Levels and correlations between PCBs and PCDD/Fs concentrations in Belgian plasma

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Introduction

Following the dioxin event of 1999, the Scientific Institute of Public Health set up a survey to assess the health effect of the crisis among Belgian citizens. Dioxin analyses, performed using plasma samples from 248 donors, revealed a slight increase of the concentration of 2 furan congeners between 1998 and 2000 [1]. Given that the pollution of the food chain was due to an Arochlor contamination [2], analyses of the 7 marker PCBs were also performed on a limited number of these samples.

This abstract presents the dioxin and PCB levels, obtained through analyses of 50 paired samples, and investigates the Pearson correlation coefficients for the organochlorine compounds under study.

Materials and Methods

Studied population and sampling protocol

The studied population and the sampling protocol of this survey were presented earlier[1]. Fifty donors were selected for the PCB analyses through a stratified sampling method: firstly, the levels of the three furan congeners that were significantly present in the incident related food samples (1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF and 1,2,3,4,7,8-HxCDF) were added up per donor for 1998 and 2000 separately. Next the sum of 2000 was subtracted from the sum of 1998. This difference was sorted in ascending order of magnitude (from - 65 pg/g fat up to 43 pg/g fat) and 10 categories were created. In each of these 10 categories 5 donors were randomly selected using Stata 8. The obtained sample consists mainly of men (86%). The mean age is 45 ± 11 years (range: 24-62 years). And the mean BMI is 27 ± 4 kg/m² (range: 22 - 37 kg/m)².

Chemical analyses

Analyses of the 21 dioxin-like congeners (17 PCDD/Fs + 4 cPCBs) and the lipid contents were performed by the Centre of Analysis of Residues in Traces in Liège (CART)[1]. Analyses of the 7 marker PCBs (28, 52, 101, 118, 138, 153, 180) were carried out by the Scientific Institute of Public Health using GC-MS/MS (PolarisQ, Finnigan).

Statistical analyses

The PCDD/F and PCB levels were log-transformed in order to obtain a normal distribution. Afterwards a paired sample t-test was used to compare the PCDD/F and PCB levels between 1998 and 2000. A probability of 0.05 or less was considered as significant. STATISTICA® '98 was used to calculate the Pearson 1998 correlation coefficients (r) of some organochlorine compounds (compounds in white in Table 1).

Results and Discussion

Table 1 presents the range, the median and the mean concentrations for the different PCDD/F and PCB congeners. When expressed in pg per g lipid, the most abundant dioxin congeners are OCDD (80%), 1,2,3,4,6,7,8 HpCDD (9%) and 1,2,3,6,7,8 HxCDD (8%). The furans are dominated by 2,3,4,7,8 PeCDF which counts for 40% of the total PCDFs. 1,2,3,6,7,8 HxCDF, 1,2,3,4,6,7,8 HpCDF and 1,2,3,4,7,8 HxCDF contribute each about 16% to the total PCDFs. The faster metabolisation of the lower chlorinated congeners induces the predominance of the PCBs 169 and 126 for the coplanar PCBs and of the PCBs 153, 180 and 138 for the 7 markers PCBs. These profiles are similar to those previously observed in Belgium and elsewhere [2,3]. A comparison between 1998 and 2000 shows an increase of the 2,3,4,7,8 PeCDF levels. Although not significant in this subsample, this is probably due to the incident [1,2]. The levels of the PCBs 77, 81 and 126 are slightly increasing. This induces a rise in the total level cPCBs but not significantly. The mean concentrations of the 7 markers remain more or less constant. Only PCB101 shows a significant increase (0.177 ng/g lipids in 1998 to 0.235 ng/g lipids in 2000). As a result of the decreasing PCDD TEQ-value that cancels out the increased PCDF TEQ-value the mean total TEQ remains unchanged. The higher PCDF TEQ-value could be explained by the dioxin incident which was predominated by a furan contamination[2].

Table 2 presents the Pearson correlation coefficients (r) of 1998. For the PCDDs and PCDFs, the tetra-, penta- and hexa-

congeners are correlating well. The r-value decreases with increasing degree of chlorination. Similarly, the cPCBs and the 7 markers PCBs present better correlations with the lower chlorinated PCDD/F congeners. In most cases, the different PCDD/F and PCB congeners are correlating best with PCB 153. However, PCB 118 presents the best correlation with the cPCBs TEQ-value and with PCB 126. Correlations between the 4 markers PCBs present high coefficients, excepting the correlation between PCB 118 and PCB 180. The r-values between the 7 markers PCBs and TEQ values for PCDDs, PCDFs and cPCBs are 0.8, 0.76 and 0.71 respectively. In comparison to Longnecker et al[4], correlation coefficients between the lower chlorinated dioxins are higher in this paper. This is probably due to the modification performed on the GC-HRMS data set before statistical analysis. More details with regard to those modifications are presented elsewhere[5]. The concentration's estimation performed for congeners under LOQ and for congeners presenting interferences has probably reinforced the existing relation between some congeners. Hence, it seems normal to detect an enhancement of the r-value. On the other hand, some congeners present low r-values such as 1,2,3,4,6,7,8 HpCDF, for which most correlations are not significant. Lower coefficients are also observed between OCDD, 2,3,4,7,8 PeCDF, PCDD and the 7 marker PCBs. A comparison between 1998 and 2000 (data not shown) reveals higher correlation coefficients in 1998 for a large part of the congeners. Exceptions are seen for 2,3,4,7,8 PeCDF, 1,2,3,4,7,8 HxCDF, total PCDF, PCB 126, PCB 118 and for 1,2,3,4,6,7,8 HpCDF. For the latter correlations become significant in 2000. For most congeners, the difference between 1998 and 2000 in r-values*100 are lower than 10. Those coefficients can thus be considered as quite constant in time.

References

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Table 1: Concentrations of organochlorine compounds observed in Belgian plasma in 1998 and 2000

	1998 (n=50)					2000 (n=50)					p-value
	% >DL	mean	median	min	max	% >DL	mean	median	min	max	(t test)
pg/g lip											
2,3,7,8 TCDD	88	1,8	1,6	0	4,7	82	1,7	1,7	0	5,2	0,86
1,2,3,7,8 PeCDD	96	7,2	7,0	0	18,6	98	7,0	6,1	0	16,0	0,21
1,2,3,4,7,8 HxCDD	98	6,0	4,6	0	27,0	98	5,6	5,1	0	33,4	0,91
1,2,3,6,7,8 HxCDD	100	38,4	37,1	6,1	113,1	100	36,0	37,6	9,2	83,8	0,39
1,2,3,7,8,9 HxCDD	92	5,0	4,8	0	13,2	88	4,4	4,8	0	9,2	0,41
1,2,3,4,6,7,8 HpCDD	100	41,9	32,6	3,9	180,4	98	41,5	39,9	0	120,4	0,38
OCDD	100	393,8	293,5	57,7	2611,4	100	339,5	281,8	40,8	1624,0	0,28
2,3,7,8 TCDF	38	0,4	0,0	0	3,2	44	0,5	0,0	0	3,9	0,96
1,2,3,7,8 PeCDF	20	0,2	0,0	0	1,6	26	0,2	0,0	0	1,4	0,77
2,3,4,7,8 PeCDF	98	19,7	17,6	0	44,1	100	21,7	21,2	2,2	56,3	0,62
1,2,3,4,7,8 HxCDF	98	7,3	6,8	0	18,5	96	6,7	6,3	0	14,3	0,48
1,2,3,6,7,8 HxCDF	100	8,8	8,1	1,0	24,3	98	8,2	8,5	0	18,8	0,45
1,2,3,7,8,9 HxCDF	2	0,0	0,0	0	1,2	0	0,0	0,0	0	0,0	-
2,3,4,6,7,8 HxCDF	90	2,6	2,5	0	7,7	88	2,4	2,3	0	5,7	0,94

1,2,3,4,6,7,8 HpCDF	100	8,2	7,2	1,1	28,9	100	7,2	5,8	0,8	17,4	0,1
1,2,3,4,7,8,9 HpCDF	8	0,1	0,0	0	1,6	2	0,0	0,0	0	0,8	-
OCDF	42	1,3	0,0	0	10,7	46	1,9	0,0	0	14,2	0,81
Total PCDD	100	**494**	**401**	**76**	**2886**	100	**436**	**363**	**58**	**1788**	0,37
Total PCDF	100	**49**	**44**	**11**	**120**	100	**49**	**47**	**13**	**111**	0,81
PCB 77	16	15,3	0,0	0	187,9	20	18,7	0,0	0	164,7	0,73
PCB 81	16	4,5	0,0	0	79,9	36	25,7	0,0	0	302,7	0,71
PCB 126	100	63,9	44,6	0	273,3	100	65,8	57,5	6,0	318,9	0,95
PCB 169	100	93,4	85,2	15,1	221,5	100	92,0	83,0	12,7	230,8	0,57
Total PCBc	100	**177**	**152**	**22**	**495**	100	**202**	**169**	**27**	**475**	0,27
pg TEQ/g lip											
TEQ PCDD	100	14,4	13,7	1,9	38,0	100	13,7	11,7	1,8	29,5	0,58
TEQ PCDF	100	11,9	11,1	1,4	27,4	100	12,7	12,3	2,0	32,1	0,54
TEQ PCBc	100	7,3	5,6	0,3	29,5	100	7,5	6,9	0,9	33,5	0,58
Total TEQ	100	**34**	**30**	**5**	**95**	100	**34**	**33**	**5**	**85**	0,87
ng/g lip											
PCB 28	78	0,8	0,6	0	4,4	78	0,8	0,6	0	4,8	0,47
PCB 52	96	0,4	0,3	0	2,1	92	0,4	0,3	0	2,1	0,25
PCB 101	52	0,2	0,0	0	2,2	62	0,2	0,1	0	1,6	0,05
PCB 118	100	13,4	9,6	3,5	46,3	100	13,3	11,4	0	51,1	0,87
PCB 138	100	74,9	67,7	25,8	168,8	100	73,1	67,4	21,1	159,6	0,43
PCB 153	100	137,3	126,9	47,2	293,6	100	134,9	132,7	35,3	272,1	0,62
PCB 180	100	105,5	99,4	29,9	244,7	100	105,5	99,5	25,1	232,2	0,78
7 markers PCB	100	**333**	**312**	**107**	**717**	100	**328**	**322**	**85**	**654**	0,75

Table 2: Pearson correlation coefficient (x100) among Log concentrations of organochlorine compounds for samples of 1998

	1-PeCDD	1,4-HxCDD	1,6-HxCDD	1,9-HxCDD	1,4,6-HpCDD	OCDD	4-PeCDF	1,4-HxCDF	1,6-HxCDF	4,6-HxCDF	1,4,6-HpCDF	**PCDD**	PCB 126	TEQ PCDD	PCB 118	**PCDF**	PCB 169	TEQ PCDF	PCB 138	**PCBc**	TEQ PCBc	PCB 153	PCB 180	**7m. PCBs**
2,3,7,8 TCDD	79	79	84	84	49	49	73	82	81	52	ns	56	70	82	81	88	89	76	85	75	77	78	69	78
1,2,3,7,8 PeCDD	71	85	81	54	60		85	79	80	53	ns	65	75	66	80	80	96	86	70	52	59	67	67	68
1,2,3,4,7,8 HxCDD	86	76	67	55			75	82	82	76	ns	64	78	74	82	84	84	80	77	65	69	76	70	75
1,2,3,6,7,8 HxCDD	84	63	62				82	82	82	54	ns	70	77	71	92	90	95	84	76	63	84	88	84	88
1,2,3,7,8,9 HxCDD	70	73					81	78	81	51	ns	78	78	73	71	83	89	83	75	68	73	71	63	72
1,2,3,4,6,7,8 HpCDD	81						67	58	62	63	34	86	68	58	46	61	64	69	58	48	47	44	34	43
OCDD							58	57	58	45	45	99	65	46	42	58	64	60	47	42	44	40	33	40
2,3,4,7,8 PeCDF							71	76	61	ns		65	80	66	83	82	88	99	70	55	70	73	72	75
1,2,3,4,7,8 HxCDF								96	73	ns		64	87	76	78	88	86	77	80	66	62	69	64	69
1,2,3,6,7,8 HxCDF									76	ns		65	89	78	77	86	87	82	80	66	64	69	65	69
2,3,4,6,7,8 HxCDF										ns		51	73	65	58	62	59	67	65	44	32	41	39	41
1,2,3,4,6,7,8 HpCDF												41	44	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
PCDD													71	53	51	66	71	68	55	48	52	49	41	49
PCDF														63	73	80	81	86	66	57	59	64	60	64

PCB 126	65	87	75	69	100	89	65	67	52	66
PCB 169		88	89	85	71	54	79	87	89	88
PCBc			90	86	90	78	81	85	75	84
TEQ PCDD				91	79	64	75	80	77	80
TEQ PCDF					73	59	71	75	74	76
TEQ PCBc						88	69	72	58	71
PCB 118							73	72	56	71
PCB 138								97	86	96
PCB 153									92	99
PCB 180										95
7 markers										
PCBs										

ns : not significative correlation (p>0,05)