

# The Exposure to chemical compounds in the Japanese People

-Survey of the Exposure to  
chemical compounds  
in Human (2011 ~)-



2014

Environmental Risk Assessment Office  
Environmental Health Department  
Ministry of the Environment, Japan

## Introduction

Environmental Risk Assessment Office Environmental Health Department Ministry of the Environment, Japan, carried out a project entitled "Survey of the Exposure to Dioxins and other chemical compounds in Humans"(renamed to "Survey of the Exposure to chemical compounds in Human" from FY 2012), to obtain the state of accumulation and the amount of intake of dioxins and other chemical compounds, starting from FY 2011.

The OERA compiled the results of three years of survey conducted from FY 2011 to FY 2013.

## Summary of Survey of the Exposure of chemical compounds in Humans

### Objective of the survey

- To obtain the state of exposure of dioxins and other chemical compounds in Japanese people.
- To conduct a follow-up survey and observe chronological change in the levels of chemical compounds in people who had participated in surveys carried out in the past.
- To conduct a monitoring survey on POPs (Persistent Organic Pollutants) in biological samples, as required by each parties to Stockholm Convention on Persisting Organic Pollutants.

### Scope and methods of the survey

- Three areas were selected from survey regions of "Survey on the Accumulation of Dioxins and other chemical compounds (FY 2002 to FY 2010)" for this survey.
- Within each survey area, residents aged 40 ~ 59, who had lived in the area for a long period, were recruited and designated as survey subjects.
- Dioxin and other chemical compounds were measured in blood and urine of survey subjects.
- Survey on lifestyles of the subjects was conducted by questionnaire.
- Food samples were collected over a period of three days from some survey subjects. Levels of chemical compounds in food were measured and the amount of intake was calculated.

### Results of dioxins survey

- The average concentration of dioxins in the blood of 253 people was 12 pg-TEQ/g-fat, with a range of 0.40 ~ 56 pg-TEQ/g-fat. This result is similar to those reported in other surveys.
- Among 63 people who had participated in past studies (6 ~ 9 years had passed since the previous survey), dioxin levels in blood of 24 people had decreased.
- The average dioxin intake from food by 45 people was 0.56 pg-TEQ/kg body weight/day with a range of 0.035 - 2.4 pg-TEQ/kg body weight/day. No survey subjects exceeded the tolerable daily intake (TDI) of 4 pg-TEQ/kg body weight/day.

### Results of fluorine compounds survey

- The average of PFOS and PFOA in blood of 169 people was 5.5 ng/mL and 2.7 ng/mL, respectively. The range of PFOS and PFOA was 1.3 ~ 17 ng/mL and 0.27 ~ 13 ng/mL, respectively. This result is similar to those reported in other surveys.
- The average intake of PFOS and PFOA from food by 15 people was 0.57 ng/kg body weight/day and 0.69 ng/kg body weight/day, respectively. The range of intake of PFOS and PFOA was N.D. ~ 1.7 ng/kg body weight/day and N.D. ~ 2.9 ng/kg body weight/day, respectively.

### Results of heavy metals survey

- The average concentration of total mercury in blood of 253 people was 8.7 ng/mL with a range of 1.7 ~ 41 ng/mL. In addition, lead, cadmium, arsenic, copper, selenium, zinc, and manganese measurement in blood were conducted.
- The average concentration of cadmium in urine of 182 people was 0.80  $\mu\text{g/g}$  cr with a range of 0.11 ~ 3.9  $\mu\text{g/g}$  cr. In addition, measurement of arsenic speciation in urine was conducted.
- Intake of total mercury, methyl mercury, lead, cadmium, arsenic, copper, selenium, zinc, and manganese from food was measured for 45 people.

### Results of other chemical compounds ( including pesticides and plasticizers )

- Chemical compounds such as pesticides (including their metabolites) and plasticizers in urine of 182 people were measured.

### Results of POPs survey

- The concentration of POPs and candidates specified by Stockholm Convention in blood of 86 people was measured. In addition, amount of intake from food was calculated for 15 people. (Conducted only in FY 2011)

### Results of radioactive substances survey

- The concentration of radioactive substances (cesium 134, cesium 137, potassium, and iodine 131) in blood, urine, and food was measured.

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## 1. Overview of the Survey of the Exposure to chemical compounds in Human

Environmental Risk Assessment Office Environmental Health Department Ministry of the Environment, Japan, carried out a survey entitled “Survey on the Accumulation of Dioxins and other chemical compounds in Humans” from FY 2002 to FY 2010. In this survey, blood dioxin concentrations were measured in 2,264 people living in general environment in Japan. In addition, dioxin concentration in food was measured for 625 people, and the amount of intake from food was calculated (see Supplementary Information).

The “Survey of the Exposure to chemical compounds in Human” was newly-launched in FY 2011. In this survey, the survey regions were selected from that of the surveys carried out in the past. The blood and urine was sampled from the participating residents, and the accumulation of dioxins and other chemical compounds and so forth were studied.

Furthermore, a food study (duplicate portions study) was conducted for a part of the survey subjects. The chemical compound level in food was measured, and the amount of chemical compounds ingested into the body from food (intake) was estimated.

From FY 2011 to FY 2013, chemical compound concentration in blood of 253 people from 9 survey regions was measured. In addition, the chemical compound intake from food was estimated for 45 people.

### Survey of the Exposure to chemical compounds in Human

Organization responsible for the survey	Environmental Risk Assessment Office, Environmental Health Department, Ministry of the Environment, Japan
Survey period	From FY 2011
Survey regions	Three regions
Survey specimen	-Blood study (to ascertain the accumulation of chemical compounds in the body) -Urine study (to ascertain the excretion of rapidly-metabolizing compounds) -Food study (to ascertain the amount of intake of chemical compounds)
Number of subjects	253 people (FY 2011, 86 people; FY 2012, 84 people; FY 2013, 83 people) (45 people also participated in Food study)

## 2. Methods of Survey

### 2-1 Target regions and subjects

In “Survey on the Accumulation of Dioxins and other chemical compounds in Humans” conducted from FY 2002 to FY 2010, Japan was divided into five regions, and one prefecture was selected for each region for each fiscal year. In each prefecture, three areas classifiable as urban, agricultural, or fishery area were selected on a city, town or village unit.

In FY 2011 survey, three regions were selected from the survey regions of the past studies.

Study subjects were recruited from survey regions according to the criteria shown below, through local administrative authorities.

Furthermore, study subjects who satisfied the criteria below and who had participated in the past studies were recruited as well.

#### Study subject criteria

- Age : 40 – 59
- Residential period in the survey region: 10 years or more
- Infrequent leaves from the study regions for work or other reasons
- Having no problem in blood sampling owing to anemia or other reasons

## 2-2 Methods

### ● Blood study (all subjects)

Blood was sampled from survey subjects by a nurse in the presence of a physician. As a general rule, fasting blood samples were taken from the subjects.



#### Analysis item

Analysis item	FY 2011	FY 2012	FY 2013
• Chlorinated Dioxins	○	○	○
• Brominated Dioxins		○	
• Organofluorine compounds	○		○
• Heavy metals	○	○	○
• Hydroxylated PCB		○	○
• POPs	○		
• Radioactive substances		○	○
• General health checkup items, (blood count, hepatic function, renal function, glucose metabolism, etc.)	○	○	○
• Healthy influence index items (thyroidal function, allergic function, fatty acids etc.)	○	○	○

### ● Urine study (sampled from all subjects; measurement conducted for a part of the subjects)

Urine was sampled in urine receptacle, on the same day of blood sampling.



#### Analysis item

Analysis item	FY 2011	FY 2012	FY 2013
• Pesticides and other (organophosphorus pesticide metabolites, pyrethroid pesticide metabolites, etc.)	○	○	○
• Plasticizers and other (phthalate metabolites, bisphenol A)	○	○	○
• Heavy metals (cadmium, arsenic)	○	○	○
• Other chemical substances (PAH, cotinine, caffeine, etc.)		○	○
• POPs	○		
• Radioactive substances		○	○
• General health examination items (urine specific gravity, uric sugar, uric protein, etc.)	○	○	○

● Food study (a part of the subjects)

The food study was conducted by “duplicate portions study” over three days during the survey period, in which duplicates of the subjects’ meals for the three days were stored in containers and collected afterwards. Upon collection, a nutritionist checked the types and weight of the food commodities.

The three days’ portion of collected food was homogenized. Then, the chemical compounds were measured, and the intake of chemical compounds (kg body weight/day) was estimated.

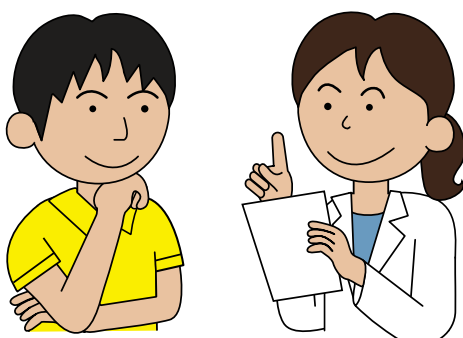


Analysis item			
Analysis item	FY 2011	FY 2012	FY 2013
• Chlorinated Dioxins	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
• Organofluorine compounds	<input type="radio"/>		
• Heavy metals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
• POPs	<input type="radio"/>		
• Radioactive substances		<input type="radio"/>	<input type="radio"/>

● Lifestyle survey (questionnaire)

The lifestyle of survey subjects were investigated through individual interviews by a health nurse or a nutritionist, based on the questionnaire sent to the subjects prior to the interview.

Analysis item
• Personal medical history, residential history, occupational history, smoking habit, dietary history, lifestyle, birth history, etc.





## 3. Results and Discussion

### 3-1 Dioxins survey

#### 3-1-1 Blood study (chlorinated dioxins)

##### ● Result summary

The blood dioxin concentrations found in this study are shown in Table 1. The average concentration of the 253 survey subjects was 12 pg-TEQ/g-fat. The range of the concentration was 0.40 ~ 56 pg-TEQ/g-fat.

□ Table 1 Statistics of blood dioxin concentration

(unit: pg-TEQ/g-fat)

	FY 2011 (n=86)	FY 2012 (n=84)	FY 2013 (n=83)	Total (n=170)
PCDDs+PCDFs +Co-PCBs				
Average	17	10	9.9	12
Standard deviation	10	6.9	6.6	8.9
Median	14	9.0	8.9	10
Range	0.83 ~ 56	0.42 ~ 40	0.40 ~ 33	0.40 ~ 56

##### ● Comparison with past survey results

Table 2 summarizes the comparison with the results of "Survey on the Accumulation of Dioxins and other chemical compounds (FY 2002 to FY 2010)", conducted on 2,264 subjects. While it is difficult to compare in a simplified manner since the average age and the number of subjects differ by surveys, the blood dioxin concentrations obtained in this survey are considered to fall generally within the range of the past surveys.

□ Table 2 Comparison with past survey results

(unit: pg-TEQ/g-fat)

Survey name	Survey on the Accumulation of Dioxins and other chemical compounds	This survey
Survey year	FY 2002 to FY 2010	FY2011 to FY2013
Subjects	People living in the general environment	People living in the general environment
The number of subject	2,264	253
Age		
Average(yeas)	44.5	50.6
Range	15 ~ 76	26 ~ 77
PCDDs+PCDFs +Co-PCBs		
Average	19	12
Standard deviation	14	8.9
Median	16	10
Range	0.10 ~ 130	0.40 ~ 56

## ● Comparison for the same subjects

Among the subjects of this survey, 63 people had participated in the past surveys. The comparison of blood dioxin results of the past surveys and this survey for these 63 people is shown in Table 3. The dioxin concentrations in blood have decreased in most of the subjects.

□ Table 3 Comparison of blood dioxin concentration in the same subjects  
(unit: pg-TEQ/g-fat)

Survey name	Past survey (n=63)	This survey (n=63)
Survey year	FY 2002 to FY2007	FY 2011 to FY 2013
PCDDs+PCDFs +Co-PCBs		
Average	23	12
Standard deviation	16	9.1
Median	18	9.9
Range	0.96 ~ 95	1.2 ~ 56

## 3-1-2 Food study (chlorinated dioxins)

### ● Result summary

Table 4 summarizes the dioxin intake from food. The average intake was 0.68 pg-TEQ/kg bw/day with a range of 0.035 ~ 2.4 pg-TEQ/kg bw/day.

In Japan, the tolerable daily intake (TDI; a value indicating the maximum intake of a given chemical substance per kg of body weight per day, below which humans may not show adverse health effects even when the chemical is ingested at this amount over a long period of time) for dioxins is 4 pg-TEQ/kg/day as stipulated by the Law Concerning Special Measures against Dioxins. No subjects exceeded this TDI value in this survey.

□ Table 4 Statistics of Dioxins intake from food

	FY 2011 (n=15)	FY 2012 (n=15)	FY 2013 (n=15)	Total (n=45)
PCDDs+PCDFs +Co-PCBs				
Average	0.65	0.72	0.32	0.56
Standard deviation	0.71	0.55	0.41	0.58
Median	0.39	0.57	0.23	0.35
Range	0.035 ~ 2.4	0.071 ~ 2.3	0.046 ~ 1.6	0.035 ~ 2.4

(unit: pg-TEQ/kg/day)

### ● Comparison with past survey results

Table 5 summarizes the comparison with the results of "Survey on the Accumulation of Dioxins and other chemical compounds (FY 2002 to FY 2010)", conducted on 625 subjects. The results of this survey are considered to fall generally within the range of the past surveys.

□ Table 5 Comparison with past survey results

(unit: pg-TEQ/kg/day)

Survey name	Survey on the Accumulation of Dioxins and other chemical compounds	This survey
Survey year	FY 2002 to FY 2010	FY 2011 to FY 2013
Subjects	People living in the general environment	People living in the general environment
The number of subject	625	45
PCDDs+PCDFs +Co-PCBs		
Average	0.82	0.56
Standard deviation	0.86	0.58
Median	0.56	0.35
Range	0.031 ~ 6.2	0.035 ~ 2.4

### 3-1-3 Blood study (brominated dioxins)

#### ● Result summary

The result of brominated dioxins concentrations in blood for FY 2012 survey is shown in Table 6. The brominated dioxins concentrations in blood of 84 subjects were all N.D. (below determination limit).

□ Table 6 Statistics of brominated dioxins in blood

(unit: pg/g-fat)

	FY 2012 (n=84)
PBDDs+PBDFs	
Average	All N.D.
Standard deviation	
Median	
Range	

## 3-2 Fluorine compounds survey

### 3-2-1 Blood study

#### ● Result summary

The result of fluorine compound concentrations in blood is shown in Table 7.

□ Table 7 Statistics of blood fluorine compound concentration

(unit: ng/mL)

	FY 2011 (n=86)	FY 2013 (n=83)	Total
PFOS			
Average	5.8	5.1	5.5
Standard deviation	3.1	2.9	3.1
Median	4.8	4.5	4.7
Range	1.5 ~ 17	1.3 ~ 16	1.3 ~ 17
PFOA			
Average	2.2	3.2	2.7
Standard deviation	1.4	2.4	2.0
Median	1.8	2.5	2.0
Range	0.66 ~ 9.6	0.27 ~ 13	0.27 ~ 13
PFHxA			
Median	—	All N.D.	All N.D.
Range	—		
PFHpA			
Median	—	N.D.	N.D.
Range	—	N.D. ~ 1.2	N.D. ~ 1.2
PFHxS			
Median	—	0.54	0.54
Range	—	N.D. ~ 1.8	N.D. ~ 1.8
PFTeDA			
Median	—	N.D.	N.D.
Range	—	N.D. ~ 0.33	N.D. ~ 0.33
PFNA			
Median	—	2.0	2.0
Range	—	0.60 ~ 7.7	0.60 ~ 7.7
PFDA			
Median	—	0.58	0.58
Range	—	0.23 ~ 2.0	0.23 ~ 2.0
PFUdA			
Median	—	1.4	1.4
Range	—	0.30 ~ 4.6	0.30 ~ 4.6
PFDS			
Median	—	N.D.	N.D.
Range	—	N.D. ~ 0.065	N.D. ~ 0.065
PFDoA			
Median	—	0.18	0.18
Range	—	N.D. ~ 0.66	N.D. ~ 0.66
PFTrDA			
Median	—	0.38	0.38
Range	—	N.D. ~ 1.3	N.D. ~ 1.3

## ● Comparison with past survey results

The comparison with the results of “Survey on the Accumulation of Dioxins and other chemical compounds in Humans” conducted from FY 2008 to FY 2010 for 609 subjects is shown in Table 8. While it is difficult to compare in a simplified manner since the average age and the number of subjects differ by surveys, the blood dioxin concentrations obtained in this survey are considered to fall generally within the range of the past surveys.

□ Table 8 Comparison with past survey results

(unit: ng/mL)

Survey name	Survey on the Accumulation of Dioxins and other chemical compounds	This survey
Survey year	FY 2008 to FY 2010	FY 2011, 2013
Subjects	People living in the general environment	People living in the general environment
The number of subject	609	169
PFOS		
Average	7.8	5.5
Standard deviation	9.2	3.1
Median	5.8	4.7
Range	0.73 ~ 150	1.3 ~ 17
PFOA		
Average	3.0	2.7
Standard deviation	2.9	2.0
Median	2.1	2.0
Range	0.37 ~ 25	0.27 ~ 13

### 3-2-2 Food study

The intake of fluorine compounds from food for the 15 subjects is shown in Table 9. The average was 0.57 ng/kg body weight/day with a range of N.D. ~ 1.7 ng/kg body weight/day for PFOS. Tolerable daily intake (TDI) is not established for fluorine compounds in Japan.

□ Table 9 Statistics of fluorine compounds intake from food

(unit: ng/kg/day)

	FY 2011 (n=15)
PFOS	
Average	0.57
Standard deviation	0.51
Median	0.53
Range	N.D. ~ 1.7
PFOA	
Average	0.69
Standard deviation	0.70
Median	0.62
Range	N.D. ~ 2.9

## 3-3 Heavy metals survey

### 3-3-1 Blood study

#### ● Result summary

Heavy metals such as total mercury, lead, cadmium, arsenic, copper, selenium, zinc, and manganese concentration in blood were studied. The blood heavy metals concentration is shown in Table 10.

□ Table 10 Statistics of blood heavy metal concentration

(unit: ng/mL)

Heavy metals	FY 2011 (n=86)	FY 2012 (n=84)	FY 2013 (n=83)	Total
Total mercury				
Median	9.1	9.0	7.3	8.7
Range	2.4 ~ 29	1.7 ~ 41	2.1 ~ 33	1.7 ~ 41
Lead				
Median	—	12	10	11
Range	—	5.0 ~ 28	4.8 ~ 31	4.8 ~ 31
Cadmium				
Median	—	1.1	1.1	1.1
Range	—	0.25 ~ 3.5	0.40 ~ 2.7	0.25 ~ 3.5
Arsenic				
Median	—	5.2	4.1	4.5
Range	—	1.4 ~ 35	1.2 ~ 19	1.2 ~ 35
Copper				
Median	—	800	870	830
Range	—	590 ~ 1100	640 ~ 1400	590 ~ 1400
Selenium				
Median	—	180	180	180
Range	—	110 ~ 480	130 ~ 390	110 ~ 480
Zinc				
Median	—	6300	6500	6400
Range	—	4700 ~ 7800	4700 ~ 7800	4700 ~ 7800
Manganese				
Median	—	—	13	13
Range	—	—	7.4 ~ 25	7.4 ~ 25

## 3-3-2 Urine study

## ● Result summary

In this survey, cadmium and arsenic speciation (As (V), As (III), monomethylarsonic acid, dimethylarsinic acid, and arsenobetaine) in urine were measured. The results are shown in Table 11.

□ Table 11 Statistics of urine heavy metal concentration

(unit:  $\mu\text{g/g cr}$ )

Heavy metals		Statistics	FY 2011 (n=15)	FY 2012 (n=84)	FY 2013 (n=83)	Total (n=182)
Cadmium		Median	0.97	0.89	0.64	0.80
		Range	0.25 ~ 3.9	0.20 ~ 3.1	0.11 ~ 3.1	0.11 ~ 3.9
Arsenic	As(V)	Median	0.30	N.D.	N.D.	N.D.
		Range	N.D. ~ 2.5	N.D. ~ 2.9	N.D. ~ 2.2	N.D. ~ 2.9
	As( III )	Median	1.5	1.7	1.5	1.6
		Range	N.D. ~ 6.2	N.D. ~ 6.6	N.D. ~ 6.9	N.D. ~ 6.9
	MMA (monomethylarsonic acid)	Median	2.0	2.1	2.1	2.1
		Range	0.89 ~ 5.1	0.38 ~ 8.5	N.D. ~ 13	N.D. ~ 13
	DMA (dimethylarsinic acid)	Median	42	33	30	32
		Range	12 ~ 170	6.7 ~ 110	8.5 ~ 100	6.7 ~ 170
	AB (arsenobetaine)	Median	73	40	31	36
		Range	15 ~ 300	2.8 ~ 640	2.1 ~ 390	2.1 ~ 640

### 3-3-3 Food study

#### ● Result summary

Heavy metals such as total mercury, methyl mercury, lead, cadmium, arsenic, copper, selenium, zinc, and manganese in food were measured (arsenic, copper, selenium, and zinc were studied starting from FY 2012). The results are shown in Table 12.

Among the heavy metals studied, Tolerable Daily Intake (TDI) is established for methyl mercury (0.29  $\mu\text{g}/\text{kg}$  body weight/day) and cadmium (7  $\mu\text{g}/\text{kg}$  body weight/week) in Japan. In this survey, no subject exceeded the TDI.

□ Table 12 Statistics of heavy metal intake from food

(unit :  $\mu\text{g}/\text{kg}/\text{day}$ )

Heavy metals	FY 2011 (n=15)	FY 2012 (n=15)	FY 2013 (n=15)	Total
Total mercury				
Median	0.063	0.079	0.039	0.062
Range	N.D. ~ 0.16	0.025 ~ 0.30	0.013 ~ 0.16	N.D. ~ 0.30
Methyl mercury				
Median	0.063	0.078	0.034	0.059
Range	N.D. ~ 0.14	0.022 ~ 0.29	N.D. ~ 0.15	N.D. ~ 0.29
Lead				
Median	0.094	0.11	0.083	0.093
Range	0.024 ~ 0.17	0.031 ~ 0.28	0.036 ~ 0.22	0.024 ~ 0.28
Cadmium				
Median	0.24	0.25	0.23	0.24
Range	0.059 ~ 0.39	0.11 ~ 0.57	0.11 ~ 0.56	0.059 ~ 0.57
Arsenic				
Median	—	2.8	1.8	2.4
Range	—	1.0 ~ 14	0.76 ~ 5.8	0.76 ~ 14
Copper				
Median	—	16	19	18
Range	—	8.2 ~ 26	12 ~ 23	8.2 ~ 26
Selenium				
Median	—	1.3	1.2	1.3
Range	—	0.90 ~ 1.8	0.64 ~ 2.5	0.64 ~ 2.5
Zinc				
Median	—	140	130	140
Range	—	80 ~ 170	99 ~ 190	80 ~ 190
Manganese				
Median	—	—	66	66
Range	—	—	38 ~ 110	38 ~ 110



## 3-4 Other chemical compounds ( including pesticides and plasticizers )

### 3-4-1 Blood study

The results of hydroxylated PCB concentrations in blood are shown in Table 13-1.

□ Table 13-1 Statistics of blood hydroxylated PCB concentration

Chemical compounds		Statistics	FY 2012 (n=15)	FY 2013 (n=15)	Total (n=30)
Hydroxylated PCB	5Cl-HO-PCBs	Median	24	21	24
		Range	1.2 ~ 69	7.6 ~ 120	1.2 ~ 120
	6Cl-HO-PCBs	Median	27	30	30
		Range	1.6 ~ 120	12 ~ 200	1.6 ~ 200
	7Cl-HO-PCBs	Median	23	22	23
		Range	4.0 ~ 94	9.0 ~ 130	4.0 ~ 130

(unit : pg/g)

### 3-4-2 Urine study

Pesticides (including metabolites), plasticizers, and others in urine were studied. The results are shown in Tables 14-1 and 14-2.

□ Table 14-1 Statistics of pesticide, plasticizer, and others in urine (1)

Classification	Chemical compounds		Statistics	FY 2011 (n=15)	FY 2012 (* )	FY 2013 (* )	Total
Pesticides	Organophosphorous pesticide metabolites	DMP	Median	5.6	2.4	3.3	3.3
			Range	1.8 ~ 14	0.60 ~ 11	N.D. ~ 140	N.D. ~ 140
		DEP	Median	5.8	5.6	2.1	4.0
			Range	N.D. ~ 32	N.D. ~ 520	N.D. ~ 14	N.D. ~ 520
		DMTP	Median	12	7.7	3.5	7.3
			Range	N.D. ~ 62	N.D. ~ 82	N.D. ~ 110	N.D. ~ 110
	DETP	Median	N.D.	N.D.	N.D.	N.D.	
		Range	N.D. ~ 2.7	N.D. ~ 8.3	N.D. ~ 4.6	N.D. ~ 8.3	
	Pyrethroid pesticide metabolites	PBA	Median	0.22	0.22	N.D.	0.19
			Range	N.D. ~ 3.4	N.D. ~ 1.6	N.D. ~ 3.3	N.D. ~ 3.4
		DCCA	Median	N.D.	N.D.	All N.D.	N.D.
	Range	N.D. ~ 13	N.D. ~ 3.1		N.D. ~ 13		
	Carbamate pesticide metabolite	Ethylenethiourea	Median	N.D.	N.D.	All N.D.	N.D.
	Range	N.D. ~ 0.23	N.D. ~ 0.50		N.D. ~ 0.50		
	Imidachloprid metabolite	6-Chloronicotinic acid	Median	—	N.D.	All N.D.	N.D.
	Range	—	N.D. ~ 1.8		N.D. ~ 1.8		
	Fenitrothion metabolite	3-methyl-4- nitrophenol	Median	—	N.D.	0.30	N.D.
	Range	—	N.D. ~ 2.8	N.D. ~ 2.7		N.D. ~ 2.8	
	p-nitrophenol		Median	—	0.67	0.97	0.73
			Range	—	0.23 ~ 4.6	0.49 ~ 2.4	0.23 ~ 4.6
Acephate		Median	—	N.D.	N.D.	N.D.	
		Range	—	N.D. ~ 0.30	N.D. ~ 1.9	N.D. ~ 1.9	
Methamidophos		Median	—	N.D.	All N.D.	N.D.	
		Range	—	N.D. ~ 0.058		N.D. ~ 0.058	

(unit :  $\mu\text{g/g cr}$ )

Classification	Chemical compound		Statistics	FY 2011 (n=15)	FY 2012 (*)	FY 2013 (*)	Total
Plasticizers	Phthalate metabolites	MBP	Median	20	17	20	19
			Range	11 ~ 670	6.6 ~ 54	5.5 ~ 5200	5.5 ~ 5200
		MEHP	Median	4.2	2.9	3.2	3.2
			Range	0.98 ~ 8.1	0.61 ~ 21	0.54 ~ 22	0.54 ~ 22
		MEHHP	Median	15	9.9	11	11
			Range	5.7 ~ 44	2.7 ~ 59	2.8 ~ 58	2.7 ~ 59
		MEOHP	Median	9.6	6.3	7.1	6.8
			Range	4.6 ~ 18	1.6 ~ 31	1.1 ~ 35	1.1 ~ 35
		MBzP	Median	0.59	0.68	0.60	0.61
			Range	0.25 ~ 10	N.D. ~ 38	N.D. ~ 7.0	N.D. ~ 38

\* In FY 2012, the number of subjects was 84 for phthalate metabolites and 30 for other chemical compounds.

\* In FY 2013, the number of subjects was 83 for phthalate metabolites, 30 for organophosphorous pesticide metabolites, pyrethroid pesticide metabolites and carbamate pesticide metabolite, and 15 for other chemical compounds.

□ Table 14-2 Statistics of pesticide, plasticizer, and others in urine (2)

(unit :  $\mu\text{g/g cr}$ )

Classification	Chemical compound		Statistics	FY 2011 (n=15)	FY 2012 (*)	FY 2013 (*)	Total
Others	Iodine		Median	—	310	290	300
			Range	—	110 ~ 3,000	75 ~ 9,100	75 ~ 9,100
	Perchloric acid		Median	—	3.5	4.7	4.0
			Range	—	1.2 ~ 10	N.D. ~ 67	N.D. ~ 67
	Triclosan		Median	1.3	1.3	1.1	1.2
			Range	0.27 ~ 79	0.15 ~ 120	0.15 ~ 380	0.15 ~ 380
	Bisphenol A		Median	0.76	0.44	0.26	0.37
			Range	0.23 ~ 1.4	N.D. ~ 31	N.D. ~ 8.2	N.D. ~ 31
	Deet		Median	—	All N.D.	All N.D.	All N.D.
			Range	—			
	PAH metabolites	1-Hydroxypyrene	Median	—	0.19	0.071	0.15
			Range	—	0.045 ~ 0.76	N.D. ~ 0.54	N.D. ~ 0.76
		1&9-Hydroxyphenanthrene	Median	—	0.15	0.085	0.12
			Range	—	0.038 ~ 0.60	0.029 ~ 0.21	0.029 ~ 0.60
		2-Hydroxyphenanthrene	Median	—	0.14	0.066	0.11
			Range	—	0.031 ~ 0.39	N.D. ~ 0.19	N.D. ~ 0.39
		3-Hydroxyphenanthrene	Median	—	0.24	0.079	0.20
			Range	—	0.077 ~ 0.65	N.D. ~ 0.37	N.D. ~ 0.65
		4-Hydroxyphenanthrene	Median	—	N.D.	N.D.	N.D.
			Range	—	N.D. ~ 0.20	N.D. ~ 0.043	N.D. ~ 0.20

Classification	Chemical compounds		Statistics	FY 2011 (n=15)	FY 2012 (*)	FY 2013 (*)	Total
Others	Parabens	Methylparaben	Median	—	55	95	55
			Range	—	1.3 ~ 870	1.4 ~ 2,500	1.3 ~ 2,500
		Ethylparaben	Median	—	2.5	3.4	2.7
			Range	—	N.D. ~ 120	N.D. ~ 410	N.D. ~ 410
		Propylparaben	Median	—	1.0	2.0	1.2
			Range	—	N.D. ~ 71	N.D. ~ 77	N.D. ~ 77
		Butylparaben	Median	—	N.D.	N.D.	N.D.
			Range	—	N.D. ~ 25	N.D. ~ 64	N.D. ~ 64
		Benzylparaben	Median	—	All N.D.	All N.D.	All N.D.
			Range	—			
	Benzophenone-3	Median	—	N.D.	N.D.	N.D.	
		Range	—	N.D. ~ 120	N.D. ~ 190	N.D. ~ 190	
	Cotinine	Median	—	0.92	N.D.	0.36	
		Range	—	0.060 ~ 1,600	N.D. ~ 2.0	N.D. ~ 1,600	
	Caffeine	Median	—	1,100	3,200	2,000	
		Range	—	0.36 ~ 9,100	100 ~ 22,000	0.36 ~ 22,000	
	Phytoestrogens	Genistein	Median	—	1,700	880	1,300
			Range	—	360 ~ 5,700	190 ~ 3,800	190 ~ 5,700
		Daidzein	Median	—	2,700	1,600	1,800
			Range	—	240 ~ 7,800	97 ~ 19,000	97 ~ 19,000
Equol		Median	—	690	170	370	
		Range	—	6.1 ~ 28,000	N.D. ~ 11,000	N.D. ~ 28,000	

\* In FY 2012, the number of subjects was 84 for bisphenol A and 30 for other chemical compounds.

\* In FY 2013, the number of subjects was 83 for bisphenol A ,30 for triclosan and 15 for other chemical compounds.

## 3-5 POPs survey

### 3-5-1 Blood and food study

The results of POPs concentrations in blood and POPs intake from food in FY 2011 survey are shown in Tables 15-1 and 15-2.

□ Table 15-1 Statistics of blood POPs concentration and POPs intake from food (1)

Chemical compounds		Statistics	Blood concentration FY 2011(n=86)	Intake from food FY 2011(n=15)
		Unt	pg/g-fat	pg/kg/day
PCB	MoCBs	Median	N.D.	7.4
		Range	N.D. ~ 430	3.0 ~ 89
	DiCBs	Median	100	200
		Range	N.D. ~ 800	100 ~ 620
	TrCBs	Median	920	400
		Range	210 ~ 3700	180 ~ 1400
	TeCBs	Median	6400	750
		Range	650 ~ 33000	230 ~ 4100
	PeCBs	Median	18000	930
		Range	1900 ~ 140000	130 ~ 8200
	HxCBs	Median	87000	980
		Range	12000 ~ 670000	100 ~ 14000
HpCBs	Median	62000	420	
	Range	10000 ~ 520000	37 ~ 7500	
OcCBs	Median	13000	71	
	Range	2600 ~ 110000	4.1 ~ 1100	
NoCBs	Median	1300	11	
	Range	370 ~ 6600	1.1 ~ 91	
DeCB	Median	630	6.0	
	Range	220 ~ 2500	0.74 ~ 50	
Total PCB	Median	190000	5100	
	Range	31000 ~ 1400000	820 ~ 35000	
DDT	o,p'-DDD	Median	N.D.	39
		Range	N.D. ~ 500	4.1 ~ 550
	p,p'-DDD	Median	730	380
		Range	N.D. ~ 5000	19 ~ 4900
	o,p'-DDE	Median	200	27
		Range	N.D. ~ 1100	4.8 ~ 210
p,p'-DDE	Median	120000	1600	
	Range	17000 ~ 1000000	240 ~ 8200	
o,p'-DDT	Median	600	66	
	Range	N.D. ~ 4500	8.5 ~ 1400	
p,p'-DDT	Median	6100	300	
	Range	1100 ~ 29000	28 ~ 7600	
Chlordane	<i>cis</i> -Chlordane	Median	100	490
		Range	N.D. ~ 800	63 ~ 1400
	<i>trans</i> -Chlordane	Median	N.D.	170
		Range	N.D. ~ 400	41 ~ 800
	Oxychlordane	Median	10000	95
Range	1600 ~ 43000	22 ~ 340		
<i>cis</i> -Nonachlor	Median	3700	130	
Range	600 ~ 29000	10 ~ 950		
<i>trans</i> -Nonachlor	Median	23000	440	
	Range	3000 ~ 110000	59 ~ 2100	
Drins	Aldrin	Median	All N.D.	N.D.
		Range	All N.D.	N.D. ~ 5.2
	Dieldrin	Median	3200	510
Range		1300 ~ 40000	71 ~ 1800	
Endrin	Median	All N.D.	69	
	Range	All N.D.	N.D. ~ 200	
Hexachlorobenzene (HCB)		Median	14000	630
		Range	3400 ~ 39000	160 ~ 2100

□ Table 15-2 Statistics of blood POPs concentration and POPs intake from food (2)

Chemical compounds		Statistics	Blood concentration FY 2011(n=86)	Intake from food FY 2011(n=15)
		Unt	pg/g-fat	pg/kg/day
Hptachlor	Heptachlor	Median Range	All N.D.	13 4.5 ~ 47
	<i>cis</i> -Heptachlor epoxide	Median Range	1800 600 ~ 6500	110 63 ~ 430
	<i>trans</i> -Heptachlor epoxide	Median Range	All N.D.	All N.D.
Toxaphene	parlar-26	Median Range	790 N.D. ~ 3500	52 N.D. ~ 340
	parlar-50	Median Range	1100 N.D. ~ 4300	98 1.5 ~ 550
	parlar-62	Median Range	0 N.D. ~ 3400	73 N.D. ~ 430
Mirex		Median Range	1800 400 ~ 6600	14 2.2 ~ 190
PBDE	TeBDEs	Median Range	520 180 ~ 1100	290 160 ~ 1500
	PeBDEs	Median Range	210 N.D. ~ 870	150 63 ~ 710
	HxBDEs	Median Range	800 N.D. ~ 2600	36 8.9 ~ 510
	HpBDEs	Median Range	All N.D.	N.D. N.D. ~ 40
	OcBDEs	Median Range	300 N.D. ~ 3400	25 N.D. ~ 110
	NoBDEs	Median Range	N.D. N.D. ~ 2000	36 N.D. ~ 120
	DeBDEs	Median Range	700 N.D. ~ 5100	230 72 ~ 980
	Total PBDEs	Median Range	2600 500 ~ 8600	780 530 ~ 3000
Pentachlorobenzene		Median Range	300 40 ~ 1500	63 31 ~ 220
HCH	$\alpha$ -HCH	Median Range	120 N.D. ~ 1200	160 64 ~ 1000
	$\beta$ -HCH	Median Range	27000 2800 ~ 240000	250 48 ~ 2000
	$\gamma$ -HCH	Median Range	N.D. N.D. ~ 1000	47 23 ~ 430
	$\delta$ -HCH	Median Range	All N.D.	14 3.7 ~ 29
Chlordecone		Median Range	N.D. N.D. ~ 1.0	All N.D.
Hexabromobiphenyl		Median Range	N.D. N.D. ~ 700	N.D. N.D. ~ 6.3
Endosulfan	$\alpha$ -Endosulfan	Median Range	1300 N.D. ~ 3700	570 390 ~ 1300
	$\beta$ -Endosulfan	Median Range	N.D. N.D. ~ 1200	280 130 ~ 810
HBCD	$\alpha$ -HBCD	Median Range	N.D. N.D. ~ 10	N.D. N.D. ~ 9.0
	$\beta$ -HBCD	Median Range	All N.D.	All N.D.
	$\gamma$ -HBCD	Median Range	N.D. N.D. ~ 3.4	All N.D.
	$\delta$ -HBCD	Median Range	All N.D.	All N.D.
	$\epsilon$ -HBCD	Median Range	All N.D.	All N.D.

## 3-6 Radioactive substances survey

### 3-6-1 Blood, urine, and food study

The results of radioactive substances concentrations for FY 2013 survey are shown in Table 16.

□ Table 16 Statistics of radioactive substances concentrations

(unit : Bq/kg)

Classification	Chemical compounds	Statistics	Blood concentration FY 2013(n=83)	Urine concentration FY 2013(n=83)	Diet concentration FY 2013(n=15)
Cesium	Cesium134	Average	All N.D.	All N.D.	All N.D.
		Standard deviation			
		Median			
		Range			
	Cesium137	Average	All N.D.	All N.D.	All N.D.
		Standard deviation			
		Median			
		Range			
Iodine	Iodine131	Average	All N.D.	All N.D.	All N.D.
		Standard deviation			
		Median			
		Range			
Potassium	Potassium40	Average	53	34	23
		Standard deviation	9.0	18	11
		Median	53	32	19
		Range	37 ~ 72	N.D. ~ 82	10 ~ 40

## Committee Members for the Survey of the Exposure to chemical compounds in Human

Arisawa, Kokichi	Professor, Social and Environmental Medicine Division, Institute of Health Biosciences, University of Tokushima Graduate School
Kadokami, Kiwao	Professor, University of Kitakyushu Graduate School
Kayama, Fujio	Professor, Division of Environmental Medicine, Center for Community Medicine, Jichi Medical University
Shibata, Yasuyuki	Senior Principal Researcher, Environmental Measurement Research Center, National Institute for Environmental Studies
Shima, Masayuki	Professor, Department of Public Health, Hyogo College of Medicine
Suzuki, Takaichiro	Former President, Kansai Medical Technical College
Suzuki, Noriyuki	Leader, Risk Management Strategies Research Section, Research Center for Environmental Risk, National Institute for Environmental Studies
Tohyama, Chiharu	Professor, Health and Environmental Sciences Division, Center for Disease Biology and Integrative Medicine, Graduate School of Medicine, University of Tokyo
Nagai, Masaki	Professor, Department of Public Health, Saitama Medical University
Fukushima, Tetsuhito	Professor, Department of Hygiene & Preventive Medicine, Fukushima Medical University
Miyata, Hideaki	Professor emeritus, Setsunan University
Yoshinaga, Jun	Associate Professor, Graduate School of Frontier Sciences, University of Tokyo

## Supplementary Information

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## Overview of the Survey on the Accumulation of Dioxins and other chemical compounds in Humans (FY2002 ~ FY2010)

### (1) Nationwide survey

#### ● Blood dioxin concentrations

□ Table 17 Blood dioxin concentrations by fiscal year

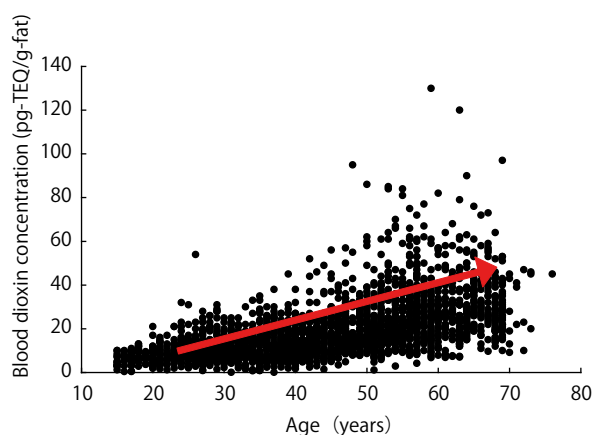
(unit: pg-TEQ/g-fat)

Survey year	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Nine-year average
Subjects (N)	259	272	264	288	291	282	257	178	175	Total:2,264
Age (years)										
Average	44.4	41.7	45.2	44.3	43.0	44.2	47.6	46.3	44.4	44.5
Range	16~72	15~69	15~70	15~70	15~72	15~69	17~70	18~76	16~70	15~76
PCDDs+PCDFs Co-PCBs										
Average	22	19	19	22	17	20	21	17	14	19
Standard deviation	14	12	13	15	12	15	15	12	13	14
Median	19	17	16	17	14	16	17	14	11	16
Range	0.96~95	2.7~97	0.64~85	1.5~75	0.82~67	1.6~120	0.43~130	1.1~59	0.10~82	0.10~130

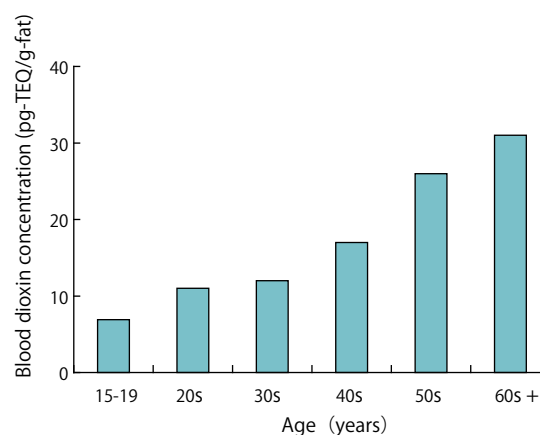
(According to WHO 2006 TEFs)

#### ● Relationship to age

□ Figure 1 Relationship between age and blood dioxin concentrations



□ Figure 2 Blood dioxin concentrations by age group



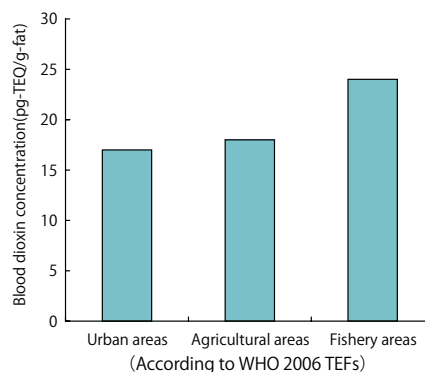
(According to WHO 2006 TEFs)

## ● Differences in blood dioxin concentrations by area

□ Table 18 Blood dioxin concentrations by types of survey area

	Urban areas	Agricultural areas	Fishery areas
Subjects (N)	938	675	651
Average age (years)	43.5	45.4	44.8
Blood dioxin concentration (pg-TEQ/g-fat)			
Average	17	18	24
Standard deviation	11	12	17
Median	15	15	19
Range	0.11~77	0.10~97	0.43~130

(According to WHO 2006 TEFs)

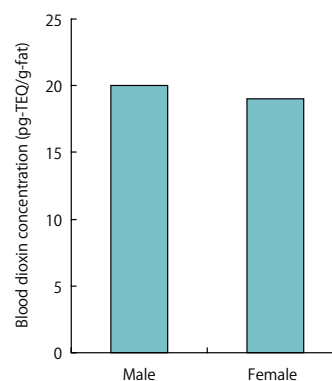


## ● Difference in blood dioxin concentrations by gender

□ Table 19 Blood dioxin concentrations by gender

	Male	Female
Subjects (N)	1,063	1,201
Average age (years)	43.5	45.3
Blood dioxin concentration (pg-TEQ/g-fat)		
Average	20	19
Standard deviation	15	13
Median	16	16
Range	0.64~130	0.10~95

(According to WHO 2006 TEFs)



## ● Dioxin intake from food

□ Table 20 Dioxin intake from food by fiscal year

Study year	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Nine-year average
Subjects (N)	75	75	75	75	75	75	75	50	50	Total: 625
Dioxin intake from food (pg-TEQ/kg/day)										
Average	1.1	1.1	0.89	0.89	0.57	0.75	0.68	0.79	0.44	0.82
Standard deviation	1.1	0.92	0.66	0.89	0.44	0.90	0.75	1.2	0.42	0.86
Median	0.75	0.91	0.68	0.59	0.41	0.46	0.39	0.43	0.34	0.56
Range	0.058~5.6	0.14~5.6	0.16~3.7	0.13~5.2	0.099~2.2	0.060~6.2	0.054~4.8	0.055~6.2	0.031~2.0	0.031~6.2

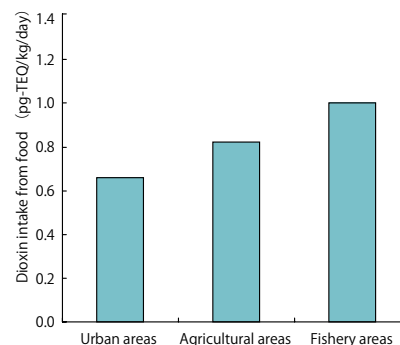
(According to WHO 2006 TEFs)

● Differences in dioxin intake from food by area

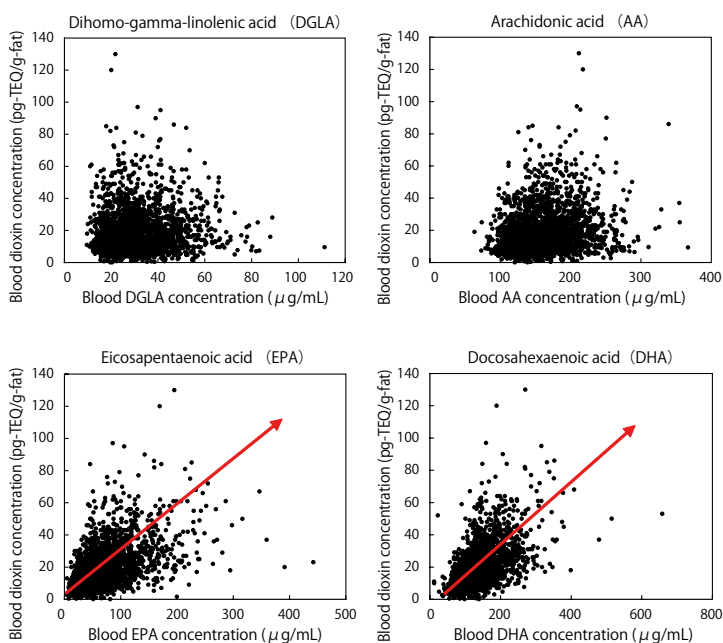
□ Table 21 Dioxin intake from food by area

	Urban areas	Agricultural areas	Fishery areas
Subjects (N)	229	201	195
Dioxin intake from food (pg-TEQ/kg/day)			
Average	0.66	0.82	1.0
Standard deviation	0.65	0.86	1.0
Median	0.46	0.53	0.71
Range	0.031~6.2	0.080~5.6	0.054~6.2

(According to WHO 2006 TEFs)

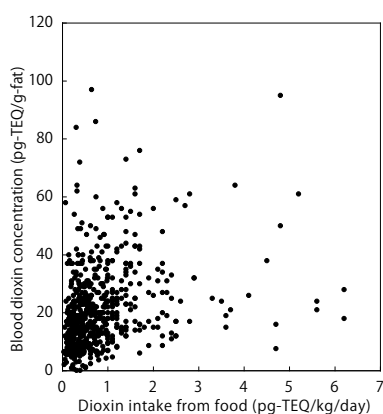


□ Figure 3 Relationship between fatty acids and blood dioxin concentrations



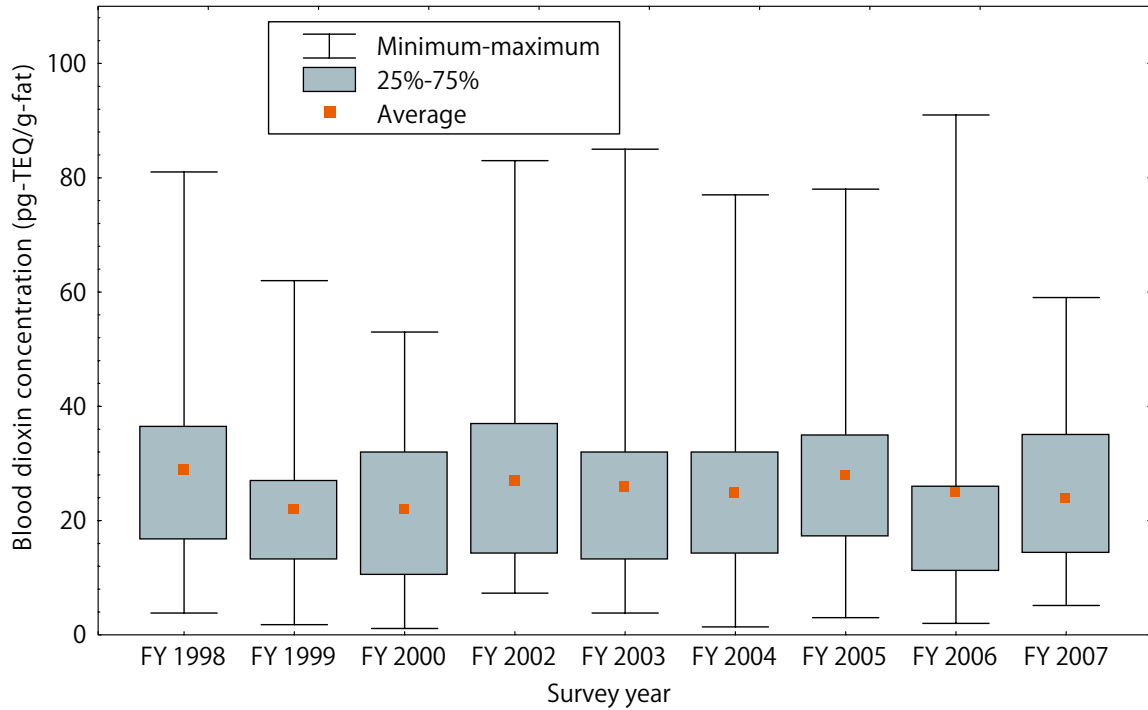
● Relationship between blood concentrations and intake from food

□ Figure 4 Relationship between dioxin intake from food and blood dioxin concentrations

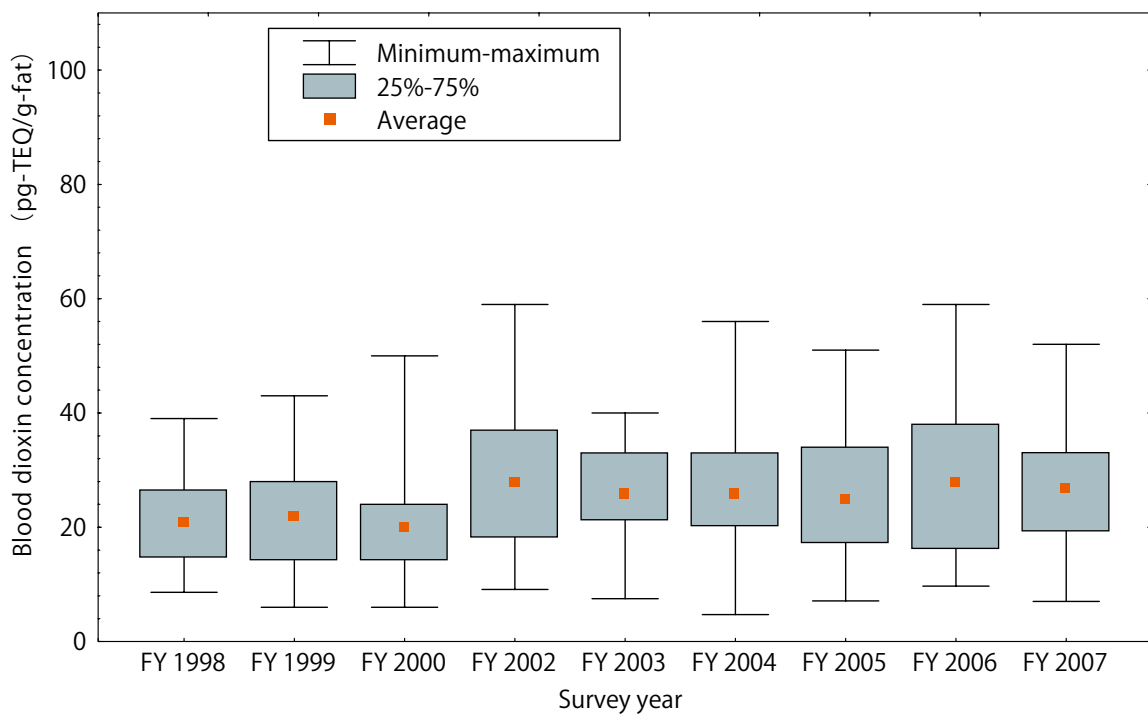


## (2) Follow-up survey

□ Figure 5 Chronological change in blood dioxin concentrations in Nose, Osaka Prefecture



□ Figure 6 Chronological change in blood dioxin concentrations in Saitama Prefecture



## Chemical compounds which measured it in this survey

### 1. Dioxins

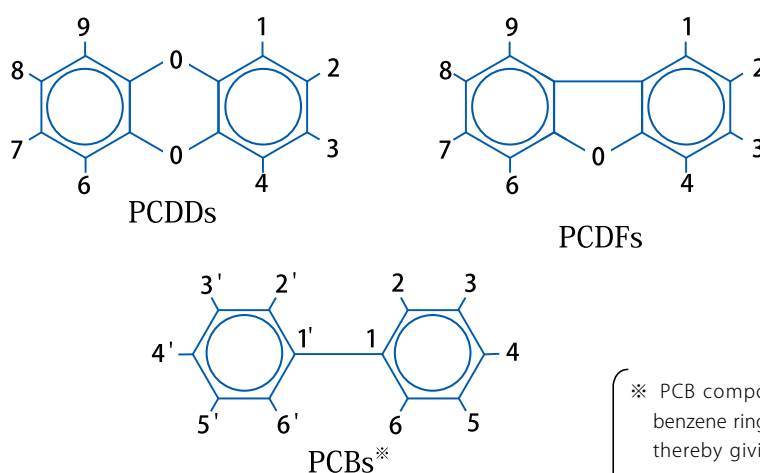
#### 1.1 Structure of dioxins

Polychlorodibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are collectively called dioxins. Co-planar polychlorinated biphenyls (co-planar PCBs or dioxin-like PCBs) possess toxicity similar to those of dioxins and are called dioxin-like compounds.

“Dioxins” are defined to include PCDDs, PCDFs, and co-planar PCBs in Japan’s Law Concerning Special Measures against Dioxins, promulgated on July 16, 1999.

Accordingly, throughout this report, the term “dioxins” will be used to refer to PCDDs, PCDFs, and co-planar PCBs.

The chemical structure of a dioxin molecule is generally composed of two rings of six carbon atoms (benzene rings, shown as in the figure below) bound by oxygen atom(s) (shown as O in the figure below) with chlorine or hydrogen atoms attached (the numbered positions: 1-9 and 2'-6' in the figure below). There are 75 types of PCDDs, 135 types of PCDFs and 12 types of co-planar PCBs, depending on the numbers and locations of the attached chlorine atoms (among these dioxins, 29 types have toxicities similar to 2,3,7,8-TCDD toxicity).



※ PCB compounds in which the two benzene rings are on the same plane, thereby giving the compound a flat structure, are known as co-planar PCBs. Some PCBs, which do not have the planar structure but possess dioxin-like toxicity, are classified for practical reasons as co-planar PCBs in current documents of the Government of Japan.

## 1.2 Properties of dioxins

Dioxins in general are colorless solids of very low water solubility and low vapor pressure. On the other hand, dioxins characteristically exhibit a high degree of solubility in fats and oils. They are generally stable, not reacting easily with other compounds, acids, and alkalis, but are considered to gradually decompose in the presence of solar ultraviolet light.

## 1.3 Toxicity of dioxins

Carcinogenicity and chronic toxicity have long been used to assess the health risks posed by the toxicities of dioxins. Dioxins have been reported to show carcinogenicity in rats, producing hepatocellular carcinoma, follicular adenoma of the thyroid, lymphoma, and other tumors. As for the carcinogenic mechanism of dioxins, they are considered to act as a promoter—that is, dioxins do not act directly on genes; rather, they promote the carcinogenic activity of other carcinogens. At present, the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) has classified 2,3,7,8-TCDD as a human carcinogen. In terms of hepatotoxicity, it is recognized to cause elevated liver enzymes and hyperlipidemia. When the WHO reevaluated the risk assessment of dioxins and related compounds in 1998, and whenever risk assessments in and outside Japan have been conducted thereafter, reproductive organ toxicity, central nervous system toxicity, and immune system toxicity were identified as adverse effects observed after birth following dioxin exposure during the fetal stage, and these toxicities have been used as endpoints of dioxins. Shortened anogenital distance in males, congenital abnormalities in the vagina, diminished learning ability, diminished resistance to viral infection and other outcomes in laboratory animals are used as endpoints. At present, the effects of dioxins are widely recognized to develop as a result of endocrine disruption through the arylhydrocarbon receptor (AhR) within cells. However, further studies are required, since there is very little understanding of why these diverse toxicities appear.

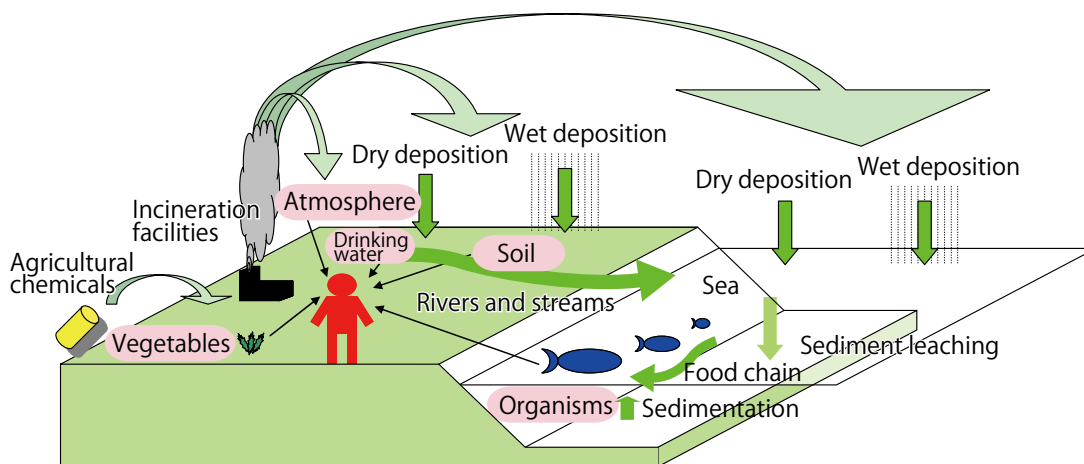
## 1.4 Generation and behavior of dioxins in the environment

Dioxins are not produced intentionally, except for research purposes, *i.e.*, production of a standard material for dioxin analysis. Dioxins are by-products generated during the processes that occur when heat is applied to substances containing carbon, oxygen, hydrogen and chlorine.

The major source of dioxins at present is waste incineration, particularly the incineration of plastic waste and other products made from fossil fuels. Dioxins are formed in combustion processes and emitted into the air without being fully captured by waste-gas treatment equipment. Other sources exist, such as emissions from electric steel-making furnaces, cigarette smoke, and automobile exhaust. Some reports indicate that dioxins may have accumulated in bottom sediment in aquatic environments owing to the past use of PCBs and some types of agricultural chemicals, which contain dioxins as impurities.

The behavior of dioxins in the environment is not fully known. For example, dioxins in the air may be adsorbed to particulate matter, fall to the ground, and pollute soil and water. It is considered that over long period of time, these dioxins, together with those released into the environment via various other pathways, ultimately accumulate in aquatic sediments and enter the food chain when ingested by plankton and fish, thereby accumulating in various organisms in the biota.

While dioxins are mostly anthropogenically produced, small amounts are generated in the nature. For instance, dioxins are said to be produced through forest fires and volcanic activity.



## 1.5 Brominated dioxins

Brominated dioxins have similar structure as chlorinated dioxins, where a part of chlorines of chlorinated dioxins are substituted by bromines.

Like chlorinated dioxins, brominated dioxins are not produced intentionally except for research purposes and are by-products that occur when heat is applied to organobromine compounds and combustion processes. It is said to be produced especially through heating processes during production and processing of plastics including Brominated Flame Retardants.

The toxicity and health effects are not as much known as chlorinated dioxins.

## 2. Fluorine compounds

PFOS (perfluorooctanesulfonic acid) and PFOA (perfluorooctanoic acid) are organofluorine compounds, whose fluoride is bound to carbon. The carbon and fluoride are strongly bound to each other, and the compounds are highly resistant to heat and chemicals.

These compounds have been used widely as “surfactants” readily soluble to oil and water in water-repellent sprays, foam fire extinguishers, and coatings of nonstick frying pans until very recently. However, studies have been reported that they are difficult to decompose in environment and within living organisms, and that they have substantial bioaccumulation properties.

PFOS is listed as POPs in Stockholm Convention

In this survey, fluorine compounds including PFOS and PFOA were studied for blood and food.

□ Table 22 Fluorine compounds

Chemical compound	Usage	Measurement case in Japan (average)	Standard; Tolerable intake
PFOS PFOA	Used in water-repellent sprays and foam fire extinguishers as surfactants.	< Blood > PFOS : 6.3 ng/mL PFOA : 2.1 ng/mL (N=609 Ministry of the Environment, Japan 2008-2010)	
		< Food > PFOS: 0.98 ng/kg/day (ND and/or below = 0) 12.1 ng/kg/day (ND and/or below = 1/2 ND) (Maitani et al., 2007 market-basket system) PFOA : 0.06 ng/kg/day (ND and/or below = 0) 11.5 ng/kg/day (ND and/or below = 1/2 ND) (Maitani et al., 2007 market-basket system)	※ Tolerable intake is not established.

## 3. Heavy metals

Heavy metals are widely distributed on Earth and are used for various purposes. However, some heavy metals are potentially toxic within organisms.

In the past, Japan have experienced pollution-related health damage due to heavy metals, such as Minamata Disease caused by methyl mercury and Itai-Itai Disease caused by cadmium.



□ Table 23 Heavy metals studied in this survey

Chemical compounds	Usage	Measurement case in Japan (average)	Standard; Tolerable intake
Total mercury / Methyl mercury	Methyl mercury is used in fluorescent lights, amalgam, batteries, catalysts, and others. Methyl mercury is produced by methylation of metal mercury. Methyl mercury have higher toxicity.	<p>&lt; Total mercury / blood &gt;            5.4 ng/mL            (600 mothers Shimada et al., 2008)            5.18 ng/mL            (115 mothers Sakamoto et al., 2007)            18.2 ng/mL            (56 females Yamauchi et al., 1994)</p> <p>&lt; Total mercury / food &gt;            0.225 <math>\mu\text{g}/\text{kg}</math> body weight/day            (Tokyo, 2005 10 samples by duplicated portion method)            0.238 <math>\mu\text{g}/\text{kg}</math> body weight/day            (Tokyo, 2010 market-basket system)</p> <p>&lt; Methyl mercury / food &gt;            0.198 <math>\mu\text{g}/\text{kg}/\text{day}</math>            (Tokyo, 2005 10 samples by duplicated portion method)            0.152 <math>\mu\text{g}/\text{kg}/\text{day}</math>            (Tokyo, 2010 market-basket method)</p>	<p>&lt; Methyl mercury &gt;            0.29 <math>\mu\text{g}/\text{kg}</math> body weight/day            2.0 <math>\mu\text{g}/\text{kg}</math> body weight/week</p>
Lead	Used widely in electrodes, weight, glass products, solder, and others.	<p>&lt; Blood &gt;            1.07 <math>\mu\text{g}/\text{dL}</math>            (352 Yoshinaga et al., 2008-2010)            1.3 <math>\mu\text{g}/\text{dL}</math>            (137 people including infant Tokyo 2006)</p> <p>&lt; Food &gt;            0.154 <math>\mu\text{g}/\text{kg}</math> body weight/day            (Tokyo, 2010 market-basket system)            4.5 <math>\mu\text{g}/\text{kg}</math> body weight/week            (Ministry of Health, Labour and Welfare, Japan, 2007 market-basket system)</p>	<p>※ Tolerable intake is not established.</p>
Cadmium	Used in watch batteries, plating materials, and others. Cadmium is produced and recovered during the zinc refinery process.	<p>&lt; Blood &gt;            2.54 <math>\mu\text{g}/\text{L}</math> <sup>Note1</sup>            (1243 females kayama et al., 2010-2011)</p> <p>&lt; Urine &gt;            3.46 <math>\mu\text{g}/\text{g cr}</math> <sup>Note1</sup>            (1243 females Kayama et al., 2000 – 2001)            1.26 <math>\mu\text{g}/\text{g cr}</math> <sup>Note1</sup>            (10753 females Ikeda et al., 2000 – 2001)</p> <p>&lt; Food &gt;            0.320 <math>\mu\text{g}/\text{kg}</math> body weight/day            (Tokyo, 2005 10 samples by duplicated portion method)            0.317 <math>\mu\text{g}/\text{kg}</math> body weight/day            (Tokyo, 2010 market-basket method)</p>	<p>7 <math>\mu\text{g}/\text{kg}/\text{week}</math></p>

Chemical compounds	Usage	Measurement case in Japan (average)	Standard; Tolerable intake
Arsenic	In the past, arsenic compounds were used in rat poisons. Organic arsenic is found in seafood (seaweeds, shrimps, and crabs) but are basically non-toxic. Inorganic arsenic is highly toxic.	<p>&lt; Total Arsenic / blood &gt; 0.5 <math>\mu\text{g}/\text{dL}</math> (137 people including infant Tokyo 2006)</p> <p>&lt; Arsenic speciation / urine &gt; MMA: 2.01 <math>\mu\text{g}/\text{g cr}</math> DMA: 40 <math>\mu\text{g}/\text{g cr}</math> (248 residents near metropolitan area Chiba et al., 2001)</p> <p>As (III) 4.0 <math>\mu\text{g}/\text{g cr}</math> As (V) 0.2 <math>\mu\text{g}/\text{g cr}</math> MMA: 3.2 <math>\mu\text{g}/\text{g cr}</math> DMA: 38.5 <math>\mu\text{g}/\text{g cr}</math> AB: 71.4 <math>\mu\text{g}/\text{g cr}</math> (142 males Nakajima et al., 2001)</p>	※ Tolerable intake is not established.
Copper	Used widely in electric wire, roofing, and others.	<p>&lt; blood &gt; 950 ng/mL (145 males) 970 ng/mL (163 females) (Saitoh et al., 1980)</p> <p>&lt; food &gt; 1,080 <math>\mu\text{g}/\text{day}</math> (Matsumoto et al., 2009 market-basket system)</p>	10 mg/day (tolerable upper intake level) <sup>Note2</sup>
Selenium	Used in photosensitive drum of copier, colorant for glass, and soil amendments for place of selenium deficiency.	<p>&lt; blood &gt; 157 ng/g : males 157 ng/g : females (331 subjects Seki et al., 1981)</p> <p>&lt; food &gt; 121.9 <math>\mu\text{g}/\text{day}</math> (6 females samples by duplicated portion method) (Koyama et al., 2002)</p>	210 ~ 300 $\mu\text{g}/\text{day}$ (tolerable upper intake level) <sup>Note2</sup>
Zinc	Used widely in corrugated galvanised iron, pigment, alloy material and cosmetic, and others.	<p>&lt; blood &gt; 8,540 ng/mL (145 males) 8,150 ng/mL (163 females) (Saitoh et al., 1980)</p> <p>&lt; food &gt; 7,560 <math>\mu\text{g}/\text{day}</math> (Matsumoto et al., 2009 market-basket system)</p>	30 ~ 45 mg/day (tolerable upper intake level) <sup>Note2</sup>
Manganese	Used in Battery materials and fertilizer raw materials.	<p>&lt; blood &gt; 13.2 <math>\mu\text{g}/\text{L}</math> (1,420 females) (Ikeda et al., 2010)</p> <p>&lt; food &gt; 3.6 mg/day (19 samples by duplicated portion method) (Shiraishi et al.,)</p>	11 mg/day (tolerable upper intake level) <sup>Note2</sup>

Note1 : The result of urine cadmium concentration are geometric mean.

Note2 : Tolerable upper intake level is applied for man and women 18 years or older.

## 4. Other chemical compounds ( including pesticides and plasticizers )

□ Table 24 Pesticide metabolites studied in this survey

Chemical compound	Usage	Measurement case in Japan (average)
Organophosphorous compound metabolites	Used in pesticides, disinfectant, wood preservatives, and others (metabolites were measured)	DMP : 1.5 $\mu\text{g/L}$ (73 subjects, Toyama) : 3.1 $\mu\text{g/L}$ (60 subjects, Tokyo) DMTP : 3.2 $\mu\text{g/L}$ (73 subjects, Toyama) : 5.8 $\mu\text{g/L}$ (60 subjects, Tokyo) DEP : 0.8 $\mu\text{g/L}$ (73 subjects, Toyama) : 1.2 $\mu\text{g/L}$ (60 subjects, Tokyo) DETP : <0.5 $\mu\text{g/L}$ (73 subjects, Toyama) : <0.5 $\mu\text{g/L}$ (60 subjects, Tokyo) (Toyama Institute of Health)
Pyrethroid pesticide metabolites	Used in pesticides, insecticides, and others (metabolites were measured)	< Urine > PBA : 0.40 $\mu\text{g/g cr}$ (42 males Toshima et al., 2010) PBA : 0.73 $\mu\text{g/g cr}$ (448 subjects Ueyama et al., 2009)
Carbamate pesticide metabolites	Used in pesticides, insecticides, and others (metabolites were measured)	—
Imidachloprid metabolite	Metabolite of neonicotinoid pesticide.	—
Fenitrothion metabolite	Metabolite of Fenitrothion.	—
p-nitrophenol	Metabolite of pesticides.	—
Acephate	A type of organophosphorus pesticides. Used widely as pesticides and insecticides, known as "Orthoran".	—
Methamidophos	A type of organophosphorus pesticides. Used as pesticides and insecticides (banned to use in Japan).	—
Phthalate monoesters	Used as plasticizer in plastic, adhesive agents, and others.	< Urine > MBP : 52.2 $\mu\text{g/g cr}$ (48.1 ng/mL) MEHP : 5.84 $\mu\text{g/g cr}$ (4.44 ng/mL) MEHHP : 10.1 $\mu\text{g/g cr}$ (8.61 ng/mL) MEOHP : 11.0 $\mu\text{g/g cr}$ (9.2 ng/mL) MBzP : 4.70 $\mu\text{g/g cr}$ (3.46 ng/mL) (149 pregnant women Suzuki et al., 2010) } median
Iodine	Essential element for human and is the main component of thyroid hormone. Found abundantly in sea weeds. Deficiency causes hyperthyroidism, but excessive intake also causes thyroid abnormalities as well.	< Urine > 91 $\mu\text{g/g cr}$ : median (14 women Hisada et al., 2009)
Perchloric acid	Has strong oxidizing effect. Used as analytical chemistry reagent, metal/ alloy/ mineral ore solvent, organic synthesis catalysis, and as manufacturing material of perchloric acid and its derivatives.	—
Triclosan	Used as disinfectant	—

Chemical compound	Usage	Measurement case in Japan (average)
Bisphenol A	Used as monomer or ingredients in plastic manufacturing	< Urine > 24.1 $\mu\text{g/L}$ (University students 1992) 21.5 $\mu\text{g/L}$ (University students 1999) (Kawamoto et al., 1999)
Deet	Used as mosquito and mite repellent.	—
PAHs metabolites	Metabolite of PAHs, found mainly as mixtures in tar, crude oil, and in petroleum.	—
Parabens	Used as antiseptic (antibacterial) agent in food, medicine, cosmetics, etc.	< Urine > Methylparaben : 180 $\mu\text{g/g cr}$ Ethylparaben : 52.5 $\mu\text{g/g cr}$ Propylparaben : 169 $\mu\text{g/g cr}$ Butylparaben : 5.12 $\mu\text{g/g cr}$ (110 pregnant women Shirai et al.)
Benzophenone-3	Used in sunscreen cosmetics due to its ultraviolet absorption effect.	—
Cotinine	Metabolite of nicotine found in tobacco.	< Urine > 16 ng/mg cr (smoking parents) 12 ng/mg cr (Only the mother smokes) 3 ng/mg cr (only the father smokes) 1 ng/mg cr (non-smoking parents) (927 three year old children Tateishi et al., 2009) 3,048 ng/mg cr (smoking) 28.7 ng/mg cr (non-smoking and passive smoking) 33.9 ng/mg cr (non-smoking and non-passive smoking) (504 adult Sakanashi et al.)
Caffeine	Naturally derived organic compound found abundantly in coffee, tea, and chocolate.	—
Phytoestrogens	Found abundantly in leguminous plants (bean plants) such as soy beans, and act as female hormone .	< Urine > Daizein: 1,000 $\mu\text{g/g cr}$ Genistein: 860 $\mu\text{g/g cr}$ (80 adult women Tsukane et al.)
Hydroxylated PCB	Metabolite of PCB.	< Blood > 40 pg/g (40 Pregnant women Ito et al.)

## 5. POPs and POPs candidates

POPs is the abbreviation of Persistent Organic Pollutants and has following properties:

- remain intact for exceptionally long period of time;
- accumulate in bodies of organisms and are highly bioaccumulative;
- have long range transport and are widely distributed on Earth; and
- have toxic effects within bodies of organisms, etc.

The Stockholm Convention on Persistent Organic Pollutants is a global treaty. Initially, twelve POPs have been recognized, and nine new POPs were amended.

These compounds include those produced and used intentionally as pesticides and others. On the other hand, there are compounds like dioxins, which could be produced in the process of combustion or manufacturing of other chemicals.

In the Convention, each party is to prohibit the production, use, and import and export of POPs, and to take every appropriate measure possible in eliminating and reducing the unintentionally produced compounds. Furthermore, each party is encouraged and/or to undertake measures for POPs under Stockholm Convention. Thus, considering this, monitoring surveys on the environment and biological samples are conducted by MOE of Japan.

In this survey, all POPs, listed in Stockholm Convention, in blood and food was measured.

□ Table 25 POPs studied in this survey

Chemical compounds	Usage
Dioxins	Produced unintentionally due to combustion, as well during the manufacture of chlorinated substances
PCBs	Used as heat exchange fluids, in electric transformers, and as additives in carbonless copy papers and such
DDT	Used as hygiene pesticides and insecticides
Chlordane	Used to control termites and as pesticides
Aldrin	Used as pesticides
Dieldrin	Used as pesticides, insecticides, and termite control
Endrin	Used as pesticides
Hexachlorobenzene (HCB)	Used as material for herbicide manufacturing
Heptachlor	Used as pesticide and termite control
Toxaphene	Used as pesticides overseas
Mirex	Used as pesticides overseas
PBDE	Used as fire-retardant
Pentachlorobenzene	Used as chemical intermediate of agricultural fungicides
HCH	Used as pesticides
Chlordecone	Used as insecticides overseas
Hexabromobiphenyl	Used as fire-retardant
Endosulfan	Used as pesticides and insecticides
HBCD	Used as fire-retardant

## 6. Radioactive substances

Radioactive substances emit radiation with radioactive decay over time. These substances are present in nature but are also emitted into the environment through explosion of atomic bombs and nuclear power plant accidents. In FY 2012, potassium 40 which is present in nature, and cesium 134, cesium 137, and iodine 131 which are emitted into the environment through explosion of atomic bombs and nuclear power plant accidents were studied.

## 7. Dioxin intake

In Japan, the tolerable daily intake (TDI) of dioxins was set at 4 pg-TEQ/kg/day in June 1999, based on the latest available scientific information. Safety of the total amount of dioxins ingested by humans is evaluated by comparing with this value.

On the average, the total daily intake of dioxins by the Japanese people is estimated to be approximately 0.69 pg-TEQ/kg/day.

A similar figure has been reported in Western countries.

Conceivable routes of intake include food, ambient air, and soil, but the intake from food is estimated to account for the largest portion. A survey by the Ministry of Health, Labour and Welfare, Japan (FY 2011 Survey on the Daily Intake of Dioxins from Food) estimated the daily intake at approximately 0.68 pg-TEQ/kg/day. A survey by the Ministry of the Environment (FY 2011 Environmental Survey of Dioxins) estimated the intake from the ambient air at approximately 0.0082 pg-TEQ/kg/day and the intake from soil at approximately 0.0039pg-TEQ/kg/day. These levels are below the TDI and thereby considered to be below the level which can cause adverse effects on human health.

Once dioxins are absorbed into the body, they remain mostly in adipose tissue. The rate of decomposition and excretion of dioxins is very slow. It is reported to take approximately seven years for dioxin concentrations to be reduced by one half (half life) in humans.

□ Figure 7 Specification of the average daily intake of dioxins by the Japanese people (FY 2011) <sup>Note 1</sup>

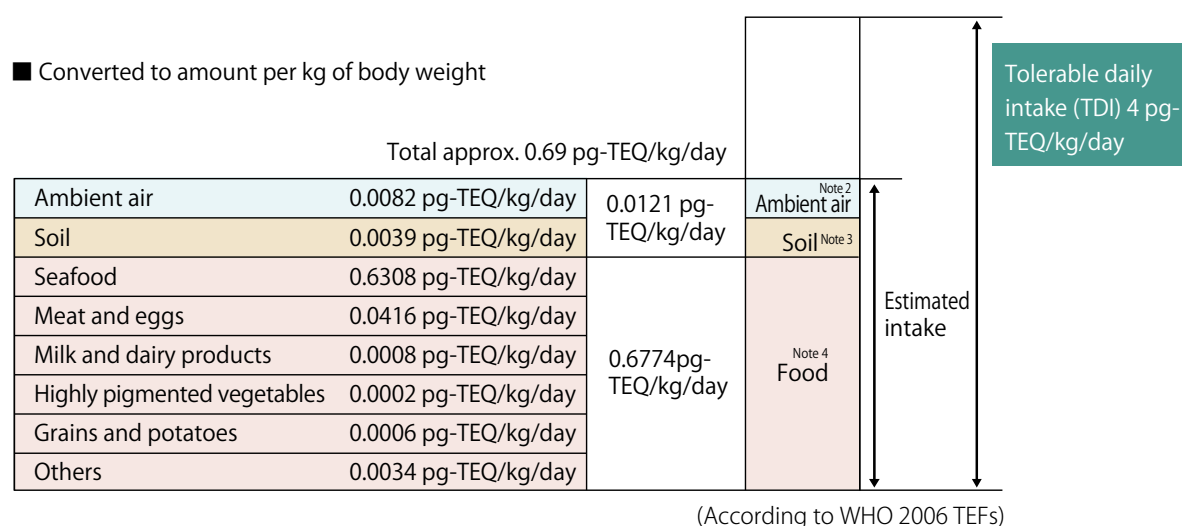


Table 26 and Figure 8 show chronological change of estimated total daily intake of dioxins by the Japanese people using the results of "Survey on the Daily Intake of Dioxins from Food (Ministry of Health, Labour and Welfare, Japan)" and "Environmental Survey of Dioxins (the Ministry of the Environment, Japan)".

Enforcement of the "Act on Special Measures against Dioxins (January, 2000)" has greatly decreased emission of dioxins to environment.

Dioxin concentration of food and environment (ambient air and soil) have also decreased.

As a result, trend of total daily intake of dioxins by the Japanese people has decreased.

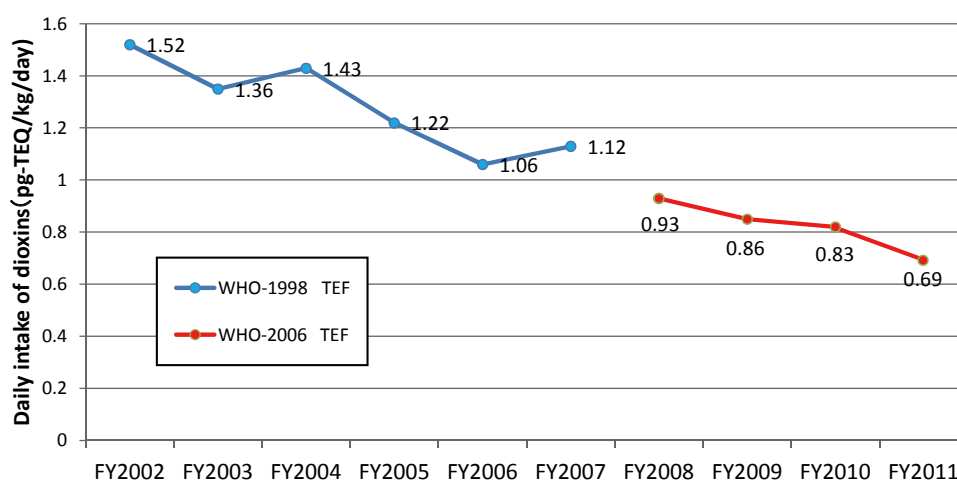
The total daily intake is believed due to continuous measures being taken to decrease dioxins emission.

□ Table 26 Chronological change in of the average daily intake of dioxins by Japanese people <sup>Note 1, Note 5</sup>  
pg-TEQ/kg/day

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
Ambient air <sup>Note 2</sup>	0.028	0.019	0.018	0.015	0.015	0.012	0.011	0.0093	0.0093	0.0082	
Soil <sup>Note 3</sup>	0.0068	0.0052	0.0044	0.0040	0.0038	0.0054	0.0056	0.0042	0.0042	0.0039	
Food: <sup>Note 4</sup>	Seafood	1.290	1.147	1.245	1.090	0.9400	1.033	0.8634	0.7840	0.7626	0.6308
	Meat and eggs	0.150	0.141	0.101	0.0686	0.0704	0.0422	0.0396	0.0398	0.0416	0.0416
	Milk and dairy products	0.0346	0.0322	0.0468	0.0328	0.0212	0.0226	0.0076	0.013	0.0028	0.0008
	Highly pigmented vegetables	0.0030	0.002	0.0028	0.0028	0.001	0.0006	0.0008	0.0004	0.0006	0.0002
	Grains and potatoes	0.001	0.001	0.0026	0.0022	0.0054	0.001	0.0008	0.001	0.0004	0.0006
	Others	0.010	0.0070	0.010	0.0064	0.0064	0.0058	0.0030	0.0042	0.0054	0.0034
Total approx.	1.52	1.36	1.43	1.22	1.06	1.13	0.93	0.86	0.83	0.69	

(According to WHO 1998 TEFs from FY2002 to FY2007, WHO 2006 TEFs from FY2008 to FY2011)

□ Figure 8 Chronological change in the average daily intake of dioxins by Japanese people <sup>Note 1, Note 5</sup>



Note 1 : Graphed by MOE based on "Environmental Survey of Dioxins [MOE]" and "Survey on the Daily Intake of Dioxins from Food [MHLW] - Health and Labour Sciences Research"

Note 2 : Values used for statistical analysis were derived as follows : average the general environmental monitoring data and the roadside monitoring data, respectively; multiply each average value by the number of monitoring points; add the multiplied values; and divide this value by the total number of monitoring points.

Note 3 : Values are the average of general environmental monitoring data.

Note 4 : The significant figures are based on the daily intake values of dioxins from each food groups and total food.

Note 5 : The handling of significant values had changed after FY 2009. Last digit may differ from the results of previous fiscal year.

Please address opinions and inquiries to:

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**Environmental Risk Assessment Office  
Environmental Health Department  
Ministry of the Environment, Japan**

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1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8975 JAPAN  
Tel (main) : +81-3-3581-3351 (extension 6343)  
Tel (direct): +81-3-5521-8262  
Fax: +81-3-3581-3578  
<http://www.env.go.jp/en>