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Screening of persistent halogenated compounds in human adipose tissue and blood from Sweden

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Abstract

To expand our monitoring focus and to make complementary additions to the POPs traditionally measured we undertook a POP screening study of human tissue representative for Swedish adults in 2007. Among the compounds assessed in this study are several classes of organohalogen contaminants, such as polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs) and their brominated homologues (PBDD/Fs), polychlorinated biphenyls (PCBs) and their hydroxylated metabolites (OH-PCBs), polybrominated diphenyl ethers (PBDEs) and other bromine containing compounds, a number of organochlorine Stockholm Convention pesticides including toxaphene, and several recently identified perfluorinated chemicals (PFCs). The analytical techniques used were based on various GC and HPLC mass spectrometry applications after clean-up and fractionation of blood and adipose tissue samples.

The profile of the PCDD/F in 2007 is considered to be unchanged since the 90's. The shift in congener profile from BDE #47, earlier being the dominant congener in human tissues, to BDE# 153 being dominant is confirmed in this study. Levels of PCBs are lower in this study group in relation to earlier fish consumers' levels. Six individual PFCs were detected in the blood samples analysed. PFOS was detected at the highest concentration, with a geometric mean of 16 ng/ml, followed by PFOA, 2,4 ng/ml, PFHxS, PFNA, PFDA and PFUnDA were present at similar levels. There is a need to further investigate individual exposures to PFCs and identify high exposure groups.

Brominated PBDFs were found in human adipose at concentrations of 0.27-2.24 pg/g, being the first results on a larger material of the general population in Sweden.

The screening of a larger sample seize of human adipose tissue revealed several unknown, bromine containing POPs. Both smaller and larger bromine containing compounds besides the known BDEs were found. Positive identification of these compounds will require authentic standards and high resolution GC/MS analysis.

1. Introduction

When analyzing human tissue for the classical persistent halogenated pollutants (POPs) during the last ten years, we have observed a number of unidentified components in our samples. To expand our monitoring focus and to make complementary additions to the POPs traditionally measured we undertook a screening study of human tissue representative for Swedish adults in 2007. The past and current POP exposure of people can be assessed through screening of human fat tissue and blood. Compounds of concern are those that are persistent, bioaccumulate and toxic, including known as well as unknown/unidentified compounds. Among the compounds assessed in this study are several classes of organohalogen contaminants, such as polychlorinated dibenzo-*p*-dioxins and furans (PCDD/Fs) and their brominated homologues (PBDD/Fs), polychlorinated biphenyls (PCBs) and their hydroxylated metabolites (OH-PCBs), polybrominated diphenyl ethers (PBDEs) and bromine containing compounds, a number of organochlorine Stockholm Convention pesticides, toxaphene, and several recently identified perfluorinated chemicals (PFCs). The analytical techniques used were based on various mass spectrometry applications.

Dioxins
PCDD and PCDF are unintentional by-products from various industrial and thermal processes with 75 and 135 possible congeners of PCDD and PCDF respectively. In humans seven PCDDs and ten PCDFs of the most toxic 2,3,7,8-substituted congeners are found. In the past 20-30 years there has been a marked decrease in the levels of PCDD/Fs in the general population (1). Levels of PCDD/F are reported using toxic equivalents corresponding to the toxicity by the most toxic congener, 2,3,7,8-TeCDD. This TEQ concept is also used when reporting PCBs having "dioxin-like" structures, the non-*ortho*-PCB and the mono-*ortho*-PCBs. Intake levels of dioxin TEQs have decreased in Europe since the mid 80's but recently a stagnation of this trend was reported (2). The rapid increase in the use of brominated flame retardants (BFRs) has raised the level of environmental concern regarding brominated dibenzo-*p*-dioxins and furans, PBDD/Fs. It is likely that human, as well as wildlife, exposure to brominated dioxins and furans will increase with this increased use and waste disposal of BFR products (3).

PCBs
PCBs have been used globally in a great variety of applications since 1930 (4). The main use of PCBs was for industrial purposes, such as dielectrics fluids in transformers and capacitors, as heat exchange fluids, in pesticides, paint additives and in plastics. The use and production of PCBs have been banned for decades, but PCBs are still an environmental problem in many places in Eastern part of Europe. The concentrations in food have declined since the reports by Sören Jensen and others in the 1970s and 80s. However, Bignert (5) recently reported that in fish from some parts of the Baltic Sea, the decline has not continued during the 90s.

Pesticides
Synthetic pesticides, including chlordane, DDT, hexachlorobenzene (HCB) and toxaphene have been used extensively to fight insect pests world wide. Chlordane is a pesticide mixture of 140 different components with persistent and toxicological properties. Its use has been banned in Sweden since 1971, but it is found in fish, bird and seal from the Baltic Sea. When chlordane is metabolized oxychlordane is one possible metabolite in biological samples. In biological samples the metabolite DDE is the most abundant of the group of DDTs. Levels of *p,p*-DDE are despite decreasing levels, still the highest among the organochlorine compounds. Declining levels of sumDDT has been reported in the Kattegatt and Skagerak in

1980-2000 (5). Hexachlorobenzene, HCB, was withdrawn from the Swedish market in 1980 because of its carcinogenic effects and its persistence. Bignert (5) reports decreasing concentrations of HCB in herring, cod, guillemot's eggs and dab in the Baltic proper since 1988. For PCB and DDE there is an increase of the bodyburden with age which entails age matching in comparing levels of exposure. For HCB and PBDE similar age related levels are not found. Toxaphene is a pesticide mainly consisting of chlorobornanes, found worldwide in the environment even after it was banned in most countries in the 1980's (6).

PBDEs
Polybrominated diphenyl ethers (PBDEs) belongs to a class of chemicals known as brominated flame retardants (BFR) which are used for fire protection in various consumer products, such as electronic equipment, textiles, plastics and in construction materials. PBDEs have been in production since the 1970'ies (7) and were first reported in the Swedish environment in 1981 (8). Recently Fängström et al (9) reported decreasing human milk levels of tetra- and penta-substituted congeners, peaking around year 1995, but the hexa-substituted congener BDE #153 has continued to increase at least to 2001 and thereafter seem to have stabilized. This is indicative of a shift in congener profile from BDE #47 earlier being the dominant congener in human tissues.

PFCs
Perfluorinated chemicals (PFCs) are man-made chemicals used in a wide variety of industrial and household applications. In Sweden the major applications of PFCs are impregnation of textiles, leather, and cleaning aids, and as surfactants (10). PFCs are present in biota and humans worldwide (11-13). Perfluorooctane sulfonates (PFOS), the most frequently detected PFCs, have been suggested as candidate for the Stockholm Convention on persistent organic pollutants, POPs. In Sweden PFCs are present at higher levels (on whole blood basis) in human blood compared to individual classes of classical POPs (14).

The PFCs and some BFRs are considered as emerging chemicals although they may not necessarily be new compounds, as with other emerging substances. The PFCs had been in production for more than half a century before they were detected in humans and biota after improvements in analytical methodology in their detection and identification at trace levels. In the U.S. and Canada some 30 000 chemicals are used commercially, of these about 400 resist degradation in the environment and can accumulate in fish and wildlife. Of these 400, only four percent are routinely analyzed (15). Screening of unknown compounds is important to assess possible body burden of emerging contaminants. If present at high enough concentrations this can be done by performing full scan gas chromatography coupled to mass spectrometry (GC/MS) or scanning of specific fragments.

Materials and Methods

2.1 Samples

Human adipose tissue and blood samples were collected during 2007 at Örebro University hospital from ten persons as listed in Table 1. After blood collection into heparin tubes, blood samples were divided into whole blood and plasma samples and all samples were stored at -20°C.

Table 1. Human adipose tissue and blood samples; age and gender.

Sample	*Age*	*Gender*
ID 1	61	Female
ID 2	61	Male
ID 3	53	Female
ID 4	38	Male
ID 5	41	Female
ID 6	54	Male
ID 7	19	Female
ID 8	21	Female
ID 9	48	Male
ID 10	65	Male

2.2 Chemicals

For the analysis of chlorine and bromine contaminants internal standards for PCBs, ^{13}C-labeled PCB #28, #52, #70, #101, #105, #118, #138, #153, #156, #170, #180, #194, #202, #206, and #209, were purchased from Wellington Laboratories. Internal standards for PBDEs, ^{13}C-labeled BDE #77 was from CIL, and #139 was purchased from Wellington Laboratories (Guelph, Ontario, Canada). A ^{13}C-labeled PCB recovery standard was used, containing PCB #81, #114, and #178. A quantification standard (IUPAC Nordic Standard, 99,9%) for PCBs included PCB #28, #52, #47, #74, #66, #101, #99, #110, #118, #114, #122, #105, #153, #141 #138, #128, #167, #156, #157, #187, #183, #180, #170, #189, #194, #206, #209, and for PBDEs congener #28, #47, #66, #85, #99, #100, #138, #153, #154, #183. For determination of pesticides Pesticides-Mix 13 from Labor Dr. Ehrenstorfer-Schäfers, Germany, was used. A standard for toxaphenes, purchased from LGC Standards, Borås, Sverige, included toxaphene compound #2, # 26, # 38, #40/41, # 44, # 50 and # 60.

For dioxin analysis ^{13}C-labeled internal PCDD/F standards including ^{13}C- 2,3,7,8-TCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDD, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF, OCDD and OCDF. As recovery standards ^{13}C-labeled 1,3,7,8-TCDD and 1,2,3,7,8,9-HxCDD were used. The quantification standard included 2,3,7,8-TCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDD, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,6,7,9-HxCDD, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,4,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,7,8,9-HpCDF, OCDD and OCDF. All PCDD/F standards were purchased from Wellington Laboratories Inc., Guelph, Canada. PBDD/F standards; 4-MoBDF, 2,7-DiBDF, 2,8-DiBDF, 2,3,8-TriBDF, 1,2,7,8-TeBDF, 1,2,3,7,8-PeBDF, 1,3,4,7,8-PeBDF were purchased from Wellington Laboratories Inc., Guelph, Canada, and ^{13}C-labeled 2,3,7,8-TeBDF, 1,2,3,7,8-PeBDF, 2,3,4,7,8-PeBDF and 1,2,3,4,7,8-HxBDF were from Cambridge Isotope Laboratories Inc., Andover, MA, USA.

Organic solvents used were of pesticide grade and purchased from Riedel de Haën (methanol, n-hexane, dichloromethane, toluene, and xylene). Water used for blank samples and column washing was water, gradient HPLC grade from Scharlau. Ethanol was purchased from Kemetyl.

For the analysis of perfluorinated chemicals ammonium acetate (>99%, pa for HPLC) was purchased from Fluka (Steinheim, Germany), formic acid (98-100%) from Scharlau (Barcelona, Spain), and methanol (HPLC) from Labscan (Dublin, Ireland). All water used

was laboratory produced ultra pure water. Ammonium hydroxide (NH_4OH, 25 % in water) and sodium acetate was purchased from Merck (Darmstadt, Germany). Perfluorobutanesulfonate (PFBuS) tetrabutylammonium salt (≥98%), PFOS potassium salt (≥ 98%), perfluorodecanoic acid (PFDA; >97%), and perfluorohexanoic acid (PFHxA; ≥ 97%) were purchased from Fluka. Perfluoroheptanoic acid (PFHpA; 99%), perfluorononaoic acid (PFNA; 97%), perfluorooctanoic acid (PFOA, 96%), perfluorodecanesulfonate (PFDS) ammonium salt (25 wt% in 2-butoxyethanol (37%) in water), perfluoroundecanoic acid (PFUnDA; 95%), and perfluorotetradecanoic acid (PFTDA, 97%) were purchased from Aldrich (Steinheim, Germany and Milwaukee, WI). Perfluorooctanesulfonamide (PFOSA; 97%) and 7H-PFHpA (98%) were purchased from ABCR (Karlsruhe, Germany). 1H,1H,2H,2H-PFOS (THPFOS, purity unknown), and perfluorohexanesulfonate (PFHxS; 98%) were purchased from Interchim (Montlucon, France). $^{13}C_4$-labeled PFOA and $^{13}C_4$-labeled PFOS were used as internal standards and $^{13}C_5$-labeled PFNA was used to control the recovery of internal standards, all from Wellington Laboratories (Guelph, Ontario, Canada).

2.3 Sample preparation

Various sample preparation techniques were used including supercritical fluid extraction coupled to liquid chromatography (SFE-LC), open column chromatography and solid phase extraction (SPE), as well as various instrumental techniques for the analysis of halogenated contaminants in human tissues. The various techniques used are summarized in Table 2.

Table 2. Overview of sample preparation and instrumental techniques used for the analysis of halogenated compounds in human tissues.

Compound group	Matrix	Extraction and clean up	Instrumental technique
PBDEs	Lipid	Open columns	GC-NCI-LRMS
	Plasma		GC-EI-HRMS
PCBs	Lipid	SFE-LC	GC-EI-HRMS
	Plasma	Open columns	
PCDD/Fs, PBDDFs	Lipid	SFE-LC, open columns	GC-EI-HRMS
	Plasma	Open columns	
Pest	Lipid	SFE-LC	GC-EI-HRMS
	Plasma	Open columns	GC-EI-LRMS
PFCs	Whole blood	WAX SPE	UPLC-MS/MS
OH-PCBs*	Whole blood	Open column and derivatization	GC-EI-HRMS
Toxaphenes	Lipid	SFE-LC	GC-NCI-LRMS
	Plasma	Open columns	

* Performed in collaboration with CAL-EPA Toxic substances

2.3.1 Adipose tissue

Adipose tissue samples were ground with anhydrous sodium sulfate. Sample extraction was performed using SFE-LC. During dynamic extraction at 40 °C and 280 atm with CO_2 for 45 minutes, the target compounds from approximately one gram adipose tissue were collected on a solid phase trap containing AX-21 carbon on ODS silica, then eluted with n-hexane/ dichloromethane (1:1) for non-planar compounds and xylene for planar compounds. Open column chromatography was also applied for approximately five gram adipose tissue. Sample clean-up was done on three open columns (multilayer silica, AlOx and active carbon). The multilayer silica columns contained KOH silica, neutral activated silica, 40% H_2SO_4 silica gel, 20% H_2SO_4 silica gel, neutral activated silica gel and activated Na_2SO_4 and was eluted

with hexane. This column was followed by an AlOx column eluted with hexane/ dichloromethane. Additional clean up and fractionation was done on an active carbon column, containing Carbopack C dispersed on Celite 545, which was eluted with 10 ml of hexane for non-planar compounds and then 80 ml of toluene to elute the planar fraction containing PCDD/Fs and PBDD/Fs. Addition of a ^{13}C-labeled recovery standards was done prior to instrumental analysis. Throughout the sample preparation the samples were kept shielded from UV light to avoid photo degradation.

2.3.2 Plasma
Plasma samples were ground with anhydrous sodium sulfate and cleaned up using open column chromatography as described in section 2.3.1 for adipose tissue.

2.3.3 Whole blood for PFC-analyzes
The plasma samples were extracted using solid-phase extraction (SPE) using 0.5 mL plasma. Internal standards ^{13}C-PFOA and ^{13}C-PFOS were added before Vortex mixing and addition of 2 mL formic acid/water (1:1). The solution was then sonicated for 15 min and centrifuged at 10 000 x g for 30 minutes. The supernatant was extracted on a Waters Oasis® WAX (weak anion exchange) SPE column (1cc/30 mg), previously conditioned with 2 mL methanol and 2 mL water. The column was washed with 2 ml 40% methanol in water. SPE cartridges were vented with air under vacuum suction until visual dryness. Perfluorinated compounds were eluted with 1 mL 2% ammonium hydroxide in methanol. After evaporation under a gentle stream of nitrogen the extracts were filtrated through a 0.2 µm polypropylene filter. The final volume for the serum extracts was 500 µl. Recovery standards, $^{13}C_5$-PFNA, were added to extracts before injection.

2.4 Instrumental analysis

2.4.1 GC-EI-HRMS
HRGC/HRMS analysis was performed on a Micromass Autospec Ultima operating at 10 000 resolution using EI ionization at 35 eV. All measurements were performed in the selective ion recording mode (SIR), monitoring the two most abundant ions of the molecular chlorine or bromine cluster. Quantification was performed using the internal standard method. Analyses were performed with a 30 m DB-5MS (0.25 mm id, 25 µm) column. For PBDD/Fs two different length DB-5MS columns were used, 15 m for quantification and 25 m for verification of retention times (0.10 mm id, 25 µm). Splitless injection was used to inject 1 µl of the final extract on the GC column. GC temperature programs were used to optimize the response (and minimize the degradation in both the injector and on the column) depending on column length and GC performance. Detection levels were calculated at a S/N ratio of 3, corrected for recovery of the internal standard. Toxic equivalents (TEQs) were calculated using World Health Organization avian toxic equivalency factors (TEFs) for PCDDs, PCDFs, and non-ortho PCBs (16).

2.4.2 GC-LRMS
GC low resolution MS was performed using a HP 6890 GC coupled to a HP 5973 MS working in the negative chemical ionization (NCI) mode for brominated compounds and in the electron impact (EI) mode for chlorinated compounds. Analytes were separated on a 30 m DB-5MS (0.25 mm id, 25 µm) column.

2.4.3 UPLC-MS/MS analysis

Instrumental analysis was performed using a Waters AQUITY Ultra Performance liquid chromatography (UPLC) and a Quattro Premier^{TM} XE in negative ion electrospray mode (ESI-MS/MS). Separation was performed on a Waters ACQUITY UPLC® BEH C18 (50 x 2.1 mm, 1.7 um) column, kept at 40 ºC. A holdup column (Waters prototype, 2.1 x 50 mm) was inserted immediately in front of the injector to remove any fluorochemicals originating from the UPLC system. Injection volume was 10 µl and the flow rate was set to 400 µl/min. The mobile phases consisted of 2 mM ammonium acetate in methanol and 2 mM ammonium acetate in water. The LC gradient program used started at 30% methanol followed by a five minute ramp to 90% methanol, a one minute hold and then reverting to initial conditions allowing one minute stabilization time. MS settings used were: cone voltage 15-45 kV (compound dependent), collision energy 10-40 eV (compound dependent), source temperature 120 ºC, desolvation temperature 400 ºC. All measurements were performed in the multiple reaction monitoring (MRM) mode.

2.5 Quantification and Quality Assurance

Quantification was done using the internal standard method. Method performance was controlled by extracting ^{13}C-labeled internal standards allowing recovery values between 50-150 %. Replicate samples were also performed using the various extraction and instrumental techniques depicted in table 1, resulting in comparable values. With every batch of samples extracted an extraction blank was also prepared and analyzed. The detection levels were mainly in the range 0.1-1 ppb, depending on congener, sample amount and type of tissue. The MTM laboratory participates on a regular basis in international intercalibration studies. In studies organized by AMAP, QUASIMEME and the Norwegian Institute of Public Health the MTM laboratory shows qualified results.

3. Results and discussion

A total of 30 samples have been analyzed for organohalogen contaminants according to the above described methods. Individual results for every compound class are presented in Tables 3-10 and in the Appendix. Sample identification as ID1-10, where F or M denotes male or female and the age time of sampling of the subject.

PCDD, PCDF, non-o-PCBs and TEQ

Levels of PCDD/F in human adipose tissue, reported as pg TEQ/g lipid are reported in Table 3. Plasma levels can be found in Appendix. Main contributors to the sum PCDD/F TEQ are 2,3,4,7,8- PeCDF and 1,2,3,7,8-PeCDD. Levels are comparable with those reported by Norén and Meironyté (1) in Swedish human milk from the mid 90s, reporting 14.7 pg TEQ/g lipid, and 7.99 pg TEQ/g lipid for sum PCDD/F and non-ortho PCBs respectively. The WHO 1990 TCDD levels were 2-3 pg/g lipid weight (in this study 0.2 – 3.9). The profile of the PCDD/F in 2007 is therefore considered to be unchanged since the 90's.

Table 3. PCDD/Fs reported as pg TEQ/ g lipid in ten Swedish adipose tissue samples from 2007.

Congener	ID 1 F 61 pg TEQ/g lipid	ID 2 M 61 pg TEQ/g lipid	ID 3 F 53 pg TEQ/g lipid	ID 4 M 38 pg TEQ/g lipid	ID 5 F 41 pg TEQ/g lipid	ID 6 M 54 pg TEQ/g lipid	ID 7 F 19 pg TEQ/g lipid	ID 8 F 21 pg TEQ/g lipid	ID 9 M 48 pg TEQ/g lipid	ID 10 M 65 Pg TEQ/g lipid
2378-TCDF	0.03	0.09	0.05	0.03	0.02	0.02	0.02	0.08	0.03	0.03
12378-PeCDF	0.01	0.02	0.01	0.01	0.01	0.01	<0.005	0.02	0.01	0.03
23478-PeCDF	12.5	7.26	3.40	3.09	1.61	5.68	0.62	2.30	7.34	5.78
123478-HxCDF	0.49	0.23	0.14	0.18	0.13	0.36	0.05	0.11	0.26	0.16
123678-HxCDF	0.52	0.22	0.16	0.19	0.13	0.37	0.04	0.12	0.23	0.24
234678-HxCDF	0.14	0.07	0.07	0.14	0.05	0.14	<0.03	0.06	<0.10	<0.10
123789-HxCDF	<0.002	<0.004	0.003	<0.005	<0.001	<0.009	<0.004	0.01	0.002	0.03
1234678-HpCDF	0.02	0.02	0.07	0.03	0.02	0.06	0.01	0.02	0.02	<0.03
1234789-HpCDF	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.009
OCDF	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2378-TCDD	3.86	1.50	0.95	0.76	0.51	1.25	0.19	0.55	1.52	1.05
12378-PeCDD	9.45	4.16	2.83	2.35	1.42	4.26	0.54	1.85	4.99	<2.69
123478-HxCDD	0.47	0.14	0.12	0.15	0.06	0.15	0.04	0.05	0.32	0.148
123678-HxCDD	3.23	1.19	1.31	0.83	0.71	1.98	0.17	0.59	2.51	1.46
123789-HxCDD	0.47	0.09	0.20	0.09	0.11	0.17	0.04	0.12	0.18	1.00
1234678-HpCDD	0.36	0.07	0.10	0.09	0.12	0.05	0.05	0.10	0.16	0.14
OCDD	0.02	0.01	0.01	0.01	0.02	0.01	0.002	0.01	0.02	0.01
Sum UB[a] PCDD/F	**31.5**	**15.0**	**9.40**	**7.97**	**4.93**	**14.5**	**1.83**	**5.98**	**17.7**	**12.9**
Sum LB[b] PCDD/F	**31.5**	**15.0**	**9.40**	**7.96**	**4.93**	**14.5**	**1.79**	**5.98**	**17.6**	**10.1**
PCB#77	0.0002	0.0003	0.0002	0.0002	0.0002	0.00005	<0.0002	0.0004	0.0002	NA
PCB#126	21.6	11.8	3.23	3.29	3.05	3.65	1.42	3.66	3.90	NA
PCB#169	1.06	0.84	0.50	0.45	0.29	0.91	0.04	0.16	1.01	NA
Sum UB[a] PCB	**22.6**	**12.7**	**3.7**	**3.7**	**3.3**	**4.6**	**1.5**	**3.8**	**4.9**	**NA**
Sum LB[b] PCB	**22.6**	**12.7**	**3.7**	**3.7**	**3.3**	**4.6**	**1.5**	**3.8**	**4.9**	**NA**

[a] Upper bound levels, including <-values.
[b] Lower bound levels, excluding <-values.

PBDE and sum of PBDEs

Levels of the 22 PBDEs analyzed are shown in Table 4, with sum of PBDEs ranging from 1-12 ng/g lipid. The shift in congener profile from BDE #47 earlier being the dominant congener in human tissues to BDE# 153 being dominant, as earlier shown by Fängström (9) can also be seen in this study. Levels are in the same range or somewhat lower than levels, 4-110ng/g, reported by Kärrman et al (14). PBDE levels in plasma are shown in the Appendix.

Table 4. PBDE levels (ng/g lipid) in ten human adipose tissue samples from Sweden in 2007, analysed by GC-NCI-LRMS.

	ID 1	**ID 2**	**ID 3**	**ID 4**	**ID 5**	**ID 6**	**ID 7**	**ID 8**	**ID 9**	**ID 10**
	F 61	**M 61**	**F 53**	**M 38**	**F 41**	**M 54**	**F 19**	**F 21**	**M 48**	**M 65**
Congener	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PBDE#7	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
PBDE#15	0.010	0.021	0.022	0.010	0.031	0.013	0.010	<0.007	<0.007	<0.007
PBDE#17	0.06	0.07	0.05	0.03	0.17	0.06	0.02	0.17	0.05	0.01
PBDE#28	0.13	0.05	0.07	0.04	0.06	0.10	0.004	0.22	0.08	0.10
PBDE#49	0.06	0.07	0.05	0.03	<0.01	0.06	0.01	0.03	0.09	0.04
PBDE#71	0.09	0.08	0.06	0.05	<0.01	0.07	0.04	0.06	0.01	0.02
PBDE#47	0.62	0.80	0.75	0.42	1.04	1.10	0.39	4.39	0.45	1.57
PBDE#66	0.02	0.06	0.06	0.02	<0.01	0.01	0.01	0.05	0.02	0.06
PBDE#100	0.39	0.50	0.29	0.22	0.65	0.56	0.11	0.93	0.30	0.62
PBDE#119	0.05	0.07	0.02	0.05	0.03	0.01	0.002	0.01	0.03	0.01
PBDE#99	0.11	0.12	0.15	0.10	0.27	0.19	0.18	0.82	0.11	0.52
PBDE#85	0.02	0.03	0.02	0.02	0.36	0.06	<0.01	0.09	0.15	0.06
PBDE#126	0.12	0.13	0.22	0.40	<0.01	0.21	0.02	0.12	0.08	0.04
PBDE#154	0.25	0.42	0.81	1.52	0.26	0.50	0.03	0.14	0.76	0.61
PBDE#153[a]	1.68	0.75	0.75	1.44	2.25	1.41	0.24	0.09	0.72	2.50
PBDE#138	0.06	0.10	0.07	0.15	0.07	0.14	0.01	0.10	0.07	0.10
PBDE#156	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.04	<0.01	<0.01
PBDE#184	0.01	0.07	0.04	0.04	0.07	0.09	0.01	0.01	0.05	0.03
PBDE#183	0.05	0.14	0.09	0.11	0.17	0.23	0.05	0.18	0.08	0.40
PBDE#191	0.04	0.11	0.11	0.16	0.10	0.16	0.01	0.01	0.13	0.03
PBDE#196	0.60	2.55	1.84	2.18	5.55	2.83	0.05	0.39	0.32	1.12
PBDE#197	<0.05	0.29	0.17	0.28	1.13	0.37	0.01	0.04	0.03	0.12
Sum UB[b] **PBDEs**	**4.43**	**6.44**	**5.66**	**7.29**	**12.26**	**8.18**	**1.23**	**7.91**	**3.57**	**7.96**
Sum LB[c] **PBDEs**	**4.36**	**6.40**	**5.63**	**7.27**	**12.18**	**8.15**	**1.21**	**7.90**	**3.55**	**7.94**

[a] Levels derived from GC-EI-HRMS due to coelution of PBB #154 when analyzed on GC-NCI-LRMS.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

PCB and sum of PCBs

Table 5 shows the 30 PCBs with highest concentration of a total of 60 PCBs analyzed. Levels of all PCBs are shown in the Appendix. The levels, range of sum PCBs 69-944 ng/g lipid, are lower in comparison with levels of Swedish high consumers of fish, having sum PCB ranging 61-1980 ng/g lipid (17), and similar to levels from an other Swedish study in 2006 reporting sum PCBs ranging from 141-1193 ng/g (14). Individual blood levels are correlated with the adipose tissue levels. Age related concentrations are generally not scrutinized in this study due to the limited number of representatives for each age group.

Table 5. PCB levels (ng/ml) of dominant congener in ten human adipose tissue from Sweden in 2007.

	ID 1 F 61	ID 2 M 61	ID 3 F 53	ID 4 M 38	ID 5 F 41	ID 6 M 54	ID 7 F 19	ID 8 F 21	ID 9 M 48	ID 10 M 65
Congener	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PCB#28	2.04	1.44	1.03	0.86	1.21	0.48	0.74	2.28	0.17	<0.36
PCB#74	16.6	4.35	4.50	3.27	3.23	4.83	1.02	4.52	3.03	4.93
PCB#66	2.11	0.98	0.77	0.60	0.63	0.31	0.39	1.95	0.85	2.68
PCB#99/113	25.9	11.0	6.72	5.27	3.23	12.2	1.40	8.44	12.4	7.71
PCB#97	1.14	0.19	<0.018	<0.018	0.14	0.31	0.15	0.33	NA[a]	NA[a]
PCB#118	39.4	11.8	5.81	6.16	5.37	8.77	2.64	10.3	11.9	21.3
PCB#105	6.65	2.33	1.44	0.77	0.78	2.07	0.36	2.39	4.07	3.64
PCB#146	25.0	13.0	9.03	5.70	4.88	13.1	1.47	5.05	NA[a]	NA[a]
PCB#153	229	120	90.6	68.2	53.8	180	15.7	52.0	207	175
PCB#138/164	213	93.7	77.0	45.3	36.9	153	14.6	44.7	178	128
PCB#167	8.16	2.78	1.60	1.61	1.46	3.92	0.56	1.25	NA[a]	NA[a]
PCB#156	20.7	12.2	11.7	6.94	6.01	20.8	1.77	4.79	37.6	20.5
PCB#157	3.45	1.68	1.77	1.02	0.71	3.99	0.24	0.68	4.13	3.07
PCB#178	10.9	6.65	7.18	3.70	2.83	9.83	0.62	2.00	10.6	11.9
PCB#182/187	49.3	26.1	21.7	12.7	11.0	36.9	2.32	8.14	40.9	34.9
PCB#183	21.5	9.43	6.38	4.64	4.49	18.0	1.14	3.31	19.7	16.1
PCB#174	11.1	5.30	3.60	1.83	2.25	5.15	0.61	1.61	12.2	8.86
PCB#177	5.09	3.09	2.63	1.77	1.55	5.58	0.40	1.06	17.4	8.64
PCB#172/192	7.55	4.91	4.21	2.32	2.41	8.50	0.45	1.45	7.97	9.00
PCB#180/193	128	88.5	78.2	51.0	43.0	154	9.00	28.2	131	125
PCB#170/190	57.2	40.6	34.6	22.5	19.1	74.7	4.41	13.2	70.0	48.7
PCB#189	1.52	1.51	1.23	0.81	0.70	2.59	0.13	0.38	2.28	1.60
PCB#202	4.93	4.26	3.53	1.66	1.47	6.21	0.21	0.89	13.1	10.2
PCB#199	11.6	10.5	9.66	4.43	4.19	17.8	0.64	2.35	30.8	25.9
PCB#196/203	16.0	12.1	9.47	6.06	5.45	19.1	0.89	2.96	38.7	31.8
PCB#195	3.02	2.51	2.30	1.10	1.26	4.93	0.21	0.59	10.0	8.97
PCB#194	11.1	11.0	11.1	5.88	5.39	20.1	0.67	2.01	39.8	34.9
PCB#208	1.33	0.76	0.74	0.30	0.35	1.49	0.03	0.06	6.42	5.02
PCB#206	2.64	1.97	1.64	0.88	0.93	2.95	0.09	0.29	9.34	7.01
PCB#209	2.92	2.14	2.04	1.01	1.21	3.58	0.10	0.23	9.12	7.10
Sum UB PCBs	**944**	**513**	**415**	**270**	**229**	**798**	**69**	**216**	**941**	**776**
Sum LB PCBs	**944**	**512**	**415**	**270**	**228**	**797**	**69**	**215**	**941**	**774**

[a] NA, not analyzed.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Organochlorine pesticides

Levels of organochlorine pesticides, Table 6, are dominated by *p,p*-DDE, range 5-260 ng/g lipid followed by transnonachlordane 2-31 ng/g lipid and oxyklordan 2-30 ng/g lipid. HCB was found at levels ranging 1-16 ng/g lipid. Kärrman et al (14) reported *p,p*-DDE levels of 29-895 ng/g, sum of chlordanes 6-70 ng/g and HCB 9-81 ng/g on a lipid weight basis in Swedish whole blood. Although using different clean up techniques, one gram on SFE-LC compared to five gram on open columns and using different instrumental techniques, GC high resolution versus low resolution, levels are comparable except for oxychlordane which is lost when treated with acidic silica.

Table 6. Levels (ng/g lipid) of organochlorine pesticides in nine human adipose tissue samples by open column chromatography extraction, analyzed on GC-EI-LRMS.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 8	ID 9	ID 10
	ng/g	ng/g	ng/g	ng/g	ng/g	Ng/g	ng/g	ng/g	ng/g
HCB	16.2	10.5	11.2	8.93	8.23	14.2	10.2	1.25	1.49
Cishepta-chloroepoxide	0.10	0.06	0.04	0.04	0.06	0.05	0.69	0.01	0.08
Cischlordane	0.15	0.42	0.16	0.12	0.03	0.09	0.19	0.02	0.01
Transchlordane	0.22	0.14	0.14	0.12	0.04	0.11	0.12	0.02	0.01
Oxychlordane	30.4[a]	11.9[a]	7.94[a]	7.05[a]	2.96[a]	16.7[a]	4.22[a]	0.06[b]	0.43[b]
MC6	6.49	4.33	4.59	3.92	1.03	3.11	1.65	0.60	0.43
Transnona-chlordane	31.7	27.6	17.7	15.4	4.87	19.9	10.2	2.84	1.85
Cisnona chlordane	5.01	5.14	2.76	2.26	0.54	2.54	2.32	0.45	0.34
***o,p*-DDE**	<0.05	<0.14	<0.09	<0.06	<0.09	<0.08	<0.15	<0.11	<0.11
***p,p*-DDE**	263	82.5	102	53.5	29.8	72.8	74.9	15.4	4.96

[a] Levels derived from SFE-LC extraction due to loss of oxychlordane on silica column clean up.
[b] Levels derived from open column clean up resulting in loss of oxychlordane on silica columns.

PFC

Levels of PFC in Swedish whole blood samples are reported in Table 7. PFOS was the dominant perfluorinated compound detected, ranging 2.46-13.2 ng/ml on a whole blood basis, with a geometric mean of 5.94 ng/ml. The geometric mean for PFOA and PFHxS are 1.58 and 0.51 ng/ml. Kärrman et al (14) reported sum PFC to 6-70 ng/ml in Swedish whole blood samples sampled between 1997 and 2000. PFOS was detected at the highest concentration, with a geometric mean of 16 ng/ml, followed by PFOA, 2.4 ng/ml, and PFHxS, 1.5 ng/ml. In the U.S. a declining trend in PFC levels have been reported by Olsen et al (18).

Table 7. PFC levels (ng/ml) in nine Swedish whole blood samples from 2007.

	ID 1	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10
	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml
PFBuS	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
PFHxS	0.70	0.14	0.86	0.36	0.89	0.28	0.68	0.84	0.56
PFOS	8.18	2.83	9.15	5.70	4.79	2.46	9.97	13.2	4.92
THPFOS	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82
PFHxA	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
PFHpA	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
PFOA	2.01	<0.58	1.70	<0.58	1.83	0.89	1.66	2.20	1.23
PFNA	0.47	0.22	0.48	0.30	0.61	0.19	0.65	0.68	0.35
PFDA	0.18	0.17	0.20	0.22	0.27	<0.12	0.31	0.35	0.18
PFUnDA	0.15	0.22	0.17	0.26	0.09	0.06	0.27	0.29	0.19
PFDoDA	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
PFTDA	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04

OH-PCB

The hydroxylated metabolites of PCBs, OH-PCBs are reported on whole blood basis in table 8. OH-PCB levels in Swedish plasma samples have earlier been reported at similar levels, with median levels of individual congeners ranging 0.001-0.49 ng/g wet weight from a pool of 15 individuals (19).

Table 8. OH-PCB levels (ng/g wet wt) in seven Swedish whole blood samples from 2007.

	ID 1	**ID 3**	**ID 4**	**ID 5**	**ID 7**	**ID 8**	**ID 9**
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
4-OH-CB107	<0.003	0.007	0.018	0.006	<0.003	<0.003	0.046
3-OH-CB153	0.017	0.011	0.014	0.011	<0.003	<0.003	0.011
4-OH-CB146	0.022	0.022	0.024	0.012	<0.003	<0.003	0.032
3'-OH-CB138	0.019	0.009	0.011	0.011	<0.003	<0.003	0.007
4'-OH-CB130	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
4-OH-CB187	0.048	0.034	0.048	0.040	0.023	<0.004	0.058
3'-OH-CB180	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
4'-OH-CB172	<0.004	<0.004	0.013	<0.004	<0.004	<0.004	0.016
Sum OH-PCBs	0.10	0.08	0.13	0.08	0.02	nd	0.17

Toxaphene

Levels of toxaphene in human adipose tissue are given in Table 9. The sum of toxaphenes are 0.82-17.0 ng/g lipid. These levels are in comparison with levels reported for human milk from Germany, ranging from 7-24 ng/g lipid (20).

Table 9. Toxaphene levels (ng/g lipid) in eight Swedish human adipose tissue samples.

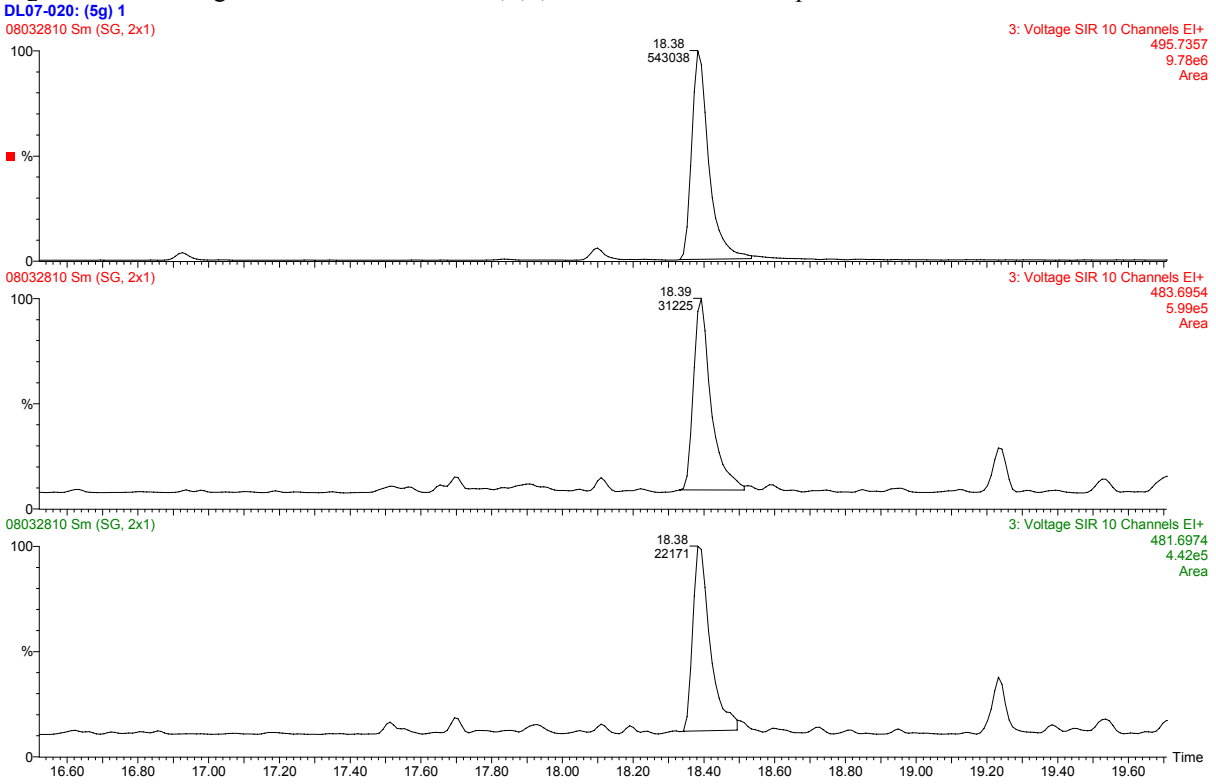
	ID 1	**ID 2**	**ID 3**	**ID 4**	**ID 5**	**ID 6**	**ID 7**	**ID 8**
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
TOX 2	1.43	0.75	0.64	0.43	0.30	1.08	0.10	0.27
TOX 26	5.49	6.55	2.04	2.07	0.56	3.11	0.30	2.73
TOX 38	<0.21	<1.09	<0.21	<0.46	<0.21	<0.21	<0.36	<0.89
TOX 40/41	0.15	0.46	0.18	0.23	0.10	0.13	0.07	0.36
TOX 44*	*53.8*	*24.5*	*23.7*	*11.8*	*12.6*	*36.6*	*2.08*	*7.35*
TOX 50	6.66	9.27	3.42	3.89	0.98	3.87	0.35	4.41
TOX 62	0.83	<0.10	<0.07	<0.10	<0.05	<0.08	<0.02	<0.15
Sum UB Tox	**14.8**	**18.2**	**6.6**	**7.2**	**2.2**	**8.3**	**1.2**	**8.8**
Sum LB Tox	**14.6**	**17.0**	**6.3**	**6.6**	**1.9**	**8.2**	**0.8**	**7.8**

* Not included in calculated sums, due to isotope ratio >15%, not confirmed as Tox 44.

PBDD/Fs

Brominated furans were detected in Swedish human tissue. Di-substituted congener (2,7/2,8-BDF) was detected in three out of nine samples analyzed, levels ranging 0.19-0.30 pg/g lipid. Tetra-substituted 2,3,7,8-BDF was detected in eight out of nine samples analyzed, levels ranging 0.27-2.24 pg/g lipid. Two penta-substituted PBDFs were also detected, levels ranging 0.23-0.89 pg/g lipid for 1,2,3,7,8-BDF, and 0.44-0.54 pg/g lipid for 2,3,4,7,8-BDF. In the chromatograms, there were also a few peaks indicating the presence of other PBDD/Fs, although this could not be confirmed by ^{13}C-labeled standards. Figure 1 shows 2,3,7,8-TeBDF run on a 25 m DB-5MS column, 0.10 μm film thickness.

Figure 1. Chromatogram on tetra-substituted 2,3,7,8-TeBDF in human adipose tissue.



Criteria for determination of PBDFs

Mono- to hexaPBDFs were analysed in all samples. Peaks were identified using ion ratio and the retention times of the following congeners: 4-MoBDF, 2,7-DiBDF, 2,8-DiBDF, 2,3,8-TriBDF, 1,2,7,8-TeBDF, 1,2,3,7,8-PeBDF, 1,3,4,7,8-PeBDF (Wellington Laboratories Inc., Guelph, Canada) and ^{13}C labeled: 2,3,7,8-TeBDF, 1,2,3,7,8-PeBDF, 2,3,4,7,8-PeBDF and 1,2,3,4,7,8-HxBDF (Cambridge Isotope Laboratories Inc., Andover, MA, USA). In those cases where the compound was not present in the standards the identity was primarily based on ion ratios. The congeners were confirmed by retention times matched with internal standards and isotope ratios within 15 %. To further confirm the identity of PBDFs the following signals will be monitored in the near future; [PBDF-COBr], [PBDE + 1Br] and [PBDE+2Br]. The fragment obtained when the COBr group leaves the PBDF molecules is formed by EI ionization of PBDFs but not for PBDEs. The other two signals are to make sure that the observed PBDFs are not resulting from thermal degradation of PBDEs at the injector or in the column.

The data clearly show the presence of brominated PBDD/Fs in the general Swedish population. The levels of 2,3,7,8-TBDF and 1,2,3,7,8-PBDF are in the same order of magnitude as their chlorinated counterparts. This confirms the slow increase of this compound class in human samples as suggested by the latest WHO monitoring study. Considering similar TEF-factors as PCDD/Fs, this is a major source of concern. Currently there are very few reports on PBDD/Fs in human tissue. In 2003, Choi et al (21) published results on PBDD/Fs in Japanese human tissue. 2,3,7,8-TeBDD, 2,3,7,8-TeBDF, and 2,3,4,7,8-PeBDF were found in both sets of samples, with medium concentrations (ranges) for the 1970 samples 1.7 (<0.8–4.2), 3.3 (1.6–4.3), and 0.31 (0.28–0.60), and for the 2000 samples 0.51 (0.1–2.0), 2.8 (1.7–4.2), and 0.99 (<0.8-1.9) pg/g lipid respectively, which are similar to the levels found in our samples.

Table 10. Levels (pg/g lipid) of PBDD/Fs in nine Swedish human adipose tissue samples.

	ID 1 F 61	ID 2 M 61	ID 3 F 53	ID 4 M 38	ID 5 F 41	ID 6 M 54	ID 8 F 21	ID 9 M 48	ID 10 M 65
Furans	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
4-MoBDF	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,7/2,8-DiBDF	<0.10	0.30	<0.11	<0.12	<0.10	<0.11	0.12	0.14	<0.12
2,3,8-TriBDF	<0.04	<0.08	<0.11	<0.14	<0.14	<0.19	<0.21	<0.19	<0.03
2,3,7,8-TeBDF	2.24	0.65	0.54	0.49	0.69	<0.71	0.41	0.27	0.80
1,2,3,7,8-PBDF	0.89	<0.11	<0.11	<0.12	0.29	<0.11	0.23	<0.08	<0.12
2,3,4,7,8-PBDF	0.54	<0.11	<0.11	<0.12	<0.10	<0.11	<0.10	<0.08	0.44
Dioxins									
1-MoBDD	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,7/2,8-DiBDD	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,3,7-TrBDD	<0.02	<0.03	<0.03	<0.03	<0.02	<0.03	<0.03	<0.02	<0.03
2.3.7.8-TeBDD	<0.04	<0.05	<0.05	<0.06	<0.05	<0.05	<0.05	<0.04	<0.06
1.2.3.7.8-PeDD	<0.16	<0.19	<0.19	<0.20	<0.17	<0.19	<0.18	<0.14	<0.21

Screening of POPs in adipose tissue.

The larger amount adipose tissue samples, extracted and treated by open column chromatography as described in the experimental section, were used for further screening for unknown or unidentified POPs. Several different MS detection techniques were used to specifically screen for brominated compounds, but also for chlorinated organic compounds. The screening is thus performed on POPs stable to the multilayer silica column. The results of the screening experiments are described in detail below.

In Figure 2 the GC/MS chromatogram of mass 79 is given from the screening experiment, monitoring mass 79 and 81, the two stable isotopes of bromine. All peaks in the chromatogram are stable organic bromine compounds present in human adipose tissue. Several peak are the earlier discussed PBDEs and BDE #47 can be seen at t_R 14.67 and BDE #153 at t_R 23.17, in addition to the IS standards, BDE #77 at t_R 16.44 and BDE #139 at t_R 23.67. Interesting several 'unknown' BFRs are found in the beginning of the chromatogram at t_R 3.70, 4.98 and 8.50 and later in the chromatogram at t_R 19.88 and 22.99. The pattern of BFRs is different from earlier samples analyzed in our laboratory in the time period 1995-2000. Several new, 'BDE replacements' seem to have found their way into the environment and finally humans. Several small BFRs including TBECH (22) which was recently found in the Arctic, might be present in the chromatograms. Currently we can only confirm that these are stable bromine containing compounds and more specific analysis is needed to definitely confirm the identity of the peaks present in the chromatogram.

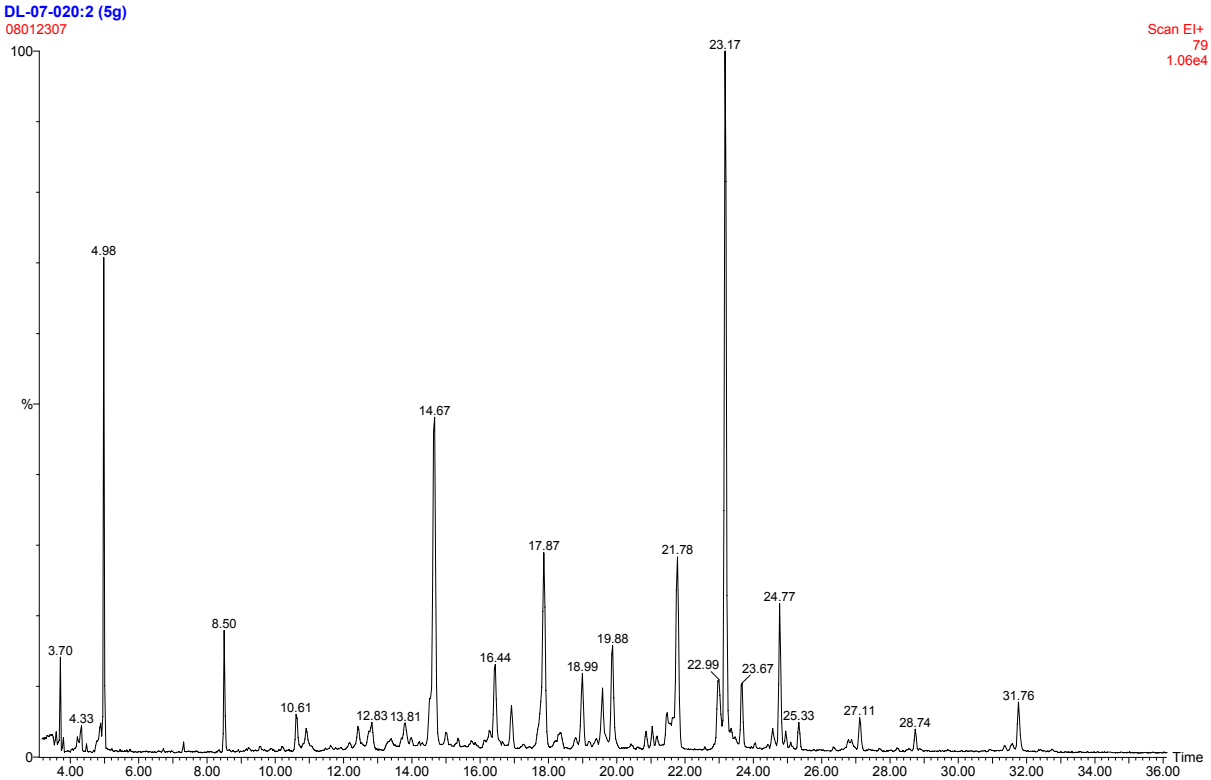


Figure 2. NCI, 5g adipose tissue, m/z 79.

To obtain more information a full scan acquisition from m/z 50 to 650 was run in the NCI mode. This affects the detection limit but gives more information on the compounds present at sufficient high levels. When acquiring full scan spectra a MS spectra specific for each compound is measured every second. Figure 3 shows the TIC of full scan of the same extract as used above for screening of bromine containing compounds. Here not only bromine but also chlorine containing compounds are ionized and can be seen in the chromatogram. The compound specific mass spectra of all peaks in Figure 3 can be used to preliminary identify new POPs. This is exemplified by the MS spectra of BDE #153 eluting at t_R 23.17 in Figure 3. The corresponding MS spectrum is given in Figure 4, where clearly the molecular ion cluster at m/z 644 is seen and the loss of one respectively two bromine atoms can be seen at m/z 563 and 484. All show the typical bromine isotope clusters. Note that the peak in the total ion chromatogram is very small compared to the dominating chlorinated POPs including PCB #153 and PCB#138 at t_R 10.96 and 11.86 respectively.

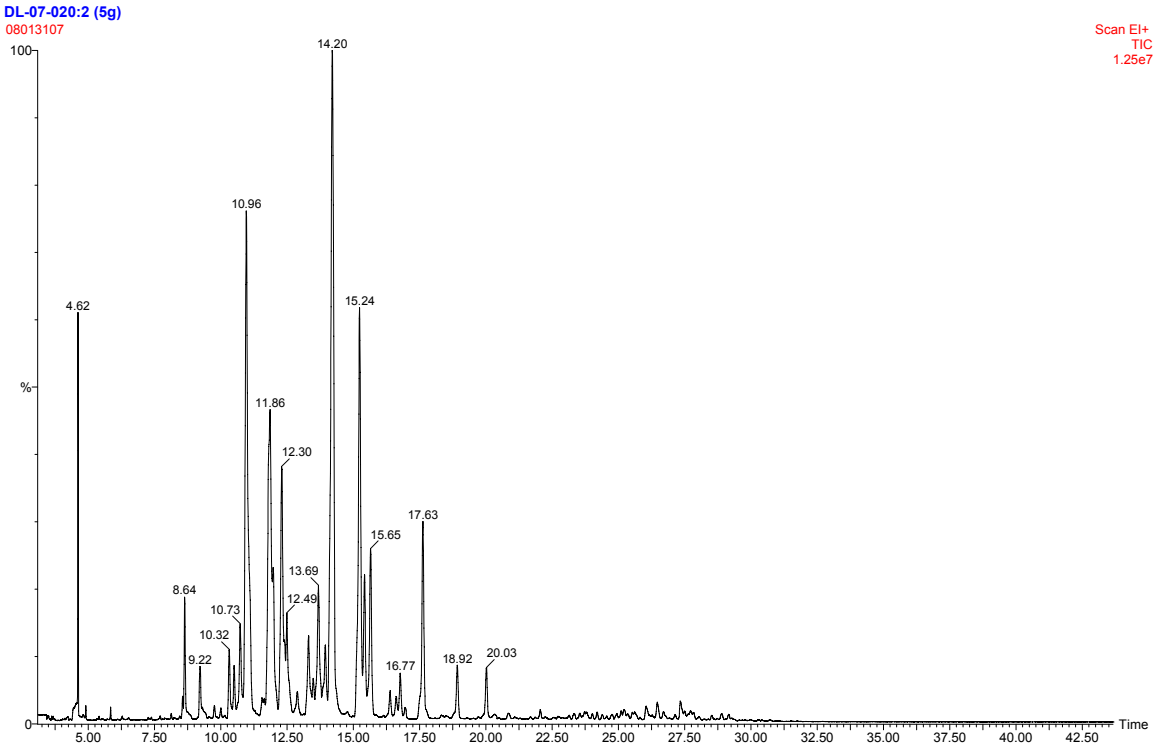


Figure 3. TIC, 5g adipose tissue, full scan NCI, 50-650.

Several examples of unidentified chlorine or bromine containing peaks are given in the appendix. On file, the NCI spectra of more than 60 compounds are registered of which about 90% are known compounds. These spectra can be used as an indication of new POPs and further identification by using identical authentic standards. The complexity of the interpretation of MS spectra is illustrated in Figure 5. At first glance this might be a MS spectrum of a mixed Br/Cl compound, but comparing the data with the earlier compound specific analysis revealed that the MS spectrum was a mixed spectrum of tetra-BDE and hepta-PCB. The spectra of several major peaks are given in Figure 6-9. Several chlordane and toxaphene congeners are normally showing good response using NCI ionization due to the large number of chlorine atoms.

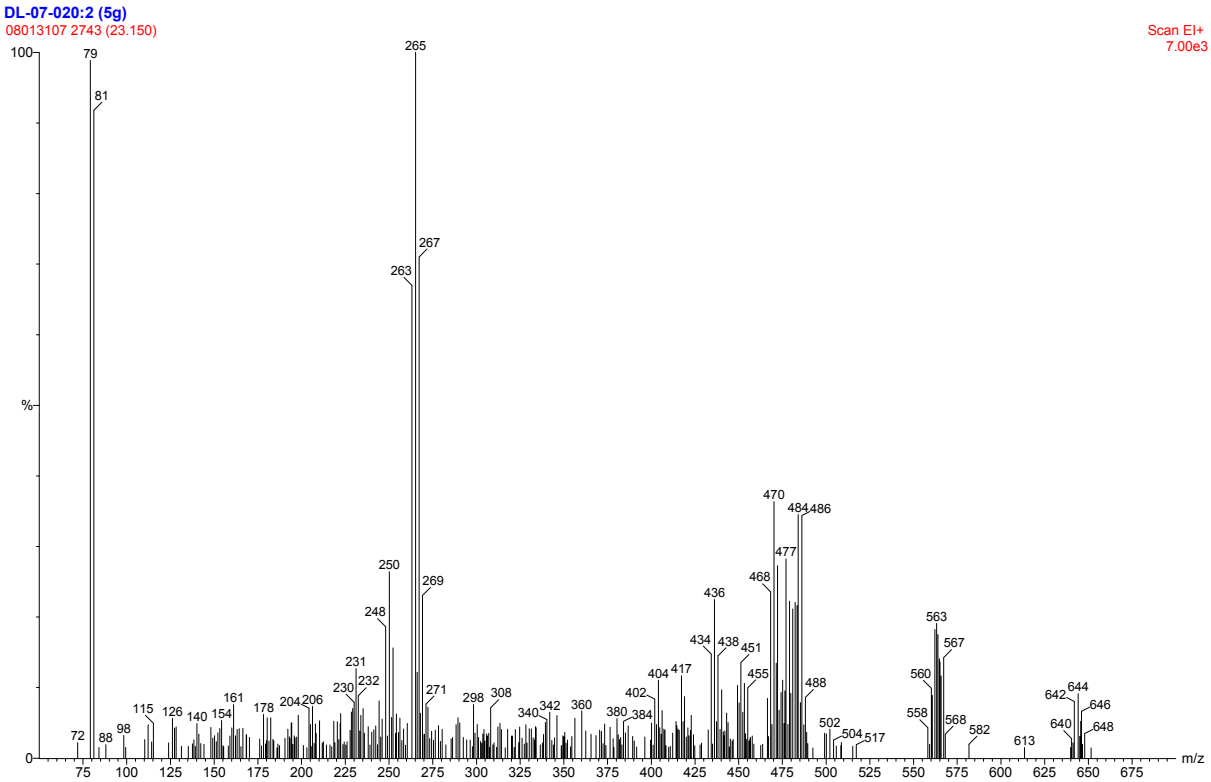


Figure 4. MS spectra of BDE #153 at t_R 23.15 extracted from the NCI full scan 50-650.

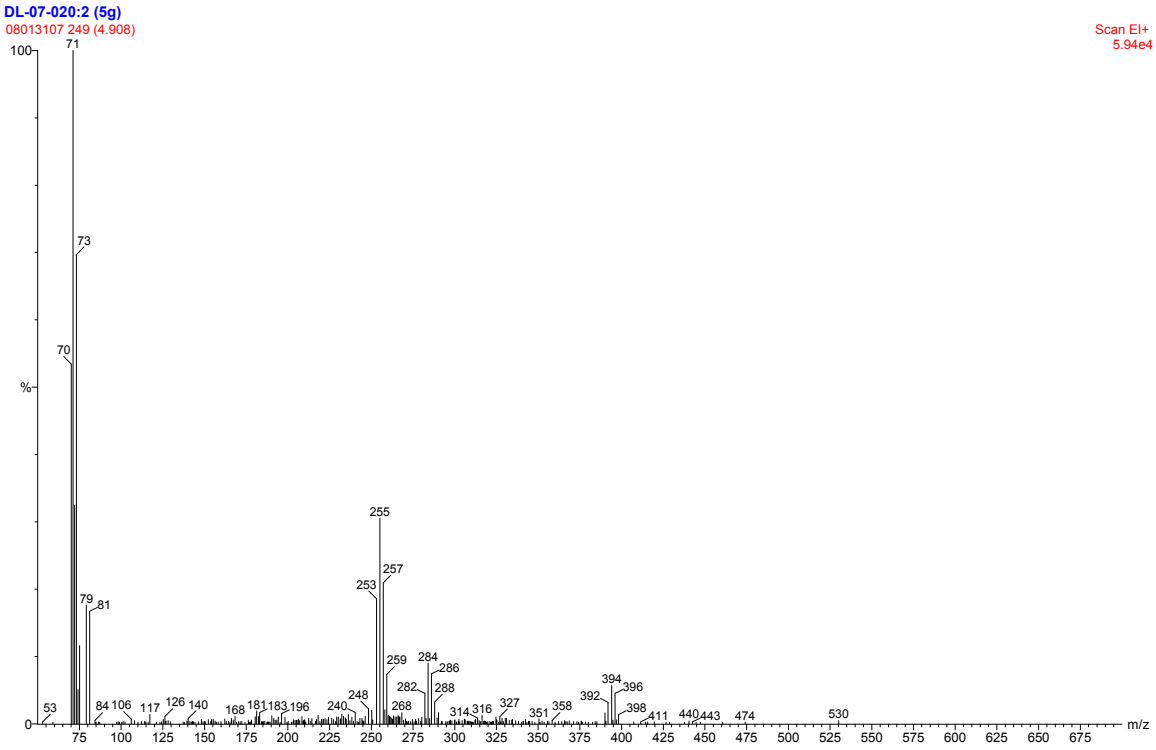


Figure 5. NCI full scan 50-650, mixed MS spectra tetra BDE and hepta PCB

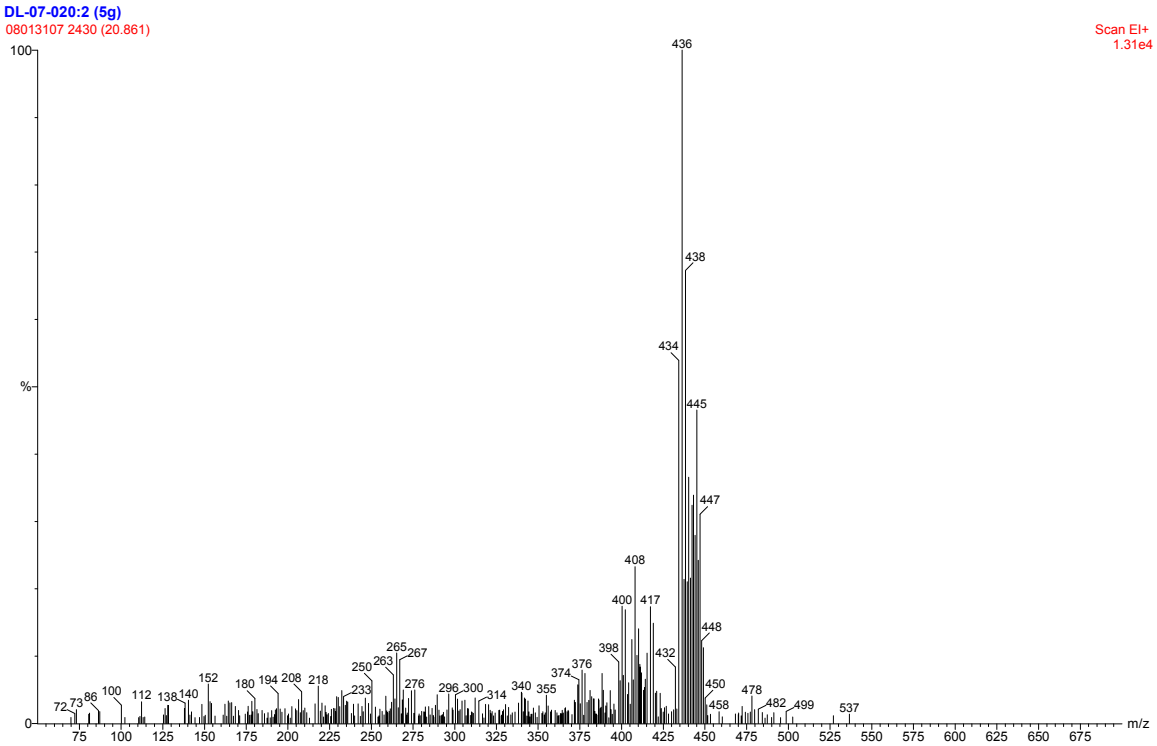


Fig 6. NCI full scan 50-650 at t_R 20.86.

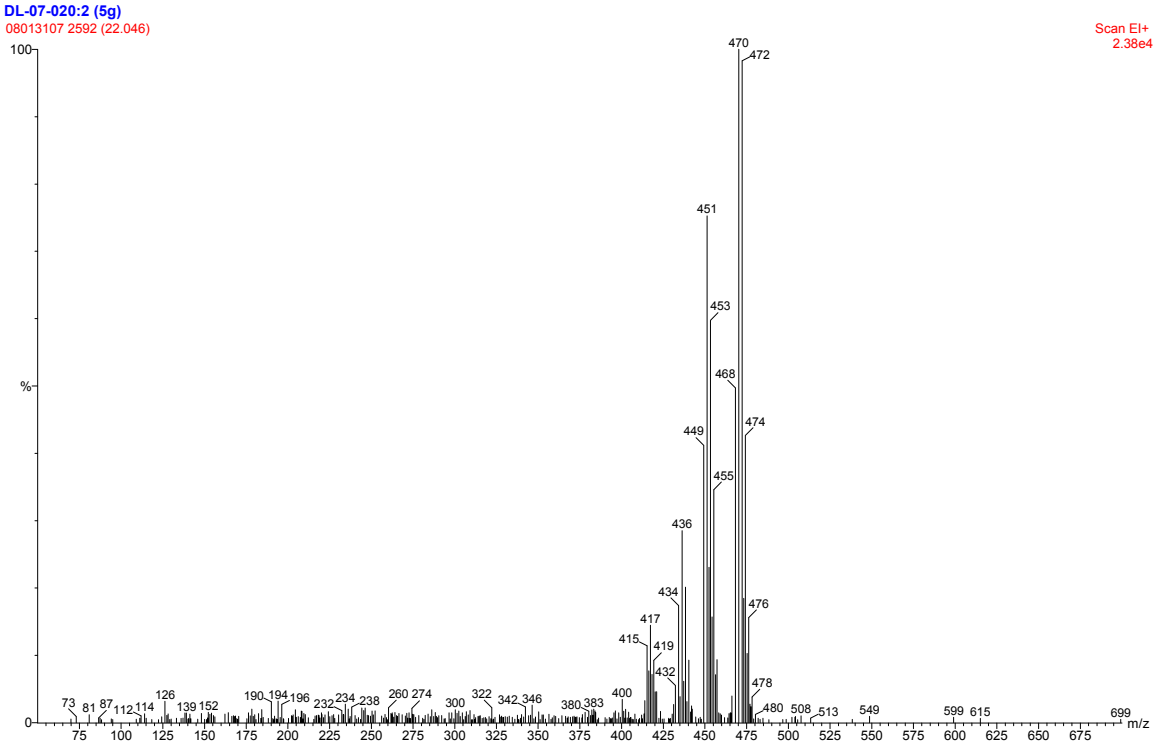


Fig 7. NCI full scan 50-650 at t_R 22.05.

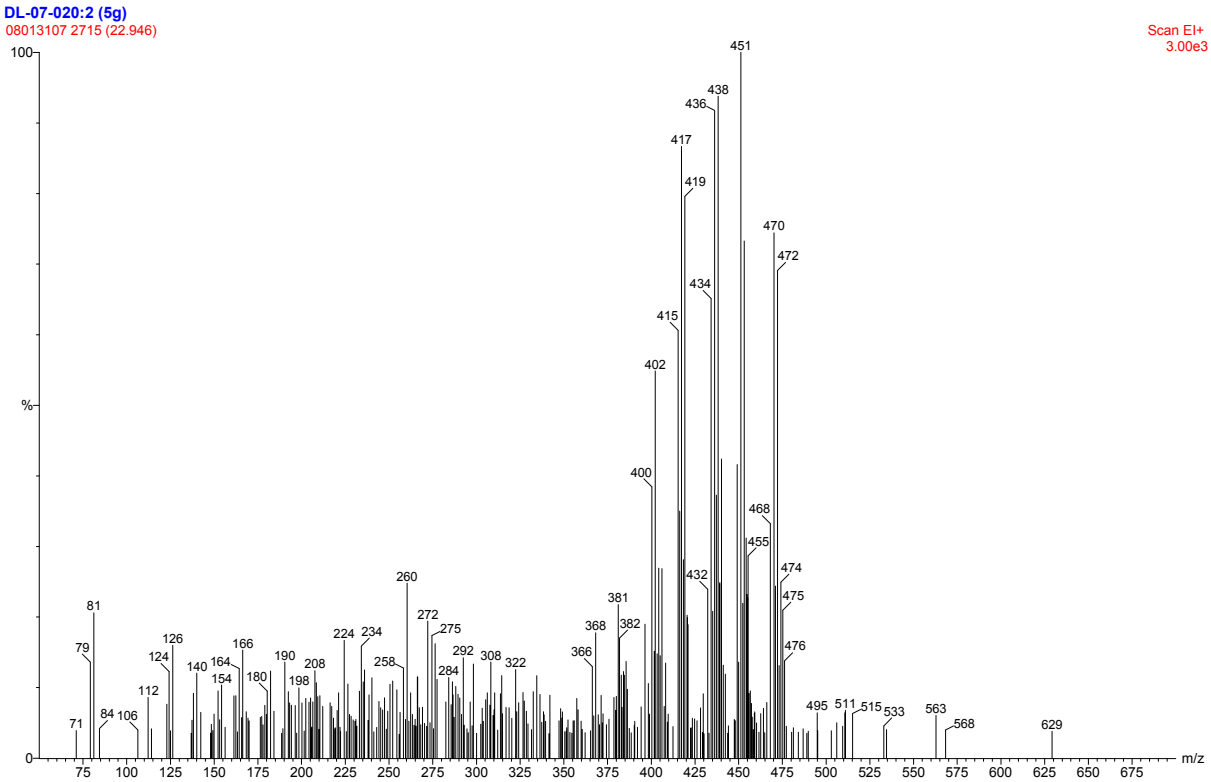


Fig 8. NCI full scan 50-650, unidentified compound at t_R 20.95

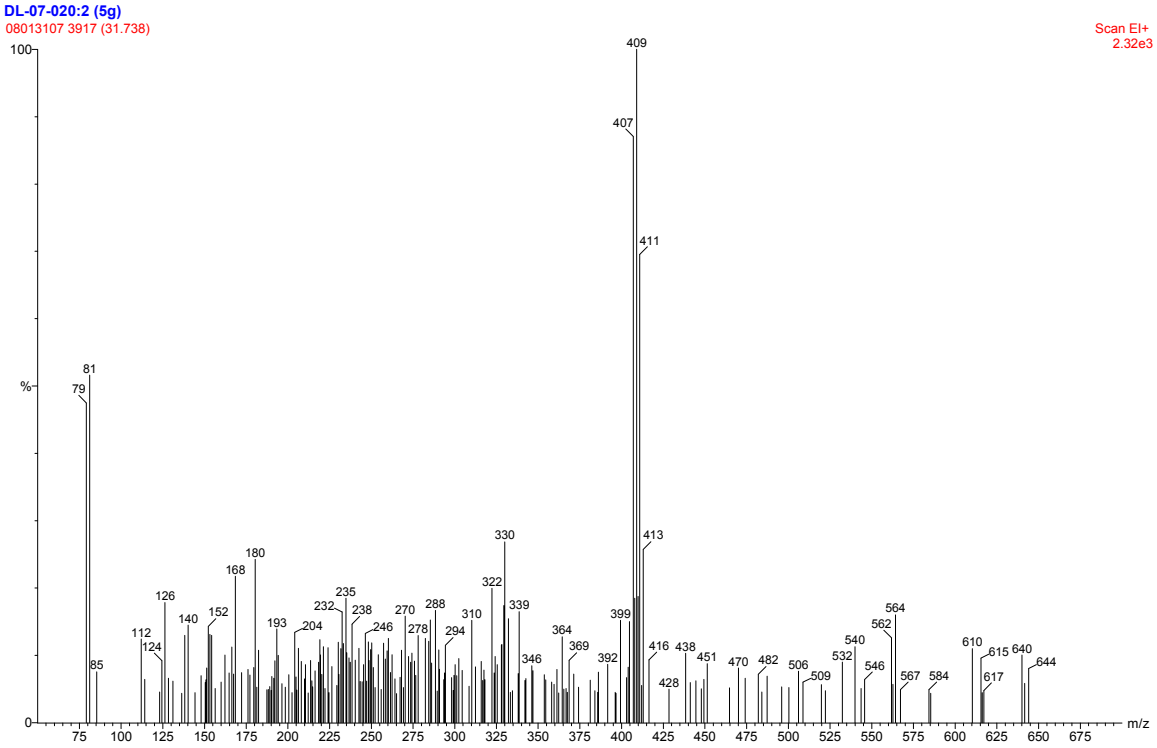


Figure 9. NCI full scan 50-650, t_R 31.76

By using EI as the ionization technique at 70 eV, more energy is added to the target compounds and more fragmentation takes place. This gives more structural information but at the same time the technique becomes less selective for bromine and chlorine containing organic compounds and all extracted compounds, column bleed and contaminants in the solvents are ionized. The TIC from a full scan, 50-650, of the extract from approximately five gram human adipose tissue of the non-planar fraction from the alumina (AlOx) fractionation described in the experimental part on the same column and the same chromatographic conditions as below is given in Figure 10. In this figure, clearly the co-eluting interferences, column bleed and contaminations from the usage of solvents and absorbents can be seen. It is even possible that not all human lipids were removed sufficiently. Again the detection limit is reduced using full scan EI compared to compound specific selective ion monitoring used to quantify 'known' POPs. As an example the full scan chromatogram of both PCB #153 and HCB are given in Figure 11 and 12. An example of a compound not targeted in the compound specific analysis (most probably a HCH isomer) eluting at t_R 4.19, is illustrated in Figure 13.

Although the detection limit is reduced more than 50 times MS spectra of good quality were acquired and are available on file. An estimated 90% are known POPs, or interfering compounds.

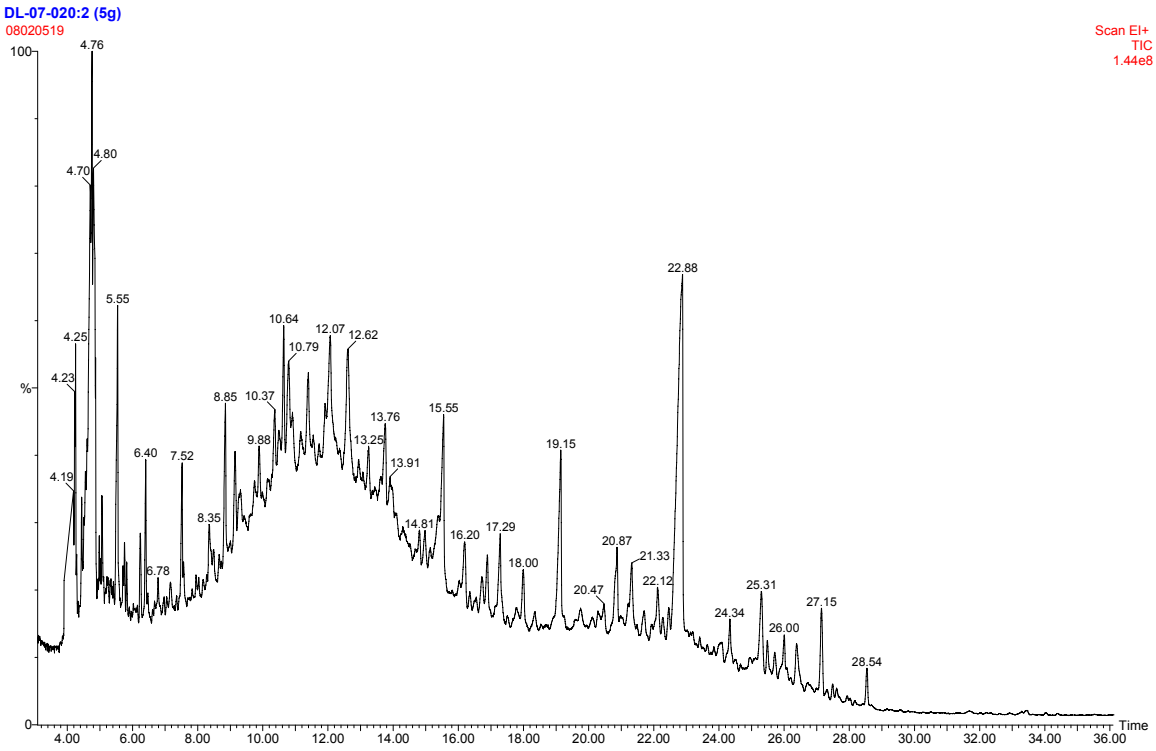


Fig 10. EI full scan 50-650.

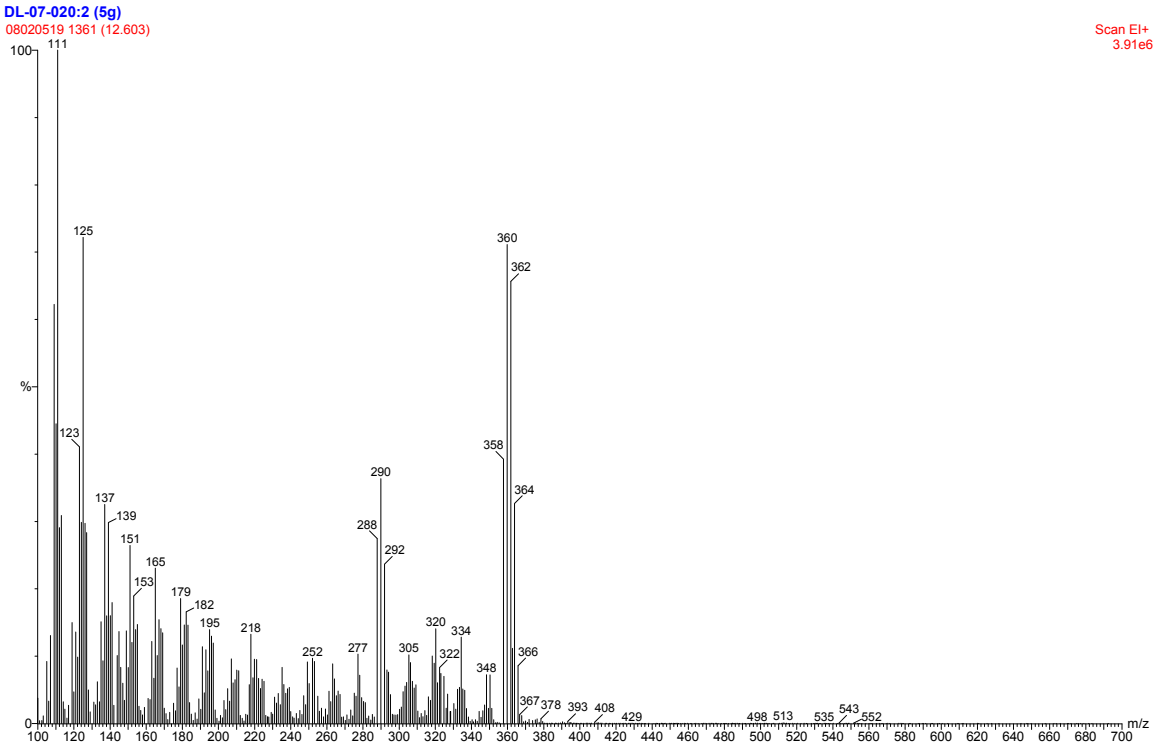


Fig 11. Mass spectra of PCB #153 from EI full scan 50-650.

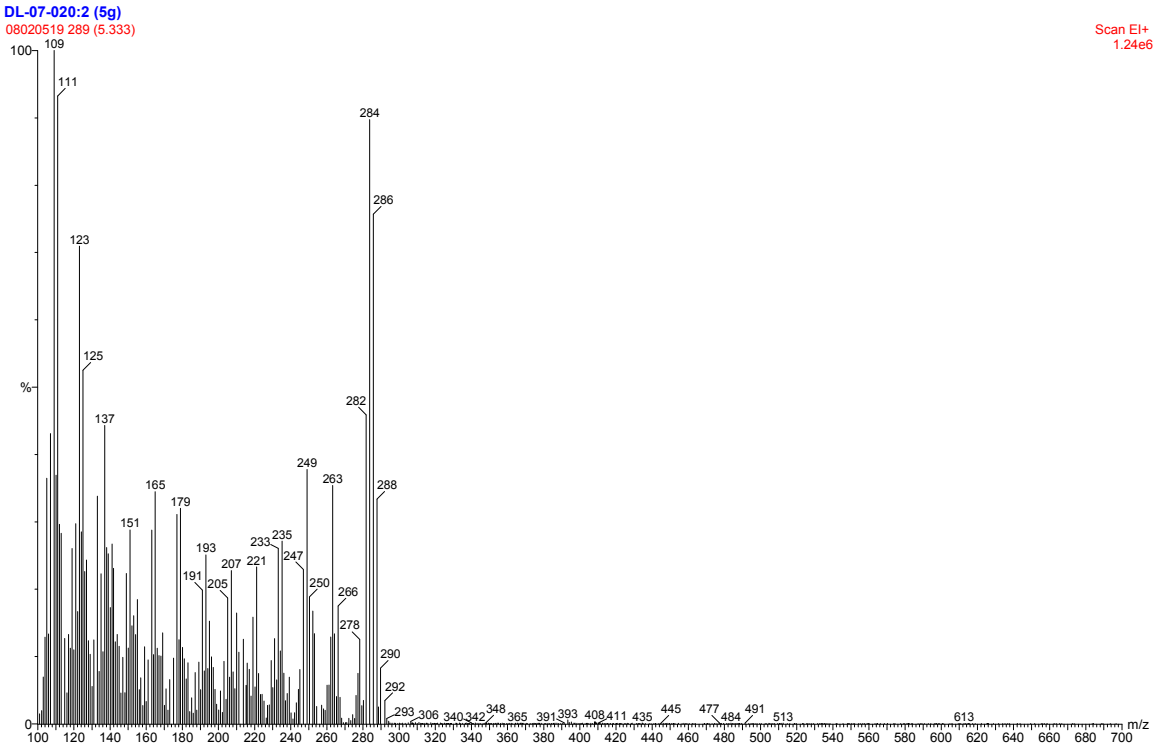


Fig 12. Mass spectra of HCB from EI full scan 50-650.

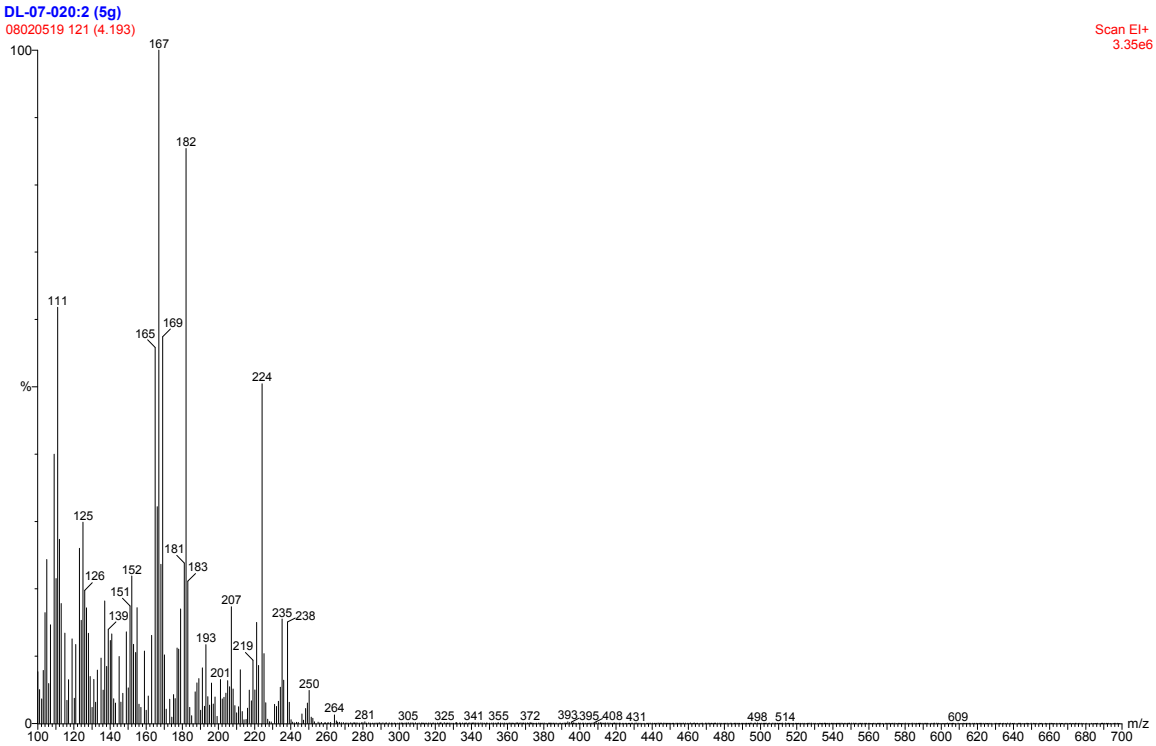


Fig l3. Mass spectra of unidentified compound at t_R 4.19 from EI full scan 50-650.

New BFRs in the environment.

The ban of penta- and octa-BDE mixtures by EU in 2003 (23) lead to changes in substances used for fire protection. This has resulted in a shift in congener pattern, seen in time trend studies on human milk in Sweden (1) and in this study. This is illustrated by unidentified peak eluting early in the chromatograms, possibly from smaller bromine compounds, and by unidentified peaks of larger compounds eluting closer to the end of the chromatogram.

Larger BFRs in use at the present time are tetrabromobisphenol A (TBBPA) and two other structurally similar compounds, DecaBDE, hexabromocyclododecane (HBCD), decabromodiphenylethane, 1,2-bis(2,4,6-tri-bromophenoxy)ethane, tetrabromophtalic anhydride (24). Our data indicate that some of these larger BFRs might be present in humans.

Of special concern are a number of smaller bromine compounds that are in current use for fire protection. These include tetrabromoethylcyclohexane (TBECH), pentabromotoluene (PBT), hexabromobensene (HBB) tetrabromocyclooctane (TBCO). TBECH is an additive PFR in polystyrene which have been found to bind and activate the human androgen receptor (25). TBECH bioaccumulates in fish (26) and has been detected in Canadian Arctic Beluga (*Delphinapterus leucas*) (22). The positive identification of the several of the small BFRs tentatively found in the human tissue, including TBECH requires further authentic standards and high resolution GC/MS detection.

Conclusions

The profile of the PCDD/F in 2007 is considered to be unchanged since the 90's.

The shift in congener profile from BDE #47, earlier being the dominant congener in human tissues, to BDE# 153 being dominant is confirmed.

Levels of PCB are lower in relation to earlier fish consumers' levels.

Six individual PFCs were detected in the blood samples analyzed. PFOS was detected at the highest concentration, with a geometric mean of 16 ng/ml, followed by PFOA, 2.4 ng/ml, PFHxS, PFNA, PFDA and PFUnDA were present at similar levels. There is a need to further investigate individual exposures to PFCs and identify high exposure groups.

Brominated PBDFs were found in human adipose at concentrations of 0.27 – 2.24 pg/g, being the first results on a larger material of the general population in Sweden.

The screening of a larger sample seize of human adipose tissue revealed several unknown, bromine containing POPs. Both smaller and larger bromine containing compounds besides the known BDEs were found. Positive identification of these compounds will require authentic standards and high resolution GC/MS analysis.

Appendix

Table I. PCDD/Fs reported as pg TEQ/ g lipid in ten Swedish adipose tissue samples.

Congener	ID 1 F 61 pg TEQ/g lipid	ID 2 M 61 pg TEQ/g lipid	ID 3 F 53 pg TEQ/g lipid	ID 4 M 38 pg TEQ/g lipid	ID 5 F 41 pg TEQ/g lipid	ID 6 M 54 pg TEQ/g lipid	ID 7 F 19 pg TEQ/g lipid	ID 8 F 21 pg TEQ/g lipid	ID 9 M 48 pg TEQ/g lipid	ID 10 M 65 Pg TEQ/g lipid
2378-TCDF	0.03	0.09	0.05	0.03	0.02	0.02	0.02	0.08	0.03	0.03
12378-PeCDF	0.01	0.02	0.01	0.01	0.01	0.01	<0.005	0.02	0.01	0.03
23478-PeCDF	12.5	7.26	3.40	3.09	1.61	5.68	0.62	2.30	7.34	5.78
123478-HxCDF	0.49	0.23	0.14	0.18	0.13	0.36	0.05	0.11	0.26	0.16
123678-HxCDF	0.52	0.22	0.16	0.19	0.13	0.37	0.04	0.12	0.23	0.24
234678-HxCDF	0.14	0.07	0.07	0.14	0.05	0.14	<0.03	0.06	<0.10	<0.10
123789-HxCDF	<0.002	<0.004	0.003	<0.005	<0.001	<0.009	<0.004	0.01	0.002	0.03
1234678-HpCDF	0.02	0.02	0.07	0.03	0.02	0.06	0.01	0.02	0.02	<0.03
1234789-HpCDF	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.009
OCDF	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2378-TCDD	3.86	1.50	0.95	0.76	0.51	1.25	0.19	0.55	1.52	1.05
12378-PeCDD	9.45	4.16	2.83	2.35	1.42	4.26	0.54	1.85	4.99	<2.69
123478-HxCDD	0.47	0.14	0.12	0.15	0.06	0.15	0.04	0.05	0.32	0.148
123678-HxCDD	3.23	1.19	1.31	0.83	0.71	1.98	0.17	0.59	2.51	1.46
123789-HxCDD	0.47	0.09	0.20	0.09	0.11	0.17	0.04	0.12	0.18	1.00
1234678-HpCDD	0.36	0.07	0.10	0.09	0.12	0.05	0.05	0.10	0.16	0.14
OCDD	0.02	0.01	0.01	0.01	0.02	0.01	0.002	0.01	0.02	0.01
Sum UB[a] PCDD/F	**31.5**	**15.0**	**9.40**	**7.97**	**4.93**	**14.5**	**1.83**	**5.98**	**17.7**	**12.9**
Sum LB[b] PCDD/F	**31.5**	**15.0**	**9.40**	**7.96**	**4.93**	**14.5**	**1.79**	**5.98**	**17.6**	**10.1**
PCB#77	0.0002	0.0003	0.0002	0.0002	0.0002	0.00005	<0.0002	0.0004	0.0002	NA
PCB#126	21.6	11.8	3.23	3.29	3.05	3.65	1.42	3.66	3.90	NA
PCB#169	1.06	0.84	0.50	0.45	0.29	0.91	0.04	0.16	1.01	NA
Sum UB[a] PCB	**22.6**	**12.7**	**3.7**	**3.7**	**3.3**	**4.6**	**1.5**	**3.8**	**4.9**	**NA**
Sum LB[b] PCB	**22.6**	**12.7**	**3.7**	**3.7**	**3.3**	**4.6**	**1.5**	**3.8**	**4.9**	**NA**

[a] Upper bound levels, including <-values.
[b] Lower bound levels, excluding <-values.

Table II. PCDD/Fs reported as pg TEQ/ g lipid in ten Swedish plasma samples.

	ID 1 **F 61** pg TEQ/g	**ID 2** **M 61** pg TEQ/g	**ID 3** **F 53** pg TEQ/g	**ID 4** **M 38** pg TEQ/g	**ID 5** **F 41** pg TEQ/g	**ID 6** **M 54** pg TEQ/g	**ID 7** **F 19** pg TEQ/g	**ID 8** **F 21** pg TEQ/g	**ID 9** **M 48** pg TEQ/g	**ID 10** **M 65** pg TEQ/g
2378-TCDF	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	NA	<1.71
12378-PeCDF	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	NA	<0.44
23478-PeCDF	17.8	12.0	3.75	8.41	<1.25	8.89	1.38	<1.25	NA	13.8
123478-HxCDF	<0.65	<1.07	<0.39	<0.25	<0.25	<0.89	<0.25	<0.25	NA	1.41
123678-HxCDF	0.95	<0.4	<0.19	<0.25	<0.25	<0.25	<0.25	<0.25	NA	1.47
234678-HxCDF	0.70	<0.33	<0.06	<0.25	<0.25	<0.25	<0.25	<0.33	NA	<1.06
123789-HxCDF	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	NA	<1.06
1234678-HpCDF	<0.22	<1.27	<0.21	<0.69	<0.26	<0.25	<0.13	<0.03	NA	<0.29
1234789-HpCDF	<0.03	<0.03	<0.03	<0.03	<0.03	<0.004	<0.004	<0.03	NA	<0.1
OCDF	<0.006	<0.02	<0.003	<0.01	<0.01	<0.004	<0.005	<0.005	NA	<0.01
2378-TCDD	<2.5	<6	<2.5	<2.5	<0.25	<0.25	<0.25	<0.25	NA	<4.12
12378-PeCDD	<2.5	<8	<3.61	<22.7	<0.25	<0.25	<0.25	<0.25	NA	<16.4
123478-HxCDD	<0.25	<0.53	<0.08	<0.25	<0.25	0.30	<0.25	<0.25	NA	<1.06
123678-HxCDD	4.35	<0.6	1.39	1.32	1.75	2.70	<0.25	<0.25	NA	<2.00
123789-HxCDD	<0.25	<0.27	0.47	<0.25	<0.83	0.26	<0.25	<0.25	NA	<1.35
1234678-HpCDD	0.70	0.96	<0.16	<0.49	<0.24	0.21	<0.28	<0.5	NA	0.26
OCDD	<0.06	<0.05	<0.02	<0.03	<0.05	0.02	<0.01	<0.05	NA	0.02
Sum UB [a] PCDD/F	**24**	**13.0**	**5.6**	**9.7**	**1.8**	**12.4**	**1.4**	**4.6**	NA	**46.6**
Sum LB [b] PCDD/F	**24**	**13.0**	**5.6**	**9.7**	**1.8**	**11.6**	**1.4**	**0.0**	NA	**17.0**
PCB#77	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.003	NA	0.02
PCB#126	29.3	15.6	2.89	3.27	3.83	4.26	1.14	9.75	NA	3.94
PCB#169	0.98	0.97	0.45	0.51	0.22	0.80	<0.02	0.33	NA	0.60
Sum UB [a] PCB	**30.2**	**16.6**	**3.3**	**3.8**	**4.1**	**5.1**	**1.2**	**10.1**	NA	**4.6**
Sum LB [b] PCB	**30.2**	**16.6**	**3.3**	**3.8**	**4.1**	**5.1**	**1.1**	**10.1**	NA	**4.6**

[a] Upper bound levels, including <-values.

[b] Lower bound levels, excluding <-values.

Table III. Levels (pg/ lipid) of PCDD/F in human adipose tissue.

	ID 1 F 61	ID 2 M 61	ID 3 F 53	ID 4 M 38	ID 5 F 41	ID 6 M 54	ID 7 F 19	ID 8 F 21	ID 9 M 48	ID 10 M 65
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
2378-TCDF	0.25	0.88	0.45	0.34	0.23	0.19	0.24	0.78	0.33	0.27
12378-PeCDF	0.15	0.34	0.24	0.20	0.19	0.23	<0.10	0.38	0.11	0.67
23478-PeCDF	24.9	14.5	6.80	6.19	3.22	11.4	1.24	4.61	14.7	11.6
123478-HxCDF	4.93	2.26	1.43	1.79	1.27	3.60	0.53	1.08	2.62	1.62
123678-HxCDF	5.21	2.21	1.56	1.92	1.34	3.72	0.43	1.23	2.32	2.39
234678-HxCDF	1.36	0.66	0.65	1.44	0.50	1.36	<0.32	0.58	<0.98	<1.03
123789-HxCDF	<0.02	<0.04	<0.03	<0.05	<0.01	<0.09	<0.04	0.12	0.02	0.29
1234678-HpCDF	2.07	1.76	6.57	3.03	1.98	5.57	1.21	1.99	1.60	<3.10
1234789-HpCDF	<0.1	<0.09	<0.11	<0.12	<0.10	<0.46	<0.07	<0.14	<0.07	<0.88
OCDF	<0.14	<0.11	<0.32	<0.19	<0.18	<0.58	<0.34	<0.45	<0.20	<0.42
2378-TCDD	3.86	1.50	0.95	0.76	0.51	1.25	0.19	0.55	1.52	1.05
12378-PeCDD	9.45	4.16	2.83	2.35	1.42	4.26	0.54	1.85	4.99	<2.69
123478-HxCDD	4.74	1.38	1.18	1.46	0.65	1.50	0.44	0.54	3.17	1.48
123678-HxCDD	32.3	11.9	13.1	8.33	7.09	19.8	1.71	5.87	25.1	14.6
123789-HxCDD	4.72	0.92	1.97	0.90	1.11	1.74	0.38	1.18	1.77	10.0
1234678-HpCDD	35.9	7.23	10.1	9.17	12.3	4.78	4.68	9.67	15.8	14.2
OCDD	228	54.4	101	73.1	160	89.1	24.8	88.0	208	109
Sum UB [a] PCDD/F	**358**	**104**	**150**	**111**	**192**	**150**	**37**	**119**	**283**	**175**
Sum LB [b] PCDD/F	**358**	**104**	**149**	**111**	**192**	**148**	**36**	**118**	**282**	**167**
PCB#77	1.59	2.61	2.12	1.74	1.65	0.49	<1.64	3.85	1.57	NA
PCB#126	216	118	32.3	32.9	30.5	36.5	14.2	36.6	39.0	NA
PCB#169	106	83.7	50.2	44.6	29.3	91.5	4.14	15.6	101	NA
Sum UB [a] PCB	**323**	**205**	**85**	**79**	**61**	**128**	**20**	**56**	**142**	**NA**
Sum LB [b] PCB	**323**	**205**	**85**	**79**	**61**	**128**	**18**	**56**	**142**	**NA**

[a] Upper bound levels, including <-values.
[b] Lower bound levels, excluding <-values.

Table IV. Levels (pg/ lipid) of PCDD/F in human plasma.

	ID 1 F 61	ID 2 M 61	ID 3 F 53	ID 4 M 38	ID 5 F 41	ID 6 M 54	ID 7 F 19	ID 8 F 21	ID 9 M 48	ID 10 M 65
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
2378-TCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<17.1
12378-PeCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<8.82
23478-PeCDF	35.5	24.0	7.50	16.8	<2.5	17.8	2.76	<2.5	NA	27.6
123478-HxCDF	<6.5	<10.7	<3.89	<2.5	<2.5	<8.89	<2.5	<2.5	NA	14.1
123678-HxCDF	9.50	<4	<1.94	<2.5	<2.5	<2.5	<2.5	<2.5	NA	14.7
234678-HxCDF	7.00	<3.33	<0.56	<2.5	<2.5	<2.5	<2.5	<3.33	NA	<10.6
123789-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<10.6
23478-PeCDF	35.5	24.0	7.50	16.8	<2.5	17.8	2.76	<2.5	NA	27.6
123478-HxCDF	<6.5	<10.7	<3.89	<2.5	<2.5	<8.89	<2.5	<2.5	NA	14.1
123678-HxCDF	9.50	<4	<1.94	<2.5	<2.5	<2.5	<2.5	<2.5	NA	14.7
234678-HxCDF	7.00	<3.33	<0.56	<2.5	<2.5	<2.5	<2.5	<3.33	NA	<10.6
123789-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<10.6
1234678-HpCDF	<21.5	<127	<20.6	<68.6	<25.8	<24.8	<12.8	<2.5	NA	<28.8
1234789-HpCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<10
OCDF	<58	<183	<29.7	<103	<75.8	<35.6	<50	<49.2	NA	<51.2
2378-TCDD	<2.5	<6	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	NA	<4.12
12378-PeCDD	<2.5	<8	<3.61	<22.7	<2.5	<2.5	<2.5	<2.5	NA	<16.4
123478-HxCDD	<2.5	<5.33	<0.83	<2.5	<2.5	<2.96	<2.5	<2.5	NA	<10.6
123678-HxCDD	43.5	<6	13.9	13.2	17.5	27.0	<2.5	<2.5	NA	<20
123789-HxCDD	<2.5	<2.67	4.72	<2.5	<8.3	<2.59	<2.5	<2.5	NA	<13.5
1234678-HpCDD	69.5	96.0	<15.6	<49	<24.2	<20.7	<28.3	<50	NA	25.9
OCDD	<560	<511	<164	<296	<466	<208	<108	<469	NA	157
Sum UB [a] PCDD/F	**831**	**997**	**280**	**595**	**645**	**366**	**230**	**604**	NA	**441**
Sum LB [b] PCDD/F	**165**	**120**	**26**	**30**	**18**	**45**	**3**	**0**	NA	**239**
PCB#77	<10.5	<10.7	<6.11	<3.18	<10.8	<14.8	<16.9	<25	NA	182.35
PCB#126	293	156	28.9	32.7	38.3	42.6	11.4	97.5	NA	39.41
PCB#169	97.5	96.7	45.0	51.4	21.7	80.4	<1.7	33.3	NA	60.00
Sum UB [a] PCB	**401**	**263**	**80**	**87**	**71**	**138**	**30**	**156**	NA	**282**
Sum LB [b] PCB	**390**	**253**	**74**	**84**	**60**	**123**	**11**	**131**	NA	**282**

[a] Upper bound levels, including <-values.

[b] Lower bound levels, excluding <-values.

Table V. PBDE levels (ng/g lipid) in ten human adipose tissue samples from Sweden analyzed on GC-NCI-LRMS.

	ID 1	**ID 2**	**ID 3**	**ID 4**	**ID 5**	**ID 6**	**ID 7**	**ID 8**	**ID 9**	**ID 10**
	F 61	**M 61**	**F 53**	**M 38**	**F 41**	**M 54**	**F 19**	**F 21**	**M 48**	**M 65**
Congener	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PBDE#7	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
PBDE#15	0.010	0.021	0.022	0.010	0.031	0.013	0.010	<0.007	<0.007	<0.007
PBDE#17	0.06	0.07	0.05	0.03	0.17	0.06	0.02	0.17	0.05	0.01
PBDE#28	0.13	0.05	0.07	0.04	0.06	0.10	0.004	0.22	0.08	0.10
PBDE#49	0.06	0.07	0.05	0.03	<0.01	0.06	0.01	0.03	0.09	0.04
PBDE#71	0.09	0.08	0.06	0.05	<0.01	0.07	0.04	0.06	0.01	0.02
PBDE#47	0.62	0.80	0.75	0.42	1.04	1.10	0.39	4.39	0.45	1.57
PBDE#66	0.02	0.06	0.06	0.02	<0.01	0.01	0.01	0.05	0.02	0.06
PBDE#100	0.39	0.50	0.29	0.22	0.65	0.56	0.11	0.93	0.30	0.62
PBDE#119	0.05	0.07	0.02	0.05	0.03	0.01	0.002	0.01	0.03	0.01
PBDE#99	0.11	0.12	0.15	0.10	0.27	0.19	0.18	0.82	0.11	0.52
PBDE#85	0.02	0.03	0.02	0.02	0.36	0.06	<0.01	0.09	0.15	0.06
PBDE#126	0.12	0.13	0.22	0.40	<0.01	0.21	0.02	0.12	0.08	0.04
PBDE#154	0.25	0.42	0.81	1.52	0.26	0.50	0.03	0.14	0.76	0.61
PBDE#153[a]	1.68	0.75	0.75	1.44	2.25	1.41	0.24	0.09	0.72	2.50
PBDE#138	0.06	0.10	0.07	0.15	0.07	0.14	0.01	0.10	0.07	0.10
PBDE#156	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.04	<0.01	<0.01
PBDE#184	0.01	0.07	0.04	0.04	0.07	0.09	0.01	0.01	0.05	0.03
PBDE#183	0.05	0.14	0.09	0.11	0.17	0.23	0.05	0.18	0.08	0.40
PBDE#191	0.04	0.11	0.11	0.16	0.10	0.16	0.01	0.01	0.13	0.03
PBDE#196	0.60	2.55	1.84	2.18	5.55	2.83	0.05	0.39	0.32	1.12
PBDE#197	<0.05	0.29	0.17	0.28	1.13	0.37	0.01	0.04	0.03	0.12
Sum UB[b] **PBDEs**	**4.43**	**6.44**	**5.66**	**7.29**	**12.26**	**8.18**	**1.23**	**7.91**	**3.57**	**7.96**
Sum LB[c] **PBDEs**	**4.36**	**6.40**	**5.63**	**7.27**	**12.18**	**8.15**	**1.21**	**7.90**	**3.55**	**7.94**

[a] Levels derived from GC-EI-HRMS due to coelution of PBB #154 when analyzed on GC-NCI-LRMS.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table VI. PBDE levels (ng/g lipid) in ten human plasma samples from Sweden, analyzed on GC-NCI-LRMS.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
PBDE#7	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#17	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#28	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#49	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#71	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#47	<0.16	1.34	0.93	0.84	1.65	0.98	0.51	4.14	NA	NA
PBDE#66	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#100	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#119	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#99	0.81	0.63	0.64	0.64	0.69	0.23	0.14	1.77	NA	NA
PBDE#85	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#126	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#154	<0.02	<0.02	0.29	0.94	<0.02	<0.02	<0.02	0.16	NA	NA
PBDE#153[a]	3.65	0.98	0.55	2.28	2.65	1.28	0.50	0.50	NA	NA
PBDE#138	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#156	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#184	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#183	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#191	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#196	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
PBDE#197	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NA	NA
Sum UB[b] **PBDEs**	**5.00**	**3.32**	**2.77**	**5.06**	**5.37**	**2.87**	**1.53**	**6.93**	NA	NA
Sum LB[c] **PBDEs**	**4.46**	**2.94**	**2.41**	**4.70**	**4.99**	**2.49**	**1.15**	**6.41**	NA	NA

[a] Levels derived from GC-EI-HRMS due to coelution of PBB #154 when analyzed on GC-NCI-LRMS.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table VII. PCB levels (ng/g) of dominant congener in ten human adipose tissue from Sweden.

	ID 1 F 61	ID 2 M 61	ID 3 F 53	ID 4 M 38	ID 5 F 41	ID 6 M 54	ID 7 F 19	ID 8 F 21	ID 9 M 48	ID 10 M 65
Congener	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PCB#28	2.04	1.44	1.03	0.86	1.21	0.48	0.74	2.28	0.17	<0.36
PCB#74	16.6	4.35	4.50	3.27	3.23	4.83	1.02	4.52	3.03	4.93
PCB#66	2.11	0.98	0.77	0.60	0.63	0.31	0.39	1.95	0.85	2.68
PCB#99/113	25.9	11.0	6.72	5.27	3.23	12.2	1.40	8.44	12.4	7.71
PCB#97	1.14	0.19	<0.018	<0.018	0.14	0.31	0.15	0.33	NA[a]	NA[a]
PCB#118	39.4	11.8	5.81	6.16	5.37	8.77	2.64	10.3	11.9	21.3
PCB#105	6.65	2.33	1.44	0.77	0.78	2.07	0.36	2.39	4.07	3.64
PCB#146	25.0	13.0	9.03	5.70	4.88	13.1	1.47	5.05	NA[a]	NA[a]
PCB#153	229	120	90.6	68.2	53.8	180	15.7	52.0	207	175
PCB#138/164	213	93.7	77.0	45.3	36.9	153	14.6	44.7	178	128
PCB#167	8.16	2.78	1.60	1.61	1.46	3.92	0.56	1.25	NA[a]	NA[a]
PCB#156	20.7	12.2	11.7	6.94	6.01	20.8	1.77	4.79	37.6	20.5
PCB#157	3.45	1.68	1.77	1.02	0.71	3.99	0.24	0.68	4.13	3.07
PCB#178	10.9	6.65	7.18	3.70	2.83	9.83	0.62	2.00	10.6	11.9
PCB#182/187	49.3	26.1	21.7	12.7	11.0	36.9	2.32	8.14	40.9	34.9
PCB#183	21.5	9.43	6.38	4.64	4.49	18.0	1.14	3.31	19.7	16.1
PCB#174	11.1	5.30	3.60	1.83	2.25	5.15	0.61	1.61	12.2	8.86
PCB#177	5.09	3.09	2.63	1.77	1.55	5.58	0.40	1.06	17.4	8.64
PCB#172/192	7.55	4.91	4.21	2.32	2.41	8.50	0.45	1.45	7.97	9.00
PCB#180/193	128	88.5	78.2	51.0	43.0	154	9.00	28.2	131	125
PCB#170/190	57.2	40.6	34.6	22.5	19.1	74.7	4.41	13.2	70.0	48.7
PCB#189	1.52	1.51	1.23	0.81	0.70	2.59	0.13	0.38	2.28	1.60
PCB#202	4.93	4.26	3.53	1.66	1.47	6.21	0.21	0.89	13.1	10.2
PCB#199	11.6	10.5	9.66	4.43	4.19	17.8	0.64	2.35	30.8	25.9
PCB#196/203	16.0	12.1	9.47	6.06	5.45	19.1	0.89	2.96	38.7	31.8
PCB#195	3.02	2.51	2.30	1.10	1.26	4.93	0.21	0.59	10.0	8.97
PCB#194	11.1	11.0	11.1	5.88	5.39	20.1	0.67	2.01	39.8	34.9
PCB#208	1.33	0.76	0.74	0.30	0.35	1.49	0.03	0.06	6.42	5.02
PCB#206	2.64	1.97	1.64	0.88	0.93	2.95	0.09	0.29	9.34	7.01
PCB#209	2.92	2.14	2.04	1.01	1.21	3.58	0.10	0.23	9.12	7.10
Sum UB PCBs	**944**	**513**	**415**	**270**	**229**	**798**	**69**	**216**	**941**	**776**
Sum LB PCBs	**944**	**512**	**415**	**270**	**228**	**797**	**69**	**215**	**941**	**774**

[a] NA, not analyzed.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table VIII. PCB levels (ng/g) in ten human adipose tissue from Sweden.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PCB#19	<0.01	<0.01	<0.01	<0.01	<0.01	<0.008	<0.01	<0.01	NA [a]	NA
PCB#18	<0.06	<0.07	<0.09	<0.06	<0.05	<0.07	<0.10	<0.12	NA	NA
PCB#16/32	<0.03	<0.03	<0.03	<0.02	<0.02	<0.02	<0.03	<0.04	NA	NA
PCB#25/26	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#28	2.04	1.44	1.03	0.86	1.21	0.48	0.74	2.28	0.17	<0.36
PCB#33	<0.01	<0.05	<0.01	<0.03	<0.01	<0.02	<0.04	<0.01	NA	NA
PCB#22	<0.01	<0.02	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#52	0.18	0.28	0.15	0.12	0.18	0.09	0.58	0.32	1.25	<0.73
PCB#49	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#47/48	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.81	2.57	<0.45
PCB#44	<0.001	<0.12	<0.07	<0.11	<0.18	0.06	<0.08	<0.17	NA	NA
PCB#64/71/72	<0.003	<0.04	<0.003	<0.003	<0.003	<0.003	<0.01	<0.07	NA	NA
PCB#74	16.6	4.35	4.50	3.27	3.23	4.83	1.02	4.52	3.03	4.93
PCB#70	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#66	2.11	0.98	0.77	0.60	0.63	0.31	0.39	1.95	0.85	2.68
PCB#55	0.72	0.37	0.21	0.18	0.21	0.11	0.12	0.61	NA	NA
PCB#56/60	0.40	0.14	0.10	0.08	0.05	0.17	0.03	0.15	NA	NA
PCB#88/95	0.26	0.50	0.28	0.17	0.29	0.17	1.30	0.75	0.45	1.62
PCB#91	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
PCB#92/89/84	0.25	0.49	0.18	0.09	0.15	0.08	0.32	0.31	NA	NA
PCB#101	0.47	1.06	0.42	0.28	0.45	0.22	1.74	1.29	1.64	0.88
PCB#99/113	25.9	11.0	6.72	5.27	3.23	12.2	1.40	8.44	12.4	7.71
PCB#97	1.14	0.19	<0.018	<0.018	0.14	0.31	0.15	0.33	NA	NA
PCB#85	0.18	0.19	0.11	0.07	0.06	0.07	0.06	0.52	<0.02	1.08
PCB#110	<0.08	0.19	0.12	0.08	0.11	<0.06	0.47	0.80	0.31	<0.48
PCB#123	0.94	0.49	0.20	0.17	0.12	0.12	0.09	0.50	NA	NA
PCB#118	39.4	11.8	5.81	6.16	5.37	8.77	2.64	10.3	11.9	21.3
PCB#114/122	0.34	0.11	0.09	0.08	0.05	0.21	<0.02	0.11	0.58	1.61
PCB#105	6.65	2.33	1.44	0.77	0.78	2.07	0.36	2.39	4.07	3.64
PCB#151	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.20	0.28	NA	NA
PCB#135/144	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
PCB#149	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.60	0.57	NA	NA
PCB#146	25.0	13.0	9.03	5.70	4.88	13.1	1.47	5.05	NA	NA
PCB#153	229	120	90.6	68.2	53.8	180	15.7	52.0	207	175
PCB#141	0.07	0.19	0.06	0.03	0.08	0.04	0.18	0.23	<0.01	0.17
PCB#138/164	213	93.7	77.0	45.3	36.9	153	14.6	44.7	178	128
PCB#128	0.28	0.61	0.22	0.14	0.22	0.29	0.17	0.85	3.61	3.59
PCB#167	8.16	2.78	1.60	1.61	1.46	3.92	0.56	1.25	NA	NA
PCB#156	20.7	12.2	11.7	6.94	6.01	20.8	1.77	4.79	37.6	20.5
PCB#157	3.45	1.68	1.77	1.02	0.71	3.99	0.24	0.68	4.13	3.07
PCB#178	10.9	6.65	7.18	3.70	2.83	9.83	0.62	2.00	10.6	11.9
PCB#182/187	49.3	26.1	21.7	12.7	11.0	36.9	2.32	8.14	40.9	34.9
PCB#183	21.5	9.43	6.38	4.64	4.49	18.0	1.14	3.31	19.7	16.1
PCB#174	11.1	5.30	3.60	1.83	2.25	5.15	0.61	1.61	12.2	8.86
PCB#177	5.09	3.09	2.63	1.77	1.55	5.58	0.40	1.06	17.4	8.64
PCB#172/192	7.55	4.91	4.21	2.32	2.41	8.50	0.45	1.45	7.97	9.00
PCB#180/193	128	88.5	78.2	51.0	43.0	154	9.00	28.2	131	125
PCB#170/190	57.2	40.6	34.6	22.5	19.1	74.7	4.41	13.2	70.0	48.7
PCB#189	1.52	1.51	1.23	0.81	0.70	2.59	0.13	0.38	2.28	1.60
PCB#202	4.93	4.26	3.53	1.66	1.47	6.21	0.21	0.89	13.1	10.2
PCB#201/204	0.91	0.39	0.22	0.14	0.16	0.42	0.03	0.13	NA	NA

PCB#197	0.26	0.15	0.09	0.06	0.06	0.19	0.01	0.07	NA	NA
PCB#199	11.6	10.5	9.66	4.43	4.19	17.8	0.64	2.35	30.8	25.9
PCB#196/203	16.0	12.1	9.47	6.06	5.45	19.1	0.89	2.96	38.7	31.8
PCB#195	3.02	2.51	2.30	1.10	1.26	4.93	0.21	0.59	10.0	8.97
PCB#194	11.1	11.0	11.1	5.88	5.39	20.1	0.67	2.01	39.8	34.9
PCB#208	1.33	0.76	0.74	0.30	0.35	1.49	0.03	0.06	6.42	5.02
PCB#207	0.64	0.30	0.24	0.16	0.12	0.49	0.02	0.03	2.95	2.18
PCB#206	2.64	1.97	1.64	0.88	0.93	2.95	0.09	0.29	9.34	7.01
PCB#209	2.92	2.14	2.04	1.01	1.21	3.58	0.10	0.23	9.12	7.10
Sum UB [b] PCBs	**944**	**513**	**415**	**270**	**229**	**798**	**69**	**216**	**941**	**776**
Sum LB [c] PCBs	**944**	**512**	**415**	**270**	**228**	**797**	**69**	**215**	**941**	**774**

[a] NA, not analyzed.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table IX. PCB levels (ng/g) in ten plasma samples from Sweden.

	ID 1	**ID 2**	**ID 3**	**ID 4**	**ID 5**	**ID 6**	**ID 7**	**ID 8**	**ID 9**	**ID 10**
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PCB#19	<0.29	<0.17	<0.02	<0.03	<0.09	<0.04	<0.04	<0.01	NA [a]	NA
PCB#18	<2.43	<1.47	<0.32	<0.46	<1.02	<0.59	<0.40	<0.92	NA	NA
PCB#16/32	<1.01	<0.57	<0.21	<0.31	<0.67	<0.26	<0.16	<0.47	NA	NA
PCB#25/26	<0.22	<0.14	<0.05	<0.09	<0.18	<0.14	<0.06	<0.01	NA	NA
PCB#28	3.54	3.32	1.65	2.14	3.69	1.75	1.27	7.14	<80	<43
PCB#33	<0.63	<0.41	<0.25	<0.36	<0.55	<0.36	<0.20	<0.40	NA	NA
PCB#22	<0.34	<0.22	<0.12	<0.19	<0.35	<0.19	<0.09	<0.34	NA	NA
PCB#52	0.50	0.98	0.48	0.64	0.96	0.60	0.91	1.59	<46	<9.7
PCB#49	<0.17	<0.14	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#47/48	<0.38	<0.82	<0.46	<0.90	<1.26	<0.82	<0.51	<2.4	<24	<13
PCB#44	<0.38	<0.47	<0.25	<0.50	<1.00	<0.31	<0.23	<0.91	NA	NA
PCB#64/71/72	<0.003	<0.10	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	NA	NA
PCB#74	16.0	7.06	4.56	4.38	4.73	6.56	1.20	10.35	<29	<11
PCB#70	<0.01	<0.01	<0.01	<0.11	<0.01	<0.01	<0.01	<0.01	NA	NA
PCB#66	1.48	1.93	1.01	0.86	1.48	0.76	0.62	4.97	<39	<11
PCB#55	0.85	0.66	0.30	0.39	0.43	0.24	0.16	1.34	NA	NA
PCB#56/60	0.47	0.25	0.12	0.09	<0.005	0.27	<0.005	0.31	<16	<5.7
PCB#88/95	0.48	1.01	0.47	0.48	0.02	0.43	1.66	1.69	NA	NA
PCB#91	0.48	<0.001	<0.001	<0.001	1.04	<0.001	<0.001	<0.001	NA	NA
PCB#92/89/84	0.18	0.67	0.14	0.12	0.20	0.11	0.33	0.39	NA	NA
PCB#101	0.76	1.52	0.52	0.66	1.25	0.46	1.99	2.34	<37	<5.1
PCB#99/113	18.2	11.3	5.39	5.37	3.38	11.3	1.07	12.2	24.7	12.7
PCB#97	0.94	<0.018	0.18	<0.018	<0.018	<0.018	0.26	<0.018	NA	NA
PCB#85	0.18	0.26	0.08	0.08	0.08	0.09	0.06	0.54	<8.7	<1.3
PCB#110	0.23	0.78	0.31	0.46	0.61	0.39	0.91	1.98	<21	<4.5
PCB#123	0.87	0.78	0.22	0.27	<0.014	0.14	0.10	0.85	NA	NA
PCB#118	40.8	18.7	5.92	9.45	8.32	10.3	2.86	18.2	81.7	49.4
PCB#114/122	0.32	0.17	0.11	0.11	0.06	0.19	0.02	2.37	2.90	<0.54
PCB#105	8.11	3.88	1.44	1.54	1.21	1.60	0.42	4.74	7.36	<0.70
PCB#151	<0.001	<0.001	<0.001	<0.001	0.36	<0.001	0.43	0.58	NA	NA
PCB#135/144	<0.001	<0.001	<0.001	<0.001	0.36	<0.001	<0.001	0.55	NA	NA
PCB#149	<0.04	0.77	<0.04	0.58	0.79	<0.04	0.95	1.22	NA	NA
PCB#146	19.9	13.7	8.38	6.47	4.25	12.8	1.15	5.98	NA	NA
PCB#153	197	138	83.3	80.0	53.8	170	11.8	65.0	309	191
PCB#141	<0.008	0.39	<0.008	0.13	0.27	<0.008	0.26	0.41	6.72	0.98
PCB#138/164	198	114	71.3	57.7	42.7	130	11.3	61.4	246	130

PCB#128	0.19	0.86	0.24	0.21	0.29	0.30	0.19	1.21	16.9	5.51
PCB#167	9.69	4.64	2.02	2.91	2.83	5.34	0.56	2.33	NA	NA
PCB#156	22.2	16.5	12.8	9.84	5.76	19.1	1.33	7.76	27.0	12.2
PCB#157	3.16	2.29	1.86	1.81	0.77	3.25	0.17	0.92	<2.5	<1.3
PCB#178	8.18	6.11	4.70	3.00	2.23	8.09	0.32	2.08	11.6	6.49
PCB#182/187	39.4	24.0	17.0	11.9	8.71	31.6	1.48	9.46	49.0	27.4
PCB#183	19.0	9.25	5.26	5.45	3.72	15.4	0.80	3.94	22.4	9.86
PCB#174	13.8	6.90	4.22	2.70	2.64	7.09	0.61	3.64	17.6	6.81
PCB#177	5.72	4.32	2.92	2.41	2.00	6.51	0.31	1.93	8.18	5.81
PCB#172/192	7.22	5.47	4.18	2.67	1.98	8.27	0.25	2.01	8.11	115
PCB#180/193	146	115	86.6	70.3	48.5	187	6.32	44.4	230	132
PCB#170/190	69.2	53.7	40.1	29.4	18.2	78.2	3.29	21.3	68.2	32.8
PCB#189	2.64	2.06	1.65	1.32	0.91	3.22	0.14	0.69	23.3	20.2
PCB#202	4.17	3.34	2.51	1.46	0.89	4.23	0.10	1.33	6.48	<2.2
PCB#201/204	0.80	0.29	0.15	0.11	0.11	0.35	0.02	0.15	NA	NA
PCB#197	0.23	<0.001	0.04	<0.004	<0.004	0.14	0.02	<0.004	NA	NA
PCB#199	13.4	10.1	8.16	5.07	3.21	13.39	0.31	3.28	<0.15	12.9
PCB#196/203	15.7	12.7	8.90	6.57	4.19	17.47	0.44	3.90	22.7	19.0
PCB#195	4.23	2.95	2.04	1.58	1.04	3.91	0.14	0.96	7.87	3.72
PCB#194	14.1	12.5	9.57	7.25	3.68	16.89	0.37	3.33	23.6	15.9
PCB#208	0.86	0.55	0.42	0.26	0.14	0.91	<0.15	0.11	<0.32	0.62
PCB#207	0.46	0.23	0.14	0.13	0.03	0.39	0.002	0.07	1.66	0.89
PCB#206	3.85	2.64	2.01	1.53	0.83	3.45	0.08	0.49	<7.8	<2.1
PCB#209	3.48	2.47	2.10	1.52	0.96	3.38	0.09	0.37	2.61	2.60
Sum UB [b] PCBs	**923**	**623**	**407**	**344**	**249**	**789**	**59**	**327**	**1536**	**924**
Sum LB [c] PCBs	**917**	**619**	**405**	**341**	**244**	**786**	**57**	**322**	**1226**	**814**

[a] NA, not analyzed.
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table X. Levels (ng/g lipid) of organochlorine pesticides in nine human adipose tissue from open column chromatography extraction, analyzed on GC-EI-LRMS.

	ID 1	**ID 2**	**ID 3**	**ID 4**	**ID 5**	**ID 6**	**ID 8**	**ID 9**	**ID 10**
	ng/g	ng/g	ng/g	ng/g	ng/g	Ng/g	ng/g	ng/g	ng/g
HCB	16.2	10.5	11.2	8.93	8.23	14.2	10.2	1.25	1.49
Cishepta-chloroepoxide	0.10	0.06	0.04	0.04	0.06	0.05	0.69	0.01	0.08
Cischlordane	0.15	0.42	0.16	0.12	0.03	0.09	0.19	0.02	0.01
Transchlordane	0.22	0.14	0.14	0.12	0.04	0.11	0.12	0.02	0.01
Oxychlordane	30.4[a]	11.9[a]	7.94[a]	7.05[a]	2.96[a]	16.7[a]	4.22[a]	0.06[b]	0.43[b]
MC6	6.49	4.33	4.59	3.92	1.03	3.11	1.65	0.60	0.43
Transnona-chlordane	31.7	27.6	17.7	15.4	4.87	19.9	10.2	2.84	1.85
Cisnona chlordane	5.01	5.14	2.76	2.26	0.54	2.54	2.32	0.45	0.34
***o,p*-DDE**	<0.05	<0.14	<0.09	<0.06	<0.09	<0.08	<0.15	<0.11	<0.11
***p,p*-DDE**	263	82.5	102	53.5	29.8	72.8	74.9	15.4	4.96

[a] Levels derived from SFE-LC extraction due to loss of oxychlordane on silica column clean up.
[b] Levels derived from open column clean up resulting in loss of oxychlordane on silica columns.

Table XI. Levels (ng/g lipid) of organochlorine pesticides in ten human plasma samples from open column chromatography extraction, analyzed on GC-EI-LRMS.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
HCB	38.6	40.4	17.4	30.4	23.2	39.2	8.09	40.9	2.86	2.47
Cishepta-chloroepoxide	<0.01	0.05	<0.01	0.05	0.05	0.13	<0.01	<0.03	<0.05	<0.13
Cischlordane	<0.03	<0.23	<0.02	<0.10	<0.08	<0.09	<0.06	<0.44	<0.21	<0.08
Transchlordane	0.32	<0.21	<0.04	<0.07	<0.10	0.43	0.09	<0.18	<0.18	<0.14
Oxychlordane	<0.03	<0.11	<0.05	<0.11	<0.12	<0.03	<0.02	<0.18	<0.13	0.32
MC6	4.21	2.05	1.52	2.68	0.53	3.82	0.12	1.80	0.26	0.29
Transnona-chlordane	29.1	24.7	10.7	8.73	3.66	24.4	0.81	16.0	1.69	1.04
Cisnona chlordane	1.42	0.85	1.25	0.13	<0.06	0.94	0.05	1.60	<0.26	<0.17
***o,p*-DDE**	<0.11	<0.28	<0.25	<0.22	<0.44	<0.25	<0.13	<1.16	<0.66	<0.35
***p,p*-DDE**	667	172	131	112	210	273	26.5	151	44.6	7.95

Table XII. PFC levels (ng/ml) in nine Swedish whole blood samples.

	ID 1	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10
	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml	ng/ml
PFBuS	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
PFHxS	0.70	0.14	0.86	0.36	0.89	0.28	0.68	0.84	0.56
PFOS	8.18	2.83	9.15	5.70	4.79	2.46	9.97	13.2	4.92
THPFOS	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82
PFHxA	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
PFHpA	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
PFOA	2.01	<0.58	1.70	<0.58	1.83	0.89	1.66	2.20	1.23
PFNA	0.47	0.22	0.48	0.30	0.61	0.19	0.65	0.68	0.35
PFDA	0.18	0.17	0.20	0.22	0.27	<0.12	0.31	0.35	0.18
PFUnDA	0.15	0.22	0.17	0.26	0.09	0.06	0.27	0.29	0.19
PFDoDA	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
PFTDA	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04

Table XIII. OH-PCB levels (ng/g wet wt) in seven Swedish whole blood samples.

	ID 1	ID 3	ID 4	ID 5	ID 7	ID 8	ID 9
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
4-OH-CB107	<0.003	0.007	0.018	0.006	<0.003	<0.003	0.046
3-OH-CB153	0.017	0.011	0.014	0.011	<0.003	<0.003	0.011
4-OH-CB146	0.022	0.022	0.024	0.012	<0.003	<0.003	0.032
3'-OH-CB138	0.019	0.009	0.011	0.011	<0.003	<0.003	0.007
4'-OH-CB130	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
4-OH-CB187	0.048	0.034	0.048	0.040	0.023	<0.004	0.058
3'-OH-CB180	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
4'-OH-CB172	<0.004	<0.004	0.013	<0.004	<0.004	<0.004	0.016

Table XIV. Toxaphene levels (ng/g lipid) in eight Swedish human adipose tissue samples.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
TOX 2	1.43	0.75	0.64	0.43	0.30	1.08	0.10	0.27
TOX 26	5.49	6.55	2.04	2.07	0.56	3.11	0.30	2.73
TOX 38	<0.21	<1.09	<0.21	<0.46	<0.21	<0.21	<0.36	<0.89
TOX 40/41	0.15	0.46	0.18	0.23	0.10	0.13	0.07	0.36
TOX 44 [a]	*53.8*	*24.5*	*23.7*	*11.8*	*12.6*	*36.6*	*2.08*	*7.35*
TOX 50	6.66	9.27	3.42	3.89	0.98	3.87	0.35	4.41
TOX 62	0.83	<0.10	<0.07	<0.10	<0.05	<0.08	<0.02	<0.15
Sum UB [b] Tox	14.8	18.2	6.6	7.2	2.2	8.3	1.2	8.8
Sum LB [c] Tox	14.6	17.0	6.3	6.6	1.9	8.2	0.8	7.8

[a] Levels not included in sum duo to isotope ratio >15%
[b] Upper bound levels, including <-values.
[c] Lower bound levels, excluding <-values.

Table XV. Levels (pg/g lipid) of PBDD/Fs in nine Swedish human adipose tissue samples.

	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 8	ID 9	ID 10
	F 61	M 61	F 53	M 38	F 41	M 54	F 21	M 48	M 65
Furans	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
4-MoBDF	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,7/2,8-DiBDF	<0.10	0.30	<0.11	<0.12	<0.10	<0.11	0.12	0.14	<0.12
2,3,8-TriBDF	<0.04	<0.08	<0.11	<0.14	<0.14	<0.19	<0.21	<0.19	<0.03
2,3,7,8-TeBDF	2.24	0.65	0.54	0.49	0.69	<0.71	0.41	0.27	0.80
1,2,3,7,8-PBDF	0.89	<0.11	<0.11	<0.12	0.29	<0.11	0.23	<0.08	<0.12
2,3,4,7,8-PBDF	0.54	<0.11	<0.11	<0.12	<0.10	<0.11	<0.10	<0.08	0.44
Dioxins									
1-MoBDD	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,7/2,8-DiBDD	<0.07	<0.08	<0.08	<0.09	<0.07	<0.08	<0.08	<0.06	<0.09
2,3,7-TrBDD	<0.02	<0.03	<0.03	<0.03	<0.02	<0.03	<0.03	<0.02	<0.03
2.3.7.8-TeBDD	<0.04	<0.05	<0.05	<0.06	<0.05	<0.05	<0.05	<0.04	<0.06
1.2.3.7.8-PeDD	<0.16	<0.19	<0.19	<0.20	<0.17	<0.19	<0.18	<0.14	<0.21

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