Effects of Lactational Exposure to Organochlorine Pesticides on Lymphocyte Subpopulations and Thyroid Functions in Japanese Babies

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Abstract

Effects of lactational exposure to organochlorine pesticides such as hexachlorocyclohexanes (HCHs), 1,1,1-trichloro-2,2-bis-(4-chlorophenyl)-ethane (DDT), dieldrin and heptachlor-epoxide (HCE) on lymphocyte subpopulations and thyroid functions in the peripheral blood of 75 breast-fed Japanese babies.Estimated total intakes of DDT (p,p'-DDE + p,p'-DDT) from the breast milk significantly and negatively correlated with the percentages of CD3-positive (mature T-lymphocyte) and CD4-positive (helper/inducer) lymphocytes and also with the serum levels of triiodothyronine (T_3), thyroxine (T_4) and thyroxine binding globulin (TBG) in the peripheral blood of breast-fed babies. Therefore, exposure to background levels of DDT through the breast milk seems to cause some effects on both the immune system and thyroid functions in Japanese babies.

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Introduction

Japanese food has been contaminated with some organochlorine pesticides[1] and Japanese people have also been contaminated with these pesticides[2]. Consequently, some pesticides such as HCHs, DDT, dieldrin and HCE have been determinated in Japanese breast milk and their mean concentrations on fat weight basis were about 1300, 950, 20 and 9ppb, respectively[3]. Their levels were much higher than those of polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and coplanar polychlorinated biphenyls (Co-PCBs) in Japanese breast milk[3]. Therefore, we should give due attention to possible health consequences of these organochlorine pesticides in breast-fed babies.

In order to clarify the biological and/or biochemical effects of lactational exposure to HCHs, dieldrin, DDT and HCE, we investigated the lymphocyte subpopulations and thyroid functions in the peripheral blood of 75 breast-fed babies in relation to their intakes.

Experimental Methods

Eighty two mothers volunteered to participate in all in this study and they had a normal pregnancy without use of medicines. Breast milk (50~100mℓ), sampled 2 to 3 months after childbirth, was used to determine concentrations of HCHs, dieldrin, DDT and HCE by ECD gas chromatography method[1].

About 1 year after birth, 5 to 10mℓ of peripheral blood samples were individually obtained from 75 breast-fed babies. These blood samples were used to measure the lymphocyte subpopulations by indirect immunofluorescence using monoclonal mouse anti-human antibodies against CD3, CD4 , CD8, CD4 + CD8, CD16, CD20 and HLA-DR, and their relative population densities were calculated[4]. They were also employed to determine serum concentrations of T_3, T_4, TSH and TBG by radioimmunoassay methods by using commercially available kits[5].

Total intakes (μ g/kg body weight) were estimated by multiplying daily intakes (ng/kg body weight) of HCHs, dieldrin, DDT and HCE from the breast milk, which were calculated with their levels in the breast milk times an expected intake of breast milk in Japanese baby, namely, 120g/kg body weight, by individual duration of breast feeding (days).

Analysis of variance (ANOVA) was applied to examine the relationship of respective estimated total intakes of these pesticides from the breast milk to each variable of interest and statistical significance was evaluated by Student's *t*-test.

Results

1) Concentrations of the organochlorine pesticides in the breast milk

Among HCHs isomers, β-HCH only was detected and determined in the breast milk of 82 mothers. In DDT and it's metabolites, only two congeners, namely, p,p'-DDE and p,p'-DDT were detected and p,p'-DDE was dominant. Therefore, in this study DDT indicates combined concentrations of p,p'-DDE and p,p'-DDT in the breast milk.

Respective median, minimum and maximum concentrations of β-HCH, dieldrin, DDT and HCE on the whole and fat weight bases are shown in Table 1. Order of median concentration was β-HCH, DDT, HCE and dieldrin. Concentrations of β-HCH and DDT were two orders of magnitude higher than those of HCE and dieldrin.

Table 1. Concentrations of the organochlorine pesticides in the breast milk of 82 mothers

Organochlorine Pesticide	Median (min. ~ max.) in ppb	
	Whole Basis	Fat Basis
β-HCH	12.1 (0.7 ~ 51.1)	365 (39 ~ 1229)
Dieldrin	0.11 (0.02 ~ 1.04)	3.5 (1.0 ~ 27.0)
DDT	10.1 (1.0 ~ 61.4)	308 (52 ~ 1348)
HCE	0.13 (0.02 ~ 0.50)	4.0 (1.0 ~ 17.0)

2) Estimated intakes of the organochlorine pesticides from the breast milk

Estimated total median, minimum and maximum intakes of the organochlorine pesticides are indicated in Table 2. Total median intakes of β-HCH, dieldrin, DDT and HCE were 401, 3.5, 325 and 4.6 μg/kg body weight, respectively.

Table 2. Estimated total intakes of the organochlorine pesticides from the breast milk in 75 breast-fed babies

Organochlorine Pesticide	Median (min. ~ max.)
	μg/kg body weight
β-HCH	401 (24.5 ~ 2025)
Dieldrin	3.5 (0.22 ~ 33.7)
DDT	325 (18.5 ~ 2019)
HCE	4.6 (0.36 ~ 16.9)

3) Correlation between estimated total intakes of the organochlorine pesticides and peripheral lymphocyte subpopulations in breast-fed babies.

Percentages of lymphocyte subpopulations were examined in the peripheral blood of 69 brea-

st-fed babies and simple correlation coefficients of estimated total intakes of respective organochlorine pesticides with the percentages of lymphocyte subpopulations were calculated. The results are shown in Table 3.

Intakes of dieldrin and DDT from the breast milk showed significant negative correlation with the percentages of CD3-positive lymphocytes. Intake of DDT also negatively correlated with the percentages of CD4-positive lymphocytes and this relationship is indicated in Fig. 1.

Table 3. Simple correlation of estimated total intakes of the organochlorine pesticides from the breast milk with percentages of lymphocyte subpopulations in the peripheral blood of breast-fed babies

	Correlation Coefficient					
	CD3	CD4	CD8	CD16	CD20	HLA-DR
β-HCH	-0.091	-0.087	0.033	0.070	0.046	-0.025
Dieldrin	-0.272*	-0.207	-0.121	0.094	0.193	0.214
DDT	-0.325*	-0.307*	-0.119	-0.122	0.258	0.224
HCE	-0.125	-0.238	0.092	0.092	0.073	0.081

* : $p<0.05$

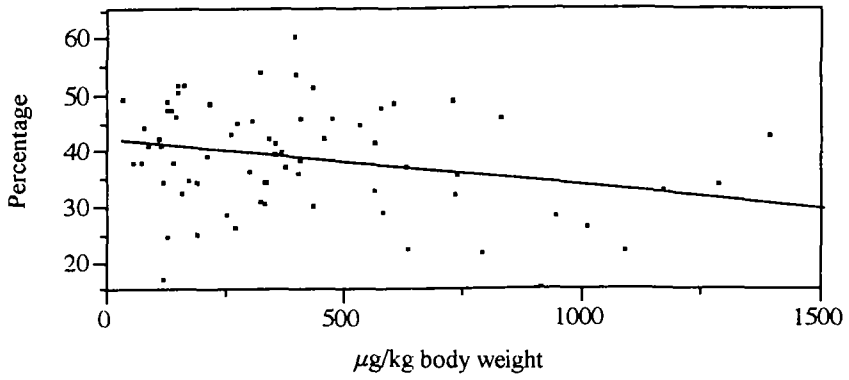

Fig. 1. Negative correlation between the estimated total intakes of DDT from the breast milk and the percentages of CD4-positive lymphocytes in the peripheral blood of 69 breast-fed babies (p=0.021)

4) Correlation between estimated total intakes of the organochlorine pesticides and thyroid functions in breast-fed babies

Serum levels of T_3, T_4, TSH and TBG were determined in the peripheral blood of 71 breast-fed babies and simple correlation coefficients of estimated total intakes of respective organochlorine pesticides with the serum levels related to thyroid functions were calculated. The results are shown in Table 4.

Table 4. Simple correlation of estimated total intakes of the organochlorine pesticides from the breast milk with serum levels related to thyroid functions in the peripheral blood of breast-fed babies

	Correlation Coefficient			
	T_3	T_4	TSH	TBG
β-HCH	-0.059	-0.159	-0.022	-0.076
Dieldrin	-0.179	-0.029	0.015	-0.008
DDT	-0.257*	-0.381**	0.146	-0.307*
HCE	-0.064	-0.183	0.045	-0.062

* : $p<0.05$, ** : $p<0.01$

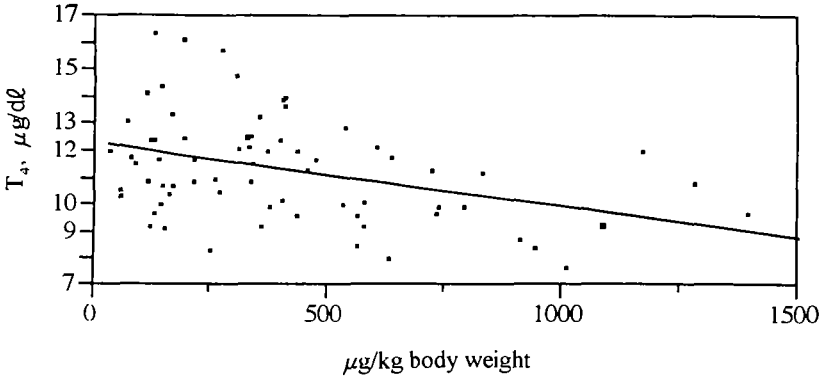

Fig. 2. Negative correlation between the estimated total intakes of DDT from the breast milk and the levels of T_4 in the serum of 71 breast-fed babies ($p=0.001$)

The estimated total intake of DDT from the breast milk showed significant negative correlation with the serum concentrations of T_3, T_4 and TBG. The relationship of the intake of DDT to the serum level of T_4 is indicated in Fig. 2.

Discussion

We have already determined these organochlorine pesticides in Japanese breast milk collected in 1990 to 1992[3]. The breast milk in this study was collected in 1994 and 1995. The concentra- tions of these pesticides in our former study were 2 to 6 times higher than those in this study and in addition to p,p'-DDE and p,p'-DDT, p,p'-DDD and o,p'-DDT were also determined. At the present time, the reason of this marked decrease in their concentrations is unknown and maybe human contamination with these pesticides was truly decreased during such a short period.

Even in such decreased levels of the pesticides in the breast milk, their estimated intakes were 100 to 10,000 times greater than those of PCDDs, PCDFs and Co-PCBs as a whole in toxic equivalent quantity (TEQ) converted into 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) and lactational exposure to DDT in particular significantly decreased the percentages of CD3- and CD4-positive lymphocytes and also serum levels of T_3, T_4 and TBG in the peripheral blood of breast-fed babies. Therefore, exposure to background levels of DDT through breast milk may cause some effects on both immune system and thyroid functions in Japanese babies.

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