

Effects of Lactational Exposure to Chlorinated Dioxins and Related Chemicals on Thyroid Functions in Japanese Babies

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Abstract

Effects of lactational exposure to polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and coplanar polychlorinated biphenyls (Co-PCBs) on thyroid functions were studied in the peripheral blood of 71 breast-fed Japanese babies. Estimated total intakes 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) from the breast milk significantly and negatively correlated with the levels of thyroxine (T_4) and positively correlated with the levels of thyroid stimulating hormone (TSH) in the blood of breast-fed babies. Therefore, exposure to background levels of PCDDs, PCDFs and Co-PCBs through breast milk may cause some effects on thyroid functions in Japanese babies.

HUMAN EXPOSURE

Introduction

Human beings have been contaminated with extremely toxic PCDDs, PCDFs and Co-PCBs¹⁾²⁾³⁾. Consequently, these chemicals have been also determined in the human breast milk. According to their levels in the breast milk, breast-fed babies in Japan are considered to have relatively a large amount of these chemicals, namely, about 100 to 200 TEQ pg/kg body weight/day²⁾. Babies seem more sensitive to the toxic chemicals, so we should give due attention to their possible health consequences in breast-fed babies.

In order to clarify the effects of lactational exposure to PCDDs, PCDFs and Co-PCBs on thyroid functions, we investigated the levels of thyroid hormones, TSH and thyroxine binding globulin (TBG) in the peripheral blood of 71 babies in relation to their intakes from breast milk.

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 PCDDs, PCDFs and Co-PCBs by high resolution GC-MS method and the amounts of TEQ were calculated in the breast milk using the international toxic equivalent factors (TEF) for PCDDs and PCDFs, and the TEFs by WHO-ECEH for Co-PCBs¹⁾²⁾³⁾.

About 1 year after birth, 5 to 10ml of peripheral blood samples were individually obtained from 71 breast-fed babies. These blood samples were used to determine serum concentrations of triiodothyronine (T_3), T_4 , TSH and TBG by radioimmunoassay methods using commercially available kits⁴⁾.

Total TEQ intakes (ng/kg body weight) were estimated by multiplying daily TEQ intakes (pg/kg body weight) of PCDDs, PCDFs and Co-PCBs from the breast milk, which were calculated with their TEQ 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 the estimated total TEQ intakes of PCDDs, PCDFs and Co-PCBs from the breast milk to each variable of interest and statistical significance was evaluated by Student's *t*-test.

Results

1) Concentrations of PCDDs, PCDFs and Co-PCBs in the breast milk

Respective median concentrations of PCDDs, PCDFs and Co-PCBs as TEQ on the whole and fat weight bases were 0.95 and 25.7ppt as a whole in the breast milk of 82 mothers. The ranges of concentrations on the whole and fat weight bases were 0.27 to 2.53ppt and 8.6 to 48.5ppt, respectively.

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2) Estimated intakes of PCDDs, PCDFs and Co-PCBs from the breast milk

The median estimated total intakes of PCDDs, PCDFs and Co-PCBs as TEQ was 29.0 ng/kg in 75 breast-fed babies and the range was 6.1 to 83.6 ng/kg.

3) Thyroid function tests in breast-fed babies

Results of the examination in thyroid functions in the serum of 71 breast-fed babies are summarized in Table 1.

Table 1. Results of thyroid function tests in the serum of 71 breast-fed babies

	Median (min. ~ max.)
Triiodothyronine (T_3 , ng/mL)	2.00 (1.00 ~ 2.50)
Thyroxine (T_4 , $\mu\text{g/dL}$)	11.3 (7.7 ~ 16.4)
Thyroid stimulating hormone (TSH, $\mu\text{U/mL}$)	2.59 (0.56 ~ 8.51)
Thyroxine binding globulin (TBG, $\mu\text{g/mL}$)	25.4 (17.2 ~ 37.9)
T_4 /TBG	0.45 (0.30 ~ 0.61)

4) Correlation between the estimated total intakes of PCDDs, PCDFs and Co-PCBs from the breast milk and thyroid functions in breast-fed babies.

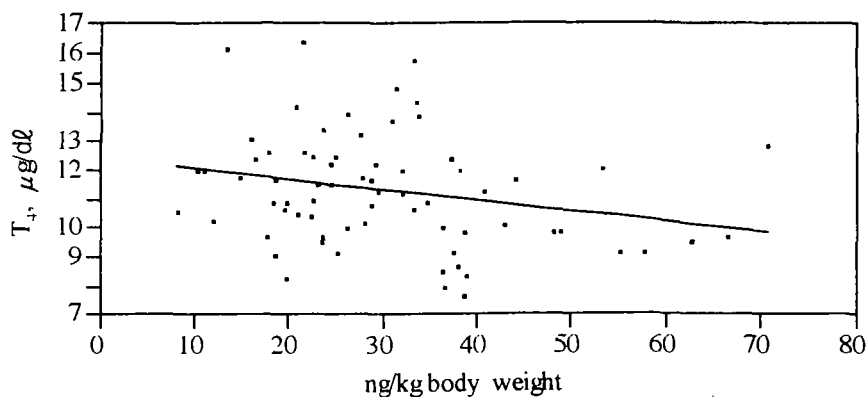


Fig. 1. Negative correlation between the estimated total TEQ intakes from the breast milk and the levels of T_4 in the serum of breast-fed babies ($p=0.033$)

HUMAN EXPOSURE

Significant negative correlation was observed between estimated total intakes of PCDDs, PCDFs and Co-PCBs as TEQ and levels of T_4 in the serum of the babies ($p=0.033$), as shown in Fig. 1. Such a kind of tendency was also seen between the estimated total intakes and serum levels of T_3 ($p=0.064$) or TBG ($p=0.057$). On the contrary, as indicated in Fig. 2, the levels of TSH in the serum of the breast-fed babies positively correlated with the estimated total intakes ($p=0.022$).

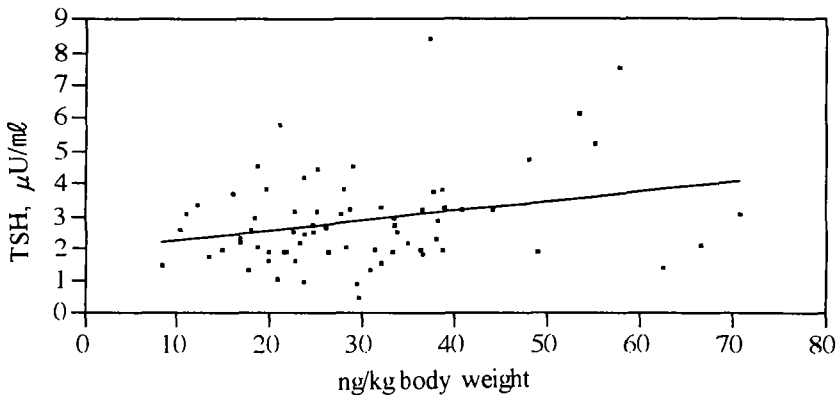


Fig. 2. Positive correlation between the estimated total TEQ intakes from the breast milk and the levels of TSH in the serum of breast-fed babies ($p=0.022$)

Discussion

The presence of PCDDs, PCDFs and Co-PCBs in the breast milk results in daily intakes of about 32 to 304 $\mu\text{g}/\text{kg}$ body weight as TEQ with the median figure of 114 $\mu\text{g}/\text{kg}$ body weight. Consequently, the babies have been estimated to take 6 to 84 TEQ ng/kg body weight with the median of 29 ng/kg body weight during whole breast-feeding periods.

Probably due to such kinds of relatively high TEQ intakes, we observed negatively significant correlation between the levels of T_4 in the serum of the breast-fed babies and the estimated total TEQ intakes. On the contrary, the levels of TSH in the serum proportionally increased with the estimated TEQ intakes. However, contrary to our results, T_4 and the ratio of T_4/TBG were significantly higher in high-exposed babies than in low-exposed ones at 7 days and 11 weeks of age⁵⁾.

Anyhow, exposure to background levels of PCDDs, PCDFs and Co-PCBs via breast milk may have some effects on thyroid functions in breast-fed babies.

References

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