

ASSOCIATION OF SOIL CONTAMINATION WITH DIOXIN LEVELS IN CHILDREN IN KITA, TOKYO, JAPAN

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Abstract

A soil contamination survey was conducted for the reutilization of the land adjacent to a large apartment complex in Kita City, Tokyo in 2005. Since some samples exceeded the environmental guideline value (1,000 pg TEQ/g) of dioxins over 1.3-2.2 times, the health authority of Kita City performed a health survey for inhabitants in this area. Blood dioxins concentrations (pg TEQ/g-lipid) were determined in a total of 138 people, including 66 children aged 3-15 yrs. The concentration of Group 1 (16 yrs \leq) was 12 ± 5.2 (m \pm SD), Group 2 (7-15 yrs) and Group 3 (3-6 yrs) had 8.0 ± 4.5 and 15 ± 13 , respectively. The congener/isomer profile of dioxins in blood and soil samples differ markedly each other. Thus the present data do not support a direct link with the soil contamination. When the children were classified into 3 groups according to their feeding mode, their blood dioxin concentrations were 21 ± 14 for breast milk only, 8.9 ± 6.5 for both breast and formula milk, and 5.9 ± 2.7 for formula milk only. Since there have been no such data for infants so far, they could be used for health risk assessment for young children.

Introduction

In 2005, in advance of the reutilization of a part of the land adjacent to a large apartment complex (approximately 5,000 families, 10,000 habitants) in Kita City, Tokyo, a soil contamination survey was carried out according to the Environment Conservation Ordinance of Tokyo Metropolitan Government. The survey results revealed that some surface soil samples from the day nursery playground and the residential squares were contaminated with dioxins, the level of which was found to exceed the environmental guideline value (1,000 pg TEQ/g) over 1.3-2.2 times. This is the very first case in Japan that the soil contamination by dioxins was found in the residential area and playground for little children who may be exposed to the compounds by handling the soil directly. This incidence evoked a great anxiety among the community. Thus, the authority of Kita City organized an expert committee (Chair and co-chair: C. Tohyama and I. Uchiyama, respectively) and performed a health survey, focusing on blood dioxin concentrations for inhabitants in this contaminated area and studied possible association of blood dioxin with the contaminated soil in terms of congener/isomer types. In addition, little information is available for the blood dioxin concentrations of young children worldwide, we studied their feeding mode, i.e. breast milk and/or formula milk with the blood dioxin concentrations.

Materials and Methods

Target area: We selected the residential squares in 5-chome Toshima, Kita City, Tokyo, because some surface soil samples from the day nursery playground and the residential squares were contaminated with dioxins, the level of which was found to exceed the environmental guideline value as described above. This soil survey had been conducted according to the Environment Conservation Ordinance of Tokyo Metropolitan Government in advance of the reutilization of a part of the land adjacent to a large apartment complex (approximately 5,000 families, 10,000 habitants) in the squares.

Target subjects: The Kita City authority distributed information on the objectives of the health survey to the inhabitants in the contaminated area by public meetings and invited an application. Among 248 applicants, we selected the subjects for the present study according to the criteria as follows: (1) To assess exposure to dioxins, children who are thought to have more frequent and direct contact with soil have a priority over adults; (2) Among children, higher graders of the elementary school in the area have priority over the lower ones who may still have the influence of the breast milk dioxins; (3) Women at reproductive age have priority over other adults

because of their concerns about the dioxin contamination for their prospective pregnancy; (4) Infants under 6 year-old who were fed with breast milk only or also with formula in combination are recruited with their mothers as a pair for this survey; and (5) People who lived in this apartment complex longer have priority over who did less. According to these criteria, adults and children who might have been exposed to more frequently the contaminated soil were selected as subjects to this health survey. The total numbers of subjects were 138 (male 52 and female 86). Their age (average and range) was 13.9 years (range: 3-36) for men and 22.9 years (range: 3-62) for women, respectively. Consents were obtained from the subjects after explanation of the details of the survey by the Expert Committee chairs. In the health survey, subjects were individually interviewed and examined by medical doctors for general health examinations, by pre-trained public health nurses for life styles, such as residential period, period of attendance in the day-care nursery, estimated times of soil contact, food habit and pregnancy episode. Blood (7 mL from infants who were 6 years or younger; and 14 mL from the rest of the subjects) were collected for dioxin analysis. Dioxin and related compounds (a total of 29 congeners that were given TEF values) were determined using high-resolution gas-chromatography connected to high-resolution mass spectrometry, according to the method authorized by the Ministry of the Environment (2002).

Results and Discussion

Blood dioxin concentrations: The blood concentrations of PCDDs, PCDFs and Co-PCBs in the subjects were summarized in Table 1. Average blood concentrations of male and female subjects who were 16 years or older were 12 ± 5.2 pg TEQ/g-lipid, and these values were similar to the ones obtained by surveys that had been conducted for inhabitants in other areas of Japan by the Ministry of the Environment (Table2)¹⁻³. The average blood concentrations of male and female subjects who were 7-15 years old and those of 3 - 6 years were found to have 8.0 ± 4.5 and 15 ± 13 pg TEQ/g-lipid, respectively. To our knowledge, as no data on blood dioxins concentrations of children who were 12 years or younger was not available, no direct comparison of the present result was possible⁴. To estimate body burden of dioxins in infants, Lorber and Phillips used one-compartment drug kinetic analysis and estimated a time-trend of blood dioxin concentrations in infants who accumulated dioxins via breast milk and /or formula milk⁵. They adopted several exposure scenarios in terms of blood concentrations and the milk feeding period. For example, the blood concentration was estimated by the assumption that the intake of dioxins from milk ranged from 242 pg TEQ/kg/day just after birth to 18pg-TEQ/kg/day one year later, and the milk feeding period was varied from 0 to 2 years. The present results on the blood dioxins concentrations of infants were within the range of this simulation model.

Relationship of blood dioxin concentrations with other factors

Soil contamination: The soil samples from the contaminated area were found to contain greater amounts of 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF and 1,2,3,4,7,8-HxCd on a TEQ basis with a special feature of PCDFs as a overwhelmingly predominant component. In contrast, the congener/isomer analysis revealed that the blood samples of the present subjects contained larger amounts of PCDDs such as 1,2,3,7,8-PeCDD and 1,2,3,6,7,8-HxCDD as well as 2,3,4,7,8-PeCD, on a TEQ basis, compared to other congener/isomers, which is similar to the results of many other studies, but was distinct from the congener/isomer pattern in the contaminated soil samples.

Period of residence, period of attendance at the day-care nursery and frequency with soil contact:

No significant relationship was found with blood dioxin concentrations of the subjects with these parameters.

Feeding mode in terms of breast milk and formula milk: To study a relationship with blood dioxin concentrations and the milk feeding mode, 66 children who were 3-15 years old were divided by three groups. Subjects who were fed with breast milk only (Group A: 17 cases), the breast milk and formula milk in combination (Group B: 44 cases) and formula milk only (Group C: 5 cases). Their blood dioxins concentrations (mean±SD) were 21 ± 14 pg TEQ/g-lipid for Group A, 8.9 ± 6.5 pg TEQ/g-lipid for Group B, and 5.9 ± 2.7 pg TEQ/g-lipid for Group C. The median and range (in parentheses) of the dioxin concentrations of Group A, B and C were 17 (5.1-55), 7.1 (1.5-34), 6.0 (2.3-9-7) pg TEQ/g-lipid, respectively. As a whole, subjects belonging to Group A had significantly higher dioxins in their blood than those of Group B and C ($p < 0.01$) In addition, the

longer the period of breast milk feeding is, the higher the blood dioxins concentrations remains. The longer the time after the termination of breast milk feeding is, the lower the blood dioxins concentrations stays.

Conclusions

- (1) The present health survey data strongly suggest that the inhabitants and day-nursery infants did not take up and accumulate an excess amount of dioxins from the soil of playground and vicinity of the residential areas.
- (2) From the present health survey, we obtained data on blood dioxins concentrations in children aged 3-12 years, the data of which have not been reported so far. In this age group, the blood dioxins levels seem to be strongly influenced by the duration of breast feeding and post-feeding duration of breast milk.

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Table1 Dioxin concentration

sex	age	No of subjects	Dioxin (pg-TEQ/g-lipid)		Dioxin (pg/g-lipid)	
			PCDDs+PCDFs	Co-PCBs	PCDDs+PCDFs	Co-PCBs
male	3-6	16	12±9.0 (8.1, 1.3-38)	5.2±3.6 (3.9, 0.36-14)	130±46 (130, 48-220)	10000±7400 (8000, 2300-34000)
	7-15	20	6.3±3.1 (5.8, 1.4-16)	2.3±1.9 (1.6, 0.33-6.1)	100±38 (100, 49-170)	4900±2900 (3500, 2000-13000)
	16≤	16	7.3±2.0 (7.5, 4.0-10)	3.1±1.4 (2.6, 1.2-6.2)	120±56 (98, 62-260)	6400±2900 (5500, 3500-14000)
female	3-6	17	9.5±8.9 (5.9, 1.2-35)	4.3±5.0 (2.3, 0.27-20)	120±83 (86, 38-290)	8400±8300 (4200, 1800-31000)
	7-15	13	5.1±2.7 (4.0, 1.9-11)	2.3±2.0 (1.5, 0.30-7.4)	81±30 (71, 49-130)	4700±2500 (4500, 2000-11000)
	16≤	56	8.6±4.5 (7.9, 0.89-26)	4.1±1.9 (3.9, 0.38-9.3)	170±90 (150, 71-500)	7500±3400 (6900, 2200-21000)
total	3-6	33	10±8.9 (7.6, 1.2-38)	4.7±±4.3 (3.3, 0.27-20)	130±67 (110, 38-290)	9300±7800 (6600, 1800-34000)
	(mean 4.5, range 3-6)					
	7-15	33	5.8±3.0 (5.1, 1.4-16)	2.3±1.9 (1.5, 0.30-7.4)	95±36 (92, 49-170)	4800±2700 (3800, 2000-13000)
	(mean 9.4, range 7-15)					
	16≤	72	8.3±4.1 (7.8, 0.89-26)	3.9±±1.8 (3.5, 0.38-9.3)	160±86 (150, 62-500)	7200±±3300 (6500, 2200-21000)
	(mean 31.1, range 16-62)					

top: mean ± standard deviation, bottom:(median, range)

Table2 The existent surveys of blood dioxins levels in Japan

organizer	the Ministry of the Environment			Hachioji City
	the whole country			Hachioji City
regions	5 regions 14 districts	5 regions 15 districts	5regions 15 districts	
year	2002	2003	2004	2004
subjects(No)	259	272	264	12
age(year)				
mean	44.4	41.7	45.2	13.3
range	16-72	15-69	15-70	13-14
PCDDs+PCDFs (pg TEQ/g-lipid)				
mean ± SD	15±9.0	14±7.8	14±9.3	6.7±2.5
median, range	14, 0.61-56	13, 2.6-51	13, 0.76-56	5.8, 4.0-11
Co-PCBs (pg TEQ/g-lipid)				
mean ± SD	11±9.7	9.4±7.2	9.3±7.5	1.9±1.1
median, range	8.8, 0.33-72	7.1, 0.27-63	7.4, 0.31-47	1.8, 0.45-3.4
PCDDs + PCDFs+ Co-PCBs (pg TEQ/g-lipid)				
mean ± SD	27±18	24±14	24±16	8.7±3.5
median, range	23, 1.6-110	21, 3.1-110	20, 1.1-90	8.1, 4.5-14