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A FOLLOW-UP STUDY OF BLOOD LEVELS OF PERSISTENT TOXIC SUBSTANCES (PTS) AMONG INDIGENOUS PEOPLES OF COASTAL CHUKOTKA, RUSSIA, 2001–2007

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ABSTRACT

Objectives: The Russian Arctic persistent toxic substance (PTS) study has revealed that some of the highest levels of polychlorinated biphenyls (PCBs), persistent organic pollutants (POPs) and lead are in the blood of the Indigenous populations of coastal Chukotka. A follow-up study was undertaken during 2007.

Study design: Individual data on PTS levels of blood samples from 17 mothers and cord blood from their corresponding babies born in the Chukotka coastal area in 2001–2002 were compared with PTS levels in blood sampled from the same women and their five-year old children in 2007. The possible influence of breastfeeding on maternal POPs serum levels and association of children's POPs blood levels and frequency of infectious diseases has been assessed.

Methods: Chemical analysis of all samples was performed in the "Typhoon" laboratory. Health data were collected from the mothers' medical files, newborns' delivery records and mothers' questionnaires.

Results: Maternal blood levels of POPs during the five-year period have decreased significantly (by 33%–74%), blood levels of Pb have decreased by 21%, while mercury levels remained the same. The infant blood serum levels of most POPs during five-year period have increased considerably; the blood lead levels have not changed, while mercury levels decreased by 31%.

Conclusions: Decline of the levels of POPs in maternal blood serum might be due to breastfeeding, but no associations have been found. Increment of POPs levels in infants' blood might be explained by prolonged breastfeeding and consumption of local food. No correlations between infants' POPs blood levels and frequency of infectious diseases has been demonstrated.

Keywords: polychlorinated biphenyls, persistent organic pollutants, persistent toxic substances, maternal-cord blood, breastfeeding, infectious diseases

INTRODUCTION

The coastal communities of Chukotka depend heavily on consumption of marine mammals, which accumulate persistent organic pollutants (POPs) in the adipose tissue from long-range and local sources. Data obtained during the Russian Arctic persistent toxic substances (PTS) study in 2001–2002 revealed the highest (for the Russian North) levels of polychlorinated biphenyls (PCBs), other POPs and lead in the blood of Indigenous populations of coastal Chukotka (1). It is well documented that newborns are exposed to organochlorines through the placenta and through breastfeeding, and exposed to POPs through breastfeeding (2,3).

The high incidence of infectious diseases in infants and children from Chukotka has been known for a long period of time. The prevalence of chronic otitis among Chukotka Indigenous children is 6 to 11 times higher than for the Russian Federation; chronic bronchitis is 4 to 8 times higher; pneumonia is 1.8 to 3.5 higher; and parasitic diseases, 1.4 to 1.8 times higher (4). However, no Russian studies have tried to assess the influence of PTS on infectious diseases. An attempt

to investigate whether organochlorine exposure is associated with the incidence of infectious diseases (upper and lower respiratory tract infections, otitis media and gastrointestinal infections) was undertaken in Inuit infants from Nunavik (Arctic Quebec, Canada) (5,6). The authors demonstrated that the relative risk of otitis media over the first year of life increased with prenatal exposure to dichlorodiphenyl dichloroethylene (4.4DDE) and hexachlorobenzene (HCB). The authors concluded that prenatal organochlorine exposure could be a risk factor for acute infections early in the life of Inuit infants.

A follow-up of human PTS biomonitoring has never been carried out in the Russian Arctic. In 2001–2002, 17 Indigenous pregnant women from selected eastern coastal Chukotka settlements (Lorino and Lavrentiya), which were located closely to each other, were examined (by interview and blood sampling) in the Lavrentiya hospital delivery department according to the unified protocol of the Russian Arctic PTS study. The protocol was approved by the Pasteur Institute Ethics Review Board, St. Petersburg, Russia. The follow-up study was undertaken during the summer of 2007, and 17 women and their children were examined again. The aim of the study was to compare individual data on PTS levels of blood samples from 17 mothers and cord blood from their 17 babies (born in 2001–2002) with PTS levels in blood sampled from the same women and their approximately five-year-old children in 2007.

A possible influence of the duration of breast-feeding on maternal POPs blood levels has been assessed. The possible association between exposure to PTS and the incidence rate of acute infections during the first five years of life of 17 children was also investigated.

MATERIAL AND METHODS

Two interviews were conducted with the women: one at pregnancy time in 2001–2002 (prenatal) and one 5.5 years later in 2007. Information on anthropometry, life style issues, socio-economic status, smoking and drinking habits, and breast-feeding duration was collected. Data on maternal and child health were also collected from the mothers' medical files, the newborns' delivery records and the infants' medical charts for the first 5.5 years of life. The sampling of maternal blood was performed after delivery (two days postpartum), umbilical cord blood at delivery and infant venous blood at 5.5 years of age. After treatment, all blood samples were frozen at –20°C. Frozen blood and plasma samples were sent to the "Typhoon" laboratory (Obminsk, Russia), accredited through the AMAP ring-test system. Associations between PTS exposure and studied parameters were tested by univariate and multivariate correlation analyses.

Study group. All women (13 from Lorino and 4 from Lavrentiya settlements) are of Chukchy ethnicity except one who is Eskimo. All women have Native mothers and fathers except two who have Russian fathers. Average age of the study group at the moment of first examination (2001–2002) was 24.6 years (range 15 to 33 years). Anthropometric parameters of the study group were quite typical for Indigenous populations of Chukotka. Height ranged from 150 to 170 cm (the average was 160 cm). Body weight ranged from 50 to 70 kg at the time of pregnancy in 2001–2002, as well as in 2007. However, about 12% of the pregnant women were evaluated as underweight and 12 % were defined as overweight. The unemployment rates among Indigenous people are known to be generally higher as compared to other populations of Russia. This was mostly true for the study group. Almost 60% of the respondents reported they were unemployed or had non-identified jobs (occasional, seasonal, self-employed); 23.5% were scrubwomen. The income rates were obviously very poor for the whole group. The reported marital status of the study group is quite different to that observed in the total Russian population. Less than 30% reported they had been officially married (Russia's average 78%) and about 35% were in common-law marriages. One-third of the women did not report identifiable marital relationships.

It is important to emphasize that Indigenous women in Chukotka generally have a higher parity compared to the national average. Chukchy women who had only one child constituted only 6% of the study group. Thirty-five percent of mothers had two children, equal to the proportion of women reporting as many as four or more live births (also 35%), which is five to seven times

greater compared to the national average values corresponding to female populations of the same ages. On average, the 2007 study group had 3.12 live births per woman (53 children born in the study group of 2007). Of 17 women in 2007, 13 women already had children born before 2001 (7 of them had more than one child); 8 women had an additional 10 births during 2002–2007 (two of them twice).

RESULTS

Maternal blood levels of POPs (Table I, Fig. 1) decreased significantly in 2007 compared with corresponding levels in 2001–2002. Reduction of the total PCBs was 44% (on average from 3.52 to 1.98 mcg/L serum), oxychlordane 74%, trans-nonachlor 72%, mirex 43%, total hexachlorocyclohexane (HCH) 33% and HCB 19% reduction.

The infant blood levels of POPs (Table 1, Fig. 1) increased considerably in 2007 in comparison with corresponding cord blood serum levels in 2001–2002, except oxychlordane and 4.4DDT, which dropped about 30% each. Increment of the total PCBs was 132% (average from 1.43 to 3.33 mcg/L serum), total HCH 90% and HCB 72%.

The maternal DDT metabolite levels dropped by 70% each, and the ratio 4.4DDE/4.4DDT did not change, remaining about 12, which might indicate "old" sources of exposure. The infant ratio 4.4DDE/4.4DDT increased substantially (by 84% from 10.6 to 19.5 mcg/L serum). This phenomena could be explained by the increase in longer life 4.4DDE metabolite levels in infant blood with simultaneous decrease of 4.4DDT level.

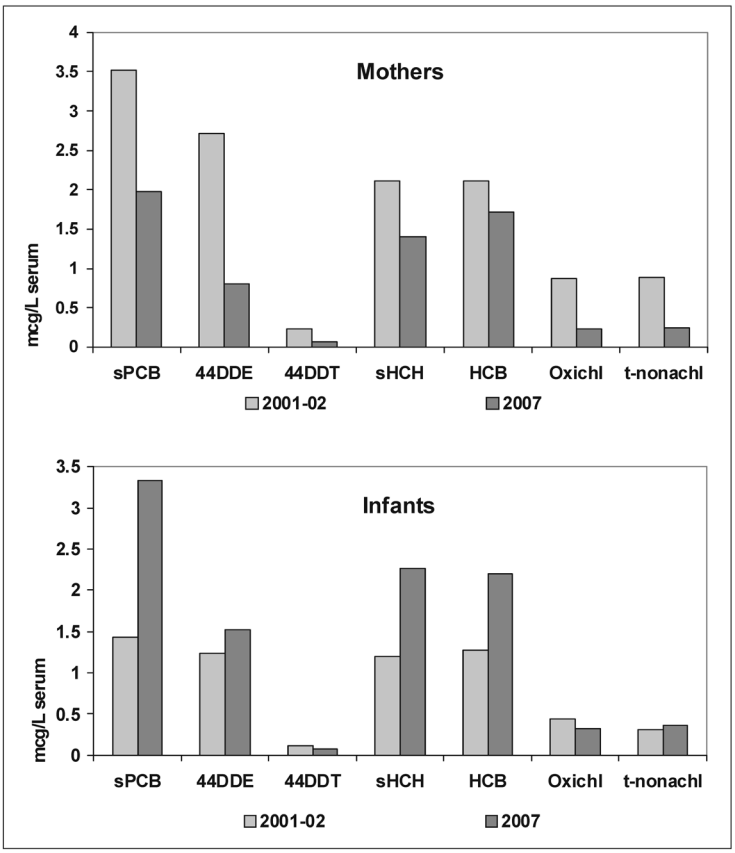

Figure 1. Maternal and infant blood concentrations of POPs, samples of 2001–2002 and 2007, geomean values, mcg/L serum.

Table I. Maternal and cord/infant blood concentrations of POPs and metals, 2001–2002 and 2007, coastal Chukotka.

		sPCB	HCB	4,4DDE	4,4DDT	4,4DDE/4,4DDT	sHCH	Oxichlor-dane	t-Nonachlor	Mirex	Pb	Hg
		mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L plasma	mcg/L blood	mcg/L blood
mothers 2001-02												
	average	4.17	2.51	3.13	0.29	14.91	2.63	1.11	1.08	0.18	39.97	2.02
	st.dev	2.36	1.46	1.68	0.26	16.28	2.03	0.76	0.65	0.13	15.23	1.26
	geomean	3.52	2.12	2.71	0.23	11.88	2.11	0.87	0.88	0.14	37.52	1.60
	range	0.83-8.88	0.54-6.04	1.03-6.55	0.06-1.20	5.46-76.83	0.81-7.60	0.09-3.52	0.12-2.87	0.04-0.50	18.3-76.8	0.5-3.9
mothers 2007												
	average	2.66	2.39	0.97	0.07	15.63	1.64	0.33	0.34	0.09	42.02	2.00
	st.dev	1.85	2.38	0.62	0.03	9.76	0.82	0.24	0.27	0.05	35.09	1.23
	geomean	1.98	1.72	0.80	0.06	12.81	1.41	0.23	0.24	0.08	29.59	1.61
	range	0.27-6.58	0.38-10.69	0.25-2.48	0.02-0.12	3.98-37.26	0.32-2.91	0.02-0.80	0.05-1.01	0.03-0.19	4.9-137.0	0.5-4.8
	%*	-44%	-19%	-70%	-72%	+8%	-33%	-73%	-72%	-43%	-21%	+1%
cord 2001-02												
	average	2.46	1.72	1.87	0.16	13.37	1.93	0.79	0.61	0.12	41.05	1.65
	st.dev	2.80	1.30	1.90	0.12	8.81	2.19	1.05	0.81	0.13	16.67	0.99
	geomean	1.43	1.28	1.23	0.12	10.62	1.19	0.43	0.31	0.07	37.64	1.35
	range	0.18-10.84	0.21-5.08	0.32-7.41	0.02-0.42	2.32-34.29	0.22-8.11	0.06-3.62	0.03-3.17	0.01-0.47	14.3-78.3	0.5-3.3
infants 2007												
	average	4.08	2.59	1.83	0.09	27.08	2.63	0.40	0.51	0.11	45.38	1.14
	st.dev	2.18	1.36	1.02	0.06	24.48	1.64	0.25	0.35	0.07	24.01	0.78
	geomean	3.33	2.20	1.52	0.08	19.54	2.26	0.32	0.36	0.09	38.24	0.93
	range	0.31-7.62	0.28-6.28	0.33-3.69	0.03-0.30	5.82-102.53	0.74-7.69	0.06-0.95	0.01-1.27	0.04-0.23	6.9-102.0	0.5-2.7
	%*	+132%	+72%	+24%	-33%	+84%	+90%	-27%	+14%	+28%	+2%	-31%

* geomean values of 2007 relative to geomean levels of 2001-02 (100%).

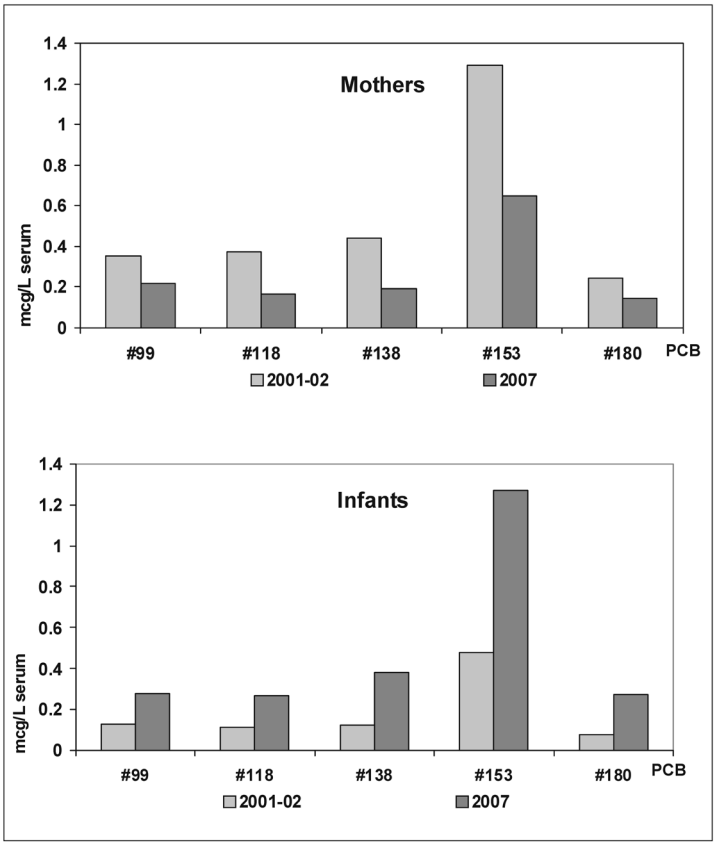

Figure 2. Maternal and infant blood concentrations of PCB congeners, samples of 2001-02 and 2007, geomean values, mcg/L serum.

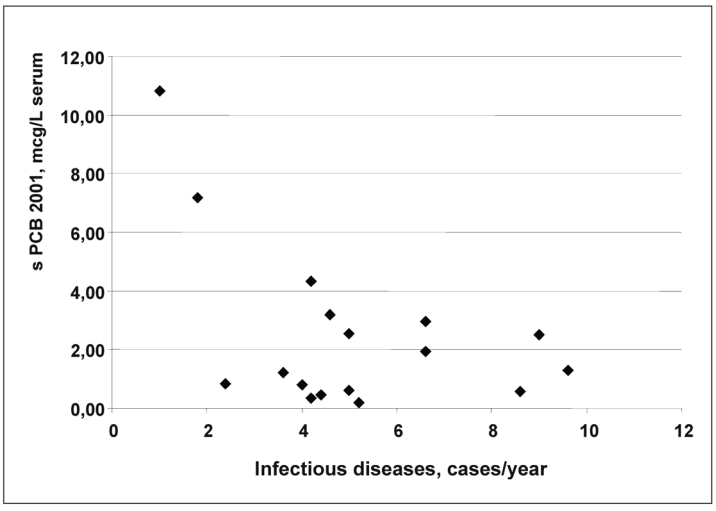

Figure 3. Association of the personal infant average annual number of infectious diseases (2001–2007) and cord blood serum concentrations of sPCB (2001).

Maternal blood serum concentrations of PCB congeners (#99; 118; 138; 153; 180) dropped 39%–57%, while infant PCB congener levels (#99; 118; 138; 153; 180) increased by 110%–241% (Figure 2). It turned out that, during the five-year period, the maternal PCB levels became similar to those observed in cord blood in 2001, and vice versa – infant PCBs levels in 2007 became similar to the maternal levels of 2001. Maternal blood levels of lead decreased by 21%, while the average mercury level did not change. Infant blood levels of lead did not change, while the average mercury level decreased by 31% (Table 1).

No associations between maternal breastfeeding duration and maternal POPs blood serum levels could be demonstrated. The average duration of breastfeeding of all babies in 2001–2007 was 24.4 months (range 1–72). Correlations between various POPs maternal blood serum levels of 2007 and 2001–2002 and duration of breastfeeding were not significant.

Infectious diseases are very frequent among infants in Chukotka. Among the 17 infants studied, acute respiratory diseases (e.g., rhinitis, tonsillitis, pharyngitis, laryngitis, tracheitis, bronchitis, pneumonia and otitis) comprised 93% of all infant infectious diseases. Only about 7% of the infectious diseases were pyodermatosis, stomatitis, conjunctivitis or enterocolitis. On

average, 4.8 infectious disease "events" per year (range 0.9–9.6 incidents per child) were recorded from the medical files. Correlations of the personal average annual number of infectious diseases (2001–2007) and cord blood serum concentrations of POPs (2001) were not significant. An interesting observation was that two children maximally exposed (to POPs and metals) got sick more rarely than others. Figure 3 demonstrates an example of an association of infant PCB body burden with infectious disease frequency.

DISCUSSION AND CONCLUSIONS

The study identified a significant decrease in maternal blood concentrations of persistent organochlorines in the period 2001–2007. Knowing that the major source of exposure in the study group was the contamination of traditional food items (including marine mammals) both from global and local sources, the decrease observed could be explained by a decrease in food contamination during almost six years and by changes in dietary habits due to frequent stays in the maternity hospital, as the participating women were fertile. A decline of the levels of POPs in maternal blood serum could also be due to breastfeeding, but no associations have been found.

The increment of POPs levels in infant blood might be explained by prolonged breastfeeding and the consumption of local food. No correlation between infant POPs blood levels with frequency of infectious diseases was found. An interesting observation is that two infants who were highly exposed to pollutants got sick more rarely than others. This contradicts the results of the Inuit infant study in Nunavik (5,6). The levels of lead and mercury in maternal and infant blood were almost similar in the two sampling periods. The follow up cohort is so far too small to make conclusions on the associations between the contaminant levels and the selected outcomes.

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