Risk Factors Affecting Blood t-PCDDs/DFs in Residents near an Industrial Incinerator in Korea

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Introduction

Numerous studies have been conducted concerning the exposure, toxicity and health effects of PCDD/DFs in the developed countries[1,2,3]. However,only limited information is available, particularly on the exposure pathways and susceptible groups, in the rest of the world includingKorea[4,5,6] In this study, we estimated whether the blood levels and isomer patterns of PCDDs/DFs in residents near an incinerator were affected by its presence in Korea and investigated the risk factors to define the risk population at high exposure to PCDDs/DFs in the area.

Materials and Methods

Study area and sampling.

The industrial waste incinerator in Pyongtak, a rural area in Korea, was in operation from 1988 until its closure in 2001. During operation, this facility processed an average of 0.8 tons of waste per hour.According to measurements made in 2000 and 2001, the average concentration of PCDDs/DFs in the stack samples was 10.4 ng I-TEQ/Nm^3. An additional source of PCDDs/DFs was open fire burning of the heaped industrial wastes dumped in the yard of the incineration facility. The residents complained of the smoke and potential health hazards posed by the facility.

We estimated the blood levels and homologue patterns of PCDDs/DFs of the groups of 40 residents from an area within 5km of an industrial incinerator (near-site zone, N-zone) and of 20 residents from areas 20 km away (far-site zone, F-zone) from January to July, 2003.

Analytic methods

To determine the PCDDs/DFs levels in the blood, serum was separated by a centrifuge (HA-1000-3, Han Il Co., Korea), and kept frozen at -10^oC until analysis. A modified method for the analysis of PCDDs/DFs in serum samples, which had originally been developed for the determination of 2,3,7,8-TCDD[7], was used in this study

Quantification of PCDDs/DFs was carried out by HRGC/HRMS (SIM), using VG-Autospec Ultima NT (UK) instrument equipped with fused silica capillary column SP2331 (Supelco, 60m×0.32 mm (i.d.)×0.20 film thickness).

The levels were expressed in 2,3,7,8-TCDD toxic equivalents (TEQ) using calculations of International Toxic Equivalent Factors (I-TEFs) for PCDDs/DFs. Statistical analysis was performed by Mann-Whitney U test, Kruskal-Wallis test, rank test, and $\chi 2$ test using SPSS 10.0 to test the differences of exposure status between the study subjects. The generalized linear model was used to analyze the risk factors to high blood level of PCDDs/DFs.

Results and Discussion

1. Characteristics of the groups from the N- and F-zones

We examined various factors that could affect the blood level of PCDDs/DFs, such as residents' age, Body Mass Index (BMI), sex, residential periods, occupation, income, education, and life habit about smoking, exercise and diet. We compared these variables of the two groups from the two zones and found no statistically significant difference

between the groups ($p > 0.05$).

2. Blood levels and isomer patterns of PCDDs/DFs

The average concentration of PCDDs/DFs of the group from the N-zone was 11.9 pg-TEQ/g lipid (3-26.3 pg-TEQ/g lipid), while that of the group from the F-zone was 11.2 (4.3-21.7 pg-TEQ/g lipid). The total mass concentrations of PCDDs/DFs were greater in the group from the F-zone than in the group from the N-zone ($P< 0.01$). However, there was no difference in the I-TEQ based concentrations of PCDDs/DFs between the two groups ($P >0.01$). But there were statistical differences in the levels of OCDD, 1,2,3,4,7,8-HxCDF, and 1,2,3,6,7,8-HxCDF between the N- and F-zone groups(P-value < 0.01). Especially, the ratio of PCDFs among all PCDDs/DFs was increased in the N-zone group. These increased PCDF isomer patterns may be an exposure biomarker, which suggested that the incinerator affected the blood levels of PCDDs/DFs of the residents, particularly those in the immediate vicinity of the incinerator.

Especially the group next to the industrial incinerator represented the typical isomer pattern, in which the proportions of OCDDs were lower and those of PCDFs higher than those of the other groups. Most groups of the F- zone had main congener of OCDDs profile, because the proportion of OCDDs was higher than that of the other congener.

3. Risk factors affecting the blood levels of PCDDs/DFs

A number of factors were found to have correlations with the blood levels of the N- and F-zone groups. The blood level of PCDDs/DFs increased at residents who have long residential periods and the specific type of occupation, such as farmer. We also considered the influence of specific dietary habits such as consumption of fish. The intake of fresh water fish and mudfish was positively correlated with the blood level ($P<0.05$).

Taking into account all factors using a generalized linear regression model, the high-risk population of increased blood PCDDs/DFs were those who had lived longer at the contaminated area, and those who had a dietary habit of frequently eating contaminated foods (Table 1).

Table 1. Regression analysis for risk factors affecting the blood t-PCDDs/DFs

Variables	Mean square	F	Sig.
Corrected Model	64.581	3.147	.008
BMI	20.096	.979	.335
Residential periods	395.185	19.260	.000*
Sex	2.449	.119	.734
Diet Habits	114.420	5.576	.030**
Smoking	9.669	.471	.501
Occupation	42.570	2.075	.155
Insecticide exposure	65.837	3.209	.090
Location of work places	13.932	.679	.421

* P < .01 ** P < .05

R Squared = .801 (Adjusted R Squared = .546)

According to these studies, the high fraction of some PCDFs indicates recent exposure to contamination sources, and this finding is consistent with the result of our study. Exposure to PCDDs and PCDFs near industrial incinerators may change the congener-distribution pattern in the blood of workers as compared with that of controls.

Among many contamination sources of PCDDs/DFs, it is important to find the particular foci which pose health risks to people. Proper analytic systems are needed to link the environmental exposures to the health effects. Especially, proper development of exposure biomarkers, localization of high exposure areas, continuous monitoring of dioxin levels in environmental media and humans, and surveys of demographic and risk factors in target populations will enable us to define susceptible populations more clearly. With these methods, we will be able to formulate preventive strategies to protect susceptible populations.

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