Type 2 Diabetes Mellitus and PCB exposure in Saku Control Obesity Program

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Introduction: We have measured blood dioxin levels among the Japanese residents and heavily contaminated municipal waste incinerator workers since 1997. Cross sectional studies found significant correlations between blood dioxin exposure and past history of diabetes. The purpose of this study is to investigate associations between PCBs (including coplanar PCB and major isomers) and diabetes.
Design and Methods: Study population is based on the subjects enrolled in the Saku Control Obesity Program (SCOP). The inclusion criteria were age 40–64 years and a body mass index (BMI) more than 28.3 (the upper quintile). Blood from 117 participants was used for this study. All common PCB isomers in the blood were summarized to 11 categories.
Results and Discussion: DM was diagnosed by the treatment history and self report. Among the 117 participants, 9 were included in the DM group and 108 were defined as group without known diabetes. In addition to the coplanar PCB 118 and 156, PCB 138, 146, 153, 163-4, 170, 180, and 180-187 showed significantly higher concentrations in the DM group.

Introduction

The increasing number of patients with metabolic syndrome and resultant lifestyle-related diseases is an urgent issue in Japan, as well as many other developed countries. Many serious medical conditions have been linked to obesity, including type 2 diabetes, hypertension, hyperlipidemia, and cardiovascular diseases. Because obesity is a common basis of these diseases, controlling obesity is an important means of prevention of these diseases.

Although unhealthy diet and physical inactivity can cause or aggravate obesity, the increase in obesity over the past 30 years has been fueled by a complex interplay of environmental, social, economic, and behavioral factors, acting on a background of genetic susceptibility. Excess abdominal fat is an important and independent risk factor for diseases.

We have measured blood dioxin levels among the Japanese residents and heavily contaminated municipal waste incinerator workers since 1997. We analyzed 740 residents in both sex in 17 areas from 1998 to 2001 and 840 workers from 60 incinerators in 24 areas from 1999 to 2005 (1,2). These cross sectional studies revealed a significant correlations between blood dioxin exposure and past history of diabetes, hypertension and hyperlipidemia. The logistic regression analysis showed that sex, age, BMI, family history and coplanar PCB were significantly contributed to the prevalence of DM.

The purpose of this study is to investigate associations between diabetes and the total PCBs (not only coplanar PCB) by measuring major isomers in the blood (3).

Design and Methods

A cognitive-behavioral treatment is being employed for a randomized intervention trial in the Saku Control Obesity Program (SCOP) (4). For this study, the inclusion criteria were age 40–64 years and a body mass index (BMI) more than 28.3 (the upper quintile). 235 participants were asked to fulfill simiquantitative dietary habit and life style questionnaire including past history and family history. Physical activity energy expenditure was calculated by a uniaxial accelerometer. All participants were randomly divided into two groups: group A will receive intervention in year 1, group B will receive intervention in year 2. Whole blood samples of 2 ml from 117 participants in group A were used for this study (Table 1).

All common PCB isomers in the blood were summarized to 11 categories (Table 2). Dioxin TEF is determined only for coplanar PCB, so the direct concentration (pg/g blood) was used for analysis. For statistical analysis, SPSS version 14.0 was used. Log transformation was done to normalize PCB and other variables, if necessary. Correlation analysis was performed between blood PCB levels and various biomarkers.

Results and Discussion

The anthropometric and biochemical data of the participants were summarized in Table 1 (Table 1).

Table 1. Characteristics of SCOP Participants

	Without-DM		DM		Total	
	Mean±	SD	Mean±	SD	Mean±	SD
AGE	54.0±	6.4	56.8±	8.5	54.2±	6.6
Body weight	79.3±	9.5	81.9±	12.5	79.5±	9.8
BMI	30.3±	2.6	31.2±	3.7	30.4±	2.7
Waist	101.6±	7.3	102.5±	8.5	101.7±	7.3
Abd.fat by CT(cm^2)	134.4±	45.5	185.9±	54.5**	138.3±	48.0
SBP	132.1±	15.9	134.3±	13.2	132.3±	15.6
DBP	81.2±	13.2	78.2±	9.5	81.0±	13.0
Total cholesterol	209.1±	33.3	203.3±	28.8	208.6±	32.9
HDLcholesterol	52.4±	12.3	50.4±	8.1	52.3±	12.0
LDLcholesterol	128.4±	30.5	110.4±	22.0	127.0±	30.3
Triacyl glycerol	144.5±	78.1	212.9±	109.2*	149.8±	82.4
Uric acid	6.0±	1.4	6.3±	1.1	6.0±	1.4
Fasting Blood Sugar	105.4±	13.9	173.8±	63.2**	110.6±	28.1
HbA1c	5.6±	0.7	7.9±	2.2**	5.8±	1.1

Significant difference between Without-DM and DM; *<0.05. **<0.01 by t-test

DM was diagnosed by the treatment history and self report. Body weight was about 80 kg, and BMI was mostly more than 30. Abdominal fat area by CT was 134 and 185 cm^2 in males and females, respectively, which were beyond the central obesity criteria (>100 cm^2 for Japanese).

Blood PCB levels were shown in Table 2 (Table 2). In addition to the coplanar PCB 118 and 156, PCB138, 146, 153, 163-4, 170, 180, and 180-187 showed significantly higher concentrations in DM group.

Table 2. Blood PCB levels of SCOP participants

	Without-DM n=108		DM n=9		Total n=117	
	Mean	SD	Mean	SD	Mean	SD
PCB74	33.7±	19.6	50.9±	31.7	35.1±	21.1
PCB118	60.0±	33.0	103.7±	77.4**	63.4±	39.5
PCB99	24.2±	11.7	40.1±	33.6	25.4±	14.9
PCB138	76.5±	34.6	133.5±	108.5*	80.9±	46.4
PCB146	23.5±	11.1	41.1±	35.0**	24.8±	14.8
PCB153	164.4±	78.1	290.6±	255.4**	174.1±	106.1
PCB156	17.6±	8.3	27.0±	18.5**	18.3±	9.6
PCB163_164	38.8±	17.6	65.2±	52.5*	40.8±	22.9
PCB170	21.4±	9.8	35.1±	29.7*	22.5±	12.7
PCB180	80.1±	33.6	148.1±	116.8**	85.3±	48.1
PCB182_187	41.4±	20.4	76.7±	64.4**	44.1±	27.5
tot_PCB	581.6±	254.6	1012.0±	817.2**	614.7±	345.1

Significant difference between Without-DM and DM; *<0.05. **<0.01 by t-test after log transformation.

Recent report of Lee, et al. (5) suggested the possibility that persistent organic pollutants might contribute to cause diabetes. They analyzed serum concentrations of 6 persistent organic pollutants, as PCB153, HpCDD, OCDD, Oxychlordane, DDE, DDT and trans-Nonachlor, with fasting plasma-glucose concentrations in a random sample of general population. They showed that the prevalence of DM was more than 5 times higher in groups with higher concentrations of PCB153, oxychlordane, or trans-nonachlor than in those with lower concentrations.

In Japan, there was a peak of PCB usage in 1970s, and breast milk showed the highest dioxin concentration at that time. The babies at that time have grown older into their 30s and 40s, and the children 50s and 60s. The half life of dioxins were generally very long, some PCB has life-long half life, so the recent epidemic of diabetes in Japan would be influenced by accumulation of dioxins inside the body. Even though TEQ was equivalent, 1000 times more accumulative dose of PCB molecules inside the body should have more adverse effects than considered. Obesity could retain dioxins longer. Because the dioxin level in the environment has been improved after the Dioxin

Legislation Law in 2000, the risk of dioxins for DM would decrease in the future.

References

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