

LEVELS OF PCDD/Fs AND DIOXIN-LIKE PCBs IN THE BLOOD OF KOREAN WORKERS AND RESIDENTS

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Introduction

Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are two groups of tricyclic, planar, aromatic compounds. These compounds (PCDD/Fs) are planar, poorly water soluble, lipophilic, and stable. PCDD/Fs are not deliberately manufactured but are released into the environment in ultra-trace amounts by various combustion processes and as the unwanted by-products of the manufacture of various chlorinated chemicals¹. Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are persistent in the environment. Since congeners of these compounds tend to accumulate in the food chain, they have been found in almost all parts of the biosphere, including humans^{2,3}. Human beings are at the top of the food chain; so relatively high levels of these compounds have been found in various human samples.

In most cases, assessment of the level of human exposure is based on the concentrations of these compounds in the blood. Investigation into human exposure to PCDD/Fs and dioxin-like PCBs typically uses blood samples, because which are available from all members of the general population compared to breast milk and adipose tissue in human anatomy⁴.

In this study, we compared the concentrations of PCDD/Fs and dioxin-like PCBs in the blood of workers (industrial and incinerator workers) and with those found in the blood of residents in the wider community, and estimated the levels of human exposure to these compounds in Korea.

Materials and Methods

Sampling & Storage

Twenty human blood samples were obtained in 1999 from volunteer workers (industrial area, n=10) and residents (n=10) in Korea. Thirty-five human blood samples were also obtained in 2001 from volunteer workers (incinerator, n=13) and residents (n=22). Information such as age, smoking, dietary habit, body weight and height etc. was obtained from a questionnaire survey. All samples were kept frozen at -20° until analysis.

Sample analysis

Approximately 40 - 50 g was analyzed for congener-specific PCDD/Fs and PCBs, as well as lipid content. Unfrozen human samples were spiked with a mixture of ¹³C₁₂-labeled PCDDs, PCDFs, PCBs internal standards as supplied by Cambridge Isotope Laboratories (Andover, MA). They were mixed with Sodium oxalate saturated water (Na₂C₂O₄ : stirred at room temperature for over 2 hours). The solution was extracted 3 times using 200 ml of 2:1 acetone/hexane for each extraction. The resultant organic layer was filtered and evaporated to dryness in order to evaluate the lipid content in the samples. Lipid content was determined by gravimetric. Dried samples were re-suspended in 50:50 DCM/hexane and subjected to further cleanup via gel permeation, silica, alumina and carbon fiber chromatography. High-resolution gas chromatography/ high-resolution mass spectrometry (HRGC/

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HRMS) analysis was performed on an Autospece Ultima (Micromass, U.K) coupled to a HP 6890 gas chromatograph (Hewlett Packard, USA).

Data analysis

Difference of concentrations of PCDD/Fs and dioxin-like PCBs between the workers and residents were examined by students t-test. The correlation between variable (age, percent body fat, body burden) and blood concentrations of the congeners was examined by the Pearson correlation coefficient test.

Results and Discussion

The observed levels of PCDD/Fs in workers and residents were 23.38 (median 15.52) and 13.47 (median 11.88) pg I-TEQ/g lipid, respectively, while those of dioxin-like PCBs were 7.33 (median 5.59) and 8.77 (median 7.38) pg I-TEQ/g lipid, respectively. When the mean concentrations for the workers were compared with those for the residents, a significant difference was found for PCDD/Fs ($P < 0.05$) while the concentration of dioxin-like PCBs was somewhat higher in residents in workers but not significantly (Fig. 1). Concentrations of PCDD/Fs and dioxin-like PCBs in the blood of workers and residents are shown in Table 1. For PCDD/Fs, OCDD was the predominant congener of both groups. Concentrations of the various PCDD/F congeners were significantly higher in the workers than in the residents. ($P < 0.05$); specifically, concentrations of 2,3,4,6,7,8-HxCDF and 1,2,3,4,6,7,8-HpCDF in human blood were significantly higher in workers than in residents ($P < 0.01$).

The ratio of total PCDFs/PCDDs is 0.37 in the workers and 0.19 in the residents. Higher blood concentrations of PCDFs were found in the workers compared with those seen in resident groups (Fig. 2).

2,3,4,7,8-PeCDF, 1,2,3,6,7,8-HxCDD, and 1,2,3,7,8-PeCDD contributed around 60 % to the TEQ value of PCDD/Fs for the workers and 70 % of this value for the residents. In addition, the contribution of dioxin-like PCBs to the total TEQ value for the workers was lower than for the residents (Fig. 3).

The mean concentrations of PCDD/Fs and dioxin-like PCBs in male subjects were slightly higher than those in female subjects. In addition, the mean concentration of PCDD/Fs in the blood of smokers was slightly higher than for non-smokers, but that of dioxin-like PCBs in smokers was lower than in non-smokers but not significantly.

The age of the 55 subjects ranged from 21 to 64. Subjects' age and the concentrations of PCDD/Fs in their blood were not correlated, but age and the concentrations of dioxin-like PCBs were strongly correlated ($r = 0.64$). In addition, age and body burden of PCDD/Fs were not correlated but age and body burden of dioxin-like PCBs were weakly correlated ($r = 0.45$). PBF (percent body fat) and concentrations of PCDD/Fs were negatively and weakly correlated ($r = -0.19$). Whereas PBF and the concentrations of dioxin-like PCBs were not correlated.

The comparisons between the workers and residents show difference in the TEQs of PCDD/Fs. In particular, some PCDF congeners occurred at a significantly higher concentration in the workers. People exposed accidentally or occupationally often display a different congener pattern than those exposed indirectly through the environment and such exposure can be identified through the analysis of PCDD/Fs in the blood⁵. This analysis suggests that the workers in the sample were exposed to PCDD/Fs at their place of work through inhalation and skin contact⁶.

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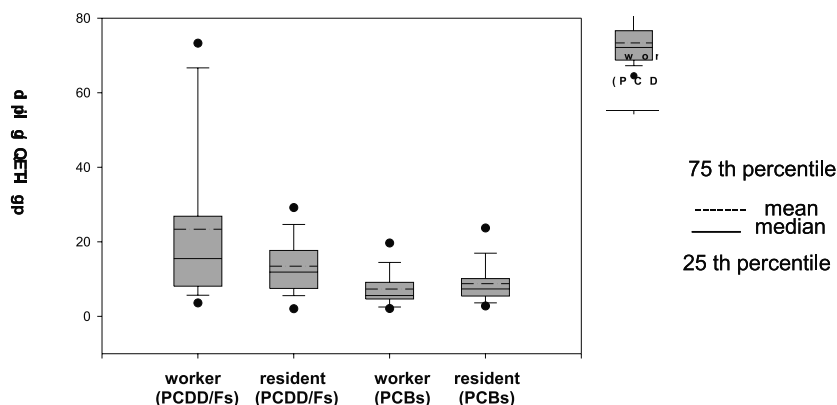


Figure 1. Comparison of TEQ value between workers and residents.

Table 1. Concentrations of PCDD/Fs and dioxin-like PCBs in the blood of workers and residents.

pg/g lipid	worker (n=23)				resident (n=32)				P-value 95C.I.
	mean	median	SD	range	mean	median	SD	range	
2,3,7,8-TCDD	0.89	0.00	1.93	(0.00-8.00)	0.09	0.00	0.35	(0.00-1.47)	0.026*
1,2,3,7,8-PeCDD	4.42	3.22	5.45	(0.00-22.68)	3.27	2.46	4.09	(0.00-15.79)	0.375
1,2,3,4,7,8-HxCDD	2.80	0.00	3.60	(0.00-10.06)	1.96	0.00	2.59	(0.00-7.90)	0.318
1,2,3,6,7,8-HxCDD	48.33	26.96	67.20	(0.00-263.14)	28.22	25.80	21.40	(0.00-122.00)	0.118
1,2,3,7,8,9-HxCDD	21.92	8.88	37.41	(0.00-142.63)	7.08	5.54	12.50	(0.00-69.00)	0.041*
1,2,3,4,6,7,8-HpCDD	52.15	24.75	56.95	(0.00-189.43)	32.38	29.15	22.77	(0.00-100.14)	0.081
OCDD	427.99	243.11	498.70	(92.07-1901.41)	640.04	346.60	919.04	(0.00-4856.29)	0.320
2,3,7,8-TCDF	6.87	2.44	10.42	(0.00-36.57)	1.58	0.00	3.77	(0.00-17.70)	0.011*
1,2,3,7,8-PeCDF	4.52	0.00	7.71	(0.00-26.83)	0.16	0.00	0.65	(0.00-3.20)	0.002*
2,3,4,7,8-PeCDF	13.21	9.59	10.24	(0.00-37.61)	10.29	9.74	5.61	(0.00-27.66)	0.181
1,2,3,4,7,8-HxCDF	15.91	9.48	15.98	(0.00-61.63)	7.11	6.85	7.05	(0.00-38.00)	0.008*
1,2,3,6,7,8-HxCDF	13.08	7.30	14.59	(0.00-51.06)	6.42	6.22	5.84	(0.00-27.67)	0.023*
2,3,4,6,7,8-HxCDF	7.57	4.95	9.24	(0.00-28.13)	1.60	0.00	2.25	(0.00-9.10)	0.006**
1,2,3,7,8,9-HxCDF	0.95	0.00	1.87	(0.00-7.44)	0.08	0.00	0.42	(0.00-2.40)	0.013*
1,2,3,4,6,7,8-HpCDF	59.11	25.11	71.75	(0.00-275.38)	15.70	12.57	16.85	(0.00-99.13)	0.009**
1,2,3,4,7,8,9-HpCDF	8.05	0.00	11.36	(0.00-39.75)	3.88	0.00	6.00	(0.00-17.50)	0.083
OCDF	91.76	6.20	177.68	(0.00-764.00)	29.34	0.00	45.21	(0.00-150.40)	0.062
total PCDD	558.49	318.10	570.54	(116.96-2129.63)	713.04	416.17	944.30	(16.94-5036.00)	0.488
total PCDF	221.03	83.80	310.31	(0.00-1300.50)	76.15	42.16	70.71	(0.00-268.90)	0.013*
total PCDD/Fs TEQ	23.38	15.52	22.47	(0.20-74.61)	13.47	11.88	7.92	(1.22-33.90)	0.025*
dioxin-like PCBs TEQ	7.33	5.59	4.93	(1.79-21.33)	8.77	7.38	5.56	(1.46-25.61)	0.325

Significantly difference in *P<0.05, **P<0.01

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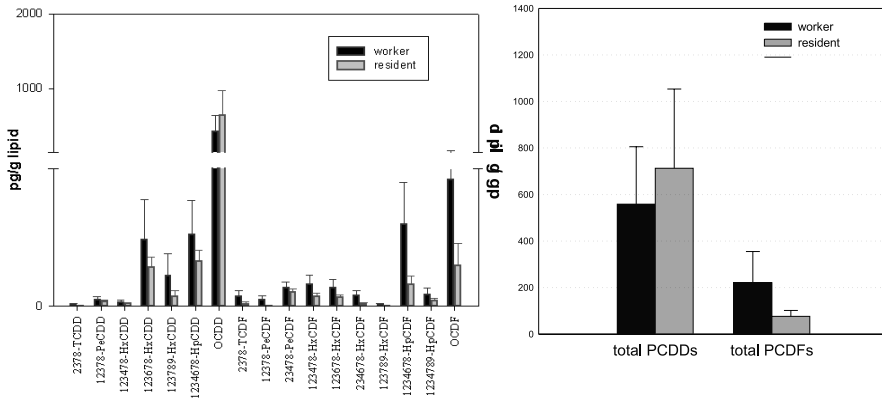


Figure 2. (a) PCDD/Fs congener profile of workers and residents and (b) Comparison of total PCDDs and total PCDFs between workers and residents.

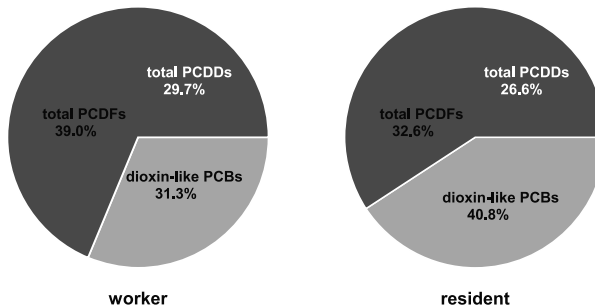


Figure 3. Relative contribution (%) of PCDDs, PCDFs, and dioxin-like PCBs to TEQs

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