Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in the Blood of New Zealanders

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Introduction

Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs and PCDFs) are ubiquitous contaminants in the environment. In New Zealand, there have been very few studies on the levels of PCDDs and PCDFs in the human population. The levels of organochlorine compounds, including PCDDs and PCDFs in mothers milk have been reported[1], as have the levels of PCDDs and PCDFs in the blood of agricultural workers spraying the herbicide 2,4,5-T[2].

This paper reports the levels of PCDDs and PCDFs in blood taken from non occupationally exposed subjects as part of a wider programme studying the effects of chlorinated organic contaminants in the human environment.

Method

Subjects were selected following publicity in the Lower Hutt region of New Zealand. These were chosen to cover a range of ages and gender. Blood samples were collected by a local blood bank and, after processing, the plasma was stored frozen until analysis. At the time of sample collection, a questionnaire was completed detailing dietary and lifestyle habits.

Analysis for PCDDs and PCDFs was essentially as previously reported[1]. Samples were spiked with a range of ^{13}C surrogate standards, ethanol added and extracted with ether/hexane. Following acid treatment and multicolumn cleanup, isomer specific determination for all 2,3,7,8-chlorinated congeners was carried out on a VG70-250S mass spectrometer. Standard quality assurance criteria were applied. The total toxic equivalents were calculated using the I-TEF values. When an isomer was less than the detection limit calculated for that isomer in that sample, one half (½) the limit of detection was used in the calculation of the total 2,3,7,8-TCDD toxic equivalent (TE) values.

The laboratory has previously qualified in the WHO Quality Control Study for the determination of PCDDs and PCDFs in human blood.

Results

The results for total TE are summarised by gender and age group categories in Table 1.

Table 1. Summary of results of 2,3,7,8-TCDD TE in plasma lipids of New Zealanders

Gender	Age range (years)	Number of samples	Mean TE pg g^{-1} lipid	Range TE pg g^{-1} lipid
Female	20 - 29	4	8.20	4.86 - 13.0
Male	20 - 29	4	8.32	4.69 - 13.4
Female	30 - 39	5	13.5	7.33 - 19.1
Male	30 - 39	5	12.7	8.40 - 16.7
Female	40 - 60	5	13.6*	11.2 - 18.8
Male	40 - 60	5	11.9	7.24 - 19.8

* Excludes one sample having a TE level of 42.8 pg g^{-1}.

The plasma lipid concentrations of 2,3,7,8- chlorinated PCDDs and PCDFs are detailed in Table 2 (males) and Table 3 (females).

Discussion

The total TE results indicate that there is a trend for an increase in plasma lipid levels of PCDDs and PCDFs with age, consistent with the observation made in the study on mothers milk[1]. In addition, the profiles and distribution of PCDDs and PCDFs are consistent with previously reported studies.

Overall, the levels in the New Zealand population can generally be considered to be relatively low. However, there is evidence of specific exposure routes, with one sample having a plasma lipid level of 42.8 pg g^{-1}, with a level of 2,3,4,7,8-PeCDF of 54.2 pg g^{-1}.

References

1. Bates, M.N., Hannah, D.J., Buckland, S.J., Taucher, J.A., van Maanen, T., Chlorinated Organic Contaminants in Breast Milk of New Zealand Women, Environmental Health Perspectives Supplements, 102 (Suppl), 1:211-217, 1994

2. Smith, A.H., Patterson, D.G., Warner, M.L., MacKenzie, R., Needham, L.L., Serum 2,3,7,8-Tetrachlorodibenzo-p-dioxin Levels of New Zealand Pesticide Applicators and Their Implication for Cancer Hypotheses, Journal National Cancer Institute, 84, 104-108, 1992.

Table 2. Plasma concentration of PCDDs and PCDFs in the population of New Zealand men

Analyte	Plasma Concentration, (pg g^{-1} extracted lipid)					
	20 - 29 years (n = 4)		30 - 39 years (n = 5)		40 - 60 years (n = 5)	
2,3,7,8-TCDF	0.71	(0.70 - < 3)	0.48	(< 0.3 - < 2)	0.44	(< 0.3 - < 2)
2,3,7,8-TCDD	1.3	(< 1 - < 4)	1.7	(1.4 - < 3)	1.6	(< 1 - 3.2)
1,2,3,7,8-PeCDF	0.40	(< 0.3 - < 2)	0.40	(< 0.4 - < 2)	0.27	(< 0.4 - < 0.7)
2,3,4,7,8-PeCDF	2.1	(1.4 - < 4)	3.6	(2.5 - < 6)	2.7	(1.6 - 3.3)
1,2,3,7,8-PeCDD	2.9	(< 2 - 4.4)	4.5	(3.1 - < 10)	4.2	(2.6 - 6.5)
1,2,3,4,7,8-HxCDF	1.7	(1.0 - < 5)	3.0	(1.9 - < 10)	2.3	(< 2 - 3.0)
1,2,3,6,7,8-HxCDF	1.7	(1.5 - < 5)	3.2	(2.1 - < 10)	2.0	(< 1 - < 4)
2,3,4,6,7,8-HxCDF	0.83	(< 0.8 - < 4)	2.6	(< 1 - < 20)	0.90	(0.81 - < 2)
1,2,3,7,8,9-HxCDF	0.98	(< 0.8 - < 5)	1.3	(< 1 - < 4)	0.76	(< 0.6 - < 2)
1,2,3,4,7,8-HxCDD	1.5	(1.2 - < 4)	4.3	(2.1 - < 10)	3.1	(1.6 - 4.5)
1,2,3,6,7,8-HxCDD	19.8	(13.0 - 30.5)	33.4	(17.9 - 49.7)	37.8	(16.5 - 87.1)
1,2,3,7,8,9-HxCDD	3.7	(2.0 - 7.7)	5.7	(3.0 - 7.1)	4.6	(2.6 - 7.8)
1,2,3,4,6,7,8-HpCDF	7.0	(3.6 - 14.5)	8.7	(6.1 - 12.1)	7.3	(3.8 - 9.7)
1,2,3,4,7,8,9-HpCDF	0.48	(< 0.5 - < 2)	1.5	(< 0.8 - < 10)	0.46	(< 0.5 - < 2)
1,2,3,4,6,7,8-HpCDD	59.3	(33.9 - 123)	75.8	(48.0 - 109)	90.5	(42.0 - 175)
OCDF	2	(< 2 - < 10)	11	(< 4 - < 100)	1.8	(< 2 - < 5)
OCDD	806	(344 - 1680)	785	(383 - 1560)	589	(274 - 899)

Levels are mean (range). Half the limit of detection concentration was taken for non detectable congeners.

Table 3. Plasma concentration of PCDDs and PCDFs in the population of New Zealand women

Analyte	Plasma Concentration, (pg g^{-1} extracted lipid)					
	20 - 29 years (n = 4)		30 - 39 years (n = 5)		40 - 60 years (n = 5)	
2,3,7,8-TCDF	0.30	(< 0.5 - < 0.7)	0.29	(< 0.4 - < 1)	0.16	(< 0.4 - < 1)
2,3,7,8-TCDD	1.5	(< 1 - 2.3)	2.1	(1.4 - < 3)	3.8	(1.7 - 5.8)
1,2,3,7,8-PeCDF	0.39	(< 0.5 - < 1)	0.27	(< 0.5 - < 0.7)	0.39	(< 0.3 - < 2)
2,3,4,7,8-PeCDF	2.1	(1.6 - 3.3)	4.6	(1.5 - 7.8)	3.9	(2.6 - 6.2)*
1,2,3,7,8-PeCDD	2.9	(2.4 - 5.0)	5.2	(2.3 - 10.3)	3.6	(< 3 - < 7)
1,2,3,4,7,8-HxCDF	1.7	(1.8 - 3.1)	1.8	(1.3 - < 5)	2.6	(< 2 - < 8)*
1,2,3,6,7,8-HxCDF	1.8	(1.7 - 3.5)	2.1	(1.3 - < 5)	3.3	(< 2 - < 10)
2,3,4,6,7,8-HxCDF	0.88	(< 1 - < 2)	0.88	(< 0.8 - < 3)	1.9	(0.79 - < 10)
1,2,3,7,8,9-HxCDF	1.0	(< 2)	0.79	(< 0.9 - < 3)	0.98	(< 0.8 - < 5)
1,2,3,4,7,8-HxCDD	1.8	(< 1 - 4.0)	3.2	(1.9 - 5.6)	3.2	(1.7 - 5.1)
1,2,3,6,7,8-HxCDD	17.6	(10.7 - 26.3)	30.5	(16.4 - 47.1)	31.0	(21.9 - 37.5)
1,2,3,7,8,9-HxCDD	4.8	(2.4 - 6.6)	5.9	(3.0 - 8.3)	5.8	(4.2 - 8.3)
1,2,3,4,6,7,8-HpCDF	8.5	(4.2 - 14.7)	7.8	(3.6 - 11.2)	7.3	(5.0 - 14.6)
1,2,3,4,7,8,9-HpCDF	0.70	(< 1 - < 2)	0.86	(< 0.6 - < 3)	0.77	(< 0.7 - < 4)
1,2,3,4,6,7,8-HpCDD	50.9	(34.4 - 84.5)	88.8	(63.0 - 122)	84.4	(62.2 - 123)
OCDF	2.4	(< 3 - < 7)	2.3	(< 2 - < 10)	3.1	(< 2 - < 20)
OCDD	592	(296 - 962)	887	(546 - 1390)	634	(524 - 829)

Levels are mean (range). Half the limit of detection concentration was taken for non detectable congeners.

* Excludes one sample (n = 4 for these congeners) having 2,3,4,7,8-PeCDF level of 54.2 pg g^{-1} and 1,2,3,4,7,8-HxCDF level of 19.2 pg g^{-1} (TE level 42.8 pg g^{-1}, cf. Table 1)