A PLACENTA SURVEY FOR POLYCHLORINATED DIBENZO-P-DIOXINS, DIBENZOFURANS AND BIPHENYLS (PCDD/FS, PCBS) AND THE RELATED FACTORS

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Introduction

Polychlorinated dibenzo-p-dioxins, dibenzofurans (PCDD/Fs) and polychlorinated biphenyls (PCBs) are recognized important environmental endocrine disruptors, which are environmentally persistent and bio-accumulate in human bodies. Pregnant women may pass these pollutants to their fetus through placenta during the critical developmental stages. Our previous study has established high correlation of the levels in placenta with levels in breast milk, perinatal maternal blood and umbilical cord blood from the same mother[1]. We carried out a larger survey on placenta and examined the levels' related factors.

Methods and materials

Each of the pregnant women over 18 weeks of gestation, who came in for a routine check-up in the obstetrics clinic, was questioned if she intended to have her baby delivered in this same hospital. The name list of subjects was based on those with an affirmative answer. The interviewer then collected personal data of subjects randomly selected from the list, including demographics, breastfeeding history, residential and occupational histories, social and economic statutes, prenatal and postnatal dietary habits and life styles, reproductive and medical histories, and physical factors such as body fat and blood pressures. A total number of 430 subjects were interviewed. Placenta together with umbilical cord serum, for hormone analysis, were gathered upon delivery. The newborns were carefully scored including structural and functional assessments.

A total number of 119 subjects with complete data and placenta analyzed were presented in this article. A total number of 17 PCDD/F and 12 dioxin-like PCB congeners with World Health Organization (WHO) defined Toxic Equivalent Factors (TEF) [2] and 6 indicator PCBs were measured by High Resolution Gas Chromatography / High Resolution Mass Spectrometry. The analytical methods used were validated at international quality control studies[3]. Pearson and Spearman correlation analyses were utilized to evaluate the association between PCDD/F and PCB levels for normal and non-normal distributed data respectively. The analysis of variance (ANOVA) and General Linear Model were utilized to examine the factors associated with the dioxins/PCBs levels. All statistical analyses were carried out using Statistical Analysis Software (version 8.2).

Results and discussion

We found comparable levels of PCDD/F and PCB levels in placenta compared to previous studies for the United States[4], with mean level of 12.9 TEq-pg/g lipid (SD=4.9) for PCDD/Fs, 2.9 (SD=1.6) for dioxin-like PCBs (Table 1, Figure 1). Total concentration of PCB 138, 153 and 180 (25.6 ng/g lipid, SD=18.6) correlated well with the levels in other congeners by Pearson correlation analyses (Table 2). The total WHO TEq (R^2=0.202, p<0.001) and mono-ortho PCB (R^2=0.67, p<0.001) levels can be well predicted by PCB 138, 153 and 180 levels through linear regression functions (Figure 2). We further found subjects with greater age, higher annual income, and lower Apgar score in their babies, tended to have higher PCDD/F TEq levels with statistical significance. Age of first marriage, obesity, dietary habits, and home use of pesticides were more related to PCBs levels. Blood pressures were significantly associated with indicator PCBs levels. PCDD/F and PCB TEq levels were significantly associated decreased Thyroid Stimulating Hormones (TSH) and increased levels of T4 concentrations in cord blood.

Table 1. Summarized levels of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and polychlorinated biphenyls (PCBs) in concentration and toxic equivalent (TEq) formats

Congeners	Concentration (pg/g lipid)			Toxic equivalence (pg/g lipid)			%>D.L. [b]
N=119	Mean	S.D. [a]	Median	Mean	S.D. [a]	Median	
PCDDs	193.34	118.72	168.86	5.80	2.15	5.61	100
PCDFs	21.15	16.08	17.61	4.90	2.24	4.54	80
PCDD/Fs	214.49	123.20	186.99	10.70	4.11	10.16	89
Non-ortho PCBs [c]	38.97	41.39	28.27	1.78	1.15	1.67	81
Mono-ortho PCBs [d]	5180.42	3639.73	4571.80	1.14	0.67	0.99	100
Coplanar PCBs	5219.39	3647.91	4585.70	2.92	1.60	2.67	93
PCDD/Fs, PCBs	5433.88	3678.84	4751.80	13.62	5.07	12.83	90
PCB 138, 153, 180 [e]	25.26	18.48	21.67	--	--	--	100
Total indicator PCBs [f]	28.48	27.41	22.63	--	--	--	67

a. S.D.: standard deviation
b. D.L.: detection limit
c. Non-ortho PCBs include those featuring the IUPAC numbers 81, 77, 126 and 169.
d. Mono-ortho PCBs include the remaining eight dioxin-like PCBs.
e. There is not toxic equivalent factor for to calculate TEq for indicator PCBs.
f. Total indicator PCBs include those featuring the IUPAC numbers 18,52,101,138,153

Conclusions

This is the first study of transfer evaluation of dioxins and dioxin-like chemicals from placenta to the newborns. The levels in placenta are comparable with previous studies. There were different associations for PCDDs, PCDFs, and PCBs in relation to maternal and infant factors. The association between the exposure levels and thyroid hormones in cord blood is worth of further investigations.

Table 2. Spearman correlation coefficients between toxic equivalent (TEq) levels of individual PCDD/F and PCB congeners and summarized TEq levels

Congeners	2,3,7,8-TCDD [a]	1,2,3,7,8-PeCDD	1,2,3,6,7,8-HeCDD	OCDD	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HeCDF	PCB 126	PCB 118	PCB 153,138,180
2,3,7,8- TCDD	--	0.82***	0.55***	0.20*	0.75[a]***	0.47***	0.35[a]***	0.43**	0.32***
1,2,3,7,8-PeCDD	0.82***	--	0.65***	0.40***	0.82***	0.49***	0.22	0.39**	0.34***
OCDD	0.20*	0.40***	0.64***	--	0.27**	0.62***	0.40***	0.27*	0.35***
2,3,4,7,8-PeCDF	0.75[a]***	0.82***	0.52***	0.27**	--	0.62***	0.27[a]**	0.44***	0.39***
1,2,3,4,7,8-HeCDF	0.47***	0.49***	0.58***	0.62***	0.62***	--	0.54[a]***	0.52***	0.52***
PCB126	0.35[a]***	0.22	0.27*	0.50***	0.27[a]**	0.55***	--	0.59***	0.53***
PCB118	0.43**	0.39**	0.42**	0.27*	0.44***	0.52***	0.59***	--	0.77***
PCB156 [a]	0.42[a]**	0.33**	0.46***	0.26*	0.55[a]***	0.58***	0.43***	0.76***	0.82***
PCB153,138,180	0.32***	0.34***	0.55***	0.35***	0.39***	0.52***	0.53***	0.77***	--
PCDDs	0.87[a]***	0.96***	0.75***	0.45***	0.760[a]***	0.57***	0.33[a]***	0.47***	0.41***
PCDFs	0.74[a]***	0.81***	0.55***	0.32***	0.99[a]***	0.69**	0.32[a]***	0.48***	0.44***
Non-ortho PCBs	0.35[a]***	0.29***	0.35***	0.43***	0.27[a]**	0.56***	1.00[a]***	0.60***	0.82***
Mono-ortho PCBs	0.40[a]***	0.41***	0.59***	0.33***	0.52[a]***	0.60***	0.48[a]***	0.87***	0.42***
Indicator PCBs	0.25***	0.29**	0.47***	0.33***	0.33***	0.47***	0.55***	0.75***	0.96***
PCDD/F	0.86[a]***	0.91***	0.66***	0.38***	0.94[a]***	0.67***	0.35[a]***	0.48***	0.55***
Dioxin-like PCBs	0.42[a]***	0.38***	0.47***	0.44***	0.41[a]***	0.64***	0.92[a]***	0.78***	0.74***
Total TEq	0.78[a]***	0.81[b]***	081[b]***	0.47[b]***	0.82[a]***	0.76[b]***	0.70[a]***	0.69[b]***	0.63[b]***

a Pearson's correlation analysis was utilized for normal distribution of both congener levels, $P < 0.05$; **: $p<0.01$; ***: $p<0.001$

b Spearman's correlation was utilized for non-normal distribution of either congener levels.

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Figure 1. Concentrations of PCDD/PCDF congeners in placenta from Taiwan compared to the other studies

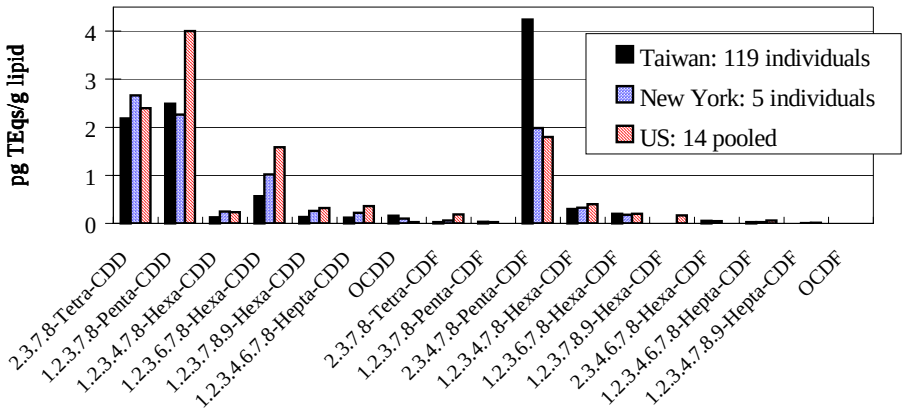

Figure 2. Total concentration of PCB #138, 153, and 180 predicting total TEq of mono-ortho PCBs