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# CONCENTRATION OF MICROELEMENTS IN THE BIOMEDIA BETWEEN THE MOTHER AND THE NEWBORN

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**Abstract.** The levels of heavy and biometals Pb, Cd, Cu, Zn, and Se were studied in the blood, blood serum, and human milk for the mother and newborn in two regions of Estonia. The concentration of Pb and Cd did not surpass the toxicity limit. The transfer of Pb and Cd in the blood from the mother to the newborn had been about 80%.

**Key words:** blood, blood serum, human milk, Pb, Cd, Cu, Zn, Se, determination.

The levels of heavy and biometals Pb, Cd, Cu, Zn, and Se was studied in the blood, blood serum, and human milk of mothers and newborn children in several regions of Estonia.

A deterioration of child health has been observed in Virumaa in the last years. In accordance with the Estonian Health Development Centre's research "Infant Mortality in Estonian districts in 1966–1990", the infant mortality rate (IMR) in Lääne-Virumaa was constantly higher than the average value for all Estonia in 1966–90. Starting from 1985 the average IMR for Estonia has been decreasing, but the IMR value for Lääne-Virumaa has remained unchanged. The frequency of several diseases has increased (alopecia). Despite of the work of a state commission in the town of Sillamäe (1989), no reasonable explanation why children fell ill was put forward. One of the possible causes suggested was the influence of heavy metals to the children's biomechanism, in particular, to the equilibrium of the biometals in the organism. This gave reason to start an investigation of the concentration of heavy metals in the blood, blood serum, and human milk.

## NUTRITIONAL TRACE ELEMENTS: COPPER, ZINC, AND SELENIUM

Copper is an essential element in biological systems. A 70 kg human body contains approximately 80 mg of copper, one third in muscle and the remainder in other tissues and fluids. Copper, in the divalent state, has the capacity to form complexes with many proteins. Approximately 56% of dietary copper is absorbed in the adult. The main route of the extraction of copper is through the bile, with less than 50 mg/day extracted in urine. In plasma, copper is present in two forms. Approximately 90% of the total plasma copper is firmly bound to the ceruloplasmin and 10% is loosely bound in albumin, which acts as the plasma carrier of copper.

It is generally agreed that there is a gender difference in serum copper levels. The range of copper levels in females is from 0.8 to 1.55 mg/l and in males from 0.7 to 1.4 mg/l. In newborns the levels are from 0.12 to 0.67 mg/l [1, 2].

Zinc is an important nutritive factor; it is a cofactor of many metalloenzymes. Over 90 metalloenzymes require zinc for proper functioning, including red blood cells carbonic anhydrase, alkaline phosphatase, lactic acid, and many enzymes involved in RNA and DNA synthesis.

Zinc deficiency has many causes, but malnutrition and malabsorption are the most common. Pregnant women are at risk for suboptimum levels of zinc, which can adversely affect fetal outcome. Patients receiving chronic total parenteral nutrition are also at risk unless they are given supplemental zinc.

The range of zinc in serum in females is from 0.65 to 1.15 mg/l, and in newborns from 0.38 to 1.1 mg/l. The range of zinc in blood is from 4.5 to 7.0 mg/l [1, 2].

Selenium is known as an essential trace element for man. It is a component of enzyme glutathione peroxidase, which has been demonstrated by the isolation of glutathione peroxidase from human erythrocytes. Selenium concentration in the human body varies from 0.02 to 0.26 ppm of moist matter. In blood the amount of selenium has been found to be three times bigger in erythrocytes than in plasma.

The normal values of whole blood selenium range from 0.1 to 0.19 mg/l; the range in blood serum is from 0.06 to 0.12 mg/l, and in human milk from 0.01 to 0.03 mg/l [3].

## NONNUTRITIONAL TOXIC TRACE ELEMENTS: LEAD AND CADMIUM

Although only 8 to 12% of orally ingested lead is absorbed by the small intestines, the toxic effect of lead is a major problem in many societies. Lead, like many other heavy metals, can react with sulphhydryl groups in enzymes, thereby inactivating them. The pathological effects of lead have

been recognized for centuries. Many physiological systems, including renal, nervous, reproductive, immune, and haemopoietic, are affected.

The typical range of lead in blood for healthy nonexposed adults is from 0.1 to 0.2 mg/l. The toxicity limit of blood lead level is 0.15 mg/ml [2].

Cadmium is toxic to virtually every system of the body and has been implicated in renal disease, hypertension, anaemia, itai-itai disease, and other conditions. Cadmium accumulates in the red blood cells. Cadmium is bound chiefly to the low-molecular-weight protein metallothionein in all tissues, and it has been suggested that it is in this form that it is transported.

The critical level for blood cadmium is 0.01 mg/l when the exposure is chronic and long-term. The blood level in smokers is 0.0015 mg/l, and in human milk 0.001 mg/l [2].

## MATERIALS AND METHODS

Samples of blood, blood serum, and human milk were collected at a maternity hospital. Samples were stored in acid-washed polyethylene bottles and kept frozen until analysed.

Five-ml blood or milk samples mixed with 10 ml concentrated nitric acid at 180 °C for 10 h were mineralized in Tephlone bombs.

Pb, Cd, Cu, Zn, and Se were determined in the blood; Cu and Zn in the blood serum; Zn and Se in the human milk.

The concentrations of the microelements were determined by atomic-absorption spectrometry (Philips models PU 9-700 and PU 9100X with HGA/P3105).

## RESULTS AND DISCUSSION

Fifty mothers and newborns were investigated in Tallinn and Rakvere from 1993 to 1994.

The mean concentrations, standard deviations, and modes of Pb, Cd, Cu, and Zn in blood are given in Table 1. The concentrations of bio- and heavy metals in blood serum and human milk are presented in Table 2.

*Table 1*

**Blood levels of bio- and heavy metals in mother and newborn ($n$=22), µg/l**

| Heavy metals | Mean | | Standard deviation | | Mode | |
|---|---|---|---|---|---|---|
| | Mother | Newborn | Mother | Newborn | Mother | Newborn |
| Pb | 3.37 | 2.33 | 2.38 | 2.01 | 2.50 | 2.5 |
| Cd | 0.23 | 0.18 | 0.17 | 0.14 | 0.1 | 0.1 |
| Cu | 1864 | 3180 | 1004 | 1746 | 1250 | 750 |
| Zn | 1563 | 1785 | 1419 | 1768 | - | 1500 |

*Table 2*

**Blood serum and human milk levels of bio- and heavy metals in mother and newborn ($n$=22), μg/l**

| Heavy and biometals | Serum | | Human milk |
|---|---|---|---|
| | Mother | Newborn | |
| Cu | 0.9–3.5 | 0.9–1.8 | 0.35–0.8 |
| Zn | 0.9–2.6 | 0.8–2.2 | 1.8–10.5 |
| Se | - | - | 5.2–20.5 |
| Pb | - | - | 0.08–0.18 |
| Cd | - | - | 0.08–0.16 |

The concentrations of Pb and Cd did not surpass the toxicity limit. The transfer of Pb and Cd in the blood from the mother to the newborn had been about 80% (Figs. 1 and 2).

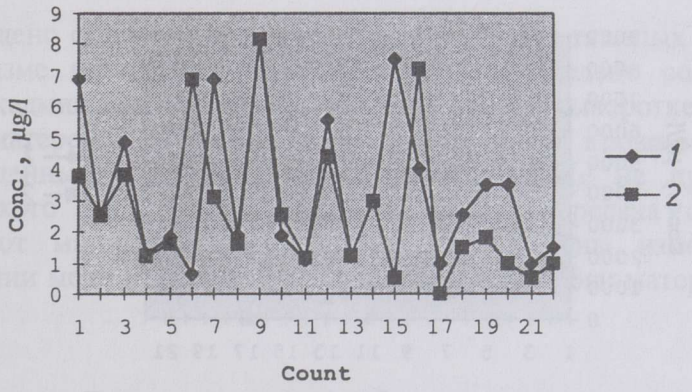


Fig. 1. Pb concentration (μg/l) in the blood of mothers (*1*) and newborns (*2*).

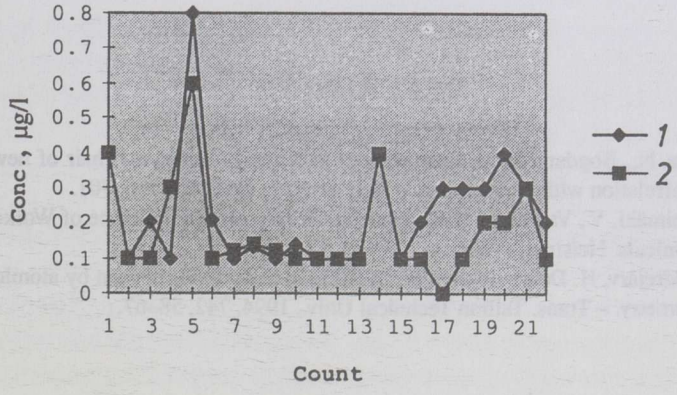


Fig. 2. Cd concentration (μg/l) in the blood of mothers (*1*) and newborns (*2*).

The concentration of Cu and Zn in the blood and blood serum of mothers was essentially changed as compared to normal values of adult females. The concentration of Cu was two to three times higher, and the concentration of Zn two to three times lower than the normal one (Figs. 3, 4). The concentration of Se in the human milk was on a normal level.

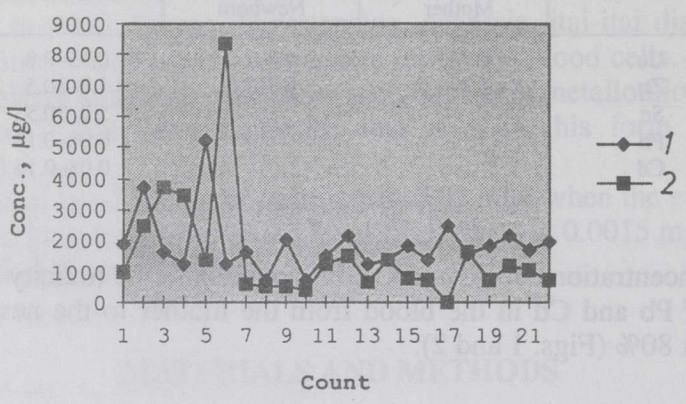


Fig. 3. Cu concentration (µg/l) in the blood of mothers (*1*) and newborns (2).

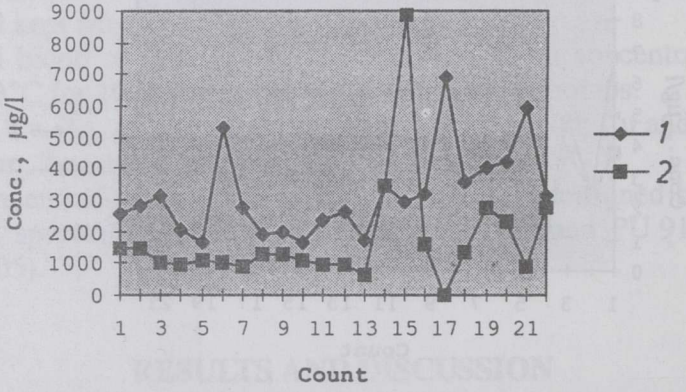


Fig. 4. Zn concentration (µg/l) in the blood of mothers (*1*) and newborns (2).

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## MIKROELEMENTIDE SISALDUS EMA JA VASTSÜNDINUD LAPSE VAHELISES BIOKESKKONNAS

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On püütud välja selgitada rask- ja biometallide suhe ning ülekanne ema ja vastsündinud lapse veres, vere seerumis ja emapiimas. Uuritavateks mikroelementideks olid Pb ja Cd kui toksilised elemendid ning Cu, Zn ja Se kui bioelemendid. Pb ja Cd sisaldus biomaterjalides ei ületanud toksilisuse piire ja nende ülekanne emalt lapsele oli 80%. Muutunud oli Cu ja Zn sisaldus veres ja seerumis. Cu, Zn ja Se sisaldus emapiimas oli normi piires.

## СОДЕРЖАНИЕ МИКРОЭЛЕМЕНТОВ В БИОСРЕДАХ МАТЕРЕЙ И НОВОРОЖДЕННЫХ

Ану ВИИТАК, Хельви ХЁДРЕЯРВ, Майли ТРЕУМАНН

Проведено сравнительное исследование уровня тяжелых металлов в организме матерей и новорожденных. Определено содержание свинца, кадмия, цинка, меди и селена в крови, сыворотке крови и молоке матерей. Содержание свинца и кадмия в крови матерей и новорожденных, а также в материнском молоке не превышало токсического уровня. Установлена 80%-ная передача свинца и кадмия от матерей новорожденным, и выявлены изменения в содержании меди и цинка в крови и сыворотке крови матерей.