The Exposure to Dioxins and other chemical compounds in the Japanese People

-Survey of the Exposure to Dioxins and other chemical compounds in Humans (2011)-

2012

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

Introduction

The Office of Environmental Risk Assessment of the Environmental Health Department of the Ministry of the Environment, Japan, carried out a project entitled "Survey of the Exposure to Dioxins and other chemical compounds in Humans," 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 the survey conducted in FY 2011, as its first year of the project.

Summary of Survey of the Exposure of Dioxins and other chemical compounds in Humans

Objective of the survey

- To obtain the state of accumulation of dioxins and other chemical compounds in the Japanese people.
- Conduct a follow-up survey and obtain 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 regions 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 in 86 people was 17 pg-TEQ/g-fat, with a range of 0.83 – 56 pg-TEQ/g-fat. This result is similar to those reported in other surveys.
- Among 8 people who had participated in past studies (in FY 2002 or FY 2003), dioxin levels in blood of 7 people had decreased.
- The average dioxin intake from food by 15 people was 0.65 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 concentration of PFOS and PFOA in the blood of 86 people was 5.8 ng/mL and 2.2 ng/mL, respectively. In addition, the range of PFOS and PFOA concentration was 1.6 – 17 ng/mL and 0.66 - 9.6 ng/mL, respectively. This result is similar to those reported in other surveys.
- The average PFOS and PFOA intake from food by 15 people was 0.57 ng/kg body weight/day and 0.69 ng/kg body weight/day, respectively. In addition, the range of PFOS and PFOA intake from food 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 86 people was 11 ng/mL with a range of 2.4 – 29 ng/mL. This result is similar to those reported in other surveys.
- The average concentration in cadmium in urine of 15 people was 1.2 μg/g cr with a range of 0.25 - 3.9 μg/gcr. In addition, measurement of arsenic speciation in urine was conducted.
- Among 15 people, the average intake of total mercury from food was 0.069 μg/kg body weight/day with a range of N.D. - 0.16 μg/kg body weight/day. The average intake of methyl mercury from food was 0.064 μg/kg body weight/day with a range of N.D. - 0.14 μg/kg body weight/day. The average intake of lead from food was 0.24 μg/kg body weight/day with a range of 0.059 - 0.39 μg/kg body weight/day. The average intake of cadmium from food was 0.091 μg/kg body weight/day with a range of 0.024 - 0.17 μg/kg body weight/day. No survey subjects exceeded TDI of methyl mercury and cadmium.

Pesticide metabolites, plasticizers, and others

- Pesticide metabolites (organic phosphorous compound metabolites, pyrethroid pesticide metabolites, and triclosan) in urine of 15 people were measured. In addition, measurements were conducted on plasticizers (phthalate monoesters, and bisphenol A).

POPs

- 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.

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1. Overview of the Survey of the Exposure to Dioxins and other chemical compounds in Humans

The Environmental Risk Assessment Office of the Environmental Health Department of the 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 2011. 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 Dioxins and other chemical compounds in Humans" 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 was studied.

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

In FY 2011, chemical compound concentration in blood of 86 people from 3 survey regions was measured. In addition, the chemical compound intake from food was estimated for 15 people.

Survey of the Exposure to Dioxins and other chemical compounds in Humans

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 (two fishery regions and one agricultural region)

Survey specimen:
- Blood study (to ascertain the accumulation of chemical compounds in food)
- Urine study (to ascertain the excretion of rapidly-metabolizing compounds)
- Food study (to ascertain the amount of intake of chemical compounds)

Number of subjects: 86 people (15 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, the entire country 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 in survey regions according to the criteria shown below, through local administrative authorities.

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

Study subject criteria

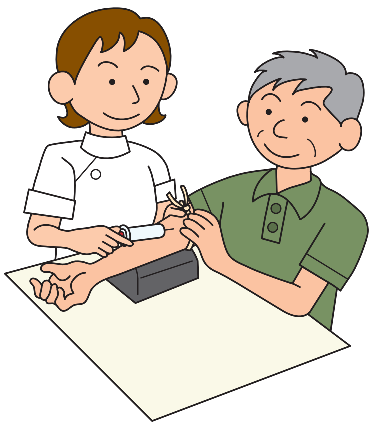
- Age : 40 – 59
- Residential period in the survey region: 10 years or more
- Infrequent leaves from the study regions for work or other reasons
- Having no problem in blood sampling owing to anemia or other reasons

2-2 Methods

● Blood study (all subjects)

Blood samples from survey subjects were taken by a nurse in the presence of a physician.

As a general rule, fasting blood samples were taken from the subjects.



Analysis item

- Dioxins (7 congeners of PDDDs, 10 congeners of PCDFs, 12 congeners of Co-PCBs)
- Organofluorine Compounds (PFOS, PFOA)
- Heavy metal (total Hg)
- POPs (PCBs, DDTs, clordens etc.)
- 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 some of the subjects）

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

Analysis item

- Pesticides and others (organic phosphorous compound metabolites, pyrethroid pesticide metabolites, carbamate pesticide metabolites, triclosan)
- Plasticizers and others (phthalate monoesters, and bisphenol A)
- Heavy metals (cadmium, lead)
- General health examination items（urine specific gravity, urinary sugar, uric protein, and others）

※ General health examination items were examined for all subjects, and other items were analyzed for 15 people participating in the food study.

Food study (some of the subjects)

The food study was conducted as a "duplicate portions study." over the three days of the survey period : duplicates of the subject's meals for the three days were stored in containers and collected later. Upon collection, a nutritionist checked the types and weight of the food commodities.

The three days' portion of collected food was then homogenized, and the dioxins were extracted from the homogenate.

Analysis item

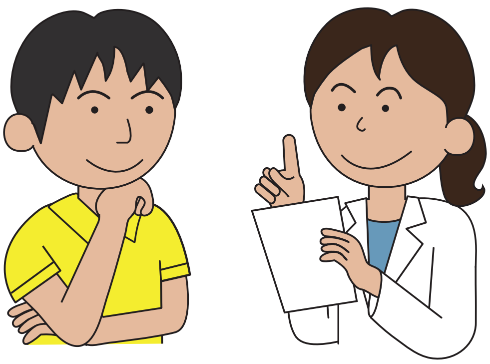
- Dioxins (7 congeners of PDDDs, 10 congeners of PCDFs, 12 congeners of Co-PCBs)
- Organofluorine Compounds (PFOS, PFOA)
- Heavy metal (total Hg, metyl Hg, Cd, Pb)
- POPs (PCBs, DDTs, clordens etc.)

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, and others



3. Results and Discussion

3-1 Dioxins survey

3-1-1 Blood study

● Result summary

The blood dioxin concentrations found in this study are shown in Table 1.
The average concentration in the 86 survey subjects was 17 pg-TEQ/g-fat.
The range of concentrations was 0.83 ～ 56 pg-TEQ/g-fat.

☐ Table 1 Statistics of blood dioxin concentration

(unit: pg-TEQ/g-fat)

	(n=86)
PCDDs+PCDFs +Co-PCBs	
Average	17
Standard deviation	10
Median	14
Range	0.83 ～ 56

● Comparison with past survey results

Table 2 summarizes the results of "Survey on the Accumulation of Dioxins and other chemical compounds (FY 2002 to FY 2010) ".
While it is difficult to compare in a simplified manner since the average ages of the target subjects and determination methods for dioxins differ by survey, the blood dioxin concentrations obtained in this survey are considered to fall generally within the range of these 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
Subjects	People living in the general environment	People living in the general environment
The number of subject	2,264	86
Age		
Average (years)	44.5	50.1
Range	15 ～ 76	40 ～ 62
PCDDs+PCDFs +Co-PCBs		
Average	19	17
Standard deviation	14	10
Median	16	14
Range	0.10 ～ 130	0.83 ～ 56

Comparison for the same subjects

Among the subjects of this survey, 8 people had participated in the past surveys (FY 2002 and FY 2003).

The comparison of blood dioxin results of the past studies and this survey for these 8 people are shown in the table. The dioxin concentrations in blood have decreased.

☐ Table 3 Comparison of blood dioxin concentration in the same subjects

(unit: pg-TEQ/g-fat)

Survey year	Past survey (n=8)	This study (n=8)
Survey year	FY 2002, 2003	FY 2011
PCDDs+PCDFs +Co-PCBs		
Average	40	24
Standard deviation	33	16
Median	25	21
Range	0.96 ～ 95	3.1 ～ 56

3-1-2 Food study

Result summary

Table 4 summarizes the dioxin intake from food in the 15 people who participated in the food study. The average intake was 0.65 pg-TEQ/kg/day with a range of 0.035 – 2.4 pg-TEQ/kg/day. Tolerable daily intake (TDI) has been used as a guideline for regulating the dioxin intake. (The TDI is 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). In Japan, the TDI for dioxins is 4 pg-TEQ/kg/day as stipulated by the Law Concerning Special Measures against Dioxins, no subjects exceeded the TDI (4pg-TEQ/kg/day) value in this survey.

☐ Table 4 Dioxin intake from food

(unit: pg-TEQ/kg/day)

	(n=15)
PCDDs+PCDFs +Co-PCBs	
Average	0.65
Standard deviation	0.71
Median	0.39
Range	0.035 ～ 2.4

● Comparison with past survey results

Table 5 summarizes the results of "Survey on the Accumulation of Dioxins and other chemical compounds (FY 2002 to FY 2010) ".
The dioxin intake from food obtained in 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	Survey on the Accumulation of Dioxins and other chemical compounds	This survey
Survey year	FY 2002 to FY 2010	FY2011
Subjects	People living in the general environment	People living in the general environment
The number of subject	625	15
PCDDs+PCDFs +Co-PCBs		
Average	0.82	0.65
Standard deviation	0.86	0.71
Median	0.56	0.39
Range	0.031 ～ 6.2	0.035 ～ 2.4

3-2 Fluorine compounds survey

3-2-1 Blood study

● Result summary

The result of fluorine compound concentrations in blood is shown in the table. The average of 86 survey subjects for PFOS was 5.8 ng/mL and 2.2 ng/mL for PFOA. The concentration range for PFOS was 1.5 – 17 ng/mL and 0.66 – 9.6 ng/mL for PFOA.

☐ Table 6 Statistics of blood fluorine compound concentration

(unit: ng/mL)

	(n=86)
PFOS	
Average	5.8
Standard deviation	3.1
Median	4.8
Range	1.5 ～ 17
PFOA	
Average	2.2
Standard deviation	1.4
Median	1.8
Range	0.66 ～ 9.6

● 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 the table. Although it is difficult to make simple comparisons compare because the average age and number of the subjects differ by survey, the results obtained in this survey generally fall within the range of these past surveys.

□ Table 7 Comparison with past survey results

(unit: ng/mL)

Survey	Survey on the Accumulation of Dioxins and other chemical compounds	Current survey
Survey year	FY 2002 to FY 2010	FY2011
Subjects	People living in the general environment	People living in the general environment
The number of subject	609	86
PFOS		
Average	7.8	5.8
Standard deviation	9.2	3.1
Median	5.8	4.8
Range	0.73 ～ 150	1.5 ～ 17
PFOA		
Average	3.0	2.2
Standard deviation	2.9	1.4
Median	2.1	1.8
Range	0.37 ～ 25	0.66 ～ 9.6

3-2-2 Food study

The intake of fluorine compounds from food for the 15 subjects is shown in the table. 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 8 Statistics of fluorine compounds intake from food

(unit: ng/kg/day)

	(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

Total mercury concentration was studied for heavy metal in blood. The results are shown in the table. The average of 86 subjects was 11 ng/mL with a range of 2.4 – 29 ng/mL.

☐ Table 9 Statistics of blood total mercury concentration

(unit: ng/mL)

	(n=86)
Total mercury	
Average	11
Standard deviation	5.8
Median	9.1
Range	2.4 ～ 29

3-3-2 Urine study

● Result summary

Cadmium and arsenic speciation (As (V), As (III), monomethylarsonic acid, dimethylarsinic acid, arsenobetaine) in urine were measured. The results are shown in the table.

☐ Table 10 Statistics of urine heavy metal concentration

(unit: μg/g cr)

Chemical compounds		Statistics	(n=15)
Cadmium		Average	1.2
		Standard deviation	0.96
		Median	0.97
		Range	0.25 ～ 3.9
Arsenic	As (V)	Average	0.62
		Standard deviation	0.76
		Median	0.30
		Range	N.D. ～ 2.5
	As (III)	Average	1.7
		Standard deviation	1.5
		Median	1.5
		Range	N.D. ～ 6.2
	MMA (monomethylarsonic acid)	Average	2.3
		Standard deviation	1.2
		Median	2.0
		Range	0.89 ～ 5.1
	DMA (dimethylarsinic acid)	Average	59
		Standard deviation	44
		Median	42
		Range	12 ～ 170
	AB (arsenobetaine)	Average	100
		Standard deviation	91
		Median	73
		Range	15 ～ 300

3-3-3 Food study

● Result summary

Total mercury methyl mercury, lead, and cadmium in food was measured. The results are shown in the table. The average for total mercury was 0.069 μg/kg body weight/day with a range of N.D. - 0.16 μg/kg body weight/day. The average for methyl mercury was 0.064 μg/kg body weight/day with a range of N.D. - 0.14 μg/kg body weight/day. The average for lead was 0.24 μg/kg body weight/day with a range of 0.059 - 0.39 μg/kg body weight/day. The average for cadmium was 0.091 μg/kg body weight/day with a range of 0.024 - 0.17 μg/kg body weight/day.

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

□ Table 11 Statistics of heavy metal intake from food

(unit: μg/kg/day)

	(n=15)
Total mercury	
Average	0.069
Standard deviation	0.044
Median	0.063
Range	N.D. ～ 0.16
Methyl mercury	
Average	0.064
Standard deviation	0.037
Median	0.063
Range	N.D. ～ 0.14
Lead	
Average	0.24
Standard deviation	0.10
Median	0.24
Range	0.059 ～ 0.39
Cadmium	
Average	0.091
Standard deviation	0.040
Median	0.094
Range	0.024 ～ 0.17

3-4 Pesticide metabolites, plasticizers, and others

3-4-1 Urine study

Pesticide metabolites, plasticizers, and others in urine was studied. The results are shown in the table.

□ Table 12 Statistics of pesticide metabolites, plasticizers, and others in urine

(unit: μg/g cr)

Classification	Chemical compound		Statistics	(n=15)
Pesticides	Organophosphorous compound metabolites	DMP	Median	5.6
			Range	1.8 ～ 14
		DEP	Median	5.8
			Range	N.D. ～ 32
		DMTP	Median	12
			Range	N.D. ～ 62
		DETP	Median	N.D.
			Range	N.D. ～ 2.7
	Pyrethroid pesticide metabolites	PBA	Median	0.22
			Range	N.D. ～ 3.4
		DCCA	Median	N.D.
			Range	N.D. ～ 13
	Carbamate pesticide metabolites	Ethylenethiourea	Median	N.D.
			Range	N.D. ～ 0.23
	Triclosan		Median	1.3
			Range	0.27 ～ 79
Plasticizers	Phthalate monoesters	MBP	Median	20
			Range	11 ～ 670
		MEHP	Median	4.2
			Range	0.98 ～ 8.1
		MEHHP	Median	15
			Range	5.7 ～ 44
		MEOHP	Median	9.6
			Range	4.6 ～ 18
		MBzP	Median	0.59
			Range	0.25 ～ 10
	Bisphenol A		Median	0.76
			Range	0.23 ～ 1.4

3-5 POPs survey

3-5-1 Blood study

The result of POPs concentrations in blood is shown in the table.

☐ Table 13-1 Statistics of blood POPs concentration

(unit: pg/g-fat)

Classification	Chemical compound	Statistics	(n=86)
PCB	MoCBs	Median	N.D.
		Range	N.D. ～ 430
	DiCBs	Median	100
		Range	N.D. ～ 800
	TrCBs	Median	920
		Range	210 ～ 3700
	TeCBs	Median	6400
		Range	650 ～ 33000
	PeCBs	Median	18000
		Range	1900 ～ 140000
	HxCBs	Median	87000
		Range	12000 ～ 670000
	HpCBs	Median	62000
		Range	10000 ～ 520000
	OcCBs	Median	13000
		Range	2600 ～ 110000
	NoCBs	Median	1300
		Range	370 ～ 6600
	DeCB	Median	630
		Range	220 ～ 2500
	Total PCB	Median	190000
		Range	31000 ～ 1400000
DDT	o,p'-DDD	Median	N.D.
		Range	N.D. ～ 500
	p,p'-DDD	Median	730
		Range	N.D. ～ 5000
	o,p'-DDE	Median	200
		Range	N.D. ～ 1100
	p,p'-DDE	Median	120000
		Range	17000 ～ 1000000
	o,p'-DDT	Median	600
		Range	N.D. ～ 4500
	p,p'-DDT	Median	6100
		Range	1100 ～ 29000
Chlordane	*cis*-Chlordane	Median	100
		Range	N.D. ～ 800
	trans- Chlordane	Median	N.D.
		Range	N.D. ～ 400
	Oxychlordane	Median	10000
		Range	1600 ～ 43000
	cis- Nonachlor	Median	3700
		Range	600 ～ 29000
	trans- Nonachlor	Median	23000
		Range	3000 ～ 110000
Drins	Aldrin	Median	All N.D.
		Range	
	Dieldrin	Median	3200
		Range	1300 ～ 40000
	Endrin	Median	All N.D.
		Range	
Hexachlorobenzen (HCB)		Median	14000
		Range	3400 ～ 39000

☐ Table 13-2 Statistics of blood POPs concentration

(unit: pg/g-fat, except chlordecone and HCB, ng/g-fat)

Classification	Chemical compound	Statistics	(n=86)
Heptachlors	Heptachlor	Median	All N.D.
		Range	
	cis- Heptachlorepoxide	Median	1800
		Range	600 ～ 6500
	trans-Heptachlorepoxide	Median	All N.D.
		Range	
Toxaphene	Parlar-26	Median	790
		Range	N.D. ～ 3500
	Parlar-50	Median	1100
		Range	N.D. ～ 4300
	Parlar-62	Median	N.D.
		Range	N.D. ～ 3400
Mirex		Median	1800
		Range	400 ～ 6600
PBDE	TeBDEs	Median	520
		Range	180 ～ 1100
	PeBDEs	Median	210
		Range	N.D. ～ 870
	HxBDEs	Median	800
		Range	N.D. ～ 2600
	HpBDEs	Median	All N.D.
		Range	
	OcBDEs	Median	300
		Range	N.D. ～ 3400
	NoBDEs	Median	N.D.
		Range	N.D. ～ 2000
	DeBDEs	Median	700
		Range	N.D. ～ 5100
	Total PBDEs	Median	2600
		Range	500 ～ 8600
Pentachlorobenzene		Median	300
		Range	40 ～ 1500
HCH	α-HCH	Median	120
		Range	N.D. ～ 1200
	β-HCH	Median	27000
		Range	2800 ～ 240000
	γ-HCH	Median	N.D.
		Range	N.D. ～ 1000
	δ-HCH	Median	All N.D.
		Range	
Chlordecone		Median	N.D.
		Range	N.D. ～ 1.0
Hexabromobiphenyl		Median	N.D.
		Range	N.D. ～ 700
HBCD	α-HBCD	Median	N.D.
		Range	N.D. ～ 10
	β-HBCD	Median	All N.D.
		Range	
	γ-HBCD	Median	N.D.
		Range	N.D. ～ 3.4
	δ-HBCD	Median	All N.D.
		Range	
	ε-HBCD	Median	All N.D.
		Range	
Endosulfan	α- Endosulfan	Median	1300
		Range	N.D. ～ 3700
	β- Endosulfan	Median	N.D.
		Range	N.D. ～ 1200

3-5-2 Food study

The intake of POPs from food is shown in the table.

☐ Table 14-1 Statistics of POPs intake from food

(unit: pg/kg/day)

Chemical compound		Statistics	(n=15)
PCB	MoCBs	Median	7.4
		Range	3.0 ~ 89
	DiCBs	Median	200
		Range	100 ~ 620
	TrCBs	Median	400
		Range	180 ~ 1400
	TeCBs	Median	750
		Range	230 ~ 4100
	PeCBs	Median	930
		Range	130 ~ 8200
	HxCBs	Median	980
		Range	100 ~ 14000
	HpCBs	Median	420
		Range	37 ~ 7500
	OcCBs	Median	71
		Range	4.1 ~ 1100
	NoCBs	Median	11
		Range	1.1 ~ 91
	DeCB	Median	6.0
		Range	0.74 ~ 50
	Total PCB	Median	5100
		Range	820 ~ 35000
DDT	o,p'-DDD	Median	39
		Range	4.1 ~ 550
	p,p'-DDD	Median	380
		Range	19 ~ 4900
	o,p'-DDE	Median	27
		Range	4.8 ~ 210
	p,p'-DDE	Median	1600
		Range	240 ~ 8200
	o,p'-DDT	Median	66
		Range	8.5 ~ 1400
	p,p'-DDT	Median	300
		Range	28 ~ 7600
Chlordane	*cis*-Chlordane	Median	490
		Range	63 ~ 1400
	trans- Chlordane	Median	170
		Range	41 ~ 800
	Oxychlordane	Median	95
		Range	22 ~ 340
	cis- Nonachlor	Median	130
		Range	10 ~ 950
	trans- Nonachlor	Median	440
		Range	59 ~ 2100
Drins	Aldrin	Median	N.D.
		Range	N.D. ~ 5.2
	Dieldrin	Median	510
		Range	71 ~ 1800
	Endrin	Median	69
		Range	N.D. ~ 200

□ Table 14-2 Statistics of POPs intake from food

(unit: pg/kg/day)

Chemical compound		Statistics	(n=86)
Hexachlorobenzene (HCB)		Median	630
		Range	160 ～ 2100
Heptachlor	Heptachlor	Median	13
		Range	4.5 ～ 47
	cis- Heptachlorepoxide	Median	110
		Range	63 ～ 430
	trans-Heptachlorepoxide	Median	All N.D.
		Range	
Toxaphene	Parlar-26	Median	52
		Range	N.D. ～ 340
	Parlar-50	Median	98
		Range	1.5 ～ 550
	Parlar-62	Median	73
		Range	N.D. ～ 430
Mirex		Median	14
		Range	2.2 ～ 190
PBDE	TeBDEs	Median	290
		Range	160 ～ 1500
	PeBDEs	Median	150
		Range	63 ～ 710
	HxBDEs	Median	36
		Range	8.9 ～ 510
	HpBDEs	Median	N.D.
		Range	N.D. ～ 40
	OcBDEs	Median	25
		Range	N.D. ～ 110
	NoBDEs	Median	36
		Range	N.D. ～ 120
	DeBDEs	Median	230
		Range	72 ～ 980
	Total PBDEs	Median	780
		Range	530 ～ 3000
Pentachlorobenzene		Median	63
		Range	31 ～ 220
HCH	α-HCH	Median	160
		Range	64 ～ 1000
	β-HCH	Median	250
		Range	48 ～ 2000
	γ-HCH	Median	47
		Range	23 ～ 430
	δ-HCH	Median	14
		Range	3.7 ～ 29
Chlordecone		Median	All N.D.
		Range	
Hexabromobiphenyl		Median	N.D.
		Range	N.D. ～ 6.3
HBCD	α-HBCD	Median	N.D.
		Range	N.D. ～ 9.0
	β-HBCD	Median	All N.D.
		Range	
	γ-HBCD	Median	All N.D.
		Range	
	δ-HBCD	Median	All N.D.
		Range	
	ε-HBCD	Median	All N.D.
		Range	
Endosulfan	α- Endosulfan	Median	570
		Range	390 ～ 1300
	β- Endosulfan	Median	280
		Range	130 ～ 810

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1) Chair

Supplementary Information

Overview of the Survey on Accumulation of Dioxins in Humans (FY2002 ～ FY2010)

(1) Nationwide survey

● Blood dioxin concentrations

☐ Table 15 Blood dioxin concentrations by fiscal year

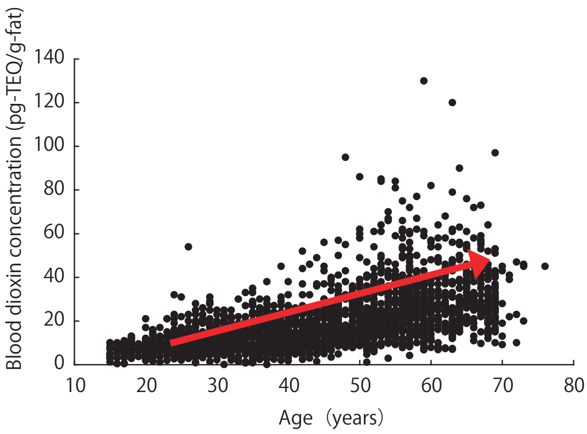
(unit: pg-TEQ/g-fat)

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

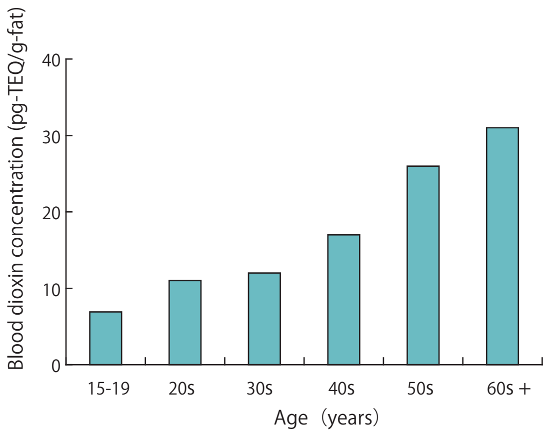
(According to WHO 2006 TEFs)

● Relationship to age

☐ Figure 1 Relationship between age and blood dioxin concentrations



☐ Figure 2 Blood dioxin concentrations by age group



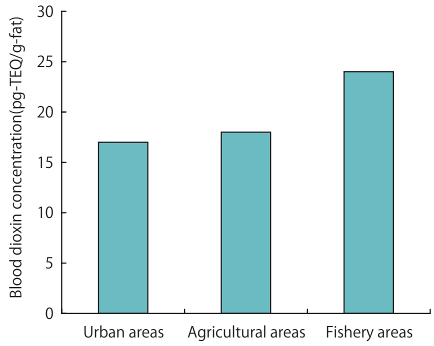
(According to WHO 2006 TEFs)

Differences in blood dixin concentrations by area

☐ Table 16 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)



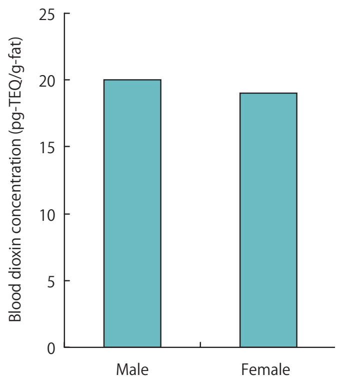
(According to WHO 2006 TEFs)

Difference in blood dioxin concentrations by gender

☐ Table 17 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 18 Dioxin intake from food by fiscal year

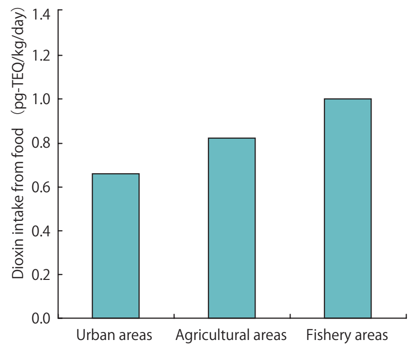
Study year	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Nine-year average
Subjects (N)	75	75	75	75	75	75	75	50	50	Total: 625
Dioxin intake from food (pg-TEQ/kg/day)										
Average	1.1	1.1	0.89	0.89	0.57	0.75	0.68	0.79	0.44	0.82
Standard deviation	1.1	0.92	0.66	0.89	0.44	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

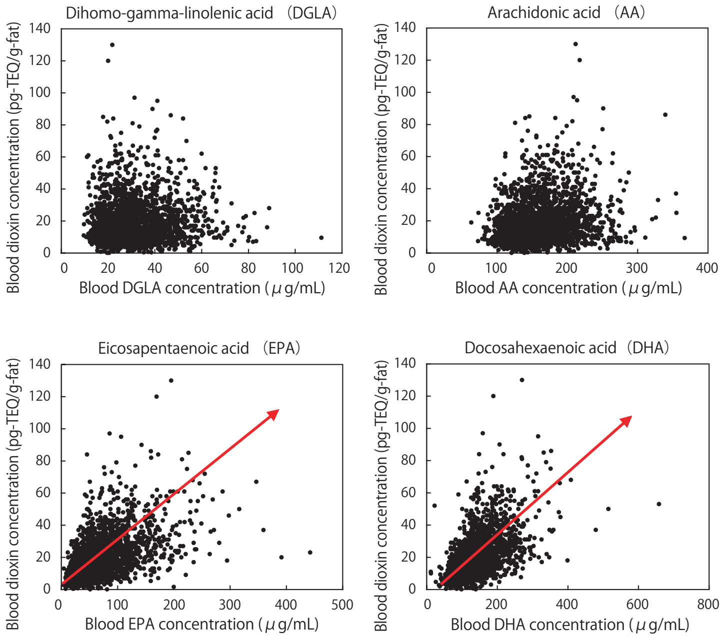
☐ Table 19 Dioxin intake from food by area

	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



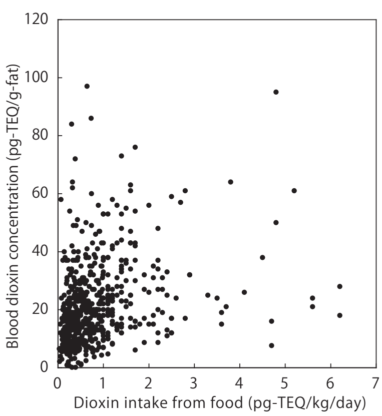
(According to WHO 2006 TEFs)

☐ Figure 3 Relationship between fatty acids and blood dioxin concentrations



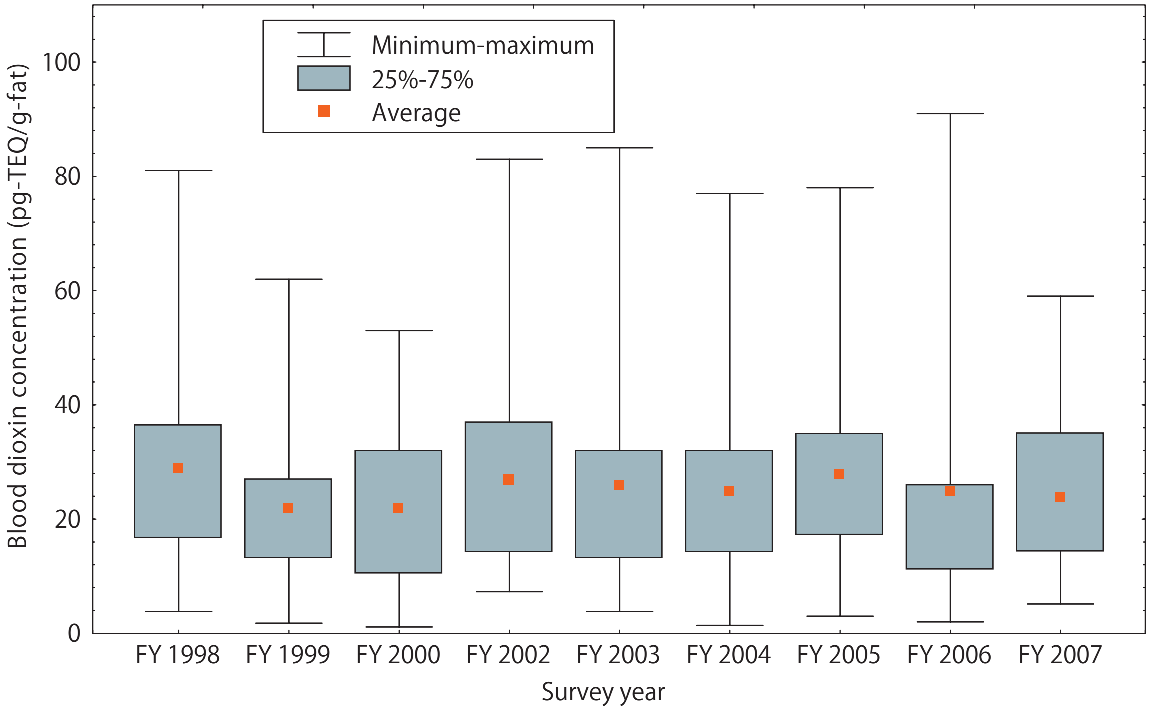
Relationship to blood dioxin concentrations

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

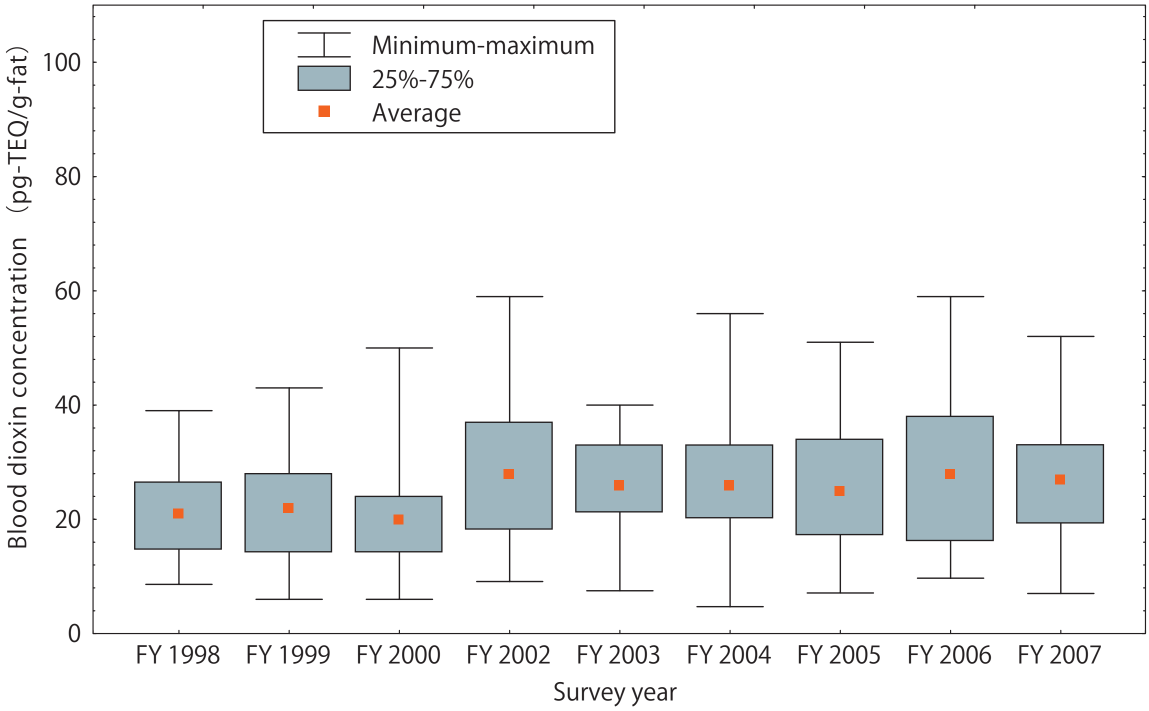


(2) Follow-up survey

□ 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

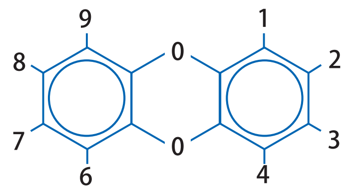
Structure of dioxins

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.

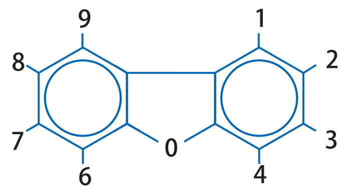
"Dioxins" are defined to include PCDDs, PCDFs and co-planar PCBs in Japan's Law Concerning Special Measures against Dioxins, promulgated on July 16, 1999.

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

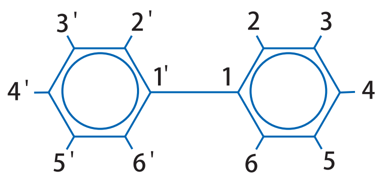
The chemical structure of a dioxin molecule is generally composed of two rings of six carbon atoms (benzene rings, shown as in the figure below) bound by oxygen atom(s) (shown as O in the figure below) with chlorine or hydrogen atoms attached (the numbered positions: 1-9 and 2'-6' in the figure below). 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).



PCDDs



PCDFs



PCBs※

※ 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.

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.

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.

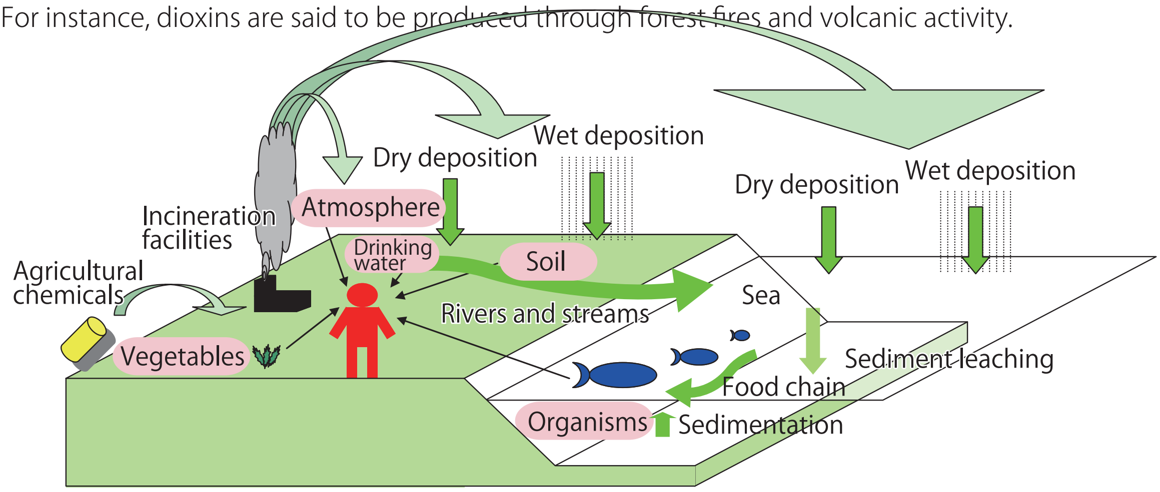
Generation and behavior of dioxins in the environment

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



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 compound 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, PFOS and PFOA measurements were conducted for blood and food.

□ Table 20 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.

In this survey, blood total mercury, urine cadmium and arsenic, and total mercury, methyl mercury, lead, and cadmium in food was measured.

Tolerable Daily Intake (TDI) is established for methyl mercury, cadmium, and inorganic arsenic by each national and international organization.

□ Table 21 Heavy metals studied in this survey

Chemical compound	Usage	Case study in Japan (average)	Standard; Tolerable intake
Total mercury Methyl mercury	Metal mercury is used in fluorescent lights, amalgam, batteries, catalysts, and others. Merhyl mercury is produced by methylation of metal mercury. Methyl mercury is highly toxic.	＜ Total mercury / blood ＞ 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） ＜ Total mercury / food ＞ 0.225 μg/kg body weight/day （Tokyo, 2005 10 samples by duplicated portion method） 0.238 μg/kg body weight/day （Tokyo, 2010 market-basket system） ＜ Methyl mercury / food ＞ 0.198 μg/kg/day （Tokyo, 2005 10 samples by duplicated portion method） 0.152 μg/kg/day （Tokyo, 2010 market-basket method）	＜ Methyl mercury ＞ 0.29 μg/kg body weight/day 2.0 μg/kg body weight/week
Cadmium	Used in watch batteries, plating materials, and others. Cadmium is produced with zinc and is recovered in the process of zinc refinery.	＜ Urine ＞ 3.46 μg/g cr （1243 females, Kayama et al., 2000 – 2001） 1.26 μg/g cr （10753 females, Ikeda et al., 2000 – 2001） ＜ Food ＞ 0.320 μg/kg body weight/day （Tokyo, 2005 10 samples by duplicated portion method） 0.317 μg/kg body weight/day （Tokyo, 2010 market-basket method）	7 μg/kg/week（Japan）
Arsenic	In the past, arsenic compounds were used in rat poisons. Organic arsenic is found in seafood (seaweeds, shrimps, crabs) but are basically non-toxic. Inorganic arsenic is highly toxic.	＜ Arsenic speciation / urine ＞ MMA: 2.01 μg/g cr DMA: 40 μg/g cr （248 residents near metropolitan area Chiba et al., 2001） As (III) 4.0 μg/g cr As (V) 0.2 μg/g cr MMA: 3.2 μg/g cr DMA: 38.5 μg/g cr AB: 71.4 μg/g cr （142 males Nakajima et al., 2001）	<Tolerable Intake of inorganic arsenic) ＞ 15 μg/kg body weight/week（JECFA） ※ Tolerable intake of organic compounds is not established
Lead	Used widely in electrodes, weight, glass products, solder, and others.	＜ Food ＞ 0.154 μg/kg body weight/day （Tokyo, 2010 market-basket system） 4.5 μg/kg body weight/week （Ministry of Health, Labour and Welfare, Japan, 2007 market-basket system）	※ Tolerable intake is not established.

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

4. Pesticides, plasticizers, and others

For those pesticides having harmful effects and are easily decomposed in bodies of organisms, it is general to measure their metabolites in biological samples. Because these metabolites are excreted through urine, metabolites of organophosphorous pesticides, pyrethroid pesticides, and carbamate pesticides in urine was measured in this survey.

In addition, triclosan, used as disinfectant in medicated soaps and shampoos, was measured.

□ Table 22 Pesticide metabolites studied in this survey

Chemical compound	Usage	Case study in Japan (average)
Organophosphorous compound metabolites	Used in pesticides, disinfectant, wood preservatives, and others (metabolites were measured)	＜ Urine ＞ DMP ：1.5 μg/L (73 subjects, Toyama) ：3.1 μg/L (60 subjects, Tokyo) DMTP ：3.2 μg/L (73 subjects, Toyama) ：5.8 μg/L (60 subjects, Tokyo) DEP ：0.8 μg/L (73 subjects, Toyama) ：1.2 μg/L (60 subjects, Tokyo) DETP ：<0.5 μg/L (73 subjects, Toyama) ：<0.5 μg/L (60 subjects, Tokyo) (Toyama Institute of Health)
Pyrethroid pesticide metabolites	Used in pesticides, insecticides, and others (metabolites were measured)	＜ Urine ＞ PBA：0.40 μg/g cr (42 males Toshima et al., 2010) PBA：0.73 μg/g cr (448 subjects Ueyama et al, 2009)
Carbamate pesticide metabolites	Used in pesticides, insecticides, and others (metabolites were measured)	—
Triclosan	Used as disinfectant	—

Phthalate ester and bisphenol A are used in the process of plastic manufacturing. These compounds are suspected to be endocrine disruptors (showing hormonal effects within bodies or obstructing hormone action).

Either compounds excrete from bodies in a short period of time. Therefore, concentration in urine was studied in this survey.

☐ Table 23 Plasticizers studied in this survey

Chemical compound	Usage	Case study in Japan (average)
Phthalate monoesters	Used as plasticizer in plastic, adhesive agents, and others	< Urine > MBP : 52.2 μg/g cr (48.1 ng/mL) MEHP : 5.84 μg/g cr (4.44 ng/mL) MEHHP : 10.1 μg/g cr (8.61 ng/mL) MEOHP : 11.0 μg/g cr (9.2 ng/mL) MBzP : 4.70 μg/g cr (3.46 ng/mL) median 149 pregnant women Suzuki et al., 2010
Bisphenol A	Used as monomer or ingredients in plastic manufacturing	< Urine > 24.1 μg/L (University students 1992) 21.5 μg/L (University students 1999) (Kawamoto et al., 1999)

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 of 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.

In addition, endosulfan and HBCD were measured. The amendment to add endosulfan to the Convention was adopted. HBCD is proposed for listing under the Convention.

☐ Table 24 POPs studied in this survey

Chemical compound	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
Hexachlorobenzen (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

☐ Table 25 POPs candidates studied in this survey

Chemical compound	Usage
HBCD	Used as fire-retardant
Endosulfan	Used as pesticides and insecticides

6． 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 0.83 pg-TEQ/kg/day.
A similar figure has been reported in Western countries.
Conceivable routes of intake include food and the 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 2010 Survey on the Daily Intake of Dioxins from Food) estimated the daily intake at approximately 0.82 pg-TEQ/kg/day. A survey by the Ministry of the Environment (FY 2010 Environmental Survey of Dioxins) estimated the intake from the ambient air at approximately 0.0092 pg-TEQ/kg/day and the intake from soil at approximately 0.0042pg-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 the 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 5 Specification of the average daily intake of dioxins by the Japanese people(FY 2010)

■ Converted to amount per kg of body weight

Total approx. 0.83 pg-TEQ/kg/day

Ambient air	0.0092 pg-TEQ/kg/day	0.013 pg-TEQ/kg/day	Ambient air
Soil	0.0042 pg-TEQ/kg/day		Soil
Seafood	0.78 pg-TEQ/kg/day	0.82 pg-TEQ/kg/day	Food
Meat and eggs	0.040 pg-TEQ/kg/day		
Milk and dairy products	0.013 pg-TEQ/kg/day		
Highly pigmented vegetables	0.00040 pg-TEQ/kg/day		
Grains and potatoes	0.0010 pg-TEQ/kg/day		
Others	0.0038 pg-TEQ/kg/day		

Estimated intake

Tolerable daily intake (TDI) 4 pg-TEQ/kg/day

(According to WHO 2006 TEFs)

Table 26 and Figure 6 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 (Jan,2000)" has decreased emission of dioxins to environment greatly.
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.
Further decreases in intake are expected as a result of measures to reduce dioxins emissions.

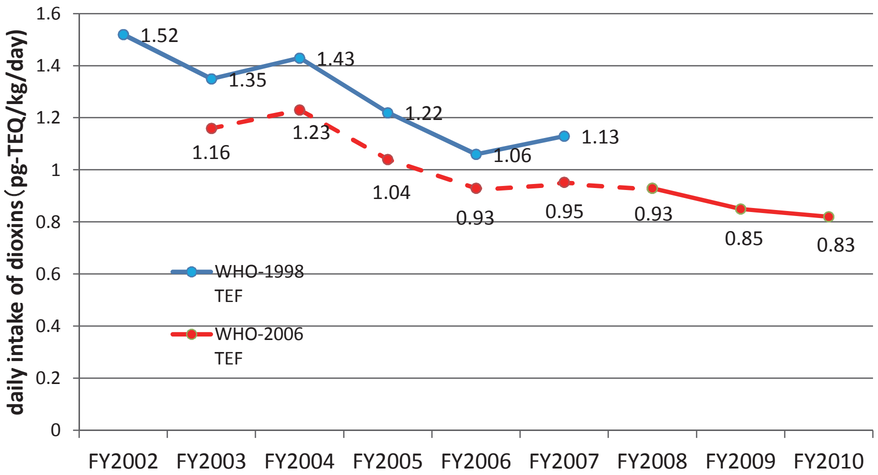
☐ Table 26 Chronological change in of the average daily intake of dioxins by Japanese people

pg-TEQ/kg/day

		FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Ambient air		0.028	0.019	0.018	0.015	0.015	0.012	0.011	0.0090	0.0092
Soil		0.0068	0.0052	0.0044	0.0041	0.0038	0.0058	0.0060	0.0042	0.0042
Food	Seafood	1.29	1.15	1.25	1.09	0.94	1.03	0.86	0.78	0.76
	Meat and eggs	0.15	0.14	0.10	0.069	0.070	0.042	0.040	0.040	0.042
	Milk and dairy products	0.035	0.032	0.047	0.033	0.021	0.023	0.0076	0.013	0.0028
	Highly pigmented vegetables	0.0030	0.0018	0.0028	0.0028	0.0012	0.00064	0.00080	0.00040	0.00060
	Grains and potatoes	0.0010	0.0014	0.0026	0.0022	0.0054	0.0014	0.00080	0.0010	0.00040
	Others	0.010	0.0070	0.010	0.0064	0.0062	0.0056	0.0032	0.0038	0.0052
Total approx.		1.52	1.35	1.43	1.22	1.06	1.13	0.93	0.85	0.83

(According to WHO 1998 TEFs from FY2002 to FY2007, WHO 2006 TEFs from FY2008 to FY2010)

☐ Figure 6 Chronological change in the average daily intake of dioxins by Japanese people



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