HUMAN EXPOSURE TO PCDDs, PCDFs AND Co-PCBs IN JAPAN, 2000

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Introduction

The level of human exposure to dioxins (PCDDs, PCDFs, and Co-PCBs) in Japan was determined in the present study. To determine exposure levels, we collected and compiled survey results derived from the regular environmental monitoring of dioxins under Japan's Law Concerning Special Measures against Dioxins,[1] as well as other dioxin surveys by national and local governmental bodies in fiscal 2000 (April 2000 – March 2001). First, the exposure level was estimated in a "point" estimate (i.e., a single value derived from arithmetic means) approach based on the compiled data. Then the contributions of inhalation, soil ingestion, diet, and various foodstuffs were considered. Because an emphasis was placed on the importance of quantitatively characterizing the variability in exposure assessments,[2] the "probabilistic" approach was also conducted using a Monte Carlo simulation. This approach uses a distribution of data rather than a single data point to represent key exposure variables (e.g., chemical concentrations, dietary intake, and body weight, etc.). Particular attention was given to the variability of dioxin concentrations in air, soil and foods.

Materials and Methods

Dioxin survey results in Ministry of the Environment (MOE) (2000)[1] and other literature cited were compiled. Point estimation was conducted while taking three pathways into account:

inhalation, soil ingestion, and diet. Estimates of exposure through inhalation were based on arithmetic means of dioxin concentrations in the air, using a body weight[3] of 50 kg and a daily respiration volume[3] of 15 m^3/day. Estimates of exposure through soil ingestion were obtained using arithmetic means of the dioxin concentration in the soil, a body weight[3] of 50 kg, and daily ingestion of soil[3] assumed to be 100mg/day. Total diet study (TDS) results in Tutsumi *et.al* (2001)[4] (n=16, average=1.45, range=0.84-2.01) were used to estimate exposure through diet. Dioxin concentration data of various foodstuffs were classified into food groups according to the Ministry of Health, Labour and Welfare (MHLW) (2002)[5], and the contribution of each food group to total dietary exposure was estimated. The scheme for the Monte Carlo simulation was same as for the point estimation, except dioxin concentrations in the air and soil, and exposure through diet were represented as probabilistic density functions (air: Weibull distribution [L, s, m=0.01, 0.15, 1.3 pg-TEQ/m^3], soil: lognormal distribution [m, ó=12, 410 pg-TEQ/g], foods: lognormal distribution [m, ó=1.46, 0.42 pg-TEQ/kg-bw/day]). The range of each probabilistic distribution was from zero to the maximum measurement result, including the data from the vicinity of pollution sources (air: 0-1.1 pg-TEQ/m^3; soil: 0-1200 pg-TEQ/g; foods: 0-2.01 pg-TEQ/kg/day). For the Monte Carlo Simulation, Crystal Ball PRO® (Decisioneering Inc.) was used, with 5,000 trials. WHO98-TEF was used.

Results and Discussion

Table 1: Dioxin concentrations in various media and total diet study results in Japan, FY2000

	n	Min.	25th%tile	Median	75th%tile	Max.	Arithmetic mean	Geometric mean	S.D.
Air pg-TEQ/m3	707	0.0073	0.065	0.12	0.19	0.76	0.14	0.11	0.11
Soil pg-TEQ/g	1943	0	0.067	0.44	2.7	280	4.6	0.38	18
Water (sea/river/lake) pg-TEQ/L	2128	0.012	0.08	0.14	0.32	48	0.31	0.17	1.2
Sediment (sea/river/lake) pg-TEQ/g	1838	0.0011	0.47	1.4	6.1	1400	9.6	1.7	46
Ground water pg-TEQ/L	1479	0.00081	0.054	0.069	0.11	0.89	0.097	0.073	0.090
Aquatic organisms pg-TEQ/g	80	0.42	1.4	2.8	4.4	17	3.7	2.7	3.2
Purified water (water purification plant)	104	0.0013	0.0052	0.012	0.022	0.10	0.020	0.011	0.022
Raw water (water purification plant)	117	0	0.014	0.023	0.063	0.41	0.056	0.031	0.075
Human breast milk pg-TEQ/g-fat	223	-	-	-	-	-	23	-	-
Total diet study pg-TEQ/kg/day	20	0.84	1.3	1.5	1.8	2.2	1.5	1.4	0.40

Table 1 shows compiled data on dioxin concentrations in various media as well as TDS results. Data from the vicinity of pollution sources are not included in this table. Point exposure estimates, which were based on arithmetic means of exposure variables, through the each pathway and in total are shown in Table 2. Total exposure was estimated at 1.50 pg-TEQ/kg-bw/day, and exposure through inhalation, soil ingestion, and diet were 0.042, 0.0092, and 1.45 pg-TEQ/kg-bw/day, respectively. Exposure through diet accounted for more than 90% of the total exposure; the contributions through inhalation and soil ingestion were relatively small. Regarding dioxins in foodstuffs, the high concentrations in fish and shellfish were remarkable (average=0.87, range=0-10 pg-TEQ/g) (Table 3). Age-group-specific contributions of various foodstuffs to total dietary exposure are shown in Figure 1; the estimates of exposure through fish and shellfish account for approximately 50-70% of total dioxin exposure in each age group. Figure 2 shows the results of a probabilistic approach using the Monte Carlo Simulation method. The estimated average, median, 5 th percentile and 95th percentile of the exposure distribution are 1.43, 1.42, 0.95 and 1.93 pg-TEQ/kg-bw/day, respectively. In conclusion, this study found that both the average and the 95th percentile of the dioxin exposure distributions in Japan were estimated below the World Health Organisation's tolerable daily intake levels (i.e., 4 pg-TEQ/kg-bw/day). This study also clarified that the diet—especially fish and shellfish—is the most important pathway for dioxin exposure in Japan. In the future, assessments of exposure for children should be elaborated, because high dioxin exposure of children is a serious health concern. In addition, because of the importance of

Table 2: Estimates of exposure estimate to dioxins (pg-TEQ/kg-bw/day)

Inhalation	0.042
Soil ingestion	0.0092
Diet	1.45
Total	1.50

Table 3: Dioxin concentrations in foodstuffs (pg-TEQ/g)

Foodstuffs	n	Min.	Median	Max.	Arithmetic mean
Rice and rice products	91	0	0.000027	0.015	0.00062
Cereals, seeds, and potatoes	26	0	0.0000030	0.00078	0.00010
Sugars and confectioneries	3	0	0.0030	0.019	0.0073
Fats and oils	5	0.24	0.40	0.98	0.47
Pulses	13	0	0	0.0010	0.00033
Fruits	61	0	0	0.35	0.010
Green vegetables	53	0	0.00024	0.15	0.021
Other green vegetables, mushrooms, and seaweed	74	0	0	0.059	0.0022
Fish and shellfish	186	0	0.32	10	0.87
Meat and eggs	64	0	0.032	1.7	0.11
Milk and dairy products	21	0	0.061	0.47	0.096

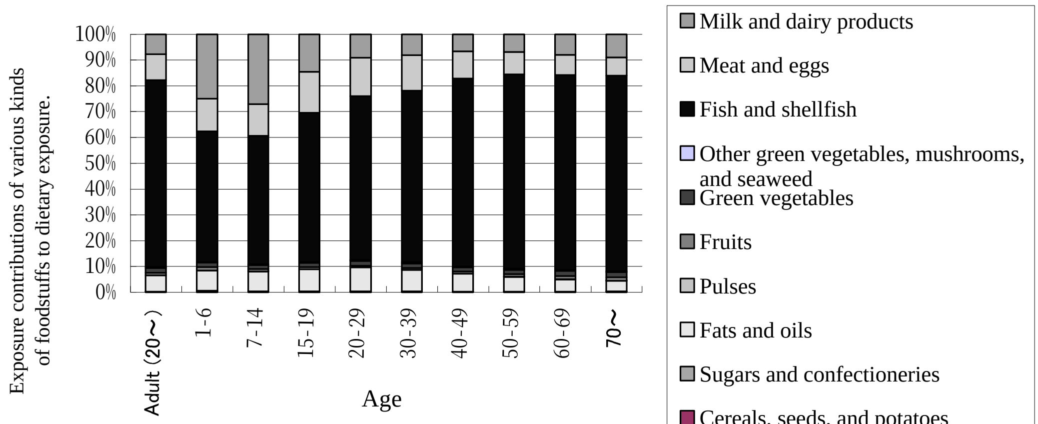

Figure 1: Age-group-specific contribution of various foodstuffs to total dietary exposure

*Dietary intake and body weight of each age group obtained from MOE(2000)[3].

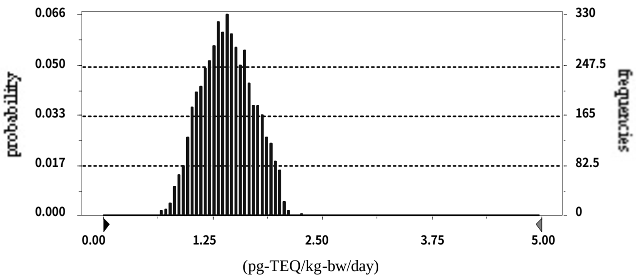

Figure 2: Distribution of dioxin exposure in Japan, FY2000 estimated by Monte Carlo simulation.

dietary exposure future research should address the variability of amounts of dietary intake, using a probabilistic approach.

References

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