The Relationships between Dioxin Accumulation in Human Body and Eating Habits

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Introduction

Exposure of human to dioxins was dominated by food. In Japan, the tolerable daily intake (TDI) of dioxins is set at 4 pg-TEQ/kg/day [1]. However, important parameters, such as adsorption rate and half-life, which are used in the calculation process to determining the TDI of dioxins, were not intensively clarified [2]. The objective of this study is to investigate the relationship between dioxin accumulation in the human body and eating habits, in order to obtain information on the accumulation behavior of dioxins ingested by humans.

Table 1 Outline of Participants

Name	1	2	3	4	6	7	8	9	10
Sex	F	F	F	F	M	F	F	M	M
Age	67	81	80	74	61	73	65	60	65

Name	11	13	14	15	16	17	18	19	20
Sex	M	F	F	F	M	F	F	M	F
Age	72	72	58	74	60	67	64	71	69

Name	21	22	23	24	26	27	28	30	31
Sex	M	F	F	M	F	M	M	M	M
Age	80	83	72	71	86	72	82	85	87

Name	32	35	37	38	41	44	46	50	52
Sex	M	F	M	M	M	F	F	F	M
Age	87	78	82	77	59	82	89	53	29

Name	53	54	55	59	65
Sex	M	M	M	M	F
Age	80	69	85	75	86

Materials and Methods

Sample: The samples used in this study were intra-abdominal adipose tissues obtained from patients who had laparotomy operation at the Niigata Prefectural Kamo Hospital (Kamo, Japan) because of a digestive organ disease. Participants were 21 males, 29 - 87 years old, and 20 females, 53 - 89 years old (Table 1). This study was approved by the ethical committee of the Niigata University School of Medicine. We paid sufficient attention to informed consent. All of the participants agreed to the use of the samples for the study of dioxins.

Questionnaire: Each participant was requested to accomplish a questionnaire containing 30 questions concerning eating habits, and 6 questions concerning smoking, location, microwave cooking, and agricultural experience. The main 23 questions concerning eating habits shown in Table 2 were used for analysis in this report.

Table 2 Questionnaire

Question How many times a week do you take:	
1) Potato	13) Ham and Sausage
2) Fried food	14) Egg
3) Stir-fly	15) Bread with butter or margarine
4) Soy products (Tofu and Natto)	16) Dressed with mayonnaise
5) Fruits (without canned foods)	17) Milk
6) Green and Yellow vegetables	18) Cheese
7) Seaweed and Mashroom	19) Instant foods and pot noodle
8) Coffee and Black tea	20) Canned products
9) Green tea	21) Canned Beer
10) Fish	22) Canned juice
11) Shellfish	23) Tap water
12) meat	
Answer a) Not at all b) 1 3 times c) 4 7 times	

Analysis

Approximately 2 - 3 g of sample from each participant was freeze dried. After the addition of ^{13}C-labeled internal standards, each sample was Soxlet-extracted with a mixture of acetone (150 mL) and hexane (150mL) for 16 h. The percentage of lipid in the sample tissue was measured using 10 % of the extract.

The remainder of the extract (90%) was treated by sulfuric acid oxidation. Sample clean up included chromatography on silica gel, aluminum oxide 60 and active-carbon-impregnated silica gel. Identification and quantification of PCDD/DFs and Co-PCBs were performed by HRGC-HRMS. The separation of PCDD/DFs was achieved using an HP6890 instrument equipped with DB-5 columns. TEQ concentrations were calculated using TEFs for humans provided by the WHO in 1998.

Results and Discussion

The observed concentration range was 24 - 417 pg-TEQ/g-lipid, and the average value was 107 pg-TEQ/g-lipid (Fig.1). The ratio of Co-PCB to total dioxins was relatively large, the average was 60 %. The concentrations observed in this study were rather higher than those reported by the Japan Ministry of the Environment, the range of which was 17 - 87 pg-TEQ/g-lipid, the average was 46 pg-TEQ/g-lipid, and the number of samples was 21 [3].

In terms of arranging congeners according to TEQ, #126-5CB, 23478-P5CDF, 12378-P5CDD, #156-6CB, and #118-5CB were almost always ranked among the top 5.

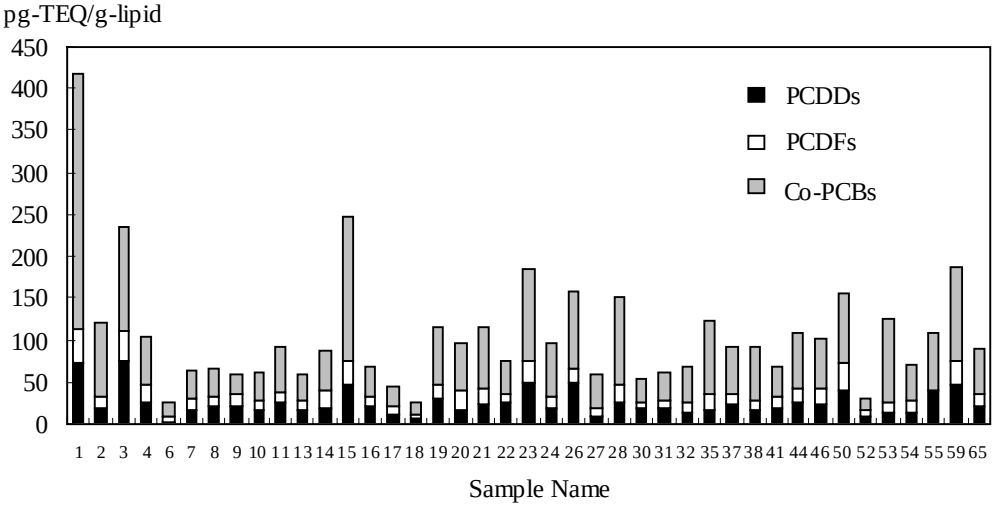

Fig. 1 Dioxin concentrations in adipose tissues for each sample.

Relationship with Age: Although the dioxins seemed to show a tendency to accumulate with age, as shown in Fig.2, there was no significant correlation between dioxin concentration and age ($p < 0.1$).

Relationship with Sex The average dioxin concentration in males is 87 pg-TEQ/g-lipid, and that in females is 128 pg-TEQ/g-lipid, which is about 1.5 times higher than that in males (Fig. 3). Since the average age of both male and female participants was the same (72 years old), the difference in average dioxin concentration was not attributable to age. Results of the t-test show that the average dioxin concentration in females is significantly higher than that in males ($p < 0.05$).

The variance of the female data was considerably larger than that of the male data. This is probably because women excrete dioxins through childbirth and breastfeeding, furthermore the number of children and the amount of mother's milk have large personal equation.

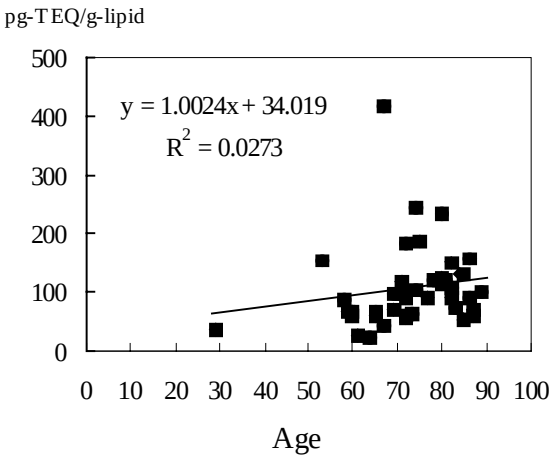

Fig.2 Relationship between age and dioxin concentration.

Relationship with Eating Habits: Using the results of the questionnaire, we divided participants into two groups on the basis of eating frequency for each food. "High Consumer" denotes a participant who eats a certain food frequently, and "Low Consumer" denotes one who eats a certain food less frequently. The average dioxin concentrations of "High Consumer" and "Low Consumer" for each food were compared.

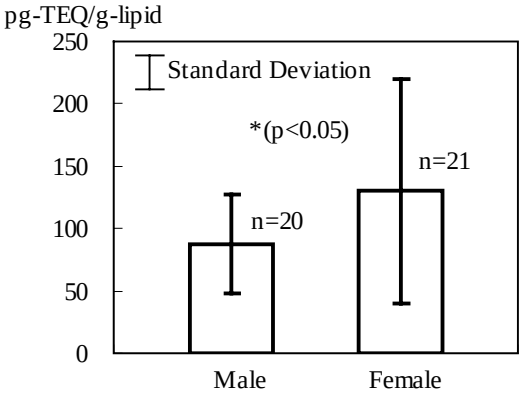

Fig.3 Comparison between dioxin concentrations in adipose tissues of Males and Females.

We calculated ratio of “high consumer” to “law consumer” in average dioxin concentration on each food, the result of which represents Beer shown the highest ratio of 1.52, followed by Milk(1.44), Green Tea(1.42), Ham and Sausage(1.31) and Fish(1.29) (the numbers in parentheses represent the ratio). The average concentration and variance for “High Consumer” and “Low Consumer” for these five food groups were shown in Fig.2. Results of the t-test show that the difference between the average concentrations of the “High Consumer” and “Low Consumer” is statistically significant in the case of Beer ($p < 0.05$), Milk $p < 0.05$, and Green Tea $p < 0.1$.

There seems to be found a common feature on these three foods, which is clear difference between the people who likes and dislikes these foods. These food can be taken habitually by some people, however, can not be taken at all by the others. That feature might cause the difference between the average dioxin concentrations of the “High Consumer” and “Low Consumer”.

For other food groups except for Beer, Milk and Green Tea, we were not able to find a significant difference between the average dioxin concentration of the “High Consumer” and the “Low Consumer”. This is probably because the consumption of the foods is moderate for most participants or the dioxin concentrations of the foods were low.

We found a difference in the concentration of dioxins in adipose tissue of the “High Consumer” and the “Low Consumer” corresponding to the foods whose cumulative intake might have a large difference due to their eating habits. The data obtained in this study will contribute to decreasing the uncertainty of important parameters concerning the dioxin behavior in the human body such as adsorption rate and half-life.

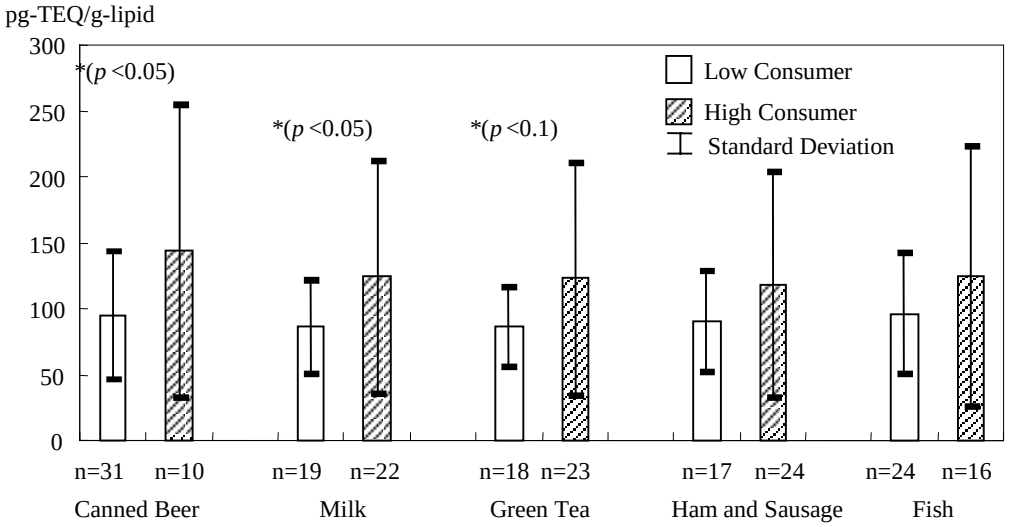

Fig.4 Comparison between dioxin concentrations in adipose tissues of "Low Consumer" and "High Consumer".

References

1. Ministry of the Environment, “Tolerable Daily Intake of Dioxins” (1999) http://www.env.go.jp/chemi/dioxin/report/TDI/all.pdf (in Japanese).
2. Harald J. Geyer, Karl-Werner Schramm, Ernst Anton Feicht, Akbar Behechti, Christian Steinberg, Rainer Brüggemann, Hermann Poiger, Bernhard Henkelmann and Antonius Kettrup, “Half-lives of tetra-, penta-, hexa-, hepta-, and octachlorodibenzo-p-dioxin in rats, monkeys, and humans—a critical review” (2002) Chemosphere 48, 631.
3. Ministry of the Environment, Investigation of the status of dioxin accumulation in the human body (1998) http://www.env.go.jp/houdou/gazou/1837/1318/384.pdf (in Japanese).