

## **Serum PCDDs/Fs Levels for the residents living in the vicinity and workers of the Municipal Incinerators in Seoul, Korea**

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### **Introduction**

PCDDs and PCDFs are detected routinely, as they are widely distributed in the environment and accumulate in the food chain (Dewailly et al., 1992). Moreover, because human beings are at the top of food chain, a relatively high level of these compounds can be found in human adipose tissues, blood lipids, and breast milk fat (Yang et al., 2002; Iida et al., 1999; Noren and Meironyte, 2000).

In Korea, the number of municipal and hazardous waste incinerators have increased since 1980. In addition, municipal waste incinerators are almost always located in residential areas. Therefore, the human health risks caused by dioxin is become an increasing public concern in Korea.

The aim of this study was to determine the concentrations of PCDDs/PCDFs in blood from individuals living in the vicinity area of the municipal solid waste incinerator (MSWI), and to compare PCDDs/PCDFs levels in blood for residents living near the MSWI, workers at the MSWI and general population living in the urban area not including the MSWI. Analysis of the results was made in terms of sociodemographic characteristics such as age, sex, smoking habit, food consumption patterns, and proximity to the MSWI.

### **Materials and Methods**

The blood samples were obtained between 2001 and 2002 from volunteer workers of the MWIs and residents living near to the MWIs in urban area of Korea. The MWI worker group was 28 employees (average 4.7 years of working durations) at the MWIs in urban area and the residents group was 49 vicinity residents living at distance < 300m from the MWIs. For background exposure, the general group was 11 adults living in the urban area not including the MWIs. The participants answered a detailed questionnaire regarding the sociodemographic variables, lifestyle, possible exposure through occupational and non-occupational

contact the locations of their former and present residences, and their food intake patterns.

The quantitative assessment of the dioxin levels in blood was analyzed by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) according to the US EPA 1613 method. Calculation of PCDDs/PCDFs body burden was made according to a subject's body weight and percentage of body fat (Schechter et al., 1998). The equation used for calculating body burden was :

$$\text{Body Burden (TEQ ng)} = C_{\text{blood}} (\text{TEQ ng/kg lipid}) * BW_{\text{subject}} (\text{kg}) * f1$$

where  $C_{\text{blood}}$  (TEQ ng/kg fat) : Concentration in blood  
 $BW_{\text{subject}}$  (kg) : Body weight of subject  
 $f1$  : Proportion of subject's body fat

PCDDs/PCDFs concentrations were reported as picograms TEQ/g lipid. Toxic equivalents (TEQ) were calculated using the toxic equivalent factors (TEFs) established by WHO in 1998.

### Results and Discussions

The average ages of the subjects were 35 years old, 48 years old and 29 years old, respectively, the MSWI workers, the vicinity residents of the MSWI, and general population. The percentages of smoker were 68%, 22%, and 27%, respectively, in the MSWI workers, the vicinity residents, and general population.

The detection ranges of dioxin in group were 5.44–25.02 pg/g lipid, 5.63–29.33 pg/g lipid, and 5.32–13.46 pg/g lipid for workers, residents and general, respectively (Table 1). In all samples, PCDFs levels (above 54% to PCDDs/PCDFs TEQ concentration) were slightly higher than PCDDs levels in blood. In blood of subjects, 2,3,4,7,8-pentachlorinated dibenzofuran (2,3,4,7,8-PeCDF) was approximately 40% to PCDDs/PCDFs TEQ concentration and was most predominant among the PCDDs/PCDFs congeners. The proportion of 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (2,3,7,8-TCDD) was less than 1% to PCDDs/PCDFs TEQ concentration in all subjects.

# BODY BURDENS AND DIETARY INTAKE

Table 1. PCDDs/PCDFs concentrations in blood of the subjects (pg TEQ/g lipid)

Congeners	MSWI <sup>1)</sup>						General population (n=11)		
	Worker (n=28)			Vicinity residents (n=49)					
	Mean	SD <sup>2)</sup>	Range (Min-Max)	Mean	SD	Range (Min-Max)	Mean	SD	Range (Min-Max)
2,3,7,8-TCDD	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.53	0.00-1.40
1,2,3,7,8-PeCDD	2.07	2.51	0.00-8.49	3.48	3.29	0.00-11.85	2.07	2.61	0.00-5.37
1,2,3,4,7,8-HxCDD	0.10	0.23	0.00-0.89	0.14	0.24	0.00-0.79	0.04	0.11	0.00-0.30
1,2,3,6,7,8-HxCDD	1.53	0.97	0.00-4.29	2.43	1.24	0.00-5.15	1.71	1.18	0.00-3.55
1,2,3,7,8,9-HxCDD	0.26	0.38	0.00-1.19	0.38	0.43	0.00-1.40	0.00	0.00	0.00
1,2,3,4,6,7,8-HpCDD	0.21	0.20	0.00-0.81	0.34	0.25	0.00-1.08	0.23	0.19	0.00-0.56
OCDD	0.03	0.04	0.01-0.19	0.07	0.09	0.01-0.49	0.04	0.03	0.00-0.11
2,3,7,8-TCDF	0.28	0.77	0.00-2.80	0.01	0.04	0.00-0.23	0.00	0.00	0.00
1,2,3,7,8-PeCDF	0.04	0.12	0.00-0.47	0.00	0.00	0.00	0.00	0.00	0.00
2,3,4,7,8-PeCDF	4.76	2.73	0.00-9.98	6.63	2.87	2.30-13.83	3.87	2.02	0.00-6.11
1,2,3,4,7,8-HxCDF	0.80	0.55	0.00-2.54	0.81	0.58	0.00-2.50	0.46	0.44	0.00-0.95
1,2,3,6,7,8-HxCDF	0.49	0.44	0.00-1.57	0.68	0.45	0.00-1.60	0.61	0.55	0.00-1.39
2,3,4,6,7,8-HxCDF	0.26	0.58	0.00-2.39	0.18	0.20	0.00-0.52	0.05	0.14	0.00-0.37
1,2,3,7,8,9-HxCDF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2,3,4,6,7,8-HpCDF	0.19	0.22	0.00-1.06	0.14	0.08	0.04-0.42	0.07	0.07	0.00-0.17
1,2,3,4,7,8,9-HpCDF	0.00	0.01	0.00-0.05	0.00	0.00	0.00	0.00	0.00	0.00
OCDF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCDDs	4.20	3.05	0.76-11.50	6.83	4.75	0.47-17.92	4.29	2.41	1.56-8.09
Total PCDFs	6.83	4.30	0.00-20.82	8.45	3.54	3.31-16.71	5.06	2.49	1.15-8.07
Total Dioxin	11.04	5.20	5.29-24.66	15.27	7.47	5.44-34.63	9.34	4.05	5.32-15.78

1) MSWI : municipal solid waste incinerator, 2) SD : standard deviation

The PCDDs/PCDFs levels in blood from subjects classified according to gender, age, smoking habit and specific place of residence are given in Table 2. The average PCDDs/PCDFs concentrations were found to be similar to men (13.22 pg TEQ/g lipid) and women (13.49 pg TEQ/g lipid) and to be higher in non-smokers (14.07 pg TEQ/g lipid) than in smokers (12.15 pg TEQ/g lipid). Higher levels of PCDDs/PCDFs in blood were observed in older subjects than in younger subjects. The average levels of dioxin were 11.04 pg TEQ/g lipid, 15.27 pg TEQ/g lipid, and 9.34 pg TEQ/g lipid for workers, vicinity residents and general population, respectively. There were not significantly difference between the group living at distances < 300m from the MSWI and those living at greater distances. Germany investigations of PCDDs/PCDFs concentrations showed PCDDs/PCDFs values ranging from 5.2 to 34.5 pg TEQ/g lipid in subjects who lived in the vicinity of a waste incinerator, and 11.2-113.6 pg TEQ/g lipid in the general population (Deml et al., 1996; Ewers et al., 1996). For the subjects who lived who lived in the vicinity of a MSWI in Spain, significant differences were not found in relation to the specific residential area, while a significant correlation between the age of the subjects and the levels of PCDDs/PCDFs in blood could be observed (Schuhmacher et al., 1999). These results are consistent with our results. The levels of dioxin in blood were not significantly different between the groups, gender, and smoking habit, whereas a significant correlation between the age of the subjects and the levels of dioxin in blood could be observed.

Table 2. Concentration of PCDDs/PCDFs in blood from subjects living in the urban area of Korea according to sociodemographic characteristics

	N <sup>1)</sup>	Mean	SD <sup>2)</sup>	Minimum	Maximum
<b>Gender</b>					
Male	49	13.22	6.84	5.29	34.63
Female	39	13.49	7.08	5.37	31.35
<b>Age</b>					
20-29 years old	14	8.50	3.11	5.29	12.96
30-39 years old	24	10.60	4.96	5.37	24.66
40-49 years old	27	15.01	6.70	5.60	31.35
> 50 years old	23	16.29	8.16	5.44	34.63
<b>Smoker habits</b>					
Non-smokers	55	14.07	6.60	5.37	31.55
Smokers	33	12.15	7.33	5.29	34.63
<b>Proximity of MSWI<sup>3)</sup></b>					
Worker	28	11.04	5.20	5.29	24.66
< 300 m (vicinity residents)	49	15.27	7.47	5.44	34.63
> 10 km (general population)	11	9.34	4.05	5.32	15.78

1) N : number of samples, 2) SD : standard deviation, 3) MSWI : municipal solid waste incinerator

The correlation coefficients between age and PCDDs/PCDFs levels in blood found were 0.27 ( $p=0.042$ ) and 0.58 ( $p=0.003$ ) in non-smokers and smokers, respectively. The correlation between age and blood dioxin level was reported by Jimenes et al. (1996) and Schumacher et al. (1999) for a population in Spain, and Chen et al. (2003) for residents living near the incinerators in Taiwanese. On the other hand, Deml et al. (1996) found the highest blood PCDDs/PCDFs levels in age groups between 40 and 60 years, indicating an age-dependent increase of the body burden for residents living vicinity the MSWI in Germany. However, significant correlation between age and PCDDs/PCDFs concentrations in blood were not found, possibly due to large interindividual variations (Schumacher et al. 1999).

Significantly higher PCDDs/Fs concentrations in blood were found in older (40+ years old) and smoker subjects (17.24 pg TEQ/g lipid) than younger (20-29 years old) and non-smoker subjects (8.68 pg TEQ/g lipid) in the residents living vicinity of the MSWI and general population except MSWI workers (figure 1).

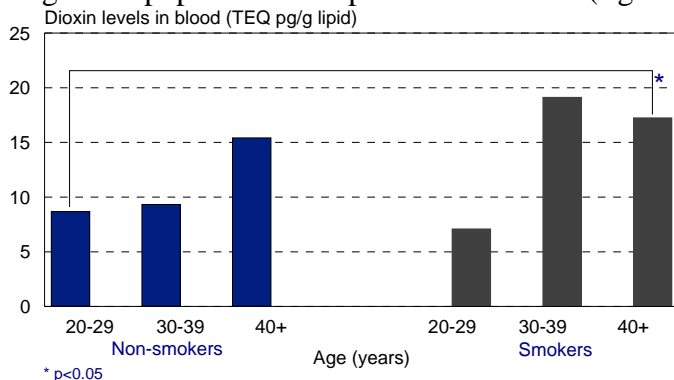


Figure 1. Comparison of PCDDs/PCDFs levels in blood by smoking habit of the subjects except MSWI workers

To examine how dietary patterns were associated with subject's PCDDs/PCDFs levels in blood, the non-smoker subjects except MSWI workers were grouped into 3 categories according to their weekly dietary preferences for dioxin-rich foods consumption such as meat, fish and shellfish, dairy products, and fast foods: lower consumer group, below 1 time/week as consumption frequency of dioxin-rich foods; moderate consumer group, average 2-3 times/week as consumption frequency of dioxin-rich foods; higher consumer group, above 4 times/week as consumption frequency of dioxin-rich foods. PCDDs/PCDFs levels in blood of the higher consumer group (19.39 pg TEQ/g lipid) were significantly higher ( $p=0.048$ ) than those of the lower consumer group (9.64 pg TEQ/g lipid) (Figure 2). This

result is partly consistent with previous findings that seafood, meat, and high-fat food are the main contributors to blood dioxin concentrations (Jimenez et al., 1996; Ryan et al., 1997; Zuccato et al., 1999). Furthermore, Chen et al. (2003) were reported that dioxin levels in blood were significantly different among those subjects with different consumption frequencies of poultry ( $p=0.048$ ) and dairy products ( $p=0.011$ ).

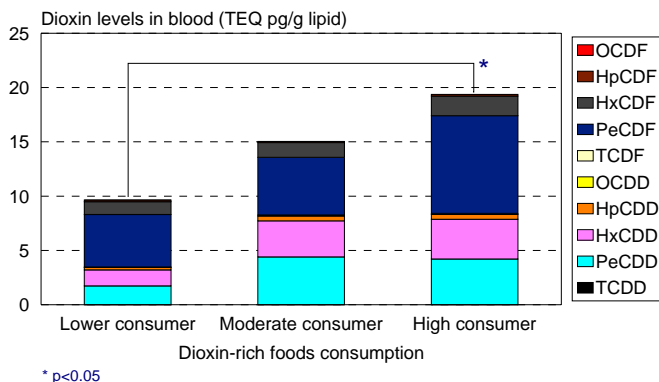


Figure 2. Comparison of PCDDs/PCDFs levels in blood by consumption pattern for dioxin-rich foods of the non-smoker subjects except MSWI workers

Figure 3 shows the body burden levels based on the concentration of PCDDs/PCDFs in blood of subjects. The average levels of body burden were found to be lower than those of adult in the USA (about 9 ng TEQ/kg) (Birnbaum et al., 1997).

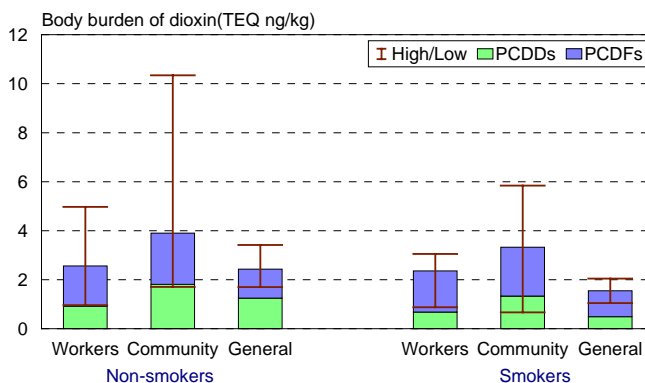


Figure 3. Comparison of body burden of PCDDs/PCDFs based on subject's concentration in blood

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