FISH CONSUMPTION AND HUMAN EXPOSURE TO DIOXINS AND DIBENZOFURANS.

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ABSTRACT

Fat fish from the Baltic Sea contains high levels of polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF). Human exposure through consumption of such fish have been studied. PCDD/PCDF levels in plasma were analysed, and eleven subjects with high fish consumption had 63.5 pg/g (median), expressed as Nordic TCDD equivalents, while nine subjects, who never eat fish had 17.5 pg/g. There were significant correlations between several of the PCDDs/PCDFs and amounts of consumed fish. PCDD/PCDF also correlated with serum levels of n-3 polyunsaturated fatty acids, mainly derived from marine foods. Our conclusion is that fish is a major source of exposure to PCDD/PCDF in the fish-eating population around the Baltic Sea.

INTRODUCTION

Wild salmon and herring from the Baltic Sea have been found to contain high levels of some polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs; Rappe et al., 1989). Thus, consumption of these fat fish species might cause an exposure to these toxic substances.

METHODS

Study groups

Thirty, healthy men from southern Sweden were recruited. Nine of these never eat fish (*non-consumers*), in most cases because of allergy. Ten subjects have about one fish-meal pro week (*moderate consumers*), and 11 persons (*high consumers*) have a very high, and daily, consumption of fat fish, mainly herring and salmon caught in the Baltic Sea.

Blood sampling and analyses
Venous blood (about 420 ml) was drawn from each subject. Plasma was separated and analysed for PCDDs and PCDFs with a method described earlier (Nygren et al., 1988). Fatty acid composition in serum phosphatidylcholin was determined by capillary gas chromatography (Ekström et al., 1989).

RESULTS
Differencies in plasma levels of several PCDDs/PCDFs were seen between the consumption groups (Table). The differencies were apparent particularly for 2,3,4,7,8-pentachlorodibenzofuran (PeCDF), 2,3,7,8-tetrachloro-*p*-dibenzodioxin (TCDD), and Nordic TCDD equivalents.

There were significant associations between consumed amounts of fish and levels of several of the PCDDs/PCDFs (Table). Also, n-3 polyunsaturated fatty acids (n-3 PUFAs) in serum displayed a strong association with several of the individual PCDDs and PCDFs (Table).

DISCUSSION
The close relationship between levels of several PCDDs/PCDFs in plasma, and intake of fish indicates that fish consumption is a major source for these compounds in the population of southern Sweden. Also, the correlation between serum levels of n-3 PUFAs, who have their main dietary origin in fish, and the levels of PCDDs/PCDFs confirms this assumption.

The fish consumed was mainly caught in the Baltic Sea. Composite samples of herring from these waters have about 8-18 pg TCDD equivalents/g whole fish, as compared to 2-3 pg/g in herring from the less polluted west coast of Sweden (Bergqvist et al., 1989). Wild salmons from the Baltic Sea have 30-90 pg TCDD equivalents/g, while hatched salmons from the same Sea have 3-4 pg/g (Rappe et al., 1989).

Most earlier reports on PCDD/PCDF levels in human blood come from subjects with occupational and/or accidental exposure. They are mostly concerned with one of the congeners: 2,3,7,8-TCDD. These reported levels are often much higher than the ones found in the present study (Patterson et al., 1989). However, occupational and accidental exposure is of limited duration, often for a very short time. Exposure through food however, as in the present study, results in accumulation for decades as many of the congeners have long half-lives.

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Table. - Levels (medians and ranges) of polychlorinated dibenzofurans (PCDFs) and polychlorinated p-dibenzodioxins (PCDDs) in blood plasma and polyunsatured fatty acids (PUFA) in blood serum in subjects with varying fish intake. Non- Parametric statistics (Mann-Whitney U-test) have been used in comparisons between consumption groups. Variance in PCDF and PCDD levels, explained by PUFA and intake of fish (simple regression analysis) are given as adjusted R^2. b.d.= levels below detection limit (< 1 pg/g). Asterixs denote $p<0.05$.

Plasma levels of	Fish consumption			Explained variance	
	No (n=9)	Average (n=10)	High (n=11)	PUFA (R^2; %)	Fish (R^2; %)
PCDFs/PCDDs (pg/g lipid)					
2378-TCDF	1.5 (1.2-2.4)	1.8 (1.2-2.1)	3.0* (1.5-7.8)	68*	54*
12378-PeCDF	0.15 (0.15-0.5)	0.5 (0.15-0.5)	1.3* (0.7-5.0)	70*	60*
23478-PeCDF	12 (9-29)	20* (9-51)	79* † (15-109)	68*	65*
123478-HxCDF	5.4 (4.9-14)	7.1 (3.3-10)	8.3 (4.6-17)	16*	18*
123678-HxCDF	4.4 (3.6-10)	5.4 (2.6-8.5)	11* (3.6-27)	33*	39*
234678-HxCDF	2.1 (1.1-3.5)	2.2 (1.0-3.9)	2.8 (1.4-12)	28*	23*
123789-HxCDF	b.d.	b.d.	b.d.	-	-
1234678-HpCDF	10 (6.7-26)	14 (6.0-38)	10 (8.2-51)	-2	2
1234789-HpCDF	b.d.	b.d.	b.d.	-	-
OCDF	1.0 (1.0-2.9)	1.0 (1.0-2.1)	1.0 (1.0-2.9)	-3	-3
2378-TCDD	1.8 (1.0-2.5)	2.5* (1.2-4.2)	8.0* (2.4-13)	68*	68*
12378-PeCDD	5.7 (4.1-9.9)	7.6 (3.3-14)	16* (4.2-24)	62*	59*
123478-HxCDD	2.8 (2.2-4.3)	3.0 (1.6-4.4)	3.9 (1.8-9.6)	17*	13*
123678-HxCDD	35 (28-63)	43 (24-70)	48 (21-94)	-1	0.4
123789-HxCDD	5.7 (3.6-9.7)	6.0 (3.9-9.1)	6.5 (4.7-9.3)	3	3
1234678-HpCDD	65 (43-94)	80 (40-145)	71 (47-139)	-3	-4
OCDD	357 (186-561)	458 (249-1100)	473 (241-830)	-4	-3
TCDD equivalents	17.5 (11.3-33.3)	25.8* (11.8-48)	63.5* (18.3-88)	65*	63*
PUFA; (weight %)					
All n-3 PUFA	5.5 (4.3-6.2)	7.1* (6.1-8.4)	12.5* (10.3-19.0)		86*