DEVELOPMENTAL CONDITION IN 10-MONTH-OLD JAPANESE INFANTS PERINATALLY EXPOSED TO ORGANOCHLORINE PESTICIDES, PCBs AND DIOXINS

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Introduction

Organochlorine pesticides, polychlorinated biphenyls (PCBs) and dioxins (polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans and coplanar PCBs) are widespread toxic environmental contaminant. Due to a high persistency, they can be detected in food products of animal origin, human tissue and blood [1, 2, 3]. Once entered into the food-chain, these lipophilic chemicals are bioconcentrated in exposing human beings who continuously absorb very small doses. Substantially greater amounts of PCBs and dioxins are transferred via nursing than as a result of placental passage in both animals [4, 5] and humans [6, 7]. Infant formulae contains only lipids of a vegetable origin with a negligible content of PCBs and dioxins. Since breast-fed infants receive considerably more of these compounds compared to those formula-fed, controversy exists over whether breast-feeding should be encouraged.

So far, the effects of only dichlorodiphenyldichloroethane (DDE), PCB and/or dioxins exposure have been studied concerning psychomotor development [8] and neurological condition [9]. We now report on the relationship between perinatal exposure to the organochlorine pesticides such as hexachlorocyclohexanes (HCHs), dichloro-diphenyltrichloroethane (DDT), dieldrin, heptachlor, chlordane and their metabolites, PCBs and dioxins and the developmental condition at about 10 months of age.

Materials and Methods

One hundred twenty four breast milk samples (50~100 ml each) were obtained at 2 to 4 months after childbirth. These samples were employed to determine the concentrations of the organochlorine pesticides (HCH, heptachlor epoxide (HCE), chlordane, dieldrin and DDT), PCB and dioxins by ECD gas chromatography or high resolution GC/MS method [10, 11]. Toxic equivalency factor approaches were used for dioxins [12] and toxic equivalent (TEQ)-sum of all the congeners detected in the breast milk was summarized as the total TEQ concentration or level.. At about 10 months of mean age, total developmental condition was assessed using

age-specific developmental examination, that is, the Enjohji Scales of Infant Development [13]. The Enjohji consists of three categories and six indices – the motor developmental category (gross motor and hand skill or fine motor indices), the social developmental category (social habit and personal relation indices) and the language developmental category (speech and understanding indices). Each index is scaled like standard IQs. Testing was carried out at clinic visits in the presence of the mother(s).

In order to conduct more reliable statistical analysis, data were categorized into two groups according to the concentrations of the compounds, which were adjusted for years, and the Enjohji scores, donated by 0 (less than the mean value including minimum one) and 1 (the last quartile including maximum value). Then, we examined the relationship between the Enjohji scores and the contamination levels of the organochlorine pesticides, PCBs and dioxins by simple logistic regression analysis, and calculated odds ratios. In addition, multiple logistic regression analysis was done to compute the joint effect of every two compounds, each of which showed less than 0.300 of *p*-value in simple logistic regression analysis, on the developmental condition.

Results and Discussion

Respective mean scores of the six indices for the Enjohji Scales of Infant Development are shown in Table 1. Although the Enjohji was originally standardized to a mean of 100 and standard deviation of 15, our actual means were higher. This has been observed in the Bayley Scales of Infant Development [14], and may indicate a need for new norms [15]. This seems to be also the case in the Enjohji, because it was revised about 23 years ago.

Table 1. Enjohji Scales of Infant Development scores at about 10 months of age in 106 Japanese infants

Developmental Category					
Motor		Social		Language	
Gross motor	Hand skill Understanding	Social habit	Personal relation	Speech	
116.6±1.6	116.7±1.8	115.9±1.9	123.2±1.8	113.5±2.0	114.2±1.7

Entries are means ± standard errors.

Anyhow, relationship between the Enjohji Scales of Infant Development and perinatal exposure to organochlorine pesticides, PCBs and dioxins were examined by simple logistic regression analysis and the results are shown in Table 2. Any of the Enjohji indices were not related to perinatal PCBs and dioxins exposure. HCH and DDT, however, indicated significantly negative effects on some developmental indices at around 10 months of age. In particular, HCH showed negative effects on 5 of the 6 indices, except for speech one.

Joint effects of two compounds were also studied by multiple logistic regression analysis and the results are indicated in Table 3. Combination of HCH and DDT has more negative profound effects on the hand skill, personal relation and understanding indices than each of them does. A negative joint effect of DDT and HCE is also observed on the gross motor score.

Table 2. Relationship between Enjohji Scales of Infant Development scores and perinatal exposure to organochlorine pesticides, PCBs or dioxins by simple logistic regression analysis (p-value<0.200)

Response Variable (Enjohji Scale)	Exposure Variable (Odds Ratio, p-value) Organochlorine pesticides, PCBs and Dioxins
Motor Development	
Gross motor	**HCH (0.54, 0.050)**, DDT (0.65, 0.143), HCE (0.68, 0.164)
Hand skill	**HCH (0.55, 0.054)**, Chlordane (2.31, 0.135)
Social Development	
Social habit	**HCH (0.57, 0.073)**
Personal relation	**HCH (0.59, 0.071), DDT (0.39, 0.018)**
Language Development	
Speech	—
Understanding	**HCH (0.64, 0.099), DDT (0.56, 0.067)**

Boldface indicates statistically significant exposure variable (p-value<0.100).

Table 3. Joint effects of two perinatally exposed compounds on Enjohji Scales of Infant Development scores by multiple logistic regression analysis

Response Variable (Enjohji Scale)	Exposure Variables (Organochlorine pesticides, PCBs and Dioxins) X_1	X_2	Odds Ratio	p-value
Motor Development				
Gross motor	HCH (0.80)	DDT (0.63)	0.50	0.256
	HCH (0.59)	HCE (0.75)	0.44	0.101
	DDT (0.62)	**HCE (0.59)**	**0.37**	**0.096**
Hand skill	**HCH (0.69)**	**DDT (0.52)**	**0.36**	**0.070**
Social Development				
Social habit	—	—		—
Personal relation	**HCH (0.70)**	**DDT (0.34)**	**0.24**	**0.013**
Language Development				
Speech	—	—	—	—
Understanding	**HCH (0.60)**	**DDT (0.62)**	**0.37**	**0.055**

Number in parenthesis is odds ratio of the single compound.

Boldface shows statistically significant joint effect of the two compounds (X_1, X_2) at p-value less than 0.100.

Transplacental exposure to PCBs was associated with lower psychomotor scores at both 6 and 12 months of age [16] and has a small negative effect on the neurological condition in 18 month-old toddlers [9]. In this study, however, neither PCBs nor dioxins showed negative effect on the total developmental condition at about 10 months old Japanese infants.

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