INTRA-INDIVIDUAL VARIATIONS AND TEMPORAL TRENDS IN DIOXIN LEVELS IN HUMAN BLOOD 1987 TO 2002

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Introduction

In Sweden, an important source for exposure to persistent organohalogen pollutants (POP), such as PCDD and PCDF, is through intake of fatty fish from the Baltic Sea, off the Eastern coast of Sweden.[1-3] The present study aimed to assess temporal trends for human levels of PCDD/F between 1987 and 2002 among 26 men from Sweden whom in 1987 had various intakes of fish from the Baltic Sea. In addition, we investigated the impact of potential determinants on the relatively change in individual PCDD/F congener levels between 1987 and 2002.

Material and Methods

Study population and sampling in 1987

In 1987, 29 men with a median age of 42 years (range 20-57), donated venous blood samples after a 24-hours diet that was restricted in fat, and were interviewed about their dietary habits.[1] Nine of them never ate fatty fish from the Baltic Sea - ”zero consumers”, nine had 0.5-9 (median 3) such meals per month - ”moderate consumers”, and the remaining 11 had 6-19 (median 8.5) such meals per month - ”high consumers”.

Study population and sampling at the repeated examination in 2002

We repeated blood sampling for PCDD/F analyses 15 years later for as many as possible of the original 29 subjects. A linkage with the Swedish population register showed that two of the subjects were deceased. The remaining 27 were contacted by letter and afterwards by telephone. Another subject had to be excluded from blood sampling due to severe illness. All the other 26 men, 9 originally characterized as ”zero consumers”, 8 as ”moderate consumers” and 9 as ”high consumers” volunteered for a new blood sampling, and for an interview focused on dietary habits (Table). Body weight and height had been recorded at the initial examination in 1987 and was measured also at the new examination in 2002.

Analysis of PCDD/F in serum in 1987 and 2002

Two different lipid extraction methods were used for determining the PCDD/Fs in 1987 and 2002, respectively. In the 1987 study, conventional liquid-liquid extraction using chloroform-methanol was used. In the present study, a sorbent-assisted liquid-liquid extraction (Chem-Elute) method using hexane-2-propanol was used. Work by Wingfors et al showed that there is no significant difference between the two lipid extraction methods. The Chem-Elute method was also found to have a high reproducibility.[4]

Before the extraction of the samples on a Chem-Elut extraction column an internal standard containing ^{13}C-congeners was added. The cleanup of PCDD/Fs was performed with two types of liquid-chromatography columns, one multilayer column composed of silica gel, sulfuric acid- and potassium hydroxide- impregnated silica gel and an active-carbon column. On the last-mentioned column PCDD/F are separated from PCB. Prior to the final analysis additional ^{13}C-congeners, so-called recovery standards, were added. Isomer-specific analysis was made by means of gas chromatography-mass spectrometry (GC-MS) and so-called isotope-dilution technique. A high-resolution MS (VG 70-250) was used. It was operated with electron ionization (EI) and selective ions were registered (SIR). The quantification was made by comparing quotient of response between native congeners and ^{13}C-congeners in sample with corresponding quotient in a quantification standard containing known amounts of native and ^{13}C-congeners. As a result of this procedure the calculated contents are compensated for losses during clean-up. PCDD- and PCDF- content was estimated for all 2,3,7,8-substituted congeners. Serum lipids were determined with a gravimetric method.

Statistical methods

Pair-wise comparisons of the individual PCDD/F congener levels in 1987 and 2002 were made with Wilcoxon's rank-sum test. In addition, the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) equivalents (TEQ) were estimated for the PCDD, PCDF and PCDD/F, respectively, according to the WHO factors. Bivariate correlations were assessed by Spearman's correlation coefficients. Despite the relatively low number of individuals, linear regression models were used to estimate the effect of age, consumption of fatty fish from the Baltic Sea and relative change in body mass index (BMI) on the relative change in individual PCDD/F congener levels between 1987 and 2002. Model assumptions were checked by residual analyses. In addition, to evaluate that associations not only were driven by single extreme values, analyses were also performed without extreme values. Consumption of fatty fish from the Baltic Sea was considered in two ways: 1) classification of subjects made in 1987 (zero, moderate and high consumers), or 2) relative change of consumption between 1987 and 2002. If more than one of the variables in the univariate analyses showed any association ($p<0.10$) with the outcome variables, they were included in the models simultaneously.

Results and discussion

The correlation between PCDD/F WHO-TEQ values for 1987 and 2002, was significant but rather moderate in strength ($r_s=0.47$; $p=0.01$).

There were no significant intra-individual differences between 1987 and 2002 in plasma/serum-levels of WHO-TEQ for PCDD (p=0.23), PCDF (p=0.60) and PCDD/F (p=0.32). On the other hand, the plasma/serum-levels for the PCDD congeners 2,3,7,8-TCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD had decreased significantly over the 15-year period. Considering PCDF, only the level of 2,3,7,8-TCDF had significantly decreased over time, while the level of OCDF had increased. The Figure illustrates the median levels for the different congeners in 1987 and in 2002.

Neither age, fish consumption nor relative change over time in BMI, affected the relative change over time for WHO-TEQ for PCDD, PCDF or PCDD/F, or for the specific congeners that had significantly changed in concentration over the 15-years period (all p-values ≥ 0.10).

In conclusion, the information from the present study may be of importance for risk assessment and setting standards for food contamination with PCDD/F.

Acknowledgements

The work has been funded by the Swedish Environmental Protection Board. Authors thank Ms Anita Nilsson for collecting blood samples and interview data.

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Table Age, relative change in body mass index (BMI) between 1987 and 2002, and consumption of fatty fish from the Baltic Sea in 1987 and 2002, in 26 Swedish men.

Consumption of fatty fish from the Baltic Sea in 1987		Age	Relative change in BMI (%)	Consumption of fatty fish from the Baltic Sea (meal/month)		Amount fatty fish from the Baltic Sea in 1987 (g/week)
		1987	1987→2002	1987	2002	
Zero	Mean	41	5.7	0	0	0
(n=9)	Median	41	5.4	0	0	0
	Min	24	-1.3	0	0	0
	Max	56	17.0	0	0	0
Moderate	Mean	36	3.4	4	3	114
(n=8)	Median	34	3.1	3	2	95
	Min	26	-6.9	0.5	0	20
	Max	49	15.1	9	5	240
High	Mean	40	5.1	10	13	750
(n=9)	Median	43	4.6	8	8	700
	Min	19	-8.5	6	2	600
	Max	47	13.6	19	58	1200
All	Mean	39	4.8	4	5	295
(n=26)	Median	39	4.6	3	2	95
	Min	19	-8.5	0	0	0
	Max	56	17.0	19	58	1200

Figure Comparison of congener patterns of 2,3,7,8-substituted PCDDs and PCDFs in blood samples from 1987 and 2002.