LEVELS OF PCBs AND HYDROXYLATED PCB METABOLITES IN BLOOD FROM PREGNANT FAROE ISLAND WOMEN

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Introduction

A few very persistent polychlorinated biphenyls (PCBs) and the DDT metabolite, 2,2-bis(4-chlorophenyl)-1,1-dichloroethene (4,4'-DDE), make up the major proportion of the total organo-halogen residues in e.g. human milk as determined in women from the Stockholm area [1]. This is also true for both other humans [2] and for wildlife in general [3]. However, as much as 10% of the PCB concentrations, or more, have been determined in human blood to be hydroxylated PCB metabolites (OH-PCBs) [2,4] that may be important contaminants from a toxicological point of view. So far only a limited number of exposure studies on OH-PCBs have been carried out [2,5]. In this context particularly humans with higher exposures to PCB than the general public are of concern. These are persons consuming larger amounts of fat fish from contaminated areas, such as the Baltic Sea or the Great Lakes, or those with dietary habits including the consumption of mammals or birds at high trophic levels. Median levels of e.g. the most persistent PCB congener, 2,2',4,4',5,5'-hexachlorobiphenyl (CB-153) have been reported to be 920 ng/g lipid weight (l.w.) in men from Latvia with a high intake of fat Baltic Sea fish while those that do not eat any fish had 160 ng/g [2]. For Swedish men the corresponding values were, 450 and 220 ng/g, respectively, while Canadian Inuit showed levels of 1270 ng/g l.w. [2,6].

A group of potentially exposed humans are those living on the Faroe Islands. The Faroes constitute a small community in the North Atlantic with a uniform population at about 45 000 inhabitants living on 18 islands. The Faroese are exposed to increased amounts of PCBs because the traditional diet includes pilot whale blubber. Analyses of human milk documented averages of 2 μg/g l.w. for the sum of measurable PCB congeners in milk collected from Faroese women in 1987 [7]. High levels of organohalogens such as DDE and PCBs have been reported as organic pollutants in the pilot whale, at ranges of 10-40 μg/g l.w. and 10-60 μg/g l.w., respectively [8].

The present study aimed at determining the exposures to PCBs and OH-PCB metabolites in a selected group of pregnant women from the Faroe Islands known to have different intake of pilot whale blubber and having low to high PCB levels in their milk [9].

Material and Methods

Chemicals: Synthesized reference compounds were used as standards [10] and those quantified in the present study are shown together with the results in Table 1. All solvents were of the highest available commercial grade.

Instruments: Analysis and quantification were performed by gas chromatography (GC) using electron capture (EC) detector. The DDE and PCB analysis were performed as described elsewhere[11]. The OH-PCB analysis were performed on a CP-Sil 8-column (25 m, 0.15 mm i.d.

and 0.12 μm film thickness from Chrompack, EA Middelburg, The Netherlands). The column temperature was programmed as follows: 80 °C (2 min), 50 °C/min to 200 °C, 1 °C/min to 230 °C and 30 °C/min to 330 °C (3min). The injector temperature was 280 °C, the detector temperature 360 °C and the pressure 31 psi.
Samples: From a cohort of mother-child pairs generated in 1994-1995, milk was obtained and analyzed for major PCB congeners [9]. Based on these results, samples were selected, and stored serum was retrieved for analysis. Human serum samples were taken at Landssjukrahusið in Tórshavn, Faroe Islands. Forty-three serum samples were collected at approximately the 32nd week of pregnancy. A brief nutritional questionnaire was used to obtain information about the frequency of blubber dinners during pregnancy (number of meals per month). No attempt was made to assess life-time intake levels.

Analysis: The extraction and clean-up procedure for the serum is described elsewhere [11] with a few modifications. Surrogate standards, CB-53 (100 ng), CB-189 (4 ng) and 4-OH-CB193 (2 ng), were added to the samples prior to extraction. The neutral fraction was separated on a column of activated silica gel (1 g); the PCB congeners were eluted with hexane (5.5 ml). Since the lipid content in the samples were higher than in the samples in the original method it had to be further purified. The remaining fat was removed by one more silica gel/sulfuric acid column (0.5 g). The column was cleaned with hexane (2 ml) before the sample was applied, and the analytes were eluted with hexane (8 ml).

Table 1. Concentrations (ng/g lipid weight) of PCB and OH-PCB congeners and of DDE in serum from pregnant women from the Faroe Islands with different intake of pilot whale blubber. For each substance, the median and percentil range (10-90%) are given.

Compound	Non/low blubber consumption (n=22)		High blubber consumption (n=16)	
	Median	10-90 %[a]	Median	10-90 %[a]
Lipid (%)	0.78		0,83	
Polychlorinated biphenyls				
CB-118	48	25-470	370	46-790
CB-146	28	16-210	210	18-350
CB-153	190	120-1500	1500	130-3000
CB-138	140	92-1100	1100	110-1900
CB-187	63	35-510	520	42-1000
CB-180	120	67-980	890	61-2300
CB-170	49	27-330	300	25-730
ΣPCB*	620	390-4900	4900	430-9800
Total PCB**	770	460-5900	6000	520-12000
Polychlorobiphenylols				
4-OH-CB107	12	5.1-73	71	49-230
3-OH-CB153	13	3.9-82	64	21-190
4-OH-CB146	23	9.8-170	120	13-270
3'-OH-CB138	13	3.5-99	96	48-170
3'-OH-CB187	14	3.3-32	20	7.7-56
4-OH-CB187	37	18-220	190	23-470
ΣOH-PCB***	100	40-620	580	36-1400
DDE	190	110-2600	2900	260-3800

[a]Percentile range; *Sum of the PCBs shown; **Sum of 21 PCB congeners; **Sum of the OH-PCBs shown

Results and Discussion

The median concentrations, on a lipid weight basis, of seven PCB congeners, sum of these PCB congeners (ΣPCB) and total PCB levels are given in Table 1, as are concentrations of the OH-PCB congeners and sum OH-PCB. The levels of DDE in the pregnant women's serum are also shown. The data are presented in relation to what is known about the intake of blubber from pilot whale caught at the Faroes. The median of CB-153, making up approximately 25% of the total PCB concentration in the subjects, in the group of women stated to eat 2-8 meal of pilot whale blubber per month, was 1500 ng/g l.w. that is far more than in the none or low consumers (0-1 meal per month), with 190 ng/g l.w. The latter group thus shows concentrations similar to several other groups of humans from Sweden, Latvia and Canada [2,6,12], Figure 1, while the former group is even higher than the Canadian Inuit population [6].

As many as 20 OH-PCBs were identified by comparison to authentic reference standards among which six major OH-PCBs were quantified (Table 1) after methylation. The identities of >20 OH-PCBs in male blood have recently been reported elsewhere [13]. Still it may be mentioned that the majority of all OH-PCBs identified have the hydroxy-group bound in the *para*-position of one of the phenyl rings and with chlorine atoms substituted in both *ortho*-positions to the hydroxy group. Sixteen out of 20 OH-PCB congeners have six to nine chlorine substituents indicating that mainly PCB congeners with six or more chlorines are metabolized to OH-PCBs that are retained in the blood.

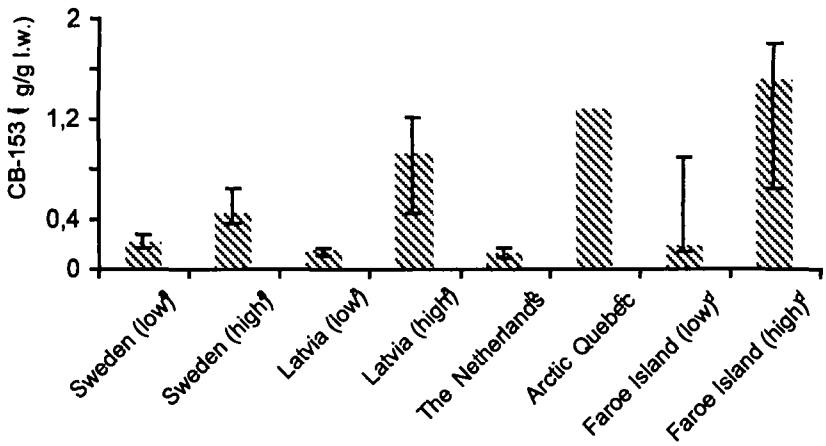

Figure 1. Concentrations of CB-153 (μg/g lipid weight) in human plasma samples. Quartile limits are indicated with bars. a) The Swedish and Latvian male samples are divided into groups according to consumption of fatty fish, with "low" being 0-1 fish meals/month and "high" ≥12 fish meals/month [2]. b) Serum samples from pregnant women in The Netherlands (unpublished). c) Male and female plasma samples from Arctic Quebec, mean level only [6]. d) The Faroe Island material presented in this study: "low" 0-1 meal of blubber/month and "high" 2-8 meal of blubber/month.,

The major OH-PCB - 4-OH-CB187 - concentration was in the range 10-20% of the CB-153 level determined in the blood. The relation between PCB and OH-PCB concentrations was similar to the one previously reported and as high as the highest levels reported among men with a high fish consumption in Latvia [2], even tough the OH-PCB patterns differ between these two groups. The Latvian men showed a high concentration of one of the lower

chlorinated OH-PCBs while the Faroese women were similar to the Swedish men with a OH-PCB pattern dominated by 4-OH-CB187.

The major pathway for OH-PCB retention in human blood goes via their binding to the thyroxine binding and transporting protein, transthyretin [5]. The potential effects of this accumulation in the blood are still unknown even though some indications of adverse effects of at least one OH-PCB have been reported. Thus, both fetal brain thyroxine levels were significantly reduced, menstrual cycle affected and behavioral effects observed in rats dosed with 4-OH-CB107 (A. Brouwer and I. Meerts, person. commun.)

The results confirm that high exposure levels occur among some Faroese. Thus, the results from the high-exposure group seem to be among the highest reported so far. PCBs and OH-PCBs may have important adverse health effects also in humans, and studies in this regard are taking place in the Faroes. However, of particular concern in this context is that the serum samples were obtained from women just before parturition, so that the PCB concentrations are likely also to reflect the level of developmental exposure of the child. In 1998, the Faroese authorities issued a recommendation "*The best way to protect foetuses against the potential harmful effects of PCB's, is if girls and women do not eat blubber until they have given birth to their children*" [14]. The present results, from samples collected before this statement was issued, reinforces this recommendation.

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