

HEALTH EFFECTS OF CHRONIC EXPOSURE TO POLYCHLORINATED DIBENZO-P-DIOXINS, DIBENZOFURANS AND COPLANAR PCB AROUND MUNICIPAL WASTE INCINERATORS

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Introduction

A national survey of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in emission gases from municipal waste incinerators in 1997 revealed that the several factories emitted excess amount of PCDD/PCDF. Watanabe et al. reported the results of 92 incinerator workers in DIOXIN'99, in which blood dioxin levels ranged from 13.4 to 805.8 pg TEQ/g lipid. It caused serious social problems among workers in the incinerators, so the Ministry of Health, Labor and Welfare started health screening for the workers in other incinerators.

Subjects and Methods

Twenty-six incinerators factories were selected according to the emitted dioxins in the smoke. Four hundred forty-one workers who had worked at the high risk workplaces and control areas in the factory were voluntarily participated in the study after giving us the written informed consent. Number of participants from each factory was about 20.

A preliminary health check-up was performed by a physician if the subjects would allow collection of 180 ml blood for dioxin and laboratory analysis in 1999 and 90 ml in 2000-2001. Height, body weight, percentage body fat and blood pressure were measured. Life habits and dietary habits were collected by the questionnaire and checked by trained dieticians. The questionnaire included dietary habits, smoking and drinking habits, residential and work environment, physical activity, past history of diseases and treatments, reproductive history, etc.

Blood was collected into a 200 ml transfusion bag containing heparin sodium solution (SH-207-Terumo, Japan). About 30 ml of blood was divided into tubes to perform peripheral blood tests, such as RBC, WBC, and platelet counts, and hematocrit, and blood chemistry studies, such as determination of AST(GOT), ALT(GPT), gamma-GTP, LDH, ALP, LAP, creatine phosphokinase, amylase, total cholesterol, HDL-cholesterol, triacylglycerol, total protein, albumin, total bilirubin, blood urea nitrogen, creatinine, uric acid, and glucose. These tests were performed by the Serum Research Laboratory (Tokyo) or in Tokyo Rosai Hospital Research Laboratory.

As immunologic markers, T lymphocytes subsets determined by surface antigens, such as CD3, CD4, CD8, and CD4/CD8 ratio, were also measured. NK activity was measured by surface antigen (CD56), and natural killer cell activity was determined against K562 cells. Stimulation by PHA and Con A was also applied.

Blood PCDD/PCDF/Co-PCB was measured by a modification of Patterson's method. Lipids were extracted from 80-100 g of whole blood with a solution of 30 ml saturated ammonium sulfate and 80 ml of ethanol:hexane (1:3) solution after the addition of an internal standard of ¹³C- labeled mixed dioxin congener solution, which contained 30 pg of ¹³C₁₂-PCDDs, ¹³C₁₂-PCDFs, and ¹³C₁₂-Co-PCBs, except OCDD (60 pg)(Cambridge Isotope Laboratories, Massachusetts, USA)). All solvents were of

dioxin analysis level. Pooled hexane layers were condensed, washed with distilled water, treated with anhydrous sodium sulfate, and evaporated to dryness, and lipid weight was measured.

Clean-up was achieved by a multilayer silica column with 44% sulfuric acid and 33% potassium hydroxide, and an activated carbon column. Analysis of PCDD/PCDF/Co-PCB was carried out by gas chromatography-high resolution mass spectrometry (GC-MS). Further details are described in the previous paper¹. Samples in 1999 were measured in our laboratory, and those in 2000-2001 were measured at the Otsuka Assay².

The exposure of the dioxins was calculated by the WHO TEF method (1997) and is expressed as TEQ/g lipid. SPSS version 10 was used for the statistical analyses. Correlation analysis was performed between PCDD/PCDF/Co-PCB and various variables. Linear regression analysis and logistic analysis were used for evaluating the effects of dioxins, if a significant correlation ($p < 0.05$) was obtained, and Odds Ratio was calculated if necessary.

Results

Characteristics of the workers:

As the number of female workers was only 10 and their dioxin exposure level was low, they were excluded from the study. Total number of participants who completed the study protocol was 412. The average age of the workers was 44 \pm 11 years old (median 47 year-old, ranging from 20 to 74). The physical characteristics of the subjects were as follows: height; 167.9 \pm 6.5; body weight, 68.1 \pm 10.6 kg, body mass index, 24.2 \pm 3.4, body fat, 22.5 \pm 5.4%; systolic blood pressure, 137 \pm 19 mmHg; and diastolic blood pressure, 83.7 \pm 12.8 mmHg, and pulse 77.9 \pm 13.8.

Blood dioxin levels:

The average concentrations of blood PCDD/PCDF/Co-PCB congeners are shown in Table 1. Congener-specific distribution is characterized by high PCDF in some factories. Blood TEQ of workers were as follows: PCDD; 9.6 \pm 6.5 pg TEQ/g lipid (median 8.2, max 54.2), PCDF; 7.8 \pm 7.9 pg TEQ/g lipid (median 6.1, max 75.0), Co-PCB; 8.0 \pm 6.0 pg TEQ/g lipid (median 6.3, max 42.1). Total TEQ was 25.5 \pm 16.8 pg TEQ/g lipid (median 21.6, max 133.0) and body burden was 5.8 \pm 4.0 ng TEQ/kg body weight (median 4.8, max 30.3). The concentration of PCDD/PCDF and Co-PCB by age showed a linear increase and significant correlation.

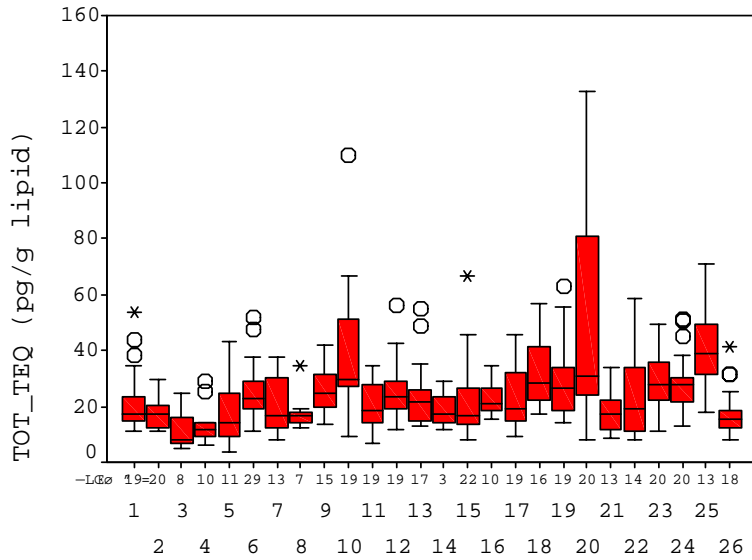
Working place and dioxin levels:

Any work in the incinerator factory did not yield specific accumulation of dioxins in the body. Working length and age was both significantly correlated to the dioxin levels, but the age factor was larger than the length of work. Use of protecting clothes, goggles, dust protecting masks and rubber boots seemed to protect from exposure.

Dioxin levels and laboratory data:

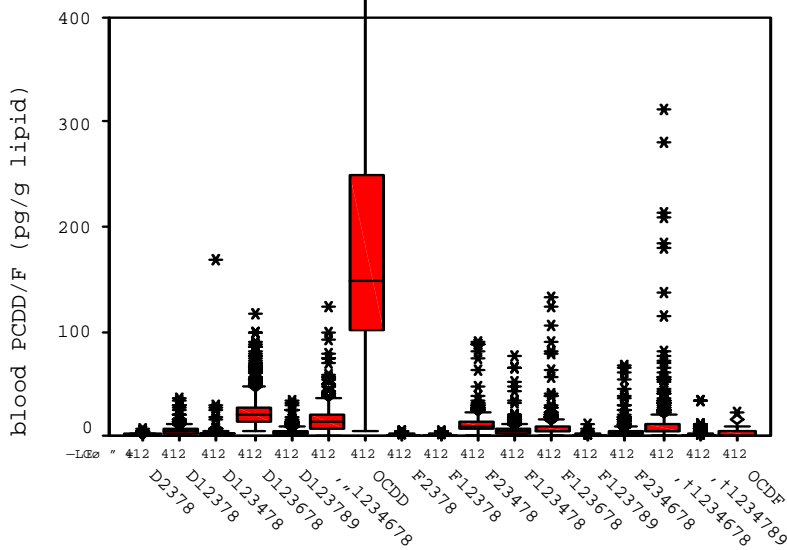
Blood PCDD/F TEQ levels positively correlated with total cholesterol and HbA1c, and PCB TEQ correlated with total protein, albumin, GOT, GPT, LAP, gamma GTP, uric acid and total cholesterol. PCDF TEQ negatively correlated with platelet number, and PCDD/F TEQ also negatively correlated with PHA response.

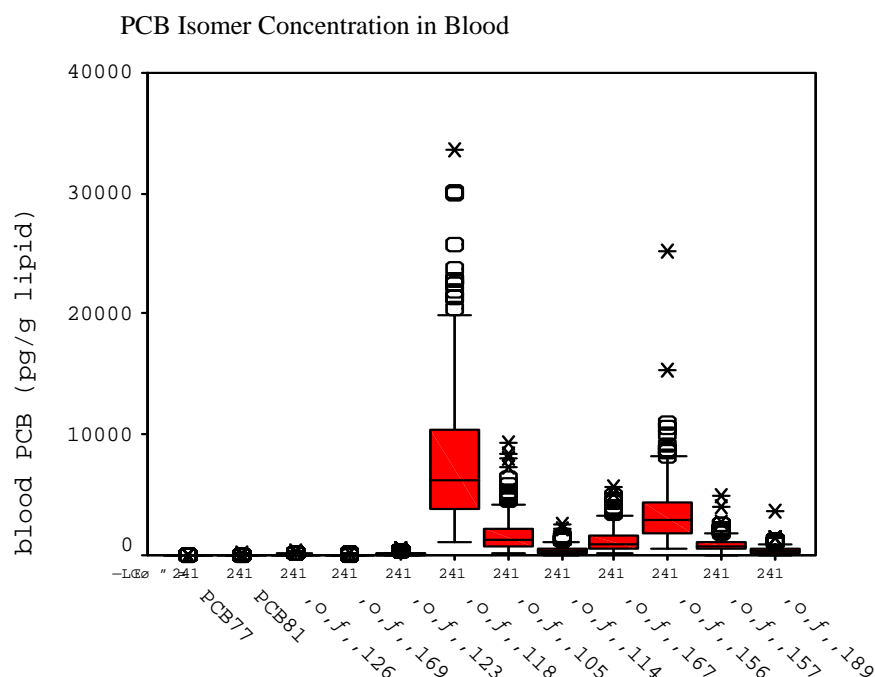
Blood total TEQ level by Factory



AREA

PCDD/F Isomer Concentration in Blood





Discussion

Workers in one municipal incinerator showed accumulation of PCDD/PCDF/Co-PCB in blood lipid, ranging from 13.4 pg TEQ/g lipid to 805.8 pg TEQ/g lipid, as reported at Dioxin1999. In the present study median value of blood dioxins was 21.6 pg TEQ/g lipid and that of calculated body burden was 4.8 ng TEQ/kg body weight. These values were similar to those of Japanese background exposure level of 21.5 pgTEQ/g lipid in average. Some workers who showed increased blood PCDF seemed to be influenced by the incinerator. In Japan, 90% of the daily intake of PCDDs, PCDFs, and other dioxin-like compounds is estimated to come from food.

In this study, several laboratory markers correlated with PCB TEQ, rather than PCDD/F TEQ. Correlation between PCDD/F TEQ and HbA1c was consistent with previous report from US Veteran Study. HbA1c and uric acid showed higher value who worked in a job with higher possibility of exposure to dioxins in the factory.

Prediction of future health effects in the subjects with low level exposure is difficult. Very long half-life of dioxins inside the body, however, may cause various effects at the lipid membrane of lipoprotein and cells. Further study on the chronically exposed people should be important.

References

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