

Age-related Increase of PCDDs/PCDFs and Coplanar PCBs Levels in Human Adipose Tissue

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Introduction

In our previous studies, we investigated concentrations and distribution of PCDDs, PCDFs and Coplanar PCBs(Co-PCBs) in several human tissues / organs (adipose tissue, liver, blood and brain) obtained from 7 individuals who had died from accidental death during years between 1988 and 1990. The results were presented at DIOXIN'92 Symposium which was held in Tampere, Finland in 1992¹⁾. The study concerning the age-related changes of these highly toxic chemicals in Japanese people has never been reported and their age-related change is considered to be very important to evaluate their risk in human population. Therefore, in the present study, we have analyzed total of 36 human adipose tissue samples for PCDDs, PCDFs and Co-PCBs and examined their levels in relation to age in detail. This is the first study about the age-related increase of PCDDs, PCDFs and Co-PCB in Japanese people.

Methods

Human adipose tissues collected in Fukuoka Prefecture, were subjected for extraction with hexane/acetone using POLYTORON™ homogenizer. Ten kinds of ¹³C-labeled PCDDs/PCDFs and three kinds of ¹³C-labeled Co-PCBs were added as internal standards for checking recoveries of PCDDs/PCDFs and Co-PCBs through whole analytical procedure. The extract was washed with conc. sulfuric acid, purified on a AgNO₃-silica gel column and activated carbon column, and then finally, separated into Co-PCBs and PCDDs/PCDFs. The PCDDs/PCDFs and Co-PCBs were analyzed by HRGC/HRMS technique using a Finnigan MAT-90 mass spectrometer (Finnigan MAT, Germany) directly interfaced with a Varian Model 3400 gas chromatograph. Co-PCBs, hexa-CDDs/DFs and octa-CDD/DF were measured with 50 % methyl phenyl silicon, OV-17 (0.25mm×25m, film thickness, 0.1μm) and for the analysis of other PCDDs/PCDFs, SP-2331 capillary column (0.32mm×60m, film thickness, 0.25μm) was used. The mass resolution (5 % valley) was 7000 to 8000. Two ions of molecular cluster were recorded.

Results and Discussion

Levels of PCDDs,PCDFs and Co-PCBs were determined in human adipose tissue samples of 36 people (16 males and 20 females) in Fukuoka Prefecture, Japan, with the mean age of 55.6 years old ranged 19 to 82 years. Analytical results are summarized in Table 1 on fat-weight basis. The 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) toxic

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Table 1 Concentrations of PCDDs, PCDFs and Co-PCBs in human adipose tissue on a fat basis (pg/g) n=36

Isomers	Min.	Max.	Mean	Median	S.D.
2,3,7,8-TCDD	0.5	6.1	2.9	2.9	1.3
1,2,3,7,8-PeCDD	4.1	21.6	12.2	11.7	4.2
1,2,3,6,7,8-HxCDD	17.1	132.4	60.6	54.9	29.7
1,2,3,4,6,7,8-HpCDD	0.0	1232.6	104.4	33.6	213.9
OCDD	95.5	4525.6	1023.2	643.6	997.4
2,3,7,8-TCDF	0.5	12.6	2.9	2.3	2.3
2,3,4,7,8-PeCDF	7.5	60.5	23.9	23.1	12.6
1,2,3,4,7,8-HxCDF	1.6	19.2	7.4	6.4	4.0
1,2,3,6,7,8-HxCDF	3.0	19.7	6.8	6.0	3.4
1,2,3,4,6,7,8-HpCDF	0.0	13.5	3.7	3.4	2.3
OCDF	0.0	13.0	1.6	1.0	2.3
3,3',4,4'-TCB	3.1	54.6	22.1	21.1	13.3
3,3',4,4',5-PeCB	41.4	863.1	261.5	228.1	158.7
3,3',4,4',5,5'-HxCB	41.1	214.4	112.6	113.7	47.9
Total PCDD	169.5	4897.2	1219.0	792.0	1121.5
Total PCDF	17.7	103.7	48.8	44.5	21.2
Total PCDD/PCDF	194.8	4969.3	1267.8	824.3	1131.6
Total Co-PCB	91.0	1091.1	396.2	353.1	199.4
Total PCDD TEQ	5.7	30.5	17.3	17.6	5.5
Total PCDF TEQ	4.3	33.9	13.8	13.4	6.9
Total PCDD/DF TEQ	10.0	53.6	31.1	30.8	10.7
Total Co-PCB TEQ	4.6	88.2	27.3	24.1	16.1
Total PCDD/DF & Co-PCB TEQ	14.6	141.8	58.4	55.0	24.2
Age	19.0	82.0	55.6	61.0	18.4

equivalent (TEQ) of PCDDs and PCDFs were calculated using I-TEF and those of the Co-PCBs were calculated using the data reported by WHO/IPCS²). In PCDDs, the highest concentration in the adipose tissue was observed in OCDD and generally, their levels seemed to increase in proportion to higher grade of chlorination. In PCDFs, 2,3,4,7,8-PeCDF, the second most toxic congener, showed the highest level. In Co-PCBs, the highest concentration was seen in 3,3',4,4',5-PeCB, the most toxic congener in Co-PCBs. The levels of PCDDs, PCDFs and Co-PCBs of the minimum and the maximum were 14.6 pg/g and 141.8 pg/g as TEQ value and therefore it showed about 10-fold difference with both age and individual. The mean concentrations of PCDDs, PCDFs and Co-PCBs as TEQ values were 17.3, 13.8, and 27.3 pg/g, respectively, and mean total concentration of these compounds was 58.4 pg/g. Therefore about 47 % of the mean total level was attributable to Co-PCBs. In order to fit the data set and for statistical evaluation, the following two models were used, model(1); $\text{CONCENTRATION} = A \times 10^{B \times \text{Age}}$ and model (2); $\text{CONCENTRATION} = A \times \text{Age}^B$. Calculated factors A and B, increase factors (10^B and 2^B) and correlation coefficients (r) for the two models are listed in Table 2. In the two models, r values for each congener seemed not so different each other. Generally, however, r value for every congener obtained from model (1) formula was considered slightly better than that from model (2). Among 14 congeners determined, only 5 ones were observed to significantly increase with age. In PCDDs and PCDFs, only two highly toxic congeners, namely, 2,3,7,8-TCDD and 2,3,4,7,8-PeCDF, seemed to increase with age. However, in Co-PCBs, all of the three congeners were considered to elevate with age. These findings for PCDDs and PCDFs were rather different from those reported by Schrey et al.³), in which almost all the congeners seemed to increase with age. The regression curves of 2,3,7,8-TCDD, 2,3,4,7,8-PeCDF, the three Co-PCBs and total 2,3,7,8-TCDD TEQ levels in human adipose tissues are plotted in relation to age in Fig. 1. Fairly good age-related increases are seen for the five congeners. According to the regression curve for the total 2,3,7,8-

Table 2 Correlations of PCDDs, PCDFs and Co-PCBs levels in human adipose tissue with age

Isomers	Statistical Model : (1) ^a				Statistical Model : (2) ^b			
	A	B	10 ^B	r	A	B	2 ^B	r
2,3,7,8-TCDD	1.1	0.007	1.016	0.576*	0.1	0.735	1.664	0.585*
1,2,3,7,8-PeCDD	9.5	0.001	1.003	0.156	7.2	0.116	1.084	0.125
1,2,3,6,7,8-HxCDD	75.0	-0.003	0.994	-0.220	238.0	-0.376	0.771	-0.312
1,2,3,4,6,7,8-HpCDD	8.1	0.012	1.027	0.262			1.000	0.209
OCDD	327.8	0.005	1.013	0.236	73.0	0.558	1.472	0.234
2,3,7,8-TCDF	1.3	0.005	1.011	0.291	0.3	0.510	1.424	0.303
2,3,4,7,8-PeCDF	8.8	0.007	1.016	0.537*	1.5	0.671	1.592	0.516*
1,2,3,4,7,8-HxCDF	4.0	0.004	1.009	0.286	1.5	0.378	1.300	0.282
1,2,3,6,7,8-HxCDF	5.0	0.002	1.004	0.152	3.4	0.151	1.110	0.137
1,2,3,4,6,7,8-HpCDF	3.5	-0.002	0.995	-0.072			1.000	-0.107
OCDF	0.1	0.015	1.034	0.316			1.000	0.277
3,3',4,4'-TCB	3.9	0.012	1.028	0.694*	0.1	1.221	2.331	0.695*
3,3',4,4',5-PeCB	61.1	0.010	1.023	0.643*	4.1	1.006	2.008	0.635*
3,3',4,4',5,5'-HxCB	51.2	0.005	1.013	0.511**	13.9	0.506	1.420	0.464**
Total PCDD	447.8	0.005	1.012	0.248	126.3	0.483	1.398	0.232
Total PCDF	23.7	0.005	1.011	0.476**	6.5	0.489	1.403	0.459**
Total PCDD/PCDF	471.9	0.005	1.012	0.263	129.7	0.493	1.407	0.247
Total Co-PCB	119.7	0.008	1.019	0.673*	13.1	0.832	1.780	0.651*
Total PCDD TEQ	15.8	0.000	1.001	0.034	19.4	-0.043	0.971	-0.049
Total PCDF TEQ	5.1	0.006	1.014	0.516**	1.1	0.610	1.526	0.496**
Total PCDD/F TEQ	20.9	0.003	1.006	0.289	12.8	0.209	1.156	0.226
Total Co-PCB TEQ	6.7	0.010	1.021	0.647*	0.5	0.975	1.965	0.637*
Total PCDD/F & Co-PCB TEQ	27.7	0.005	1.012	0.514*	8.0	0.483	1.398	0.469**

a : CONCENTRATION=A×10^B×Age

b : CONCENTRATION=A×Age^B

* : Correlation significant on the 99.9 %-level

** : Correlation significant on the 99.0 %-level

TCDD TEQ level, concentrations in the adipose tissue at 20, 40, 60 and 80 years old are 37.9, 48.2, 61.4 and 78.1 pg/g, respectively. Like this, a two-fold increase of age is associated with a significant increase of PCDDs, PCDFs and Co-PCBs as TEQ value in the adipose tissue which can be described by the increase factor 10^B and 2^B obtained from model (1) and model (2) formulae given in Table 2.

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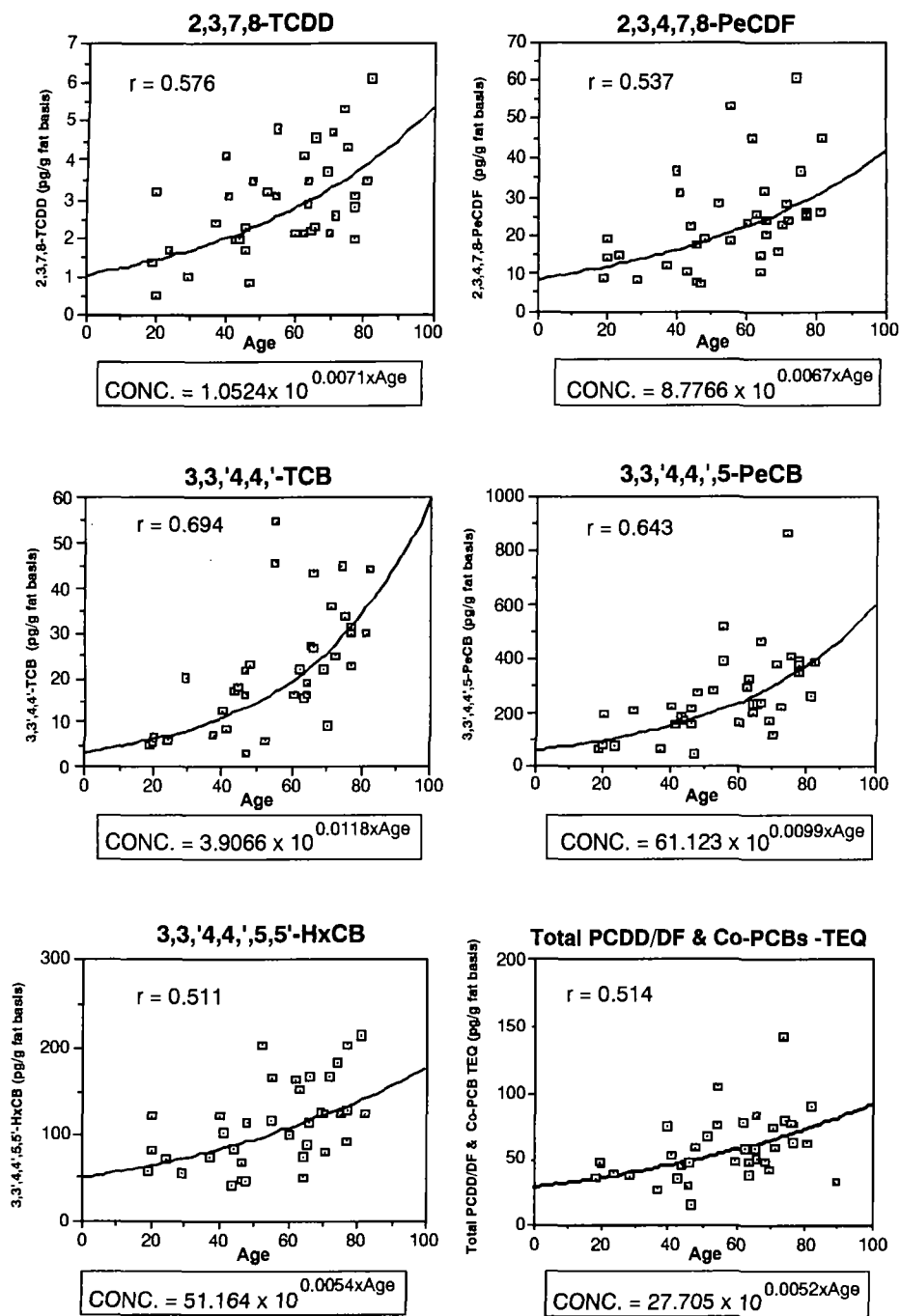


Figure 1 PCDDs/DFs levels in human adipose tissue in relation with age