

Development of Food Consumption Advisories Following Accidental Release of PCBs, PCDDs and PCDFs from a Special Waste Treatment Center

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Introduction

An initial food consumption advisory was issued in the winter of 1996 based on a preliminary assessment. Diet and activity survey and estimating exposure ratio were initiated in early 1997 to obtain accurate information on the dietary habits and activities of individuals living in the study area and to assess exposure levels resulting from consuming contaminated wild game and fish. The resulting estimates were compared to existing guidelines. Food consumption advisories were revised based on the new information.

Materials and Methods

Diet and Activity Survey

A diet and activity survey was conducted through telephone interviews during March and April 1997. The survey was divided into two phases. 327 including 12 aboriginal people of 370 respondents (88%) participated in the first telephone interview. A second telephone interview was then conducted with 100 participants selected from those who had participated in the first telephone interview. Participants were asked to recall their consumption of wild game and fish and their outdoor recreational activities within a 100 km radius of the facility for the previous 12 months. Specifically, the initial survey was used to determine types of outdoor activities within the study area; frequency, duration and amount of wild game and fish consumption; and the respondents' awareness of and adherence to the existing food consumption advisory. The second survey requested demographic characteristics (age, gender, ethnic group, weight and height, occupation, duration of residency, number of persons in the household); proportion of activity time spent indoors and outdoors and detailed information about outdoor activities; detailed information about daily food consumption including consumption of wild game, fish and wild fruit, vegetables and herbs, and cooking and preparation techniques for wild game and fish; and more detailed information about lifestyle (use of alcohol and cigarettes, health conditions and perception of the current health advisory).

Estimates of Daily Intake and Exposure Ratio

Estimated daily intake (EDI) was calculated as follows:

$$EDI = C * IR * BF / BW$$

C is measured concentrations of contaminants, IR is food consumption rate, BF is bioavailability factor (assuming 100%), and BW is average body weight (73 kg for Albertans).

Exposure ratios (ER) were calculated by using the following equation:

$$ER = EDI / TDI$$

The tolerable daily intakes (TDI) are 1 µg/kg/d for PCBs and 10 pg/kg/d for TCDD.

Results and Discussion

Diet and Activity Survey

A total of 123 (38%) respondents had consumed wild game taken from the study area and 127 (39%) had consumed fish (Table 1). Moose, deer and grouse are the most common wild game for consumption. The most commonly consumed fish species were walleye, northern pike, perch, brook trout, lake whitefish and arctic grayling. The average consumption rate was 35 grams/day of wild game and 15 grams/day of fish. A small proportion of consumers ate a relatively large quantity of local wild game and fish. Aboriginal people may have higher rates of consumption of food from local sources, though specific data for aboriginal people living in the study area are not available.

Table 1 Consumption Rate for Wild Game and Fish

Consumption Group*	Wild Game		Fish	
	Mean (g/d)	% consumed (n=123)	Mean (g/d)	% consumed (n=127)
High Intake (>100 g/d)	191	8	167	2
Medium Intake (30-99 g/d)	58	25	47	13
Low Intake (5-29 g/d)	13	31	13	28
Very Low Intake (<4 g/d)	2	36	2	57

* based on consuming muscle portion

Daily Intake and Exposure Ratio

Estimated daily intake and exposure ratio are illustrated in Table 2. The daily intake of PCBs and PCDD/Fs comes mainly from the diet through commercial food sources, and to a lesser extent, from breathing air and drinking water. The daily intake from background exposure for adult Canadians is estimated to be 2-4 pg PCDD/F/kg/d.¹ The exposure ratio reflects the ratio between the actual level of exposure (external dose) in a particular circumstance and a reference standard associated with observed toxicity in humans or animals. In the current assessment, the estimated daily intake and exposure ratios provide insight into additional exposure that might be expected from consuming local wild game and fish.

The exposure ratios for high and medium consumption groups were greater than one as compared to Health Canada TDI for TCDD at the 90th percentile concentrations of Σdioxin-like TEQ in deer and brook trout muscles (Table 2). Around the world, various regulatory guidelines have been developed for TCDD, the most toxic dioxin in the group of PCDDs/PCDFs. The guidelines are expressed as a reference dose (RfD) or a tolerable daily intake (TDI), that is, a lifetime daily dose for TCDD which is believed to be without potential health effects to humans. In the past TCDD has been treated as a threshold carcinogen by some regulatory agencies. Based on this assumption, a value of 10 pg/kg body weight/day has been

adopted by Health Canada.² Some PCB and PCDD/F congeners produce similar toxic effects to humans and animals as TCDD. The similarity of toxicity between these congeners and TCDD was assessed using toxic equivalency factors (TEFs). Σ dioxin-like TEQ combines Σ PCB TEQ and Σ PCDD/F TEQ.

Table 2 Estimated Daily Intake (EDI) and Exposure Ratio (ER)

Consumption Group			High Intake		Medium Intake		Low Intake		Very Low Intake	
Percentile Concentration*			50 th	90 th	50 th	90 th	50 th	90 th	50 th	90 th
<i>Wild</i>	EDI	Σ PCB(μ g/kg/d)	.02	.2	.005	.06	.001	.01	.0002	.002
<i>Game</i>	ER	Σ PCB	.02	.2	.005	.06	.001	.01	.0002	.002
	EDI	Σ TEQ (pg/kg/d)	6.2	175	2.0	53	.4	12	.07	1.8
	ER	Σ TEQ**	0.6	17.5	0.2	5.3	.04	1.2	.007	0.18
<i>Brook</i>	EDI	Σ PCB(μ g/kg/d)	.04	.08	.01	.02	.003	.007	.0005	.001
<i>Trout</i>	ER	Σ PCB	.04	.08	.01	.02	.003	.007	.0005	.001
	EDI	Σ TEQ (pg/kg/d)	28	66	8	18	2.2	5.1	.3	.8
	ER	Σ TEQ	2.8	6.6	.8	1.8	.2	.5	.03	.08

* concentrations at 50th percentile were 6.5 μ g/kg, wet weight, for Σ PCBs and 2.4 ng/kg for Σ TEQ in deer muscle, and 18 μ g/kg for PCBs and 12 ng/kg for Σ TEQ in brook trout muscle; concentrations at 90th percentile were 73 μ g/kg for PCBs and 67 ng/kg for Σ TEQ in deer muscle, and 36 μ g/kg for PCBs and 29 ng/kg for Σ TEQ in brook trout muscle. ** Σ TEQ = Σ dioxin-like TEQ

Based on concentrations at the 90th percentile of Σ dioxin-like TEQ, a consumption limit was recommended (Table 3). These consumption limits provide guidance on the evaluation of the potential risk associated with exposure to PCBs and PCDD/Fs for individuals who consume deer or moose meat taken within a 30 km radius of the facility and/or brook trout from Chrystina lake near the facility. The estimated values represent the amount of meat from deer or moose and from edible portions of brook trout expected to generate a risk no greater than the tolerable daily intake proposed by Health Canada, based on a lifetime of daily consumption at that consumption limit. Because the contaminants tend to accumulate in the internal organs in various animals and the measured levels of the contaminants were very high in the liver samples, people should avoid consumption of viscera from wild game and fish. The current Health Canada TDI for TCDD is based on the potential for cancer. The toxicity of TCDD and related congeners also includes reproductive, developmental and immunotoxic effects.³ Children and pregnant women or women who are breast-feeding are susceptible groups and should avoid consuming wild game and fish.

Table 3 Species-Specific Consumption Limit

Parameter	Wild Game Meat	Fish
Species	deer and moose	brook trout
Location	within 30 km radius of the facility	Chrystina lake
Type of tissue	muscle	muscle
Health Canada TDI for TCDD(pg/kg bw/day)	10	10
Body weight (kg) based on Alberta average	73	73
Consumption limit (oz /week)	3	6
Consumption limit (oz/month)	13	26

Wild game and fish may supplement the diet of a number of people living in the area surrounding the facility. Concern has been raised by both recreational users and traditional users because these two groups consume more wild game and fish than the general population. The balance between nutritional benefits and health risks arising from the consumption of contaminated food is an important consideration in issuing public health advisories.⁴⁻⁵

The current advisories address this issue in three ways. First, the dietary survey attempted to determine the extent of wild game and fish consumption by residents of the study area. Survey results indicate that only a small proportion of people ate wild game and fish caught near the facility at high consumption rate. Second, the advisories provided consumption limits developed from risk estimates rather than an outright ban on consumption. These limits do indicate that wild game and fish may still be safely consumed in moderation. Third, the advisories are restricted to a 30 km radius of the facility in accordance with evidence that contamination with PCBs, PCDDs and PCDFs is restricted to areas near the facility. Therefore, traditional and recreational users can still safely consume wild game and fish obtained from outside the affected area. Finally, it should be noted that the consumption limits provided in the advisories were calculated in reference to uncooked food. Many studies have shown that appropriate food preparation and cooking techniques can reduce the concentrations of PCBs, PCDDs and PCDFs in fish and meat.⁶⁻⁸ Thus, techniques such as removing the skin prior to cooking, broiling and baking are recommended for individuals who continue to consume wild game and fish taken from the areas immediately surrounding the facility.

References

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