Concentrations of polychlorinated biphenyls (PCBs) in blood and breast milk collected from 125 mothers in Hokkaido, Japan

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Abstract

In this study, we determined the concentrations of PCBs in the blood of pregnant women and in breast milk from the same mothers collected between 2002 and 2005 from 125 mothers living in Hokkaido, Japan. We also investigated the relationship between concentrations of PCBs in the blood and the breast milk. The ratio of PCB congeners in the blood and in breast milk were found to be quite similar, and significant positive correlations between total PCBs concentrations in the blood and breast milk were observed. These results suggest that PCBs accumulated in the blood can be transferred to the breast milk. However, the breast milk-to-blood concentration ratios of each congener of PCBs tended to decrease with higher chlorinated congeners.

Introduction

Polychlorinated biphenyls (PCBs) are widespread environmental contaminants; they accumulate in the human body through the food chain[1] and are present in the blood and in breast milk. The effects of presistent organic pollutants (POPs), including PCBs, have been of great concern in the field of public health, and there is strong interest in determining the influence of these chemicals on the health of fetuses and infants. We have previously reported[2] the concentrations of dioxin and related chemicals, including dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), non-*ortho* coplanar polychlorinated biphenyls (non-*ortho* PCBs), and mono-*ortho* coplanar polychlorinated biphenyls (mono-*ortho* PCBs) in the blood of pregnant women and in breast milk.

In this study, we determined the concentrations of PCBs in the blood of pregnant women and in breast milk from the same mothers; samples were collected between 2002 and 2005 from 125 mothers living in Hokkaido, Japan. We also investigated the relationship between concentrations of PCBs in the blood and in breast milk.

Materials and Methods

The blood and breast milk samples were collected between 2002 and 2005 from 125 mothers who had given their informed consent. The blood samples were collected from the maternal peripheral vein after the second trimester during their last pregnancy. The maternal milk specimens were collected 1 month after delivery. The mothers' ages ranged from 21 to 47 (mean: 31.3). After collection, the blood and breast milk samples were stored at -30°C until analyses for concentrations of PCBs.

The extraction of PCBs from the samples was performed using a previously reported method[3,4]. The PCB concentrations were measured using high-resolution gas chromatography/high-resolution mass spectrometry [5]. To estimate the total concentrations of PCBs, we introduced ND (less than the detection limit) values to half values of the detection limit.

Results and discussion

Of the 209 PCB congeners, 66 were identified in the blood and breast milk in the present study (Table 1). The arithmetic mean total PCB concentrations in the blood and breast milk were 132.4 (median: 120.9) and 102.5 (median: 88.6) ng /g lipid, respectively, and the concentrations were in the range of 38.1-358.8 and 31.0-404.7 ng /g lipid, respectively (Table 1). The sum of the ratios of the concentrations of pentaCBs, hexaCBs, and heptaCBs to the total concentrations of PCB congeners in the blood and breast milk were 86.5 and 89.5%, respectively. The hexaCBs ratios in the blood and breast milk were 42.8 and 50.4%, respectively, which were the

Table 1. Concentrations of PCBs in the blood of pregnant women and breast milk

	Concentration (pg / g lipid)										
	Blood (n=125)					Breast Milk (n=125)					Ratio
Congeners	Mean	Ratio(%)	SD	Min	Max	Mean	Ratio(%)	SD	Min	Max	(Milk/Blood)
245-TrCB(#29)	14	0.0	22.20	5	144	6	0.0	3.54	5	26	44.5%
244'-TrCB(#28)	1186	0.9	641.35	42	4665	811	0.8	461.21	145	2997	68.4%
344'-TrCB(#37)	618	0.5	1741.70	5	16060	9	0.0	17.82	5	154	1.4%
22'55'-TeCB(#52)	764	0.6	519.18	5	3147	349	0.3	321.15	5	2075	45.7%
22'45'-TeCB(#49)	223	0.2	147.39	5	850	71	0.1	50.83	5	261	31.6%
22'44'-TeCB(#47)	435	0.3	260.80	5	1512	207	0.2	113.61	5	612	47.5%
22'35'-TeCB(#44)	318	0.2	214.97	5	1195	86	0.1	56.19	5	306	27.0%
23'4'6-TeCB(#71)	101	0.1	107.26	5	708	42	0.0	36.77	5	196	41.6%
234'5-TeCB(#63)	57	0.0	35.37	5	194	58	0.1	31.40	5	232	101.3%
244'5-TeCB(#74)	3666	2.8	1945.13	784	13440	4038	3.9	2417.85	851	20023	110.1%
23'4'5-TeCB(#70)	169	0.1	103.73	5	522	58	0.1	43.03	5	300	34.2%
23'44'-TeCB(#66)	799	0.6	434.18	218	2075	803	0.8	450.51	173	3153	100.6%
233'4'-/2344'TeCBs(#56/60)	305	0.2	166.80	51	923	325	0.3	179.42	57	1115	106.5%
22'35'6-PeCB(#95)	463	0.3	225.83	18	1140	262	0.3	158.29	27	798	56.7%
22'355'-PeCB(#92)	358	0.3	208.16	21	1082	318	0.3	202.93	5	1186	88.7%
22'455'-PeCB(#101)	830	0.6	434.34	146	2242	743	0.7	429.03	5	2516	89.5%
22'44'5-PeCB(#99)	4637	3.5	2220.40	1044	11767	4851	4.7	2559.06	947	16596	104.6%
234'56-PeCB(#117)	344	0.3	207.61	54	1453	255	0.2	157.65	5	1097	74.1%
22'345'-PeCB(#87)	341	0.3	220.88	62	2071	207	0.2	113.39	5	795	60.6%
22'344'-PeCB(#85)	129	0.1	112.60	5	1083	90	0.1	57.97	5	317	69.9%
233'4'6-PeCB(#110)	243	0.2	188.11	5	1524	140	0.1	105.43	5	771	57.5%
233'4'5-PeCB(#107)	395	0.3	263.98	58	1676	352	0.3	230.86	5	1670	89.2%
2'344'5-PeCB(#123)	132	0.1	77.21	19	497	113	0.1	71.72	5	531	85.5%
23'44'5-PeCB(#118)	6707	5.1	3438.68	1381	19088	7006	6.8	3935.53	1440	29091	104.5%
2344'5-PeCB(#114)	417	0.3	235.89	81	1519	400	0.4	225.91	94	1708	96.0%
233'44'-PeCB(#105)	1630	1.2	852.88	372	4879	1712	1.7	953.02	303	6952	105.1%
22'355'6-HxCB(#151)	489	0.4	361.28	75	2605	415	0.4	294.92	54	2337	84.8%
22'33'56'-HxCB(#135)	188	0.1	114.88	5	578	166	0.2	101.44	5	544	88.7%
22'34'56-HxCB(#147)	147	0.1	93.30	5	583	147	0.1	99.13	5	834	100.2%
22'344'6-/22'34'5'6-HxCB(#139/149)	273	0.2	187.39	5	881	282	0.3	159.60	5	897	103.4%
22'33'56-HxCB(#134)	13	0.0	13.54	5	86	9	0.0	9.42	5	63	67.0%
233'55'6-HxCB(#165)	5	0.0	0.00	5	5	5	0.0	0.00	5	5	100.0%
22'34'55'-HxCB(#146)	3746	2.8	2116.33	802	13645	3490	3.4	2105.16	754	14622	93.2%
22'33'46'-HxCB(#132)	111	0.1	94.22	5	452	82	0.1	79.20	5	340	74.4%
22'44'55'-HxCB(#153)	26235	19.8	13205.62	5721	77686	24313	23.7	14240.55	6917	100807	92.7%
22'3455'-HxCB(#141)	132	0.1	105.08	5	537	113	0.1	75.61	5	406	85.4%
22'344'5-HxCB(#137)	896	0.7	416.67	217	2297	815	0.8	451.17	223	3194	91.0%
22'33'45'-HxCB(#130)	821	0.6	429.13	190	2806	793	0.8	511.52	5	3674	96.5%
233'4'5'6-HxCB(#164)	5141	3.9	2985.38	1187	18475	4019	3.9	2364.08	1045	16592	78.2%
22'344'5'-HxCB(#138)	14377	10.9	7161.63	3214	44627	13450	13.1	7574.65	3954	52606	93.6%
22'33'44'-HxCB(#128)	462	0.3	470.10	82	4766	345	0.3	220.40	48	1287	74.7%
23'44'55'-HxCB(#167)	861	0.7	443.94	166	2420	706	0.7	426.75	169	3184	81.9%
233'44'5-HxCB(#156)	2197	1.7	1100.94	376	6026	2003	2.0	1145.41	419	7839	91.1%
233'44'5'-HxCB(#157)	516	0.4	254.01	72	1562	463	0.5	256.71	102	1858	89.7%
22'33'566'-HpCB(#179)	88	0.1	77.89	5	658	86	0.1	63.12	5	368	96.8%
22'33'55'6-HpCB(#178)	1845	1.4	1206.10	382	7130	1277	1.2	830.27	305	5858	69.2%
22'344'56-HpCB(#182)	8292	6.3	5702.62	2065	36848	5154	5.0	3608.36	1357	30335	62.2%
22'344'5'6-HpCB(#183)	2185	1.7	1480.38	662	11206	1398	1.4	924.38	424	8141	64.0%
22'344'56-HpCB(#181)	31	0.0	25.49	5	129	16	0.0	13.38	5	62	53.2%
22'33'4'56-HpCB(#177)	1926	1.5	1287.43	402	7121	1388	1.4	945.09	232	7877	72.0%
22'33'455'-HpCB(#172)	999	0.8	666.26	254	3877	533	0.5	349.53	141	2570	53.3%
22'344'55'-HpCB(#180)	18832	14.2	12395.37	4323	75056	9801	9.6	6128.09	2812	44516	52.0%
233'44'5'6-HpCB(#191)	217	0.2	143.81	5	744	110	0.1	67.12	5	438	50.5%
22'33'44'5-HpCB(#170)	6463	4.9	4142.24	1503	24488	3620	3.5	2241.18	994	15721	56.0%
233'44'55'-HpCB(#189)	278	0.2	150.61	29	808	181	0.2	103.18	47	671	65.0%
22'33'55'66'-OcCB(#202)	586	0.4	352.84	117	2087	340	0.3	247.27	89	1798	58.0%
22'33'45'66'-OcCB(#200)	115	0.1	68.89	5	393	60	0.1	45.92	5	377	52.0%
22'33'45**-OcCB(#201/198)	2428	1.8	1453.89	483	10610	1075	1.0	772.24	267	5186	44.3%
22'344'55'6-OcCB(#203)	2033	1.5	1169.56	356	7503	900	0.9	587.32	5	4045	44.3%
22'33'44'56-OcCB(#195)	484	0.4	270.37	83	1556	272	0.3	165.43	76	1227	56.2%
22'33'44'55'-OcCB(#194)	2070	1.6	1154.80	526	7090	904	0.9	610.47	240	4123	43.7%
233'44'55'6-OcCB(#205)	94	0.1	47.61	5	300	37	0.0	28.43	5	195	39.8%
22'33'455'66'-NoCB(#208)	244	0.2	166.43	52	1045	82	0.1	68.17	5	465	33.7%
22'33'44'566'-NoCB(#207)	123	0.1	74.72	5	438	40	0.0	28.39	5	196	32.3%
22'33'44'55'6-NoCB(#206)	641	0.5	370.14	100	2278	190	0.2	132.84	5	857	29.7%
22'33'44'55'66'-DeCB(#209)	532	0.4	342.20	181	3300	77	0.1	55.66	5	377	14.4%
Total TriCBs	1818	1.4	1861.03	361	17655	826	0.8	460.47	155	3007	45.5%
Total TetraCBs	6839	5.2	2739.53	2394	19554	6037	5.9	3201.66	1683	27132	88.3%
Total PentaCBs	16626	12.6	7680.27	5946	45252	16449	16.1	8666.35	3695	63891	98.9%
Total HexaCBs	56609	42.8	27983.84	13367	174399	51615	50.4	29435.81	15650	207088	91.2%
Total HeptaCBs	41156	31.1	26810.04	10109	167563	23562	23.0	15028.94	6906	116464	57.2%
Total OctaCBs	7809	5.9	4408.88	1932	29270	3589	3.5	2419.51	968	16951	46.0%
Total NonaCBs	1008	0.8	589.94	204	3506	312	0.3	221.35	15	1519	31.0%
Total DecaCBs	532	0.4	342.20	181	3300	77	0.1	55.66	5	377	14.4%
Total PCBs	132396	100.0	65868.58	38133	358816	102466	100.0	57425.57	31036	403721	77.4%
Lipid (%)	0.38		0.082	0.26	0.72	4.3		1.39	0.9	8.4	

CB:chlorinated biphenyl, SD:standard deviation highest values compared with those of the other congeners. HexaCB-153 among hexaCBs congeners, the most abundant congener in the blood and breast milk, contributed 19.8 and 23.7% to the total concentrations of PCB congeners, respectively. Among the PCB congeners measured in the present study, pentaCB-118, hexaCB-138, hexaCB153, heptaCB-180, and heptaCB-182 also showed high ratios to total concentrations of these PCBs congeners in the blood and breast milk. The total concentrations of these five congeners in the blood and breast milk contributed approximately 56.2 and 58.3% of the total concentrations of PCB congeners, respectively. Other PCB congeners contributed less than 5% of total concentrations of PCB congeners. The PCB congeners ratios in the blood and breast milk were quite similar. In addition, significant positive correlations between total PCBs concentrations in the blood and breast milk were observed (Fig. 1). These results suggest that PCBs accumulated in the blood can be transferred to breast milk.

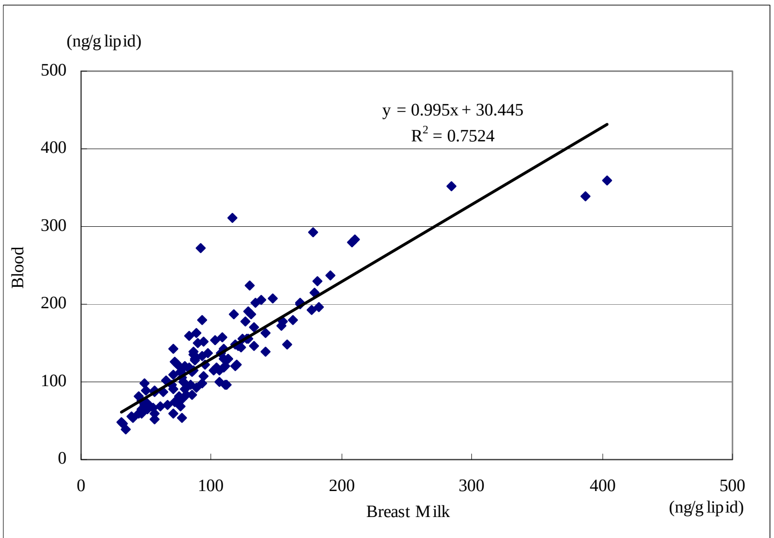

Fig. 1 Relationships between total PCBs concentrations in blood of pregnant women and breast milk

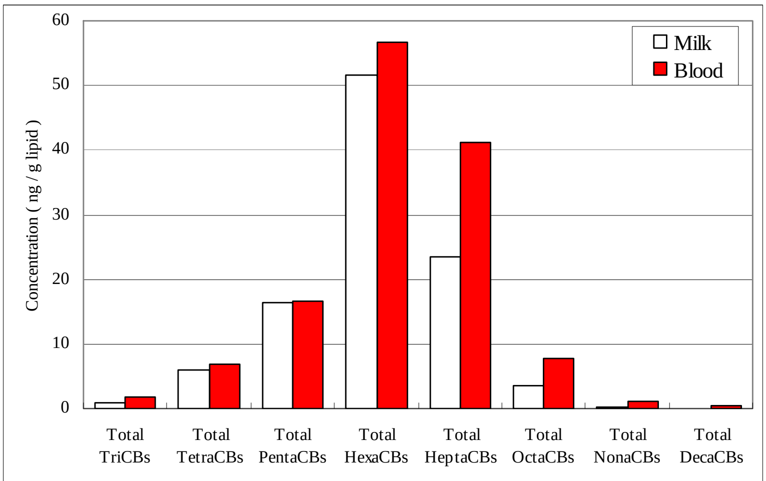

Fig. 2 PCBs congeners concentrations in the blood of pregnant women and breast milk

The breast milk mean total PCBs concentration was approximately 23% lower than that of the blood. The mean total concentrations of tetraCBs, hexaCBs, heptaCBs, and octaCBs in the blood were 6.8, 16.5, 56.6, 41.2, and 7.8 ng/g lipid, and in the breast milk were 6.0, 16.4, 51.6, 23.6, and 3.6 ng /g lipid, respectively (Fig. 2). The total concentrations of heptaCBs and octaCBs in the breast milk were 43 and 54 % lower than those in the blood, while the total concentrations of pentaCBs and hexaCBs in the breast milk were similar to those in the blood. The breast milk-to-blood concentration ratios of each PCB congener tended to decrease with higher chlorinated congeners.

In a previous study[2], we measured the concentrations of PCDDs, PCDFs, and dioxin-like PCBs in the blood and breast milk of 125 pregnant women in Hokkaido. The results indicated that the breast milk-to-blood concentration ratios of each congener of PCDDs, PCDFs, non-*ortho* PCBs, and mono-*ortho* PCBs tended to decrease with higher chlorinated congeners.

In this study, we measured the concentrations of PCBs in the blood of pregnant women and in breast milk of the same mothers. These results will be used as basic data for study of the influence of PCBs on the health of fetuses and infants.

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