COMPARING THE LEVELS OF BLOOD PCDD/Fs AND Co-PCBs BETWEEN WASTE INCINERATOR WORKERS IN JAPAN AND IN SOUTH KOREA

Saito H[1], Ogawa Y[1], Mori I[1], Yoshida R[1], Ohba K[2], Kim KW[3]

[1]National Institute of Occupational Safety and Health, Japan, 6-21-1 Nagao, Tama-ku, Kawasaki, 214-8585 Japan
[2]Kitasato University, 1-15-1 Kitasato, Sagamihara, Kanagawa, 228-8555 Japan
[3]Occupational Safety and Health Research Institute, Korea Occupational Safety & Health Agency, 34-4 Gusan-dong, Bupyong-gu, Incheon, 403-711 Korea

Introduction

It is well known that workers at waste incinerators have the risk of exposure to toxic substance such as polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzo-*p*-dibenzofrans (PCDFs), and coplanar polychlorinated biphenyls (Co-PCBs)[1, 2]. Although many studies have already reported about the blood level of dioxins of incinerator workers, at least to our knowledge, our study is the first to compare blood dioxin levels of incinerator workers from two countries, Japan and Korea.

Material and Methods

Ninety-two Japanese male subjects were recruited from three municipal solid waste incinerators (MSWIs) and one industrial waste incinerator (IWI), mean age 44.8 (22 – 64), and 53 Korean male subjects were from 9 IWIs, mean age 39.7 (27 – 62). Each Japanese incinerator was located in different region and all 9 Korean incinerators were located in the same area of Incheon city. Type of incinerator, furnace, filter and capacity are shown in table 1. This study was approved by the ethics board of both Institutes. Written informed consents were obtained from all subjects.

Table 1: Summary of subjects and subjective incinerator sites

Country	Factory	Subjects (female)	Type*	Furnace (numbers)	Filter**	Capacity
Japan (n=92)	JP1	14	MSWI	Stoker	EP	75 t/d
	JP2	18	MSWI	Stoker(3)	BF	450 t/d
	JP3	37	MSWI	Stoker(2)	BF	180 t/d
	JP4	23	IWI	Rotary kiln(1), Stoker(1)	EP, BF	330 t/d
Korea (n=53)	KR1	6	IWI	Stoker(1), Compound(1), High-temperature(1)	EP	72 t/d
	KR2	6	IWI	Stoker(4)	EP	264 t/d
	KR3	6	IWI	Stoker(2), Rotary kiln(1), High-temperature(1)	BF	97 t/d
	KR4	6	IWI	Stoker(1), Rotary kiln(1)	EP	270 t/d
	KR5	6	IWI	Stoker(1), High-temperature(2)	BF	120 t/d
	KR6	6	IWI	Stoker(1), Compound(1)	BF	75 t/d
	KR7	6	IWI	Rotary kiln(1)	BF	80 t/d
	KR8	6	IWI	Stoker(2), Rotary kiln(1)	EP	150 t/d
	KR9	5	IWI	Stoker(1)	BF	44 t/d

* MSWI: Municipal solid waste incinerator, IWI: Industrial waste incinerator
** BF: Bug filter, EP: Electrostatic precipitator

In the morning of examination day, 70~90ml of blood was collected from subjects. Blood was used for measurements of 7 PCDDs (2378TCDD, 12378PeCDD, 123478HxCDD, 123678HxCDD, 123789HxCDD, 1234678HpCDD, 12346789OCDD), 10 PCDFs (2378TCDF, 12378PeCDF, 23478PeCDF, 123478HxCDF, 123678HxCDF, 123789HxCDF, 234678HxCDF, 1234678HpCDF, 1234789HpCDF, 12346789OcDF), and 12 Co-PCBs (33'44'TeCB, 344'5TeCB, 33'44'5PeCB, 33'44'55'HxCB, 233'44'PeCB, 2344'5PeCB, 23'44'5PeCB, 2'344'5PeCB, 233'44'5HxCB, 233'44'5'HxCB, 23'44'55'HxCB, 233'44'55'HpCB). All blood PCDDs, PCDFs,

and Co-PCBs concentrations were adjusted by the lipid content and multiply each WHO-TEF and added up to get blood PCDDs, PCDFs, and Co-PCBs levels in WHO-TEQ (pg WHO-TEQ/g-lipid).
The differences between means were tested by Welch's t-test. The correlations between variables were evaluated by Pearson's correlation coefficients. The statistical package R release 2.2.1[3] was used for analysis.

Results and Discussion
The mean and the standard deviation (SD) of blood PCDDs for workers in Japan and Korea were 7.68 ± 4.31 and 6.56 ± 7.32, respectively (Fig 1). Though the level was high in Japan compared with that in Korea, the difference was not significant (p=0.31). The mean and SD of blood PCDFs for workers in Japan and Korea were 5.39 ± 3.10 and 9.60 ± 10.08, respectively (Fig 2). The level of Korean workers was significantly higher than that of Japanese workers (p=0.004). The mean and SD of blood Co-PCBs for workers in Japan and Korea were 8.52 ± 6.11 and 3.07 ± 1.72, respectively (Fig 3). The level of Japanese workers was significantly higher than that of Korean workers (p<0.001).

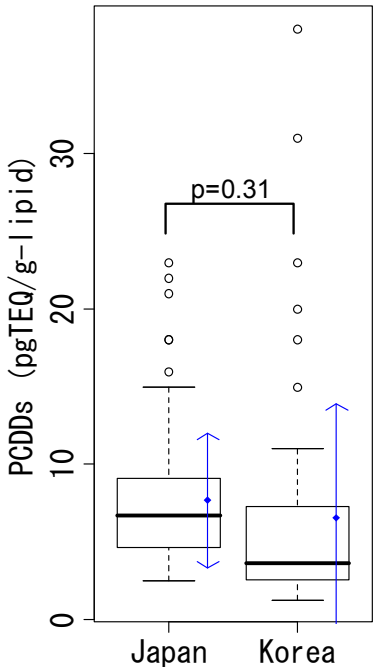

Fig.1

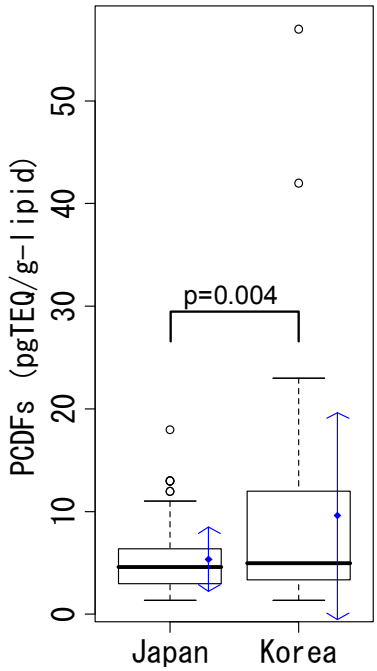

Fig.2

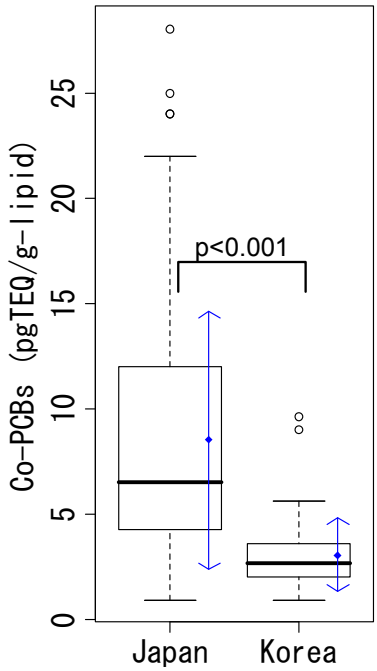

Fig.3

Fig.1~3: Distribution of blood PCDDs, PCDFs, and Co-PCBs for incinerator workers in Japan and Korea. Center line: median, Edges of boxes: the 1st and 3rd quartiles, ends of whiskers: minimum and maximum data value into a maximum of 1.5 times the inter-quartile range (1.5IQR), ○: outlier from 1.5IQR, ●: mean, ↕: SD.

Scattered plot between blood PCDDs and blood PCDFs of incinerator workers in Japan and Korea shows the linear relation (Fig 4). The linear regression among Japanese workers and Korean workers were [blood PCDFs] = 0.95 + 0.58[blood PCDDs] (R^2=0.65), and [blood PCDFs] = 1.07 + 1.30[blood PCDDs] (R^2=0.89), respectively. Scattered plot between blood PCDDs and blood Co-PCBs of incinerator workers in Japan and Korea shows the linear relation (Fig 5). The linear regression among Japanese workers and Korean workers were [blood Co-PCBs] = -0.18 + 1.13[blood PCDDs], R^2=0.64, and [blood Co-PCBs] = 2.45 + 0.095 [blood PCDDs], R^2=0.15, respectively. These relationships suggest the consistent difference of exposure pattern among the two countries. In Japan compared with Korea the exposure to PCDFs had been low and exposure to Co-PCB had been high controlling the PCDDs level.

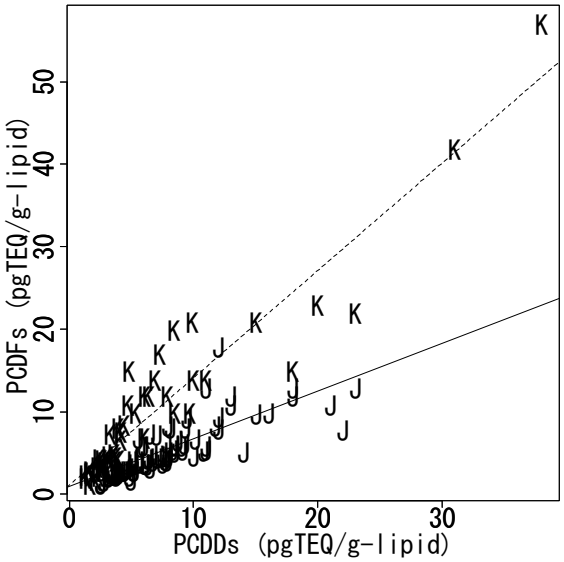

Fig.4: Relationship between blood PCDDs and PCDFs of workers in Japan (J) and Korea (K)
Japan(—): PCDFs = 0.95 + 0.58 PCDDs, R^2=0.64
Korea(·····): PCDFs = 1.07 + 1.30 PCDDs, R^2=0.89

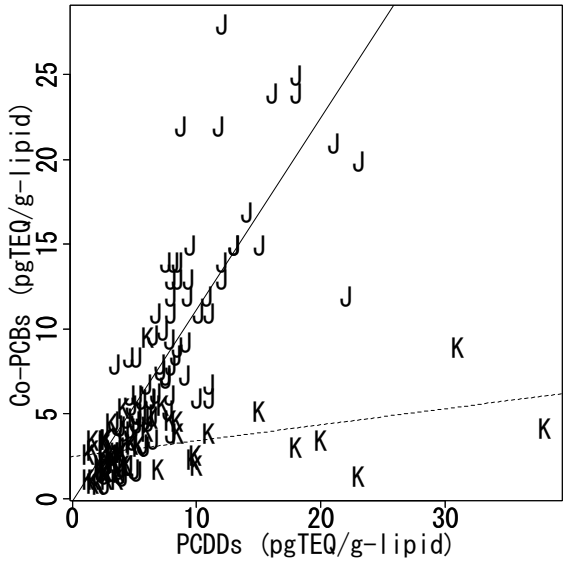

Fig.5: Relationship between blood PCDDs and Co-PCBs of workers in Japan (J) and Korea (K).
Japan(—): Co-PCBs = -0.18 + 1.13 PCDDs, R^2=0.64
Korea(·····):Co-PCBs = 2.45 + 0.095 PCDDs, R^2=0.15

Although the levels of blood PCDDs, PCDFs, and Co-PCBs were low in both countries and not exceeding the level of local residents in Japan, the level of blood PCDFs was significantly high in Korea and the level of Co-PCBs was significantly high in Japan. The difference of blood PCDFs may be explained by the difference of waste between the two countries, because all the Korean incinerators were burning industrial waste but the Japanese incinerators were burning mainly home garbage. Another explanation will be that there was difference in exposure level between the two countries. It is well known that waste incineration produces higher PCDFs than PCDDs and the exposure level of the Korean workers might have been higher than the Japanese workers. The difference in the level of blood Co-PCBs can be explained by the difference of environmental contamination. The estimated amount of total PCBs used in Japan since 1954 is about 54,000 t and it is overwhelming compared with the amount used in Korea[4-7]. Environmental contaminations assessed by mussel in coastal waters suggested that Japan was more polluted than Korea; the Co-PCBs levels in mussel were approximately 3,000 ng/g lipid wt and 170 ng/g lipid wt, respectively[8]. The levels of blood Co-PCBs of Japanese workers were not high in comparison with the level of blood Co-PCBs of Japanese general citizen[9]. To further discuss the process that was responsible to have induced the difference of blood Co-PCBs between the two countries, it is necessary to consider the difference of food intake pattern and their PCB contaminations.

Acknowledgements
This collaborative study was carried out based on an agreement between National Institute of Industrial Health (now National Institute of Safety and Health, Japan), Japan and Occupational Safety and Health Research Institute, Korea. The authors gratefully acknowledge partial financial support to this project by a Grant-in-Aid for Scientific Research from the Ministry of Health, Labour and Welfare.

References

1. Takata T (2003) Survey on the Health Effects of Chronic Exposure to Dioxins and Its Accumulation on Workers of a Municipal Solid Waste Incinerator, Rural Part of Osaka Prefecture, and the Results of Extended Survey Afterwards. Ind Health 41: 189–196.

2. Kumagai S, Koda S, Oda H (2003) Exposure Evaluation of Dioxins in Municipal Waste Incinerator Workers. Ind Health 41: 167-174.

3. R Development Core Team (2005). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

4. Ministry of Environment (2002) The Environmental Monitoring Report on the Persistent Organic Pollutants (POPs) in Japan, http://www.env.go.jp/en/chemi/pops/.

5. Breivik K, Sweetman A, Pacyna JM, Jones KC (2002) Towards a global historical emission inventory for selected PCB congeners – a mass balance approach. 1. Global production and consumption. Sci Total Environ 290(1-3):181-98.

6. Breivik K, Sweetman A, Pacyna JM, Jones KC (2002) Towards a global historical emission inventory for selected PCB congeners – a mass balance approach. 2. Emissions. Sci Total Environ 290(1-3):199-224.

7. Shin SK, Kim HJ, Chung D, Kim JK, Kim KS, Chung YH and Chung IR. A Study on the Appropriate Management of Polychlorinated biphenyls – Containing Wastes. Report of National Institute of Environmental Research, http://www.konetic.or.kr/edu_emc/edudown.asp?serialno=542 (in Korean).

8. Monirith I, Ueno D, Tkahashi S, Nakata H, Sudaryanto A, Subramanian A, Karuppiah S, Ismail A, Muchtar M, Zheng J, Richardson JB, Prudente M, Hue ND, Tana TS, Tkalin VA, Tanabe S (2003) Asia-Pacific mussel watch: monitoring contamination of persistent organochlorine compounds in coastal waters of Asian contries. Marine Polluttion Bulletin 46: 281-300.

9. Ministry of the Envifonment (2000) Detailed Study of Dioxin Exposure: Finding of the Fiscal 1999 Survey, http://www.env.go.jp/en/chemi/dioxins/dioxin-exp/.