Serum PCB, Dioxin and Furan levels in Ontario Great Lakes Anglers

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Introduction

High consumers of sport fish in the Great Lakes Basin have been identified as a human population at risk of greater exposure to environmentally persistent organochlorine compounds [1]. Ontario residents fish throughout the Basin, inland lakes and rivers and fish consumption advisories based on PCBs, mirex, dioxins and toxaphene contamination are in effect in several locations [2]. It remained to be determined whether contaminant levels were sufficiently high in consumers and different from non-consumers to warrant using the fish license holder population as a cohort for large scale health effect studies.

Objectives

To investigate the distribution of environmental contaminant levels found in plasma of licensed anglers consuming large amounts of fish and wildlife from two areas of the Great Lakes Basin in Ontario, to compare these levels with those found in non-consumers and those in other angler populations and to evaluate the toxicological significance of the contaminant levels found.

Methods

From a datafile of 1988 Ontario sport fishing license holders and with oversampling for women, approximately 4000 anglers were mailed screening consumption questionnaires in two active fishing communities: Cornwall and Mississauga. Results of this Great Lakes Anglers Survey are reported elsewhere [3]. Based on the numbers, species and locations of fish caught and kept for eating by the household and Ministry of Environment and Energy data on contaminant levels, a PCB index was calculated on 1605 respondents. Focusing on those with the highest and lowest indices, we invited 705 to complete fuller consumption questionnaires and biological sampling in their homes, 232 of whom participated. Additional information on participants and recruitment methods have been reported elsewhere [4].

Blood for organochlorine contaminants was collected in 10 ml tubes containing EDTA, centrifuged immediately and the plasma transferred to vials with a teflon lined screw cap. Shipping was under refrigeration until storage at -70°C. Within each community, plasma samples for dioxins, furans and co-planar PCBs were created by combining samples within age, fish consumption and Ar1260 plasma level (cutoff at 486 µg/kg lipid) categories, resulting in fourteen groups representing 132 plasma, randomly selected within strata. Analyses followed methods previously published by Ryan and colleagues [5]. Total dioxin equivalents (TEQs) were calculated based upon internationally agreed upon methods [6,7], substituting one-half of the detection limit for non-detectable values.

Results

Sixty-five percent of participants reported eating "Great Lakes fish" for an average of 33 years. An additional 10% had eaten for an average of 23 years but had stopped (an average 7 years ago). The remaining 25% had never eaten Great Lakes fish. In Cornwall, 109 residents reported eating an average of 34.2 (±35.0) Great Lakes fish meals/yr (range 1-173) in the last 12 months, resulting in an average consumption of 7.27 (±11.0) kg/yr (range 0.05-64.6). The most commonly eaten species were perch (90%), walleye (54%) and smallmouth bass (45%), none of which had organochlorine based advisories. In Mississauga, 43 residents reported eating an average of 10.9 (± 14.2) Great Lakes fish meals/yr (range 1-58) in the last 12 months, resulting in an average consumption of 4.50 (± 9.0) kg/yr (range 0.02-51.6). The most commonly eaten Great Lakes species were salmon (51%) and rainbow trout (49%), both of which have consumption advisories because of organochlorine levels [2]. Only 36 Cornwall and 3 Mississauga eaters reported eating waterfowl and the species eaten were in general the

least contaminated (Birgit Braune, Canadian Wildlife Service, personal communication).

Levels of dioxins and furans on a lipid weight basis are presented in Tables 1 (Cornwall) and 2 (Mississauga). CDF's not detected (detection limit 4 to 8 ppt) included: 12378-PnCDF, 123789-HxCDF & 1234789-HpCDF. Levels of CDDs from the younger age categories are similar to those found in a pool of ten samples collected in 1988 from Ontario Red Cross blood donors [8] and levels found in Swedish people eating no fish or moderate amounts of fish [9]. Levels and TEQs increase with age but are generally similar for Great Lakes fish eaters and non-eaters, except among older Mississauga anglers where TEQs are slightly higher in eaters, based on higher levels of more toxic CDD and CDF congeners. Co-planar PCB levels were available for Cornwall only (table 1) due to a faulty batch of absorbent. Levels are similar to those of Ontario Red Cross donors [8], increase with age and are slightly higher among Great Lakes fish eaters. CDD, CDF and co-planar PCB levels are below those found in Gulf of St. Lawrence fishermen and their spouses [8] or Swedes consuming large amounts of Baltic sea fish [9]. TEQ levels (>20.8-50.8) are comparable to those considered background levels in the Dioxin Reassessment by EPA (40-60 ppt in lipid) [10]. Adverse effects, if any, associated with plasma concentrations in this study would be equivalent to those in the general population.

Table 1. Dioxins, Dibenzofurans & Co-planar PCBs in Cornwall pooled serum samples (ng/kg lipid, detection limits follow non-detectable (ND) values)

Age (yrs)	Great Lakes Sport Fish Eaters					Non-Eaters		
	<38		38-50		>50	<38	38-50	>50
Ar1260 strata	lower	higher	lower	higher	higher	not applicable		
Dioxins TEF								
2378-TCDD 1.0	2.8	2.8	6.4	4.9	5.3	3.0	4.6	5.9
12378-PnCDD 0.5	6.5	7.0	8.6	10.6	11.8	8.7	6.8	15.1
123(4+6)78-HxCDD 0.1	41.6	52.7	68.4	84.5	91.0	55.5	88.1	85.5
123789-HxCDD 0.1	10.0	10.1	13.4	11.5	12.3	14.5	11.3	9.3
1234678-HpCDD 0.01	108.0	62.9	105.0	109.8	131.1	98.4	127.2	126.7
OCDD 0.001	365.3	370.0	566.7	620.6	575.5	417.2	673.1	709.8
Dibenzofurans TEF								
2378-TCDF 0.1	ND(4.3)	ND(5.4)	ND(4.2)	ND(4.1)	ND(4.3)	ND(4.6)	ND(4.0)	ND(8.0)
23478-PnCDF 0.5	12.3	11.9	11.2	14.8	15.7	13.0	14.9	17.3
123(4+6)78-HxCDF 0.1	10.0	15.0	13.8	15.9	14.2	13.7	16.9	19.8
234678-HxCDF 0.1	5.5	7.9	5.1	4.2	3.8	6.2	4.6	6.5
1234678-HpCDF 0.01	22.6	18.9	17.0	23.8	18.0	19.2	14.2	19.4
CDD & CDF TEQ	20.8	22.2	28.4	31.4	33.5	24.7	29.8	36.8
Coplanar PCBs (IUPAC #) TEF	Not Available							
33'44-TCB(77) 0.0005	due to	ND(128.4)	ND(78.2)	ND(67.2)	431.8	ND(244.6)	ND(159.5)	ND(301)
33'44'5-PnCB(126) 0.1	reagent	31.4	25.9	88.6	163.2	21.7	63.7	88.2
33'44'55'-HxCB(169)0.01	problem	40.8	46.7	65.9	78.4	36.1	43.6	85.6
PCB TEQ	N/A	3.6	3.1	9.5	17.3	2.6	6.8	9.7
Total TEQ	N/A	25.8	31.5	40.9	50.8	27.3	36.6	46.5

Table 2. Dioxins and Dibenzofurans in Mississauga pooled serum samples (ng/kg lipid)

Age (yrs)	Great Lakes Sport Fish Eaters			Non-Eaters		
	<38	38-50	>50	<38	38-50	>50
Dioxins TEF						
2378-TCDD 1.0	5.4	7.4	4.8	2.8	3.6	ND(3.0)
12378-PnCDD 0.5	ND(10.0)	17.0	15.4	ND(9.7)	11.0	11.0
123(4+6)78-HxCDD 0.1	56.8	80.1	102.0	44.5	68.1	99.0
123789-HxCDD 0.1	12.0	16.0	16.0	11.0	11.0	16.0
1234678-HpCDD 0.01	104.0	129.0	80.6	114.0	81.0	115.0
OCDD 0.001	422.0	532.2	574.1	530.8	545.7	586.3
Dibenzofurans TEF						
2378-TCDF 0.1	ND(7.0)	ND(7.7)	ND(6.0)	ND(7.7)	ND(5.0)	ND(6.0)
23478-PnCDF 0.5	24.8	18.5	24.4	15.9	17.4	21.0
123(4+6)78-HxCDF 0.1	17.3	20.0	21.0	57.7	13.7	23.0
234678-HxCDF 0.01	14.1	9.7	7.8	66.0	ND(5.7)	8.2
1234678-HpCDF 0.01	22.4	17.3	17.2	81.3	15.8	18.0
CDD & CDF TEQ	32.4	40.1	41.2	34.0	29.1	34.3

Conclusions

Differences in TEQ levels for CDDs, CDFs and co-planar PCBs between licensed Ontario sport fish and wildlife eaters and non-eaters were not sufficient to warrant further health effects linkage studies using the license holder population. TEQ levels among Ontario Great Lakes licensed anglers were within the range judged "background" in North American general populations. This range is still of ongoing concern as to potential health effects.

References

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