RISK ASSESSMENT STUDY FOR DIOXIN EXPOSURE THROUGH FOODS AND ENVIRONMENTS IN HIGH SCHOOL STUDENTS USING SMPLE PROCEDURE – GOYANG CITY, KOREA

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Introduction

I have great interest in environmental pollutants; therefore, I made a scrapbook about environmental pollutants such as endocrine disrupting chemicals (EDCs), Dioxins etc. Dioxins and furans are some of the most toxic chemicals known to science. Dioxin describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Dioxins are formed as unintentional by-products of many industrial processes. In high enough concentrations dioxins can cause adverse health effects in humans, including cancer. Scientists are also concerned, based on data from animal studies, that low level exposure in humans over long periods or high levels at decisive times might produce reproductive or developmental effects. Dioxins are found virtually everywhere in the world. Although dioxins are environmental contaminants, most human exposure is through the diet. Scientists estimate that approximately 90 percent of human exposure is through dietary intake, primarily animal fats. The best way to avoid dioxin exposure is to reduce or eliminate your consumption of meat and dairy products.

This study was performed to propose a new life style to reduce or simply eliminate dioxin exposure levels in high school students using known statistical data in Goyang City, Republic of Korea. In order to do that, the analytical results of dioxin concentrations in food and the environment were collected by KFDA and NIER. Additionally, a questionnaire for students about dietary intake has been surveyed and the dioxin exposure levels in the students' environments estimated.

Materials and methods

To find the new life style to avoid dioxin exposure, the previous research reports from 2006 to 2009 yr were collected and the average dioxin levels estimated to assess the risk of dioxin exposure through foods. The questionnaires for students about dietary intake and outside activities have been evaluated. Moreover, the dioxin exposure levels have been estimated by the following procedure as shown in Figure 1.

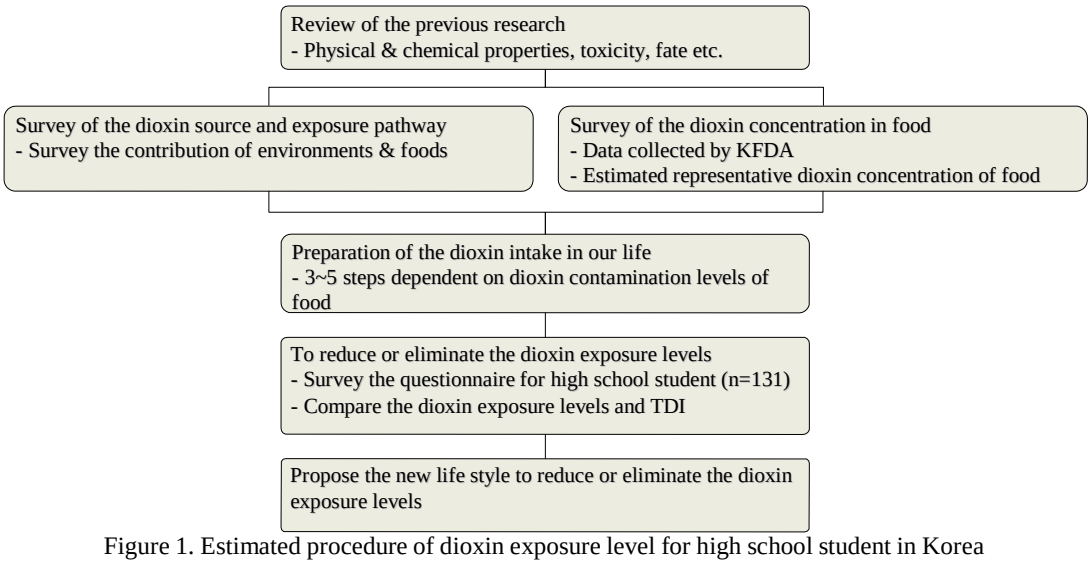


Figure 1. Estimated procedure of dioxin exposure level for high school student in Korea

Results and discussion

Statistical analysis of the questionnaire: To estimate the dioxin exposure levels for high school students in Korea, the questionnaire were surveyed (n=131, male=73, female=58). The dietary intake of dioxin was estimated as shown in Table 1. The amount of food consumption was surveyed by the questionnaire for the high school students, and the average of food intake per week estimated. The daily food intake amount and soil intake were surveyed in the previous report from KFDA (2006). The inhalation of atmosphere (11 ㎥/day) was used as the average inhalation of a Korean. The questionnaire revealed that 43.5% of the high school students, which participated in the questionnaire survey, did not hear about dioxins, and 53.4% have known about the dioxin toxicity and hazardous effect for our health and the environment.

Table 1. Estimated dietary intake of dioxin

Step 1.

$$\text{Dioxin exposure in food (pg-TEQ/kg/day)} = \frac{\text{weekly intake frequency classiied by food}}{\text{Average weekly intake frequency}} \times \text{daily intake quantity of food (g/day)} \times \text{Dioxin concentration of food (pg-TEQ/g)} \div \text{Body weight (kg)}$$

1) Intake frequency : Question research, 2)Daily intake quantity of food(Korea food & Drug Administration, 2006)
3)Dioxin concentration in food : Results of documentary research in this study, 4) Body weight : Body weight from Question research

Step 2.

$$\text{Dioxin exposure through air (pg-TEQ/kg/day)} = \text{Average daily intake quantity of air } (m^3/\text{day}) \times \text{Dioxin concentration in air } (\text{pg-TEQ}/m^3) \div \text{Body weight (kg)}$$

1) Quantity of 11,000 L(www.google.co.kr)
2)Dioxin concentration in ir : Results of documentary research in this study, 3) Body weight : Body weight from Question research

Step 3.

$$\text{Dioxin exposure in soil (pg-TEQ/kg/day)} = \text{Average expoxure time of soil (day)} \times \text{daily intake quantity of soil (g/day)} \times \text{Dioxin concentration of soil (pg-TEQ/g)} \div \text{Body weight (kg)}$$

1) Average daily intake quantity of air : Korea food & Drug Administration, Hyomin Lee etc, Background Exposure Level of PCDDs/Fs in Korea
3)Dioxin concentration in soil : Results of documentary research in this study, 4) Body weight : Body weight from Question research

Detected dioxin levels: Dioxins are found virtually everywhere in the world because of their POPs properties. Although dioxins are an environmental contaminant, most human exposure is through the dietary intake. Scientists estimate that approximately 90 percent of human exposure is through dietary intake, primarily animal fats. Estimated dietary intakes of PCDD/Fs by food consumption and environments at teen age of high school students in Korea are summarized in Table 2. Concentrations of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) were estimated using previous research report about foods commonly consumed by the Korean population from 2006 to 2009. The total toxic equivalent (TEQ) concentrations in food samples ranged from 0.000 to 1.070 pg-TEQ/g wet wt. The intake of PCDD/Fs was estimated using the previous research data, which have been collected by NIER and KFDA. The detected dioxin levels were 1.289 pg-TEQ/g for soil and 0.227 pg-TEQ/㎥ for atmosphere.

Table 2. Estimated the dioxin exposure levels from food consumption and environments

	Type		Amount of intake (per week)	Per capita food intake (g/day)	Mean conc. of dioxin (pg-TEQ/g)	Average dioxin intake (pg-TEQ/day)	Contribution ratio (%)
Food	Cereal	Rice	18.29	205.7	0.005	1.029	5.238
		Flour	6.94	115.4	0.000	0.000	0.000
	Vegetable		21.39	327.0	0.000	0.000	0.000
	Fruit						

	Fish	I	Pacific mackerel Hair tail Saury Spanish mackerel	2.96	9.2	1.070	9.850	28.54
		II	Croaker Eel Salmon Anchovy	2.66	9.5	0.375	3.192	9.35
		III	Tuna Shrimp Crab Oyster	2.32	4.9	0.110	0.539	1.57
		IV	Alaska pollack Flatfish Cuttle fish	0.71	9.7	0.109	0.469	1.03
	Meat	Beef		4.55	17.8	0.098	1.744	5.664
		Pork & chicken		6.40	41.1	0.027	1.110	3.996
	Egg & products	Milk & products		7.15	67.1	0.042	2.816	10.632
		Egg		5.40	25.3	0.244	6.178	21.019
Matrix	Soil			-	0.05	1.289	0.002	0.012
	Atmosphere(㎥/day)			-	11	0.227	2.497	12.950

1) Daily intake quantity of food(Korea food & Drug Administration, 2006), 2) KFDA, Background Exposure Levels of PCDDs/Fs in Korea, 3) Korean mean average inhalation 11 ㎥/day (www.google.co.kr)

The detected dioxin levels were 0.005(n=22) in rice, 0.244(n=40) in milk & products, 0.098(n=34) in beef, 0.027(n=63) in pork & chicken, and 0.244 pg WHO-TEQ/g wet weight in egg. As for fish and shellfish, the detected levels were 0.992(n=24) in Pacific mackerel, 1.345(n=18) in Spanish mackerel, 1.035(n=24) in hair tail, 0.207(n=21) in eel, 0.653(n=5) in salmon, 0.904 in pacific saury, 0.019(n=4) in crab, and 0.189(n=18) pg WHO-TEQ/g wet weight in oyster, respectively. Figure 2 shows the dioxin levels of fish and shellfish which have been used to estimate the mean dioxin exposure levels in this research by collecting the previous research data from KFDA.

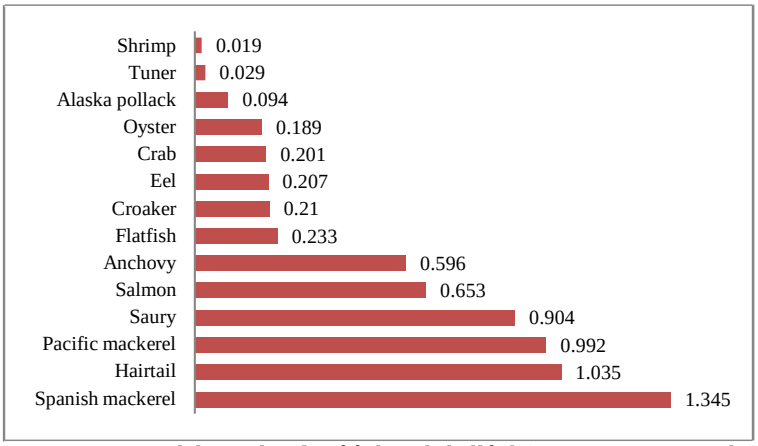
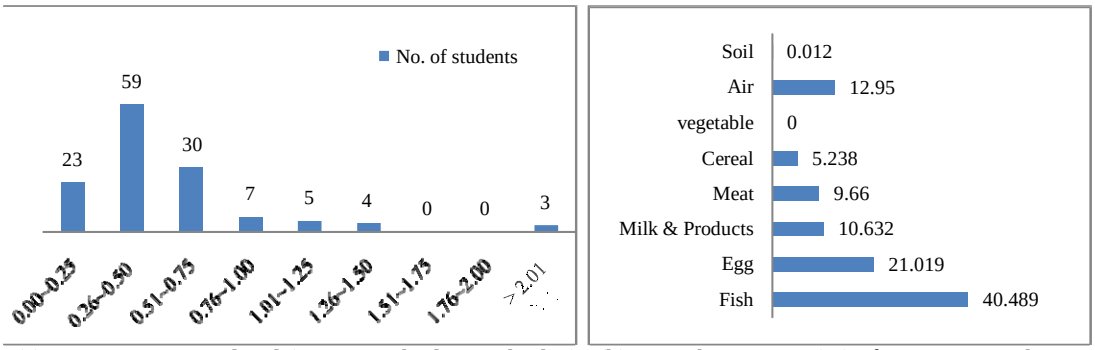


Figure 2. Detected dioxin levels of fish and shellfish(pg-TEQ/g wet weight)

Dioxin intake amount: The Korea Food and Drug Administration (KFDA) proposed a tolerable daily intake (TDI) of 4 pg TEQ/kg bw/day for dioxins and dioxin-like compounds. The dioxin intake amount estimated using the questionnaire results of n=131. The average dietary intake of PCDD/Fs through food consumption and environments (air and soil; detection in water has not been assumed) in Korea was estimated to be 0.530 pg-TEQ/kg body weight/day. The dietary intake of PCDD/Fs for males and females of the Korean high school students were estimated to be 0.526 and 0.536 pg TEQ/kg body weight/day, respectively. As a result of comparing dietary intakes with the tolerable daily intake of 4 pg TEQ/kg bw/day, the mean exposure levels of dioxin for Korean high school students was 8 times lower than that in the present TDI level proposed by the KFDA. For three students values greater than 2.01 pg-TEQ/kg/day have been estimated. For the student with the highest exposure level of PCDD/Fs a value of 3.362 pg-TEQ/kg/day (female, 160 cm, and 48 kg) has been assessed, but the exposure level was still less than 4 pg-TEQ/kg/day. For two other students a value of 2.000 pg-TEQ/kg/day has been calculated (male, 173 cm, 57 kg and 176 cm, 65 kg).

Among the seafood investigated in the present study, Group I (Pacific Mackerel, Hair tail, Saury and Spanish mackerel) contributed to the highest intake of 9.850 pg-TEQ/kg/day, accounting for 28.54% of the total dietary TEQ intake. The dietary intakes through the consumption of Group II (Croaker, Eel, Salmon and Anchovy) were 3.192 pg-TEQ/kg/day, respectively. Group III (Tuna, Shrimp, Crab and Oyster) and IV (Alaska pollack, Flatfish and Cuttle fish) showed moderate contributions, which accounted collectively for 2.60% of the total dietary TEQ intake. The mackerels were the most important contributors to dietary intake from seafood consumption in Korea.

This result was similar to those reported in other studies in Korea (KFDA, 2006~2009). The best way to avoid dioxin exposure is to reduce or eliminate the consumption of meat and dairy products of high school students. The present study emphasizes the importance of efforts to reduce the levels of dioxin-like contaminants in foods and the environment to protect human health in Korea.



(a) Dioxin exposure level (pg-TEQ/g body weight/day) (b) Contribution ratio(%) of PCDD/Fs intake

Figure 3. Exposure level and Contribution ratio (%) of PCDD/Fs

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