

LEVELS AND TEMPORAL TRENDS (2002-2008) OF DIOXINS IN THE BLOOD OF URBAN DWELLERS IN KOREA

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Abstract

We measured the recent background serum levels of exposure to PCDD/Fs and analyzed trend of dioxin levels in the blood of urban dwellers in Korea from 2002 to 2008. Blood samples were obtained between 2002 and 2008 from 278 volunteers (arithmetic mean of age, 48 years old) living in an urban area of Korea. The means and SDs (standard deviations) of dioxins were 10.66±7.34 in 2002, 8.20±6.07 in 2003, 10.01±7.56 in 2004, 10.12±5.48 in 2006, 10.66±5.64 in 2007, and 10.97±4.71 pg-TEQ05/g lipid in 2008. Mean body burden levels of PCDDs, PCDFs, and dioxins were respectively 8.74±8.09, 9.79±5.72, and 18.53±12.33 ng-TEQ05/ kg-BW. Although the dioxin levels in blood did not decline over time from 2002 to 2008, the serum levels of dioxins were significantly correlated with age and BMI. The significant time-BMI interaction of serum dioxin levels indicates that body fat affects the reduction rate of the dioxins concentration in blood.

Introduction

In Korea, the number of municipal and hazardous waste incinerators, as well as motor vehicles, which both emit dioxin-like compounds, has increased since 1980. Therefore, the human health risks caused by dioxin have become a matter of increasing public concern.

Dioxins-like compounds accumulate in the human body and can be detected in human samples from around the world. Usually, dioxins levels in human blood or serum are used as indicators of the PCDD/Fs body burden¹⁻²⁾.

To clarify the recent background levels of exposure to dioxins, we measured the blood concentrations of these compounds for the general population in an urban area in Korea from 2002 to 2008. The data were evaluated with regard to age and to the temporal trend of

dioxins blood levels of normal subjects during this time period.

Materials and Methods

Blood samples were obtained between 2002 and 2008 from 278 volunteers living in an urban area of Korea. All participants were non-smokers and were 21-75 (arithmetic mean, 48) years of age who had lived in the urban area for at least 5 years. The participants answered a detailed questionnaire regarding their sociodemographic variables, lifestyle, and food intake patterns.

About 100ml of blood was collected without anticoagulant, centrifuged to remove cells, and frozen. The serum samples were performed cleaned-up and subjected to a fractionation process. Quantitative assessment of the levels of dioxin compounds (17 congeners) in the serum was performed using HRGC-HRMS according to the US EPA 1613 method. The School of Environmental Engineering, Pohang University, conducted the instrumental analysis and the Fisheries & Oceans Laboratory of Canada collaborated with our teams for the quality assurance/quality control (QA/QC) program. PCDD/Fs concentrations were reported as 'pg TEQ/g lipid'. Toxic equivalents (TEQ) were calculated using the toxic equivalent factors (TEFs) established by WHO in 2005.

Calculation of dioxins body burden was made according to a subject's body weight and percentage of body fat^{3,4}. The equation used for calculating body burden was :

$$\text{Body Burden(TEQ ng)} = \text{C}_{\text{blood}}(\text{TEQ ng/kg lipid}) * \text{BW}_{\text{subject}}(\text{kg}) * \text{fl}$$

$$\text{fl of male} = 1.264 \times \{ \text{BW}(\text{kg}) / \text{height}(\text{m})^2 \} - 13.30$$

$$\text{fl of female} = 1.264 \times \{ \text{BW}(\text{kg}) / \text{height}(\text{m})^{1.5} \} - 0.83$$

where $\text{C}_{\text{blood}}(\text{TEQ ng/kg fat})$: Concentration in blood

$\text{BW}_{\text{subject}}(\text{kg})$: Body weight of subject

Results and Discussion

We measured the blood concentrations of 22 subjects in 2002, 38 in 2003, 36 in 2004, 61 in 2006, 60 in 2007, and 61 in 2008. The data set was divided into 6 subgroups, representing 1-year sampling periods from 2002 to 2004 (phase 1) and 2006 to 2008 (phase 2).

There were no significant differences in age, BMI (Body Mass Index) and dioxins levels among these 6-year groups. The means and SDs (standard deviations) of dioxins were 10.66 ± 7.34 in 2002, 8.20 ± 6.07 in 2003, 10.01 ± 7.56 in 2004, 10.12 ± 5.48 in 2006, 10.66 ± 5.64 in 2007, and 10.97 ± 4.71 pg TEQ05/g lipid in 2008 (Table 1). Dioxin levels in blood of between 10 and 48 pg TEQ05/g lipid were previously found in people without any

occupational exposure to these compounds⁵). These levels were considered as background concentrations in our study. In all years, age was positively associated with blood levels of dioxins, whereas the blood levels of dioxins did not significantly change over 6 years (Figure 1). The percent contribution of lower chlorinated PCDD increased but those of OCDD and PeCDF decreased. Mean body burden levels of PCDDs, PCDFs, and dioxins were respectively 8.74 ± 8.09 , 9.79 ± 5.72 , and 18.53 ± 12.33 ng TEQ05/ kg-BW (Figure 2). If the subjects' BMI was greater than 25 of the older (40+) age group, the dioxin levels of subjects who had higher BMIs (≥ 25) declined less than that of the older subjects with lower BMIs (< 25) from 2002 to 2008 (Figure 3).

As indicated above, although the dioxin levels in blood did not decline over time from 2002 to 2008, the serum levels of dioxins were significantly correlated with age and BMI (Table 2). The significant time-BMI interaction of serum dioxin levels indicates that body fat affects the reduction rate of the dioxins concentration in blood.

References

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Table 1. Serum levels of dioxins for urban adults in Korea, 2002-2008

	2002 (n=22)		2003 (n=38)		2004 (n=36)		2006 (n=61)		2007 (n=60)		2008 (n=61)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	43	12	46	10	52	10	48	8	47	8	47	9
BMI	23.4	2.6	24.6	3.1	23.9	2.7	24.1	2.8	23.6	3.1	23.3	3.3
TEQ Concentration (pg TEQ05/ g lipid)												
2378-TCDD	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.47	0.84	1.04	0.35	0.47
12378-PeCDD	1.36	1.73	1.06	1.27	1.53	4.57	1.66	2.30	1.78	2.16	2.58	2.05
123478-HxCDD	0.17	0.28	0.04	0.12	0.42	1.09	0.17	0.30	0.28	0.24	0.18	0.10
123678-HxCDD	2.03	1.35	1.39	1.35	0.76	1.00	1.69	1.37	1.06	0.66	0.92	0.61
123789-HxCDD	0.28	0.40	0.19	0.34	0.19	0.46	0.24	0.42	0.31	0.27	0.23	0.15
1234678HpCDD	0.27	0.19	0.26	0.25	0.50	0.75	0.15	0.13	0.14	0.08	0.13	0.07
OCDD	1.72	1.97	1.23	0.87	1.12	1.18	1.01	1.12	0.81	0.58	0.03	0.02
2378-TCDF	0.03	0.11	0.00	0.00	0.21	0.57	0.25	0.32	0.30	0.22	0.13	0.08
12378-PeCDF	0.00	0.00	0.00	0.03	0.00	0.02	0.02	0.05	0.05	0.09	0.05	0.04
23478PeCDF	3.34	1.82	2.62	2.25	3.31	2.29	3.14	1.83	3.06	1.75	4.77	1.75
123478-HxCDF	0.67	0.43	0.63	0.61	0.69	0.63	0.62	0.39	0.55	0.37	0.50	0.19
123678-HxCDF	0.53	0.47	0.50	0.49	0.72	0.61	0.65	0.50	0.81	0.47	0.72	0.26
123789-HxCDF	0.16	0.21	0.11	0.18	0.17	0.63	0.24	0.27	0.24	0.30	0.08	0.10
234678-HxCDF	0.00	0.00	0.00	0.00	0.21	0.54	0.06	0.23	0.29	0.26	0.24	0.10
1234678-HpCDF	0.12	0.05	0.15	0.27	0.16	0.21	0.13	0.12	0.10	0.10	0.06	0.03
1234789-HpCDF	0.00	0.01	0.00	0.03	0.00	0.01	0.00	0.00	0.01	0.02	0.01	0.01
OCDF	0.00	0.00	0.01	0.02	0.02	0.07	0.00	0.01	0.03	0.02	0.00	0.00
PCDDs	5.81	5.20	4.17	3.35	4.52	5.46	5.02	3.86	5.23	3.31	4.41	2.88
PCDFs	4.86	2.55	4.04	3.16	5.49	3.64	5.11	2.51	5.44	2.95	6.56	2.22
PCDDs/Fs	10.66	7.34	8.20	6.07	10.01	7.56	10.12	5.48	10.66	5.64	10.97	4.71

Table 2. Temporal trends (2002 – 2008) of blood levels and body burden of dioxins by age and BMI groups

Contents	Groups	Compounds	Significant change during 2002 - 2008
Age	< 40years	PCDDs	-
		PCDFs	Up
		Dioxins	Up
	40 – 49 years	PCDDs	Down
		PCDFs	-
		Dioxins	Down
	> 49 years	PCDDs	Down
		PCDFs	Down
		Dioxins	Down
BMI	< 25	Body burden-PCDDs	Down
		Body burden-PCDFs	Up
		Body burden-Dioxins	-
	≥25	Body burden-PCDDs	Down
		Body burden-PCDFs	Up
		Body burden-Dioxins	Up

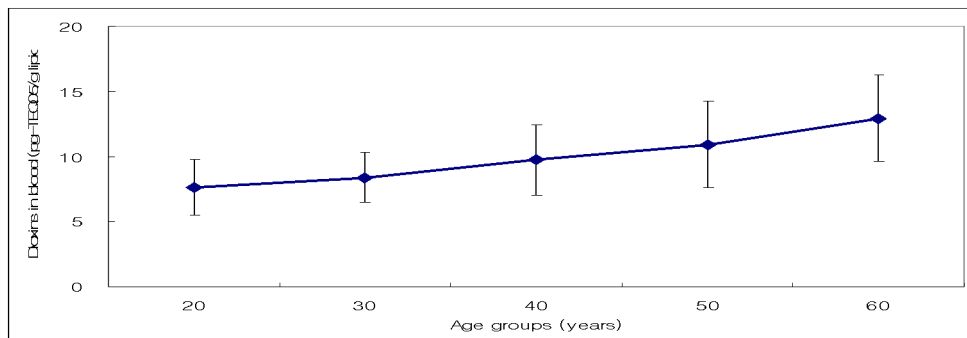


Figure 1. Serum levels of PCDD/Fs related to age group for non-smoker adults in the urban area

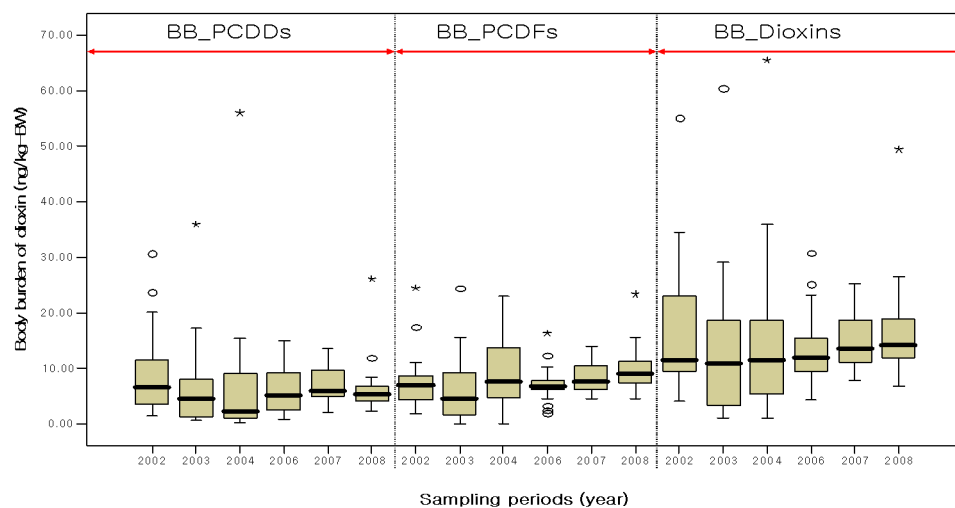


Figure 2. Comparison and temporal trends (2002 – 2008) of the body burden levels according to PCDDs, PCDFs and Dioxins

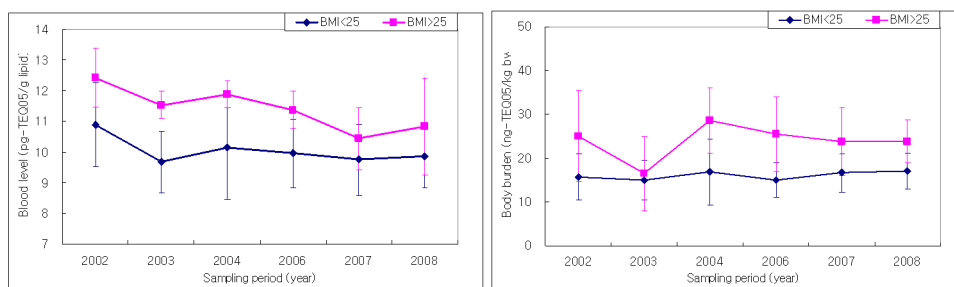


Figure 3. Sampling periods related to (a) blood level and BMI and (b) body burden and BMI of older (40+) non-smoker adults