

# **Segmental Hair Maternal and Cord blood Mercury Levels of Nine Rural Alaska Native People**

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## **Acknowledgments**

The authors dedicate this report to Nicolas Bloom who was not able to participate in preparation of this delayed report. He performed all of the analyses in 2001 when the specimens were collected.

## **Introduction**

Beginning in the 1990s, the Section of Epidemiology investigated potential health effects of naturally occurring and man-made heavy metals on the health of Alaska residents. The results of the Section's investigations were influential in developing dietary food consumption guidelines for the State of Alaska, with special emphasis on subsistence diets. These investigations and public health recommendations can be found on the Section of Epidemiology website.<sup>1-3</sup>

In 2001, the Alaska Section of Epidemiology measured methylmercury concentrations in nine rural Alaska Native women who were pregnant to correlate levels of methylmercury in blood and hair during the nine months of pregnancy, and to measure the amount of variation of methylmercury in hair from month to month. This study was conducted as a pilot to explore the feasibility of enhancing the knowledge of mercury exposure to pregnant women and their fetus during gestation. The study was conducted in collaboration with the Alaska Native Maternal-Infant Cord Blood Contaminants Study, conducted by the Alaska Native Tribal Health Consortium. While every effort was made to publish the results of this investigation after it was completed, key epidemiology staff left Alaska prior to its completion. This publication presents the project and results of the work that was conducted in 2001.

## **Methods**

The protocol for this study was approved by the Alaska Area Institutional Review Board in 2001. Women were eligible to volunteer to participate in the study if they lived in Southwestern Alaska, they self-identified as Alaska Native, they had previously provided a blood sample during a prenatal visit in their first or second trimester of pregnancy, and they had hair that was at least 12 cm long. It

is generally assumed that hair grows about 1 cm per month.<sup>3</sup> Nine pregnant Alaska Native women were recruited from Southwestern Alaska. Informed consent was obtained from all nine study participants.

### *Total and methylmercury hair analysis*

Hair samples (>12 cm in length and about 1 cm in diameter) were cut as close as possible to the scalp and placed in plastic bags. Hair was collected from 38–76 days post-delivery (Table 1).

Hair mercury analysis (total mercury and methylmercury) was performed by Frontier Geosciences Research and Consulting, Seattle, Washington. Each hair sample was cut into 1 cm segments starting from the scalp end of the hair bundle. Twelve segments were analyzed from each sample. To determine the hair segments corresponding to birth, it was assumed that hair grows an average of 1 cm per 30 days (Table 2). Detailed information on the analytical procedures used have been previously published elsewhere.<sup>4</sup>

Nine maternal blood samples were collected from 85–212 days prior to delivery and nine cord blood samples were collected at the time of delivery (Table 1). Maternal and cord blood samples were analyzed for total mercury by the Centers for Disease Control and Prevention (CDC), National Center for Environmental Health.

## **Results**

The maternal age range was 20–36 years (mean: 27 years). The average methylmercury and total mercury concentrations detected in each of the nine hair samples over the 12 hair segments was 1.0 +/-0.5 ppm and 1.1 +/-0.6 ppm, respectively. Total and methylmercury concentrations varied over the length of the hair for some individuals, suggesting

seasonal variation in their diet (Figure 1). The average total mercury concentrations detected in cord blood and maternal blood were 6.8 +/- 4.6 ppb and 5.0 +/- 3.0 ppb, respectively (Table 3).

In the nine hair samples analyzed, 90% of the mercury identified was methylmercury and 10% was inorganic mercury.

The ratio of the average mercury concentration detected in cord blood to the average concentration detected in maternal blood was 1.4 +/-0.5 ( $r^2=0.75$ ,  $p<0.0025$ ), which is consistent with the value (1.0) used in pharmacokinetic models for mercury (Table 4).<sup>5-11</sup>

The ratio of the average total mercury concentration detected over the entire length of the maternal hair strand to maternal blood was 229 +/-45 ( $r^2 = 0.90$ ,  $p=0.0001$ ; Table 4).<sup>5-12</sup>

The ratio of mercury detected over the entire length of the maternal hair to cord blood was 175 +/-58 ( $r^2 = 0.67$ ,  $p = 0.007$ ). Table 4).

The ratio of the total mercury concentration in the 1-cm segment of hair corresponding to the exposure during the last month of pregnancy to the total mercury cord blood concentration was 157 +/-48 ( $r^2=0.87$ ,  $p=0.0002$ ).

The ratio of the total mercury concentration in the 1-cm segment of hair corresponding to the month when the maternal blood was collected to the total mercury maternal blood concentrations was 225 +/-33 ( $r^2=0.99$ ,  $p=0.0001$ ).

## Discussion

The mercury levels identified here were low and represented no adverse risk to mothers or

their fetus. As expected, we found wide variations in mercury levels among the nine pregnant women. We also found temporal variations in mercury levels among each person. The mercury levels found are relatively low in this small sample of a population likely to consume fish and marine mammals.

The findings presented here are consistent with other studies indicating the majority of mercury in hair is methylmercury in fish-eating populations<sup>11</sup>. The ratios of total mercury and methyl mercury in maternal hair, blood, and cord blood are consistent with other published studies.<sup>4-11</sup>

The study was limited by the small number of subjects, and lack of dietary history of seafood consumption. Maternal ingestion of methylmercury refers to the ingested dose, the magnitude of which depends on the amount of seafood (fish and marine mammals) consumed and the concentration of methylmercury in the seafood. There are many complex relationships between maternal blood (red blood cell/ whole blood methylmercury ratio, and methylmercury in fetal vs. maternal erythrocytes). There are also variations in the growth rate of maternal hair.

Future studies can add to our growing knowledge of exposure and lead to improved dietary consumption guidelines that are based on measurements of actual exposure and balance potential risks from mercury compared with benefits of seafood consumption.

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**Table 1. Date of Collection of Hair, Cord Blood, and Maternal Blood**

<b>Maternal Age at Delivery (Years)</b>	<b>Maternal ID #</b>	<b>Delivery Date</b>	<b>Maternal Blood Collection Date</b>	<b>Hair Collection Date</b>	<b>Number of Days Hair Collected Post-partum</b>	<b>Number of Days Blood Collected Prior to Delivery</b>
26	320	9/15/2001	5/15/2001	11/2/2001	48	123
22	185	10/19/2001	3/29/2001	12/3/2001	45	204
30	309	10/28/2001	4/24/2001	12/7/2001	40	187
20	326	10/24/2001	7/10/2001	12/7/2001	44	106
36	325	10/12/2001	7/19/2001	12/8/2001	57	85
22	177	9/30/2001	3/30/2001	12/8/2001	69	184
36	313	10/31/2001	5/2/2001	12/8/2001	38	182
22	190	10/20/2001	3/22/2001	12/28/2001	69	212
29	182	9/22/2001	4/9/2001	12/7/2001	76	166

**Table 2. Total Mercury Concentration ( $\mu\text{g}/\text{kg}$ ) Corresponding to Each Maternal Hair Segment, by Maternal ID Number**

Centimeter of Hair Segment	Maternal ID Number								
	#320	#185	#309	#326	#325	#177	#313	#190	#182
					2276	386		101	552
12 (Birth segment)	1464	730	1199	650	2411	507	1244	74	1527
11	1373	866	1353	600	2354	476	1563	110	2027
10	1396	774	1283	611	2306	581	1879	110	2206
9	1265	745	1198	716	<b>2248</b>	471	2053	123	2189
8	1246	631	1468	<b>721</b>	2033	513	1902	124	552
7	<b>1112</b>	595	1407	991	1893	510	1313	117	516
6	1186	568	<b>1329</b>	966	1673	<b>694</b>	<b>1652</b>	117	<b>2040</b>
5	1302	<b>603</b>	1487	1224	1600	642	1480	<b>106</b>	1302
4	1365	681	1846	1432	1491	706	1315	104	2266
3	1302	705	1676	1099	1220	867	1478	120	1935
2	1633	802	1631	898	1241	882	1461	112	1600
1	1833	782	1527	877			1522		

*Note: Maternal blood samples indicated in **bold** roughly correspond to the month when maternal blood was collected. Four women had their 12<sup>th</sup> sample collected a month after birth.*

**Table 3. Concentration of Total Mercury and Methylmercury Detected in the Blood and Hair of Nine Alaska Native Women**

	Units	N	Total Mercury		Methylmercury	
			Mean	Standard Deviation	Mean	Standard Deviation
Maternal hair*	mg/kg	9	1.1	0.6	1.0	0.5
Cord blood	µg/L	9	6.8	4.6	-	-
Maternal blood	µg/L	9	5.0	3.0	-	-

*\*Average concentration for all 12 segments*

**Table 4. Relationship of Total Mercury Detected in Cord Blood, Maternal Blood, and Maternal Hair**

Comparison	Ratio $\pm$ SD*	Correlation and P Value
Cord blood to maternal blood	1.4 $\pm$ 0.5	$r^2=0.75$ , $p = 0.0025$
Maternal hair (entire strand) to maternal blood	229 <sup>†</sup> $\pm$ 45	$r^2=0.90$ , $p=0.0001$
Maternal hair (segment) to maternal blood	225 $\pm$ 33	$r^2=0.99$ , $p<0.0001$
Maternal hair (entire strand) to cord blood	175 $\pm$ 58	$r^2=0.67$ , $p = 0.007$
Maternal hair (segment at birth) to cord blood	157 $\pm$ 48	$r^2 = 0.87$ , $p = 0.0002$

\*SD: Standard deviation

<sup>†</sup>Ratio differs from Table 3 due to rounding



**Figure 1. Total Mercury Concentration detected in 1-cm segments of hair collected from 9 Alaska Native Women**

