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Body burdens of mercury, lead, selenium and copper among Baltimore newborns

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Abstract

Umbilical cord blood or serum concentrations of mercury, lead, selenium and copper were measured with inductively coupled plasma mass spectrometry in a population of 300 infants born Baltimore, Maryland. Geometric mean values were 1.37 µg/L (95% confidence interval: 1.27, 1.48) for mercury; 0.66 µg/dL (95% CI: 0.61, 0.71) for lead; and 38.62 µg/dL (95% CI: 36.73, 40.61) for copper. Mean selenium was 70.10 µg/L (95% CI: 68.69, 70.52). Mercury, selenium and copper levels were within exposure ranges reported among similar populations, whereas the distribution of lead levels was lower than prior reports; only one infant had a cord blood lead

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HUMAN SUBJECTS APPROVAL

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above 10 µg/dL. Levels of selenium were significantly correlated with concentrations of lead (Spearman's $\rho = 0.20$) and copper (Spearman's $\rho = 0.51$). Multivariable analyses identified a number of factors associated with one of more of these exposures. These included: increasing maternal age (increased lead); Asian mothers (increased mercury and lead, decreased selenium and copper); higher umbilical cord serum n-3 fatty acids (increased mercury, selenium and copper), mothers using Medicaid (increased lead); increasing gestational age (increased copper); increasing birthweight (increased selenium); older neighborhood housing stock (increased lead and selenium); and maternal smoking (increased lead). This work provides additional information about contemporary prenatal element exposures and can help identify groups at risk of atypical exposures.

Keywords

mercury; lead; selenium; copper; umbilical cord

INTRODUCTION

In utero environmental exposures can have long term consequences to health and development. Mercury and lead are toxic metals that serve no useful purpose for human health and are recognized for their association with deficits in neurological development with early life exposure (Grandjean et al., 1998; Lanphear et al., 2005). On the other hand, selenium and copper are essential nutrients that are components of several proteins, including glutathione peroxidase (selenium) and cytochrome c oxidase (copper) (Navarro-Alarcon and Lopez-Martinez, 2000; Uriu-Adams et al., 2010). The possibility that selenium is protective against the toxic effects of methyl mercury through binding to mercury has been explored (Chen et al., 2006; Yoneda and Suzuki, 1997) but not confirmed in longitudinal epidemiology studies (Choi et al., 2008a; Saint-Amour et al., 2006). Outside of beneficial intake ranges, either elevated or reduced levels of selenium or copper can adversely affect health (Keen et al., 1998; Rayman, 2000; Stern et al., 2007). N-3 fatty acids are essential for healthy neurological development and may counteract negative effects of methyl mercury (National Research Council, 2007). Since fish is a source of methyl mercury, n-3 fatty acids, and selenium, these nutrients and toxicants may co-vary in the bodies of people who eat fish.

Little is known about fetal levels of toxic metals and elements that may be beneficial. While in the US there is a large-scale surveillance effort to track levels of mercury, lead, selenium and copper among older children and adults, the United States Center for Disease Control and Prevention (CDC)'s National Health and Nutrition Examination Survey, there is no routine evaluation of fetal exposures. Recent epidemiology studies among non-Arctic European and North American populations have reported average umbilical cord blood or serum concentrations between 0.5–4.4 µg/L for mercury, 1–15.7 µg/dL for lead, 35–86 µg/L for selenium, and 22–52 µg/dL for copper (Bjornberg et al., 2003; Devereux et al., 2007; Jedrychowski et al., 2007; Jones et al., 2010; Koppen et al., 2009; Lorenzo Alonso et al., 2005; Morrisette et al., 2004; Osman et al., 2000; Palkovicova et al., 2008; Perveen et al., 2002; Rhoads et al., 1999; Schell et al., 2003; Schulpis et al., 2004; Takser et al., 2005; Vahter et al., 2000).

Blood lead levels in the U.S. generally are higher among minorities, people with lower socioeconomic status, and those living in older housing; sources of lead exposure include contaminated dust, water, and food (Bernard and McGeheh, 2003; Rastogi et al., 2007). In the U.S. population, 80–90% of total mercury in blood is in the form of methyl mercury. Methyl mercury levels are highest among those with higher fish and shellfish consumption,

including coastal populations, health-conscious populations, and those of Asian ethnicity (Mahaffey, 2005; Tsuchiya et al., 2008). Volatilization of mercury from dental amalgams is a source of exposure to elemental mercury, which is transformed to inorganic mercury (Palkovicova et al., 2008). Selenium and copper intake occurs through dietary sources, primarily meats, fish and eggs for selenium and cereals, nuts, organ meats, and water for copper (Leblanc et al., 2005; Navarro-Alarcon and Cabrera-Vique, 2008). The relative importance of dietary sources varies by geographic region (Navarro-Alarcon and Cabrera-Vique, 2008).

Inadequate maternal seafood intake has been reported to have detrimental effects on child development (Hibbeln et al., 2007). A number of studies indicate that there are both risks of methyl mercury as well as benefits of nutrients unique to seafood consumption in child neurodevelopment (Strain et al., 2008; Choi et al., 2008b). Thus, both the World Health Organization and the United States Food and Drug Administration have drafted risk-benefit evaluations of seafood consumption (World Health Organization, 2010; US Food and Drug Administration, 2010).

The goal of this research was to describe concentrations of mercury, lead, selenium and copper in umbilical cord blood among an urban population, in the context of serum levels of n-3 fatty acids and other personal and demographic characteristics. Understanding the extent and correlations of current prenatal exposure to these elements is a key step in designing and implementing targeted public health actions to protect fetal health.

MATERIALS AND METHODS

The Baltimore THREE (Tracking Health Related to Environmental Exposures) Study is a cross-sectional study of births at the Johns Hopkins Hospital, Baltimore, Maryland. This study was conducted with the approval of the Maternal and Fetal Research Committee, Department of Gynecology and Obstetrics and the Johns Hopkins School of Medicine Institutional Review Board.

There were 603 deliveries (612 births) at the Johns Hopkins Hospital in Baltimore, Maryland between November 2004 and March 2005. Some of these were ineligible for the THREE study because they were twin births (n=24 births, n=12 pairs), did not have umbilical cord blood available (n=250), or there was too little umbilical cord blood collected (n=41). This left a total of 300 births in the study. Of these, 294 samples were analyzed for mercury and lead and 287 samples were analyzed for selenium and copper.

Trained clinical staff obtained umbilical cord blood using standardized procedures. Cord blood was temporarily stored (< 3 hours) at 4 °C, after which aliquots of whole blood and serum were transferred to 2mL cryovials. Samples were stored at -80 °C except during shipment to offsite laboratories for analyses, when they were packed in dry ice. Specimen containers and syringes were prescreened for elements and found to be free of contamination by mercury, lead, selenium, and copper which would be significant to the planned measurements. No maternal biological samples were collected for this study.

Total mercury and lead were measured in umbilical cord whole blood using inductively coupled plasma mass spectrometry (ICP-MS) (CDC, 2008a) and selenium and copper were measured in umbilical cord serum using inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS) (CDC, 2008b) at CDC laboratories. Limits of detection (LOD) for elemental analyses were 0.33 µg/L (total mercury), 0.25 µg/dL (lead), 5 µg/L (selenium), and 4 µg/dL (copper). There were seven mercury and 13 lead samples below their respective limits of detection; these were set equal to LOD/√2. CDC laboratories also measured umbilical cord serum cotinine using liquid chromatography in conjunction with

atmospheric pressure ionization mass spectrometry. This method has a limit of detection of 0.015 ng/mL, and 75 samples were below the limit of detection. Umbilical cord serum fatty acids, including n-3 fatty acids, were measured at the National Institute for Alcohol Abuse and Alcoholism in umbilical cord serum using fast gas chromatography in an automated system featuring a robotic apparatus. This automated method has been thoroughly tested against standard analytic techniques (Masood and Salem, 2008). The present analysis used a combination of the two most commonly detected n-3 highly unsaturated fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Study personnel abstracted data from maternal and infant medical records and study clinicians reviewed a 10% random sample for accuracy. Maternal prepregnancy body mass index (BMI) was calculated as kilograms/meters² from maternal height and prepregnancy weight data. Smoking status of mothers was based on a combination of self report and umbilical cord cotinine concentrations. Women who reported smoking during pregnancy and/or had an umbilical cord serum cotinine measurement > 10 ng/mL were considered active smokers; the remainder were considered passive smokers or nonsmokers (CDC, 2005).

Maternal addresses were geocoded by GeoLytics, Inc. (East Brunswick, NJ) and study staff using TerraServer USA (Microsoft Corporation and the United States Geological Survey) or ESRI ArcMap 9.0 (Redlands, CA). These were matched with United States Census 2000 block group data to obtain the median year of housing construction. A block group is a subset of a census tract consisting of several contiguous blocks. On average, 1500 people reside in a block group. Median household income was based on 1999 values from the US Census.

Stata 11.1 (College Station, Texas) was used for statistical analyses. Mercury, lead, and copper all had lognormal distributions; therefore, their means were reported as geometric means. In contrast, selenium had a normal distribution, so arithmetic means were used. Correlations between elements were analyzed using Spearman's correlation coefficients, as this method is independent of the distribution of the variables. Analysis of variance, nonparametric tests for trend, and nonparametric smoothing curves (Lowess curves) were used to evaluate concentrations of elements across categories of personal or neighborhood characteristics (data not shown).

Descriptive multivariable models were used to describe which characteristics were independently associated with concentrations of elements in umbilical cord blood or serum. Four different linear multivariable regression models were constructed, each using a different element as the dependent variable. Individual characteristics thought *a priori* to be potential confounders were included in every model. These were maternal age, race, insurance, prepregnancy weight, smoking status, gestational length and infant birth weight. To account for possible exposure via fish and seafood, levels of n-3 fatty acids (as measured by the sum of DHA+EPA) were included in the model for mercury. Since U.S. homes built before 1955 are more likely to contain leaded paint (Rabin, 1989), average year of neighborhood home construction was included in the model for lead. As little is known regarding descriptors of selenium and copper in umbilical cord serum, both n-3 fatty acid levels and average year of neighborhood home construction were included in selenium and copper models. Covariates were described categorically if the variable was inherently categorical (race, insurance, smoking status) or differences are reasonably expected to be observed by categories as described above (smoking, age of housing). Other covariates were tested to determine whether linear, quadratic or a cubic spline provided the best fit, based on Akaike's and Schwarz's Bayesian information criteria. Linear terms were the best fit for all covariates.

Natural log transformations were used in multivariable models for mercury, lead and copper and results are presented as the ratio of geometric means. The results for selenium are presented as a change in arithmetic mean. The distributions of levels of lead and copper each have an outlier (lead=15.5 µg/dL, copper=265 µg/dL); these outliers were removed from models; the inclusion or exclusion of these outliers altered point estimates slightly but did not affect statistical significance of any covariate.

RESULTS

Age of these 300 mothers was between 14 to 43 years and 25.9 years on average (95% confidence interval: 25.2, 26.7). Most mothers were African-American (70.3%) and nearly half (47.4%) were overweight or obese prior to pregnancy. Sixty-one percent of these mothers used Medicaid. Slightly more than half (58.8%) lived in neighborhoods where the median year of housing construction was before 1955, or in the era prior to the voluntary ban on lead paint use inside homes. Among infants, mean gestational age was 38.8 weeks (95% CI: 38.3, 39.0) and mean birth weight was 3192 grams (95% CI: 3125, 3259). Mean DHA+EPA level in umbilical cord serum was 49.0 µg/mL (95% CI: 47.4, 50.7). Additional population characteristics are presented in Table 1.

Geometric mean cord blood mercury and lead levels were 1.37 µg/L (95% confidence interval: 1.27, 1.48) and 0.66 µg/dL (95% CI: 0.61, 0.71), respectively (Table 2). Two (0.7%) lead measurements were higher than 5 µg/dL, and only one (0.3%) lead measurement was higher than the CDC recommended action level of 10 µg/dL. Five (1.7%) total mercury measurements were above the umbilical cord blood value corresponding to the methyl mercury reference dose (5.8 µg/L) proposed by the National Research Council (National Research Council, 2000). Mean umbilical cord serum selenium was 70.10 µg/L (95% CI: 68.69, 70.52) and geometric mean umbilical cord serum copper was 38.62 µg/dL (95% CI: 36.73, 40.61) (Table 2). There were statistically significant correlations between lead and selenium (Spearman's ρ : 0.2, $p=0.001$) and selenium and copper (Spearman's ρ : 0.5, $p < 0.001$).

Mercury

In multivariable analyses, African-American infants had 51% higher and Asian infants had 87% higher umbilical cord mercury concentrations than Caucasian infants (Table 3). For each 10 µg/mL increase of DHA+EPA in umbilical cord serum there was a corresponding 12% increase in mercury concentrations.

Lead

In multivariable analyses, African-American infants had 43% higher and Asian infants had 119% higher lead concentrations in umbilical cord blood than Caucasian infants (Table 3). Maternal age, smoking during pregnancy, Medicaid use, and living in a neighborhood where median housing construction occurred prior to 1955 also were associated with higher umbilical cord lead levels.

Copper

In multivariable analyses, infants of Asian mothers had 21% lower copper concentrations in umbilical cord serum than Caucasian infants (Table 3). Copper concentrations increased with increasing gestational age (11% higher per 10 days) and increasing DHA+EPA levels in umbilical cord serum (7% higher per 10 µg/mL).

Selenium

In multivariable analyses, increased selenium concentrations were associated with birthweight (0.41 µg/L higher per 100 grams) and DHA+EPA levels in umbilical cord serum (1.67 µg/L higher per 10 µg/mL) (Table 4). Infants of Asian mothers had 6.58 µg/L lower selenium concentrations in umbilical cord serum than Caucasian infants. Mothers residing in neighborhoods where the median age of housing construction was prior to 1955 had 4.58 µg/L higher selenium (95% confidence interval: 1.62, 7.54) compared with those in more recently constructed neighborhoods.

DISCUSSION

Concentrations of mercury, lead, copper and selenium were consistent with recently reported concentrations among non-Arctic North American and European populations (Bjornberg et al., 2003; Devereux et al., 2007; Jedrychowski et al., 2007; Jones et al., 2010; Koppen et al., 2009; Lederman et al., 2008; Lorenzo Alonso et al., 2005; Morrisette et al., 2004; Osman et al., 2000; Palkovicova et al., 2008; Perveen et al., 2002; Rhainds et al., 1999; Schell et al., 2003; Schulpis et al., 2004; Takser et al., 2005; Vahter et al., 2000). However, there were individuals who had cord blood levels of mercury and lead in ranges associated with neurodevelopmental and other adverse health outcomes.

While average mercury levels in this study population are within North American and European population ranges, it is a concern that five infants had total mercury measurements higher than 5.8 µg/L, a concentration corresponding to the United States Environmental Protection Agency's reference dose for methyl mercury (US Environmental Protection Agency, 2001). The reference dose is an estimate, including an uncertainty factor, of daily exposure to a population that is likely to be without an appreciable risk of deleterious effects over the course of a lifetime. One recent report suggests that delays in neurocognitive performance may result from even lower mercury concentrations (Jedrychowski et al., 2006). Studies of populations in the Arctic, Asian and Amazonia have consistently reported mercury cord blood measurements above the level of the methyl mercury reference dose (Butler Walker et al., 2006; Fok et al., 2007; Santos et al., 2007). Although there were relatively few Asians in this study population, we found higher mercury levels among Asian infants. This is consistent with prior observations that people who eat more fish and shellfish generally have higher mercury levels (Tsuchiya et al., 2008), that Asian American women in the US, particularly those who were foreign-born, have babies with substantially higher mercury levels in umbilical cord blood compared to caucasian women (Lederman, et al., 2005), and that generally there are higher rates of seafood consumption among Asian Americans (Sechena et al., 2003). Based on one of the author's (FW) knowledge of women giving birth at this particular hospital, it is possible that several Asian mothers in this population were foreign-born.

Lead concentrations were lower than earlier reports, consistent with previous observations that blood lead levels are generally decreasing over time (Muntner et al., 2005). However, two infants had cord blood lead levels over five µg/dL, a level that probably confers neurodevelopmental risks (Lanphear et al., 2005). Not surprisingly, increased blood lead levels were associated with residence in neighborhoods with older housing stock. The higher lead levels observed among Asians are consistent with studies in the United States that have reported higher lead levels among Asian immigrants (Rastogi et al., 2007). Such lead levels may have resulted from maternal lead exposures that occurred prior to the mother's immigration to the United States, and subsequent release of long-term lead stores from bone during pregnancy (Gulson et al., 1997). The higher levels of lead found among infants of mothers with Medicaid are consistent with prior work identifying two factors associated with lower socioeconomic status and lead exposure: poorer nutritional status, including less

dietary iron and calcium, and living and/or working in environments with higher lead exposure levels (Bernard and McGeehin, 2003; Muntner et al., 2005; Rastogi et al., 2007).

Some infants in our study had relatively high cord serum concentrations of selenium and copper. Given that selenium and copper were strongly correlated and had similar patterns of association with demographic characteristics, it is possible that they co-occur in foods and/or environmental sources. Both copper and selenium levels were found to increase over the course of gestation; this was statistically significant for copper and close to statistical significance for selenium. This is consistent with prior studies (Galinier et al., 2005; Grandjean et al., 1992; Makhoul et al., 2004; Perveen et al., 2002). The relationships with gestational age suggest increased placental transfer over the course of gestation, perhaps to accommodate nutritional and developmental needs of the fetus. Therefore it is possible that the observed association between selenium and copper probably at least in part is related to increased transplacental transfer of copper and selenium with gestational age.

Unexpectedly, we observed a relationship between umbilical cord serum selenium and with older age of housing in neighborhood. Selenium intake is thought to almost exclusively arise from dietary sources. However, selenium is a component of paint, paint in older housing is more likely to be in poor condition, and mothers could theoretically be exposed to paint residues in such circumstances; so that it is possible that selenium in house dust could be contributing to maternal levels. On the other hand, post-hoc analyses indicate that older age of neighborhood housing is significantly related to other proxy measurements of lower socioeconomic status (data not shown), so it is possible that other factors, such as differential dietary levels of selenium, explain this finding.

Fish consumption is a source of mercury, selenium and n-3 fatty acids. If fish consumption was a common and predominant source for all three compounds, one would expect selenium, mercury and DHA+EPA to be strongly correlated with each other. However, while DHA+EPA was significantly correlated with both mercury and selenium, mercury and selenium were not correlated with each other. There are a few possible explanations for this finding. First, it is possible that there are sources of selenium in addition to or instead of fish. Also, Bjornberg and colleagues found that dietary fish intake was related to methyl mercury but not selenium in cord blood samples among Swedes (Bjornberg et al., 2003). Alternative dietary sources of selenium include wheat (Lyons et al., 2005) and meat and dairy products (Navarro-Alarcon and Cabrera-Vique, 2008). Second, it is possible that this relationship is not observable within umbilical cord serum. Chen and colleagues found a correlation of selenium and mercury in urine samples, but not in concurrent serum samples (Chen et al., 2006).

One limitation of this study is that we were unable to collect biological specimens from the mothers. Future studies should examine maternal as well as fetal serum levels. Further, it would have been preferable to have additional information about potential exposure sources for these elements e.g., dietary consumption of fish and shellfish, house dust levels of lead and selenium, and additional measures of nutritional status, especially iron, calcium and zinc.

This study provides useful information about umbilical cord blood measures of mercury, lead, selenium and copper among urban newborns. This is particularly useful for selenium and copper, for which few reference values are available. Gestational age and birthweight are related to higher concentrations of the essential elements selenium and copper, perhaps pointing to an additional benefit in reducing preterm birth. These results demonstrate that social characteristics such as maternal race and insurance are correlated with disparate umbilical cord concentrations of mercury, lead, copper and selenium. While mercury and

lead concentrations generally were below stated guidelines for exposure, there were several individuals who had higher levels. Despite the progress in reducing lead exposures in relation to deteriorating lead-based paint in the US there still is evidence that older housing is contributing to blood lead levels. In this population, Asian and African American mothers may need to be targeted for future intervention efforts. Infants born to smoking mothers had higher lead levels, yet another reason to quit smoking, especially prior to pregnancy.

No undisputedly safe levels for lead and mercury have been identified and very little is known about toxicity of early life exposures to excess levels of selenium and copper or the impacts of subnormal levels during gestation. As a result, there may still be measurable detrimental health effects even at lower concentration levels, pointing the need for more research on health effects of low-level exposures to mercury, lead, copper and selenium.

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ABBREVIATIONS

BMI	Body mass index
CI	Confidence interval
DHA	Docosahexaenoic acid
EPA	Eicosapentaenoic acid
ICP-MS	Inductively coupled plasma mass spectrometry
ICP-DRC-MS	Inductively coupled plasma dynamic reaction cell mass spectrometry
LOD	Limit of detection
THREE	Tracking Health Related to Environmental Exposures
CDC	United States Centers for Disease Control and Prevention

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Table 1

Mother and infant characteristics in the Baltimore THREE Study, 2004–2005.

Characteristic	N ^a	Percent ^b
All	300	100.0
Maternal age		
< 20 years	70	20.5
20–29 years	163	46.8
≥30 years	108	31.7
Maternal race		
White/Caucasian	64	21.3
African American	211	70.3
Asian	25	8.3
Prepregnancy body mass index		
< 25 kg/m ²	152	52.6
25–29.9 kg/m ²	65	22.5
≥30 kg/m ²	72	24.9
Smoking during pregnancy		
Active smoker	56	18.7
Passive or nonsmoker	243	81.3
Medical insurance		
Medicaid	183	61.0
Self or private insurance	117	39.0
Gestation		
<37 weeks	39	13.0
≥37 weeks	261	87.0
Infant birthweight		
<2500 grams	33	11.0
≥2500 grams	267	89.0
Tertiles of DHA+EPA in cord serum		
<41.75 µg/mL	96	33.5
41.75–52.50 µg/mL	96	33.5
>52.50 µg/mL	95	33.1
Median housing construction in block group		
Built before 1955	174	58.8
Built 1955 or later	122	41.2

THREE = Tracking Health Related to Environmental Exposures; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid.

^aNumbers may not sum to 300 due to missing values.^bPercents may not sum to 100 due to rounding.

Table 2

Distribution of mercury, lead, selenium and copper in umbilical cord whole blood^a or serum^b, Baltimore THREE Study, 2004–2005.

	Mercury, µg/L	Lead, µg/dL	Selenium, µg/L	Copper, µg/dL
N	294	294	287	287
Limit of detection (LOD)	0.33	0.25	5.00	4.00
N (%) ^c below the limit of detection	7 (2.4%)	13 (4.4%)	0 (0.0%)	0 (0.0%)
Minimum	< LOD	< LOD	42.0	12.1
10 th percentile	0.61	0.29	55.0	23.0
25 th percentile	0.95	0.46	62.0	27.9
Median (50 th percentile)	1.40	0.65	69.0	37.8
75 th percentile	2.03	0.95	78.0	51.8
90 th percentile	3.00	1.36	85.0	66.7
Maximum	16.48	15.50	114.0	265.0
Arithmetic mean (95% CI)	1.73 (1.56, 1.91)	0.84 (0.72, 0.96)	70.1 (68.7, 71.5)	42.6 (40.0, 45.2)
Geometric mean (95% CI)	1.37 (1.27, 1.48)	0.66 (0.61, 0.71)	69.1 (67.7, 70.5)	38.6 (36.7, 40.6)

THREE = Tracking Health Related to Environmental Exposures; LOD = limit of detection; CI = confidence interval.

^aMercury and lead were measured in umbilical cord whole blood.

^bSelenium and copper were measured in umbilical cord serum.

^cPercent below the limit of detection is based on the total number of measurements for that element.

Table 3

Ratio^a and 95% confidence interval for mercury, lead and copper based on multivariable linear regression analysis, THREE Study, 2004–2005.

	Mercury ^b			Lead ^c			Copper ^d		
	Ratio	95% CI		Ratio	95% CI		Ratio	95% CI	
Maternal age									
Per 5 years	1.06	0.99, 1.14		1.07	1.01, 1.14		0.99	0.94, 1.03	
Maternal race									
White/Caucasian	1.00	referent		1.00	referent		1.00	referent	
African American	1.51	1.22, 1.87		1.43	1.18, 1.73		0.99	0.87, 1.14	
Asian	1.87	1.36, 2.58		2.19	1.66, 2.90		0.79	0.65, 0.97	
Prepregnancy body mass index									
Per 10 kg/m ²	1.01	0.89, 1.13		1.01	0.91, 1.12		1.04	0.97, 1.12	
Smoking during pregnancy									
Active smoker	1.11	0.90, 1.38		1.34	1.11, 1.61		1.09	0.96, 1.25	
Passive or nonsmoker	1.00	referent		1.00	referent		1.00	referent	
Medical insurance									
Medicaid	0.85	0.70, 1.04		1.37	1.15, 1.62		1.11	0.98, 1.26	
Self or private	1.00	referent		1.00	referent		1.00	referent	
Gestation									
Per 10 days	1.03	0.96, 1.11		0.99	0.93, 1.06		1.11	1.06, 1.16	
Infant birthweight									
Per 100 grams	1.00	0.98, 1.02		1.01	0.99, 1.02		1.00	0.99, 1.01	
EPA+DHA									
Per 10 µg/mL	1.12	1.06, 1.18					1.07	1.03, 1.10	
Median housing age ^e									
Built before 1955				1.20	1.04, 1.39		1.05	0.94, 1.16	
Built 1955 or later				1.00	referent		1.00	referent	

CI = confidence interval; THREE = Tracking Health Related to Environmental Exposures; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid.

^aRatio of the adjusted geometric mean of mercury, lead or copper comparing categories or an increase in a continuous variable. Variables with ratios were included in the model.

^bN=271. Adjusted for maternal age, maternal race, prepregnancy body mass index, smoking during pregnancy, medical insurance, gestation, birthweight, EPA+DHA in umbilical cord serum.

^c N=279. Adjusted for maternal age, maternal race, prepregnancy body mass index, smoking during pregnancy, medical insurance, gestation, birthweight and median housing age.

^d N=261. Adjusted for all variables in the table.

^e Median housing age is the median age housing was built in the block group, as defined by the 2000 Census.

Table 4

Difference^a and 95% confidence interval for selenium based on multivariable linear regression analysis, THREE Study, 2004–2005.

	Selenium ^b	
	Difference	95% CI
Maternal age		
Per 5 years	0.08	−1.15, 1.32
Maternal race		
White/Caucasian	0.00	referent
African American	−0.96	−4.85, 2.93
Asian	−6.58	−12.26, −0.89
Prepregnancy body mass index		
Per 10 kg/m ²	−0.59	−2.65, 1.46
Smoking during pregnancy		
Active smoker	−1.91	−5.67, 1.86
Passive or nonsmoker	0.00	referent
Medical insurance		
Medicaid	4.04	0.63, 7.45
Self or private	0.00	referent
Gestation		
Per 10 days	1.21	−0.04, 2.46
Infant birthweight		
Per 100 grams	0.41	0.13, 0.70
EPA+DHA		
Per 10 µg/mL	1.67	0.74, 2.61
Median housing age ^c		
Built before 1955	4.58	1.62, 7.54
Built 1955 or later	0.00	referent

CI = confidence interval; THREE = Tracking Health Related to Environmental Exposures; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid.

^a Difference, in µg/L, of the adjusted mean for selenium comparing categories or an increase in a continuous variable.

^b N=262. Adjusted for all variables shown in the table.

^c Median housing age is the median age housing was built in the block group, as defined by the 2000 Census.