CHANGES IN ENVIRONMENTAL MEDIA AND SERUM TEQ LEVELS WITH IMPLEMENTATION OF THE NEW 2005 WHO TEFS

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Introduction

In 1998, the TEFs (Toxic Equivalency Factors) of only 29 congeners of polychlorinated dibenzo-p-dioxin (PCDDs) polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) were developed by WHO to quantify the total AhR-activation activity present in these compounds and to compare the activity of these compounds with 2,3,7,8-TCDD[1)]. The WHO met to re-evaluate the information on the activity of these dioxin-like compounds in 2005. The TEF of 14 of the 29 congeners was changed[2)].

We investigated daily dioxin-like compounds intake in adults in Korea, and identified factors that could possibly explain the variation observed in serum dioxin levels. All TEQ values for environmental samples and serum were originally calculated based on the WHO 1998 TEFs values[3, 4)].

The objective of this paper is to present the changes in environmental media and serum total TEQ levels after the implementation of WHO 2005 TEFs.

Materials and Methods

Blood samples from 99 volunteers living in an urban area of Korea were obtained between 2002 – 2004. The participants were 21-65 (average 47) years of age who had lived in the urban area for at least 5 years. About 100ml of blood was collected without anticoagulant and centrifuged to remove cells. All serum samples were shipped to the Pohang University of

Korea and the Fisheries & Oceans Laboratory of Canada, where they were analyzed by HRGC-HRMS and where quality assurance/quality control (QA/QC) was performed.

To evaluate the source of the dioxin in the blood of subjects, we gathered data from known contamination sources including ambient air, water, sediments and soil. This study cites papers as well as technical reports on the concentrations of the 29 dioxin-like congeners in environmental media in Korea.

All TEQ values in the study samples were recalculated based on the WHO 1998 TEFs and the WHO 2005 TEFs.

Results and Discussion

Data for a total of 377 ambient air samples, 244 surface water samples, 82 sediment samples, 212 soil samples and 96 serum samples were collected in the sampling period 2002 and 2004.

The TEQ-2005 values are lower than the TEQ-1998 values for ambient air and serum samples, but the TEQ-2005 values are higher for surface water, sediment and soil samples (Figure 1). Table 1 shows descriptive statistics for both TEQ-1998 and TEQ-2005 of all environmental media and serum according to the characteristic region or age group. For ambient air and serum, the average of the TEQ-2005 value slightly decreased compared to that of the TEQ-1998 value for all regions and age groups. This decrease ranges from about 5% in the youngest age group to 16% in the oldest group, likely reflecting the down-weighting of the increased Penta-CDFs concentrations in older individuals. For surface water and soil, the average TEQ-2005 value slightly increased compared to that of the TEQ-1998 value in all regions. For sediment, the average TEQ-2005 decreased for main streams, but increased for side streams compared to the average TEQ-1998 values. The levels of TEQ-2005 for the 14 changed-TEF congeners were higher than the levels of TEQ-1998 for these congeners in all samples except for ambient air (Table 2). The percent contributions of PCDDs increased (1~16%) and those of PCDFs decreased (<1~11%) for all samples after implementation of WHO 2005 TEFs. The percent contribution of PCBs increased 2% and 1% for ambient air and surface water, respectively, but

decreased 15% and 4% for sediment and soil, respectively, after implementation of WHO 2005 TEFs (Table 3).

As indicated above, the total TEQ-2005 were significantly reduced when the percent contributions of mono-ortho-PCBs and penta-CDFs was high. In order words, as the percent contributions of OCDD and OCDF increase, so the total TEQ-2005 increases.

References

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Table 1. Descriptive statistics for environmental and human serum samples

			TEQ calculated from 1998 TEFs, WHO		TEQ calculated from 2005 TEFs, WHO	
Media	Region	(n)	Mean ± SD	(Min.-Max.)	Mean ± SD	(Min.-Max.)
Ambient air (pg/m^3)	Metropolitan	(135)	0.13 ± 0.25	(0 – 2.11)	0.11 ± 0.22	(0 – 1.88)
	City	(33)	0.15 ± 0.16	(0.02-0.73)	0.13 ± 0.14	(0.01-0.64)
	Industrial	(172)	0.37 ± 0.56	(0 – 5.76)	0.31 ± 0.49	(0 – 4.97)
	rural	(37)	0.07 ± 0.12	(0 – 0.67)	0.06 ± 0.10	(0 – 0.57)
Surface water (pg/L)	Main stream	(144)	0.002±0.004	(0 – 0.024)	0.002±0.005	(0 – 0.026)
	Side stream	(56)	0.006±0.017	(0 – 0.12)	0.007±0.019	(0 – 0.13)
	Discharge	(44)	0.072±0.183	(0 – 0.90)	0.082±0.222	(0 – 1.24)
Sediment (pg/g)	Main stream	(54)	3.57 ± 5.30	(0 – 22.0)	5.53 ± 10.3	(0 – 57.7)
	Side stream	(28)	42.7 ± 166	(0 – 871)	38.0 ± 160	(0 – 846)
Soil (pg/g)	Ground	(135)	3.37 ± 8.46	(0 – 45.0)	4.04 ± 9.31	(0 – 45.4)
	Industrial	(33)	57.5 ± 111	(0 – 565)	58.1 ± 138	(0 - 819)
	Cultivated	(172)	7.59 ± 22.1	(0 – 152)	10.5 ± 26.4	(0 – 164)
Serum (pg/g lipid)	Aged					
	< 40	(17)	6.76 ± 5.53	(0.22 – 17.7)	6.44 ± 5.04	(0.65 – 16.3)
	41 – 49	(35)	9.90 ± 7.12	(0.44 – 27.9)	8.75 ± 6.48	(0.78 – 27.4)
	51 – 59	(33)	12.11± 8.29	(0.16 – 35.9)	10.85± 7.85	(0.47 – 34.0)
	≥ 60	(11)	14.21± 8.39	(0.76 – 29.3)	12.22± 6.92	(0.99 – 25.2)

Table 2. Percent contribution to total TEQ of the 14 congeners with updated TEFs in samples

Percent contribution	Ambient air	Surface water	Sediment	Soil	Serum

to total TEQ (%)	TEQ 1998	TEQ 2005	TEQ 1998	TEQ 2005	TEQ 1998	TEQ 2005	TEQ 1998	TEQ 2005	TEQ 1998	TEQ 2005
OCDD	0.00	0.01	4.85	5.77	40.15	55.92	42.45	47.17	10.48	20.36
$_{1,2,3,7,8}$-PeCDF	1.83	1.33	0.75	0.67	0.14	0.08	0.00	0.00	8.47	6.73
$_{2,3,4,7,8}$-PeCDF	44.38	33.81	0.50	0.34	0.00	0.00	0.00	0.00	42.33	30.42
OCDF	0.01	0.02	2.03	3.00	0.19	0.47	2.76	3.44	7.47	21.22
PCB 81	0.00	0.00	0.53	0.73	0.00	0.00	0.00	0.00	-	-
PCB 105	0.00	0.00	1.09	0.64	3.64	3.40	2.08	2.13	-	-
PCB 114	0.00	0.00	0.31	0.02	0.00	0.00	0.01	0.00	-	-
PCB 118	0.00	0.00	22.88	19.36	24.16	18.39	12.46	11.25	-	-
PCB 123	0.00	0.00	0.09	0.07	5.45	4.96	9.85	9.45	-	-
PCB 156	0.00	0.00	2.81	0.72	13.41	4.33	7.02	3.49	-	-
PCB 157	0.00	0.00	0.04	0.00	0.00	0.00	0.33	0.04	-	-
PCB 167	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-
PCB 169	0.04	0.13	19.45	25.92	1.36	1.86	2.75	3.46	-	-
PCB 189	0.00	0.00	1.27	1.27	0.00	0.00	0.00	0.00	-	-
Sum	46.2	35.31	56.59	58.51	88.50	89.41	79.71	80.43	68.75	78.73

Table 3. Percent Contribution to total TEQ for PCDDs, PCDFs, and PCBs

Media and Dioxins		1998 TEFs	2005 TEFs	Changes in % by using 2005 TEFs
Ambient air (pg/m^3)	PCDDs	15.7	18.6	Increases 3%
	PCDFs	78.4	74.4	decreases 4%
	PCBs	8.9	10.7	Increases 2%
Surface water (pg/L)	PCDDs	13.1	14.3	Increases 1%
	PCDFs	35.8	33.8	decreases 2%
	PCBs	51.1	51.9	Increases <1%
Sediment (pg/g)	PCDDs	41.1	57.3	Increases 16%
	PCDFs	5.8	4.4	decreases 1%
	PCBs	53.0	38.3	decreases 15%
Soil (pg/g)	PCDDs	51.2	55.2	Increases 4%
	PCDFs	13.8	13.7	decreases <1%
	PCBs	34.9	31.0	decreases 4%
Serum (pg/g lipid)	PCDDs	38.8	49.7	Increases 11%
	PCDFs	61.2	50.3	Decreases 11%
	PCBs	-	-	-

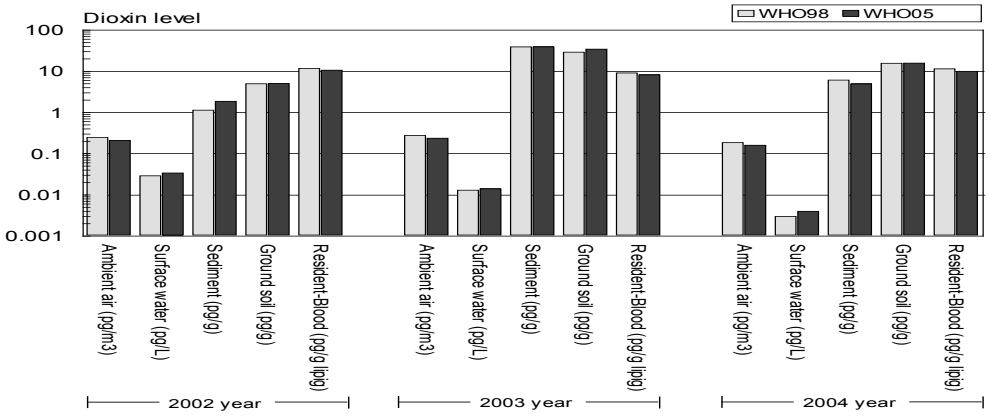

Figure 1. Dioxin-like compounds levels of environmental media and human serum during 2002 – 2004