BACKGROUND EXPOSURE LEVELS OF PCDDs/Fs IN KOREA

Hyomin Lee, Eunkyung Yoon, Dongmi Choi, Soonyoung Han, Seunghee Kim, Kyungpoong Won, Ki Hwa Yang, Kwangsup Kil, Kilchul Lee[1], Kyunghee Choi[1], Seunggi Jang[1], Jin Gyun Na[1]

National Institute of Toxicology Research, Korea Food and Drug Administration, #5 Nokbun-dong, Eunpyung-ku, Seoul122-704, Korea. National Institute of Environmental Research, Environmental Research Complex, Kyungseo-Dong, Seo-Gu, Inchon , 404-170, Korea[1]

Introduction

Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/Fs) are present in all compartments of the environment-atmospheric, aquatic, and terrestrial[1]. When they are released into the air, some fractions of PCDDs/Fs are transported to long distances, even around the globe. Main exposure routes to PCDDs/Fs are known to be as follows; eating food which contains PCDDs/Fs, breathing air, drinking water and skin contact[1, 2]. The background exposure estimates are intended to be representative of the general population. It should be noted that these estimates do not account for individuals who take specific food groups with high consumption rates.

Population living near an uncontrolled hazardous waste site containing PCDDs/Fs or incinerators releasing PCDDs/Fs may be exposed to higher levels than ones exposed to general background environment[2].

This study attempted to quantify the human background exposure levels of PCDDs/Fs and to identify exposure contribution by environmental media using domestic data [2,3].

Environmental Media and Food Concentrations

PCDDs/Fs levels in various environmental media including food are listed in Table 1 in terms of means, variability and sample sizes, which support the estimation. PCDDs/Fs levels in environmental media were collected from various studies conducted at different locations in Korea. Of the studies available for these data compilation, the results which obtained from the analyses in representing "background" sites were selected. Dioxin-like PCBs and water data were not included in this quantification due to the deficiency of data. PCDDs/Fs levels in food were obtained and treated statistically, based on the national surveys implemented by Korea Food and Drug Administration (1999, 2000)[4, 5]. In addition, other environmental levels were derived from Ministry of Environment (1999)[6].

Total 18 foods including cereal, vegetable, meat, egg, fish and dairy products, which were selected in this study as foods which are most commonly consumed by the general Korean. In addition, PCDDs/Fs levels in air and soil samples, representing residential and rural areas, were selected. The results were converted into TEQ in this estimation and N.D. assumed to zero.

Table 1. Summary of PCDDs/Fs levels in environmental media and food (whole weight basis)

Media		Sample Number	PCDDs/Fs (TEQ-WHO$_{98}$[10])
Grains (fg TEQ/g)	Rice	10 (composites)	10.5 ± 15.3 (Range=0.0~38.1)
	Barely	5 (composites)	21.1 ± 25.9 (Range=0.0~63.2)
	Bean	12 (composites)	12.6 ± 14.5 (Range=0.0~45.3)
Vegetables (fg TEQ/g)	Radish	5 (composites)	1.5 ± 1.3 (Range=0.0~3.3)
	Korean Cabbage	5 (composites)	45.6 ± 77.7 (Range=0.0~180.1)
Meats (fg TEQ/g)	Beef	14 (composites)	75.3 ± 92.9 (Range=2.0~280.0)
	Pork	14 (composites)	29.2 ± 42.2 (Range=0.9~148.0)
	Chicken	10 (composites)	10.5 ± 13.8 (Range=0.0~32.0)
Eggs (fg TEQ/g)		10 (composites)	18.3 ± 15.0 (Range=0.0~50.0)
Fishes (fg TEQ/g)	Mackerel	10 (composites)	464.0 ± 532.3 (Range=0.7~1388.0)
	Hair tail	5 (composites)	1452.0 ± 1126.5 (Range=22.0~2939.0)
	Croaker	10 (composites)	36.5 ± 37.3 (Range=0.1~109.6)
	Pollack	5 (composites)	10.9 ± 11.9 (Range=0.2~24.5)
	Squid	5 (composites)	38.6 ± 40.9 (Range=0.2~95.2)
	Oyster	5 (composites)	147.2 ± 103.0 (Range=2.0~274.0)
	Clam	15 (composites)	136.7 ± 335.0 (Range=0.0~1226.0)
Dairy Product (fg TEQ/g)	Milk	2 (composites)	23.0 ± 23.6 (Range=6.3~39.7)
	Cheese	2 (composites)	17.9 ± 25.2 (Range=0.0~35.7)
Air (fg TEQ/Nm^3)		16	285.2 ± 255.8 (Range=26.7~838.8)
Soil (fg TEQ/g)		7	85.7 ± 120.0 (Range=0.6~345.7)

Detection limit : (food) PCDDs/Fs 0.001ppt
(air) 4~5 Cl 0.01pg/Nm^3, 6~7 Cl 0.02pg/Nm^3, 8Cl 0.05pg/Nm^3
(soil) 4~5 Cl 0.2pg/L, 6~7 Cl 0.4pg/L, 8 Cl 1pg/L

Quantification of Background Exposure Levels

The background exposure estimates were intended to be representative of the general public. The general Korean adult group, with 60kg as mean of man and woman, was regarded as the target population, and the data obtained from the National Health and Nutrition Survey (MHW, 1999)[7] were used as mean consumption data for the individuals. Inhalation volume, expect for sleeping time and ingestion rate of soil (U.S.EPA, 1989)[8], were considered. The general equation used to estimate background exposure levels as follows ;

$$\text{Background exposure levels} = \sum_{i=1}^{n} \frac{\text{concentration of Media } i \times \text{contact rate} \times \text{contact fraction}}{\text{body weight}}$$

- concentration of media *i* : average PCDDs/Fs levels in the media i to which individuals are exposed
- contact rate : ingestion rates, inhalation rates, and soil contact rates for the exposure pathways

- contact fraction : distribution of total contact between contaminated and uncontaminated media *i*
- body weight : for all the pathways, the human adult body weight of 60kg is assumed[9]

Intake Estimates

Adult background exposure levels of PCDDs/Fs were estimated to average 0.4307pg TEQ-WHO_{98}/day. Daily intake was estimated by combining exposure media concentrations (food, air, soil) with contact rates (ingestion, inhalation). Food data was used as mean of mean to the regarded individual food. Table2 summarizes the media concentrations, contact rates and resulting intake estimates and illustrates the derivation of a background exposure levels to PCDDs/Fs for Korea.

Background exposures of population living near an uncontrolled hazardous waste site containing PCDDs/Fs or incinerators releasing PCDDs/Fs may extend to higher levels than the mean[3]. This estimates is assumed to result from the normal variability of diet and human behaviors.

Among the exposure media, foods contributed the greatest exposure (85.3%) to the background exposure levels of PCDDs/Fs. The exposure contribution of air and soil was 14.7% and 0.02%, respectively. The order of high exposure contribution to the total exposure was fishes, grains, meats and air. This feature of Korean background exposure levels of PCDDs/Fs may be caused by that the ingestion rate of cereal and vegetable is higher than meat and dairy product.

Table 2. Adult contact rates and background exposure levels of PCDDs/Fs in Korea

Exposure route	Contact rate	PCDDs/Fs		Daily Intake (pg/kg/day)	% of total
		Concentration TEQ-WHO_{98}	Reference		
Grains ; rice, barely, bean	271.83 g/day[1)]	0.0148 pg/g	KFDA, 1999[4)]/2000[5)]	0.0670	15.5
Vegetables ; radish, Korean cabbage	63.13 g/day[1)]	0.0235 pg/g	KFDA, 1999[4)]	0.0248	5.8
Meats ; beef, pork, chicken	68.37 g/day[1)]	0.0465 pg/g	KFDA, 1999[4)]/2000[5)]	0.0529	12.3
Eggs	20.23 g/day[1)]	0.0362 pg/g	KFDA, 1999[4)]	0.0122	2.8
Fishes ; mackerel, hair tail, croaker, oyster, clam, pollack, squid	36.00 g/day[1)]	0.3265 pg/g	KFDA, 1999[4)]/2000[5)]	0.1959	45.5
Milk & Dairy product (cheese)	42.93 g/day[1)]	0.0204 pg/g	KFDA, 1999[4)]	0.0146	3.4
Air	13.3m^3/day[2)]	0.285 pg/Nm^3	KME, 2000[6)]	0.0632	14.7
Soil	0.05 g/day[3)]	0.086 pg/g	KNE,2000[6)]	0.000072	0.02
Total				**0.4307**	

1) Adult mean in 20~64 yrs supported by 1998 National Health and Nutrition Survey[7]
2) Inhaled volume except sleeping time in U.S.EPA, 1989[8]
3) Exposure Factor Handbook, U.S.EPA, 1989[8]
4) National Dioxin Monitoring for Estimation of TDI, Korea Food and Drug Administration, 1999[4]
5) Levels of Dioxin in Food , KFDA, 2000[5]

6) Korea Ministry of Environment, 1999[6]

Conclusion

The current estimate of background exposure levels to adults in Korea was 0.4307 pg TEQ-WHO_{98}/kg/day. Additional exposure may be expected from other sources. The exposure contribution of food, air and soil was 85.3%,.14.7%, 0.02%, respectively.

It was recognized that the human exposure patterns of PCDDs/Fs were very different from those of Europe and America.

References

1. ATSDR, Toxicological Profile for Chlorinated Dibenzo-p-dioxins, 1998
2. Arnold Schector Ed., Dioxin and Health, Plenum Press, 94-97, 1994
3. U.S.EPA, Estimating Exposure to Dioxin-like Compounds. Vol II; Properties, Source, Occurrence and Background Exposure, Washington, D.C. EPA/600/6-88/005Cb, 1996
4. National Dioxin Monitoring for Estimation of TDI, Korea Food and Drug Administration, 1999
5. Levels of Dioxin in Food, KFDA, 2000
6. Korea Ministry of Environment, Environmental Monitoring Data, 1999
7. Ministry of Health and Warfare, Report on 1998 National Health and Nutrition Survey, Korea, 1999
8. U.S.EPA, Exposure Factor Handbook, 1989
9. Korea Research Institute of Standards and Sciences, Korean Anthrometric Survey, 1998
10. WHO, WHO toxic equivalent factors (TEFs) for Dioxin-like Compounds for Humans and Wildlife. Environ. Health Perspect. 106(12): 775-792,1998