

COMPARISON OF CORD BLOOD AND MATERNAL MILK PCB, p,p'-DDE, AND HCB LEVELS BETWEEN SIBLINGS AND ACROSS SIX MONTHS OF LACTATION

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Introduction

Greater lactation experience and/or parity have been associated with declines in maternal organochlorine levels.^{1,2} Still, there are few studies directly assessing the relationship of birth order or lactation with neonatal organochlorine exposures or maternal milk organochlorine levels. The purpose of this study was to compare cord blood and maternal milk concentrations of PCBs, p,p'-DDE, and HCB among siblings and across six months of lactation.

Materials and Methods

Study population. Study participants were a subset of mother-infant pairs selected from an ongoing birth cohort study evaluating the neurodevelopmental effects of intrauterine exposures to PCBs, p,p'-DDE, and HCB. This cohort has been described elsewhere³. Briefly, 788 infants were recruited between 1993 and 1998 at the time of their birth to mothers residing in southeastern Massachusetts towns bordering a PCB-contaminated site. Cord blood samples were collected from all infants and maternal milk samples were collected at approximately 10 days postpartum from those mothers (20%) who breastfed. Additional milk samples were collected at six months for mothers still lactating. The current study's infants were selected based on the availability of cord serum and milk samples with the following included in this analysis (Figure 1): 28 sibling pairs with cord serum samples, 4 sibling pairs with maternal milk samples, 160 infants with ten-day maternal milk samples, and 20 infants with both ten-day and six-month maternal milk samples.

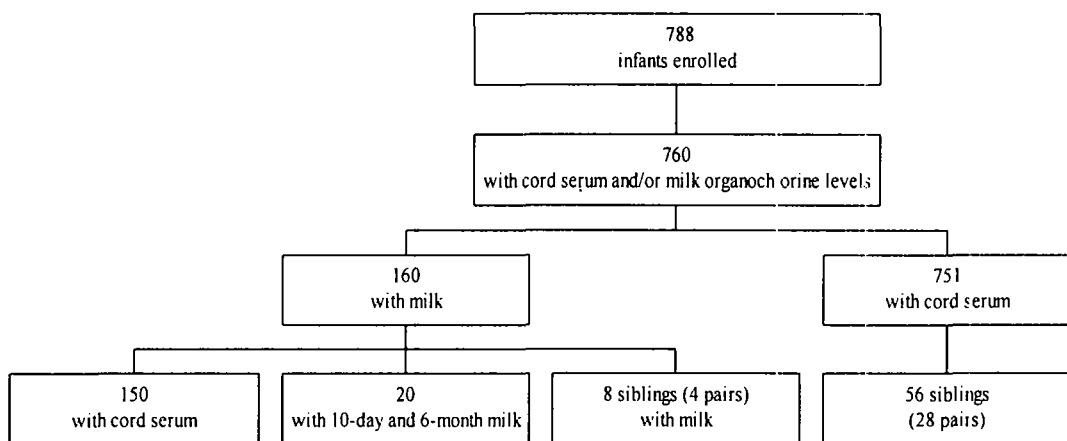
Laboratory Analysis. Breast milk and cord serum samples were analyzed for 51 individual PCB congeners and two chlorinated pesticides (p,p'-DDE and HCB). Details of cord serum analyses are reported elsewhere.³ Human milk samples were extracted using a modified AOAC procedure.⁴ A 20% aliquot of the extract was used for gravimetric lipid determination while the remainder was concentrated to approximately 1-2 ml. Interferences were cleaned from the extract using a

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chromatographic column packed with anhydrous sodium sulfate, deactivated silica gel and deactivated aluminum oxide. The sample extracts were analyzed by capillary HRGC/ECD and quantitated based on the response factor of each PCB congener or pesticide relative to an internal standard (PCB IUPAC# 166). PCB concentrations were reported as individual congeners and as the sum of all congeners assayed (Σ PCB). Final concentrations were reported after subtracting the

amount of the analyte measured in the procedural blank associated with the analytic batch. Strict quality control and quality assurance procedures were followed throughout study sample analyses.

Figure 1. Study Population



Percent lipid for cord serum was not measured because of insufficient sample volume. The average percent lipid was determined for 12 anonymous cord serum samples gravimetrically. These samples had similar lipid content with a mean (SD) of 0.17% (0.03%), consistent with the average percent lipid in cord blood (0.15%) reported elsewhere.⁵ We used the 0.17% value to lipid adjust cord serum levels in comparisons with lipid adjusted milk concentrations.

Analytic Sensitivity, Reproducibility and Accuracy. Background contamination was determined by the use of procedural blanks. Σ PCB in the 16 batches' procedural blanks ranged from 0.03 ng/g to 1.3 ng/g, with a mean (SD) of 0.19 (0.32) ng/g. Analytical accuracy was evaluated by the recoveries of two surrogates added to each sample and recoveries of target analytes added to matrix spike samples accompanying each analytical batch. The mean (SD) recoveries for PCB surrogates IUPAC# 103 and 112 were 95% (3%) and 96% (4%), respectively. The mean percent recoveries of individual target analytes in 16 pairs of matrix spike samples ranged from 86% to 105%. Analytic precision was expressed as the relative percent difference between the matrix spike duplicates and ranged from 3% to 6% with an average of 4%.

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Method Detection Limits. Method Detection Limits (MDLs) for milk samples were determined using three times the standard deviation of replicate analyses of eight whole milk (cow's) samples spiked with target analytes.⁶ The MDL values for individual PCB congeners ranged from 0.001 to 0.009 ng/g and for p,p'-DDE and HCB, the MDL values were 0.009 and 0.007 ng/g, respectively.

Data Analysis. Linear mixed models were used to examine the change in organochlorine levels with parity or over 6 months lactation adjusting for maternal age, cohort effect where appropriate, and maternal effect. These were implemented using standard statistical software (SAS PROC MIXED).

Results and Discussion

Study infants were generally healthy and predominantly full term at birth. Among the 160 infants with neonatal milk samples, 48% were female, 35% were born to nulliparous mothers, and mean (SD) maternal age at birth was 28 (5) years. Among the 56 siblings with cord serum samples, 54% were female and the mean (SD) maternal age at birth for the 1st child was 24 (5) years with an average of 2 years between the 1st and 2nd sibling's birth.

Cord serum and milk levels of Σ PCB, p,p'-DDE and HCB, and the ratio of cord serum to milk concentrations among 150 infants are presented in Table 1. For example, the mean (SD) ratio of Σ PCB concentrations (ng/g fat) in cord serum to milk was 1.2. Cord serum to milk Σ PCB ratios ranging from 0.4 to 1.4 have been observed elsewhere.^{1,7,8,9}

Table 1. Levels of Organochlorines in Cord Blood (n=150) and Maternal Milk at 10 Days (n=160)

Matrix (units)	Mean (SD)			Median		
	PCB	DDE	HCB	PCB	DDE	HCB
Cord Serum (ng/g)	0.58 (0.65)	0.46 (0.56)	0.03 (0.02)	0.41	0.31	0.02
Cord Serum (ng/g fat)	330 (380)	270 (330)	15 (12)	240	180	13
Milk (ng/g)	7.0 (9.3)	6.7 (7.1)	0.3 (0.4)	4.7	4.4	0.2
Milk (ng/g fat)	300 (330)	290 (300)	14 (19)	200	190	9
Cord:Milk (ratio)	1.2 (0.7)	1.0 (0.5)	1.5 (1.1)	1.1	0.9	1.4

Older maternal age and earlier birth year were associated with higher organochlorine levels in this cohort. After adjustment for maternal age, cord serum levels of Σ PCB and p,p'-DDE were lower in the 2nd (younger sibling) than the 1st (older sibling) infant among the 28 sibling pairs studied (Table 2). However, the reverse pattern was present after adjustment for year of birth, and in neither comparison were cord serum levels significantly different between siblings (Table 2).

ORGANOHALOGEN COMPOUNDS

Restriction of the analysis to sibling pairs for whom there had not been (n=22 pairs) or had been (n=6 pairs) breastfeeding between the births resulted in essentially the same findings.

Table 2. Comparison of Cord Serum Organochlorine Levels
Across Pregnancies in 28 Sibling Pairs.

		Mean (SE)		
		PCB	DDE	HCB
Cord Serum*	(ng/g)	-0.07 (0.04) p=0.10	-0.05 (0.03) p=0.14	-0.002 (0.002) p=0.44
Cord Serum**	(ng/g)	0.11 (0.10) p=0.31	0.06 (0.09) p=0.54	0.001 (0.004) p=0.87

* Difference between 2nd and 1st sibling's level adjusted for maternal age (at 1st sibling's birth).

** Difference between 2nd and 1st sibling's level adjusted for maternal age (at 1st sibling's birth) & birth year.

Only four sibling pairs had maternal milk samples at birth for both siblings. Milk concentrations of ΣPCB, DDE and HCB at approximately 10 days were not significantly different between siblings in this small sample.

Among the group of 20 mothers on whom two milk samples were available, milk organochlorine concentrations decreased after 6 months of breast feeding for non-lipid adjusted measures, but not after adjustment for lipids (Table 3). Milk concentration differences across lactation were not statistically significant in either comparison. Adjustment for birth year did not change the milk comparisons.

Table 3. Comparison of Organochlorine Concentrations in Milk at 10 Days and at 6 Months
(n=20 paired samples).

		Mean (SE)		
		PCB	DDE	HCB
Milk*	(ng/g)	-0.74 (0.57) p=0.21	-0.83 (0.57) p=0.16	-0.03 (0.03) p=0.26
Milk*	(ng/g fat)	14 (23) p=0.54	6.8 (13.8) p=0.63	0.40 (1.03) p=0.70

* Difference between 2nd (6-month) and 1st (10-day) milk sample adjusted for maternal age.

Conclusions

Initial comparisons of cord serum organochlorine levels among 28 sibling pairs showed consistent although nonsignificant declines with later birth order. However, this finding was confounded by

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year of birth such that there was no longer evidence of an independent role of parity once secular declines in organochlorine levels were considered (Table 2). Although, there were declines in wet weight-based concentrations of Σ PCB, p,p'DDE, and HCB in maternal milk samples across 6 months of lactation, this pattern was not seen for lipid adjusted measures and in neither case were differences significant (Table 3). In all of these analyses sample size was small thereby limiting statistical power and precluding a definitive null conclusion.

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