ND	114	ND	0.11	0.01
3	2.960	ND	51	ND	0.05	0.01
4	1.559	ND	849	243	1.09	0.11
8	2.773	ND	84	42	0.13	0.01
10	2.840	ND	242	ND	0.24	0.02
11	2.973	ND	344	ND	0.34	0.03
12	4.709	82	14938	ND	15.8	2.3
13	2.649	ND	63	ND	0.06	0.01
14	2.607	ND	180	ND	0.18	0.02
15	2.188	ND	157	55	0.21	0.02
16	4.081	ND	40	ND	0.04	0.004
17	1.780	ND	32	ND	0.03	0.003
18	3.237	ND	369	ND	0.37	0.04
19	3.766	ND	46	ND	0.05	0.005
20	1.450	ND	210	ND	0.21	0.02
22	2.567	ND	80	ND	0.08	0.008
23	3.349	ND	11	ND	0.01	0.001
25	3.096	ND	135	103	0.24	0.02
26	3.056	ND	135	110	0.25	0.02
27	4.918	ND	174	ND	0.17	0.02
28	1.618	ND	12137	ND	12.1	1.2
29	2.736	ND	127	88	0.22	0.02
30	1.431	ND	180	352	0.53	0.05
31	2.227	ND	68	ND	0.07	0.007
32	2.261	ND	109	117	0.23	0.02
33	3.698	ND	118	70	0.19	0.02

ND < 9 pg/g fat.

It is obvious that OCDD is the predominant congener of PCDD/Fs in this study. OCDD is consistent with the high amounts of 17 2,3,7,8-substituted PCDD/Fs congeners detected in the Na-PCP technical products used to control schistosomiasis (Bao 1995). This congener pattern is also obvious in studying the PCDD/Fs in lake sediments from Lake-D (Zheng 1997). Zheng compared the components of the PCDD/Fs in lake sediments and Na-PCP. The comparison suggested that the dioxin TEQ in lake sediments resulted from Na-PCP. It is a good explanation that the PCDD/Fs in human milk are also mainly resulted from Na-PCP. The intake may occur through skin contact, by inhalation, and through ingestion from the food chain. Long-term bioaccumulation of these persistent toxic compounds might be an explanation to the exposure to PCDD/Fs. Further study of the food chain would help to better characterize environmental contamination from technical Na-PCP in Lake-D.

OCDF is more abundant in sample 4, 30, 32 and 33 than in other samples. This suggested that OCDF should not simply result from typical Na-PCP contamination. The individual differences and other pollutants should be studied to get further information.

The OCDD concentration and I-TEQs of sample 12 and 28 in table 2 are much higher than those of the breast milk (5.4 pg I-TEQ / g fat) from the region in the Jiangxi Province, China (Schecter, 1994). Compared with the mixed breast milk sample (n = 50) analyzed by Schecter et al, this study shows the individual differences by analyzing individual samples.

Hashimoto et al (1995) compared the dioxin levels in some more industrialized countries. Except the three samples of 4,12 and 28, generally speaking, the region polluted by chlorinated contaminants has characteristic low levels of PCDD/Fs in human milk in comparison with most of those countries. The lower levels of chemical use and environmental contamination in China might be a good explanation.

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