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REGULAR ARTICLE

ACCUMULATION OF SELECTED METALS IN UMBILICAL CORD BLOOD OF NULLIPAROUS AND MULTIPAROUS WOMEN AND CORRELATION WITH THE NEWBORN´S PARAMETERS

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ABSTRACT

The aim of this study was to determine the content of magnesium, copper, cadmium and iron in umbilical cord blood of the newborns depending on the number of pregnancies. It was established correlations between average concentrations these metals in cord blood and newborn's parameters. The study material was collected immediately after delivery from the Department of Obstetrics and Gynecology in Bytom. The cord blood was taken from 99 women between 29-40 years old. Women were divided into two groups: nulliparous and multiparous. The concentration of metals in the cord blood was determined by flame atomic absorption spectrometry (FAAS). The conducted study demonstrates that magnesium, copper, cadmium and iron were noted in all tissues, both nulliparous women and multiparous mothers. The maximum concentration of cadmium in umbilical cord blood was observed among multiparous mothers (2.229 $mg.kg^{-1}$ d.m.). In group of nulliparous women was observed higher concentration of Fe, Mg and Cu in umbilical cord blood than in multiparous mothers. It was noted some statistically significant correlation between iron, copper and newborn's parameters. Parity influences the concentration of cadmium in umbilical cord blood with higher level found in multiparous women. Average content of iron in cord blood did not decrease with parity, it indicate that this element is preferentially taken up by the child.

Keywords: cord blood, magnesium, iron, copper, cadmium, parameters of newborn

INTRODUCTION

Heavy metals are supplied to the fetus by placental transfer. During pregnancy, the placenta acts as a selective barrier by allowing nutrients pass to the fetus, and preventing toxic compounds from crossing through **(Cross, 2006; Carter, 2009)**. Evaluation of "in utero" exposure on environmental pollutants has been mainly achieved by using umbilical cord samples **(Reis *et al.*, 2007; Röllin *et al.*, 2009; Jones *et al.*, 2010)**. The role of trace elements in fetal development and growth is well documented in the literature **(Casey *et al.*, 1988; Prohaska, 1989)**. Deficiency of trace elements during intrauterine existence is closely related to mortality and morbidity of the newborn **(Casey *et al.*, 1988)**.

Magnesium, copper, and iron are essential elements required for the normal growth and development of the fetus **(Ramakrishnan *et al.*, 1999; Raghunath *et al.*, 2000)**. Copper, iron and magnesium are microelements that are necessary for a lot of processes inside the organism. High or low level of these trace elements may cause many disorders and dysfunctions. Copper is important especially in early life, for the development and maintenance of myelin **(Yasodhara *et al.*, 1991)**. Cu is essential component for many enzymes **(Gibson, 1989)** and catalyzes a lot of biochemical processes **(Pasterniak *et al.*, 1995)**. High level of this element damages the liver, kidneys and hemoglobin. Deficiency of copper is very unfavorable during pregnancy. This metal can contribute in developing incorrect tissues and organs structure, they are able to change protein metabolism or nucleic acids and also disturb correct fetus growing **(Ashworth *et al.*, 2001; Keen *et al.*, 2003)**. Concentration of this metal must be regulated **(Steńczuk, 1990)**. Lowest content of investigated metal may contribute to early fetal death and respiratory, circulatory or bone systems defects **(Fields *et al.*, 1990; Keen *et al.*, 1998)**.

Anemia is often the consequence of iron deficiency, when dietary intake of iron is low, preterm and low-birth-weight infants are at risk of iron deficiency as a result of reduced fetal iron stores **(Allen, 2000)**. The status of these elements will have impact on normal growth and development of the fetus inside the womb **(Baranski, 1987)**. Magnesium is critical for bone formation, cellular integrity and multiple enzyme functions **(Shils, 1996)**.

Cadmium is widely distributed in an air, water and soil. It is a major component of tobacco smoke that have adverse influence on fetal development. The high reactivity of cadmium, which is present in high concentrations in cigarette smoke contribute to oxidative stress of cells and thus to carcinogenesis **(Stohs, 1997)**.

MATERIAL AND METHODS

The research was conducted using umbilical cord blood of newborns taken after delivery from women. The group of women has been divided into two groups depending on number of pregnancies: nulliparous (n=53) and multiparous (n=46). The samples were collected from Department of Gynecology and Obstetrics in Upper Silesian Region - Bytom (Poland). Written consent for the research has been taken from 99 women. We obtained information about newborns' parameters (birth weight, birth length, head circumference) and mother's diseases. Biotic Commission had agreed to conduct a survey among the patients**.**

Two grams of cord blood were burned in muffle kiln at 450°C. Incinerated materials were poured with 2 mL of 65% nitric acid and were filled up to 10 mL using demineralized water. Metal contents (magnesium, copper, cadmium and iron) were determined by the flame absorption spectrometry method (FAAS).

Elements concentrations were presented in mg/kg dry weight and were compiled statistically by Statistica 9.0. The distribution of investigated elements in umbilical cord blood was measured with Shapiro-Wilk test for normality. Non-parametric U Mann-Whitney test was used for determination of differences between elements content in multiparous and nulliparous women. Correlations between elements and parameters of newborns were measure by Pearson's correlation analyzes.

RESULTS AND DISCUSSION

The quantitative results of magnesium, copper, cadmium and iron in umbilical cord blood of newborns are presented in the Figure 1. In all tissues there were found an amount of magnesium, copper, cadmium and iron. The median levels of Mg, Cu and Fe were higher in group of nulliparous mothers than in multiparous.

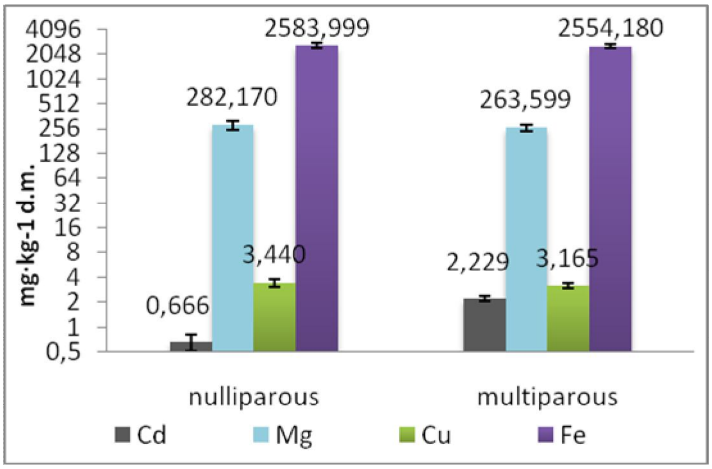

Figure 1 The average content of elements examined in cord blood received from nulliparous and multiparous woman (mg.kg^{-1} d.m.±Std.Err).

Comparing mean values of the analyzed metals in umbilical cord blood, was noticed, that contents of Cd, Mg, Cu and Fe were disparate. We did not find statistically significant differences between the average contents of Mg, Fe and Cu in the umbilical cord blood of newborns depending on the number of pregnancies. The contents of cadmium in umbilical cord blood are lower in nulliparous group than in multiparous mothers. Statistical analysis showed statistically significant correlation between average contents of cadmium in umbilical cord blood within nulliparous group of women and average contents of cadmium within multiparous mothers (p=0.000). Within the group of nulliparous, average content of Cd reached a value of 0.666±0.148 mg.kg^{-1} d.m while in group of multiparous value was significantly higher (2.229±0.176 mg.kg^{-1} d.m.). The iron level in umbilical cord blood of newborns is similar both within nulliparous and multiparous women. Mean content of copper in multiparous reached value 3.165±0.369 mg.kg^{-1} d.m whilst in nulliparous was 3.440±0.269 mg.kg^{-1} d.m.

The average parameters of newborns in groups of multiparous and nulliparous were presented in Table 1. We noted difference with birth weight, birth length and head circumference of newborns among multiparous and nulliparous mothers. Women who have never born children had lower birth weight of their child, lower birth length and head circumference of a newborn.

Table 1 Characteristics of the newborn's parameters depending on the number of pregnancies (multiparous n=46, nulliparous n=53)

Newborn's parameters	Multiparous				Nulliparous			
	Mean	Min	Max	Std.Err	Mean	Min	Max	Std.Err
Birth weight (g)	3084.13	1400.00	4250.00	104.1235	2991.13	1400.00	4000.00	83.81058
Birth length (cm)	53.48	42.00	60.00	0.5653	53.43	45.00	59.00	0.47774
Head circumference (cm)	33.85	28.00	38.00	0.3347	33.49	29.00	36.00	0.24338

Table 2 presents correlations between xenobiotic (Cd), nutritional (Mg, Fe) and biogenic metals (Cu) and newborn's patametres like body weight, body length, circumference of head in umbilical cord blood taken from multiparous and nulliparous women. We found a negative and statistically significant correlation in umbilical cord blood between average contents of copper in group of nulliparous and birth weight of a newborn (birth weight/Cu: r^2 =-0.311; p=0.024). **Kantola *et al.*** (**2000**) noticed the significant negative correlation between copper in human placenta and newborn's birth weight.

Within multiparous group, there were found some statistically significant negative correlations between average concentrations of Fe and head circumference (r^2=-0.358; p=0.014) and between average contents of iron in cord blood and birth weight of newborns (r^2 =-0.495; p=0.000). There were observed positive and statistically important correlation between concentrations of researched elements and newborn's parameters in umbilical cord blood. We did not find any correlation with birth length of newborns and concentrations of Fe, Mg, Cu, Cd in cord blood.

Table 2 Pearson correlation coefficient between xenobiotic, nutritional and biogenic metals and newborn's parametres in umbilical cord blood taken from multiparous and nulliparous women.

Parity	Newborn's parameters	Metals	Perason coefficient (r^2)	Walue „p"
NULLIPAROUS	**Birth weight** (g)	Cd	-0.003	p=0.981
		Mg	-0.197	p=0.158
		Cu	-0.311	p=0.024*
		Fe	-0.002	p=0.988
	Birth length (cm)	Cd	0.087	p=0.533
		Mg	-0.005	p=0.973
		Cu	-0.161	p=0.250
		Fe	0.115	p=0.411
	Head circumference (cm)	Cd	0.137	p=0.327
		Mg	-0.079	p=0.572
		Cu	-0.204	p=0.143
		Fe	-0.073	p=0.601
MULTIPAROUS	**Birth weight** (g)	Cd	-0.027	p=0.860
		Mg	-0.192	p=0.201
		Cu	-0.274	p=0.065
		Fe	-0.495	p=0.000*
	Birth length (cm)	Cd	-0.029	p=0.848
		Mg	-0.156	p=0.300
		Cu	-0.108	p=0.477
		Fe	-0.290	p=0.050
	Head circumference (cm)	Cd	0.044	p=0.773
		Mg	-0.153	p=0.310
		Cu	-0.144	p=0.339
		Fe	-0.358	p=0.014*

Determination of Cd content in umbilical cord blood indicates that level of this essential element is influence by the parity. Women, who have never born children, had lower average contents of cadmium in umbilical cord blood than multiparous women. In a study by **Lagerkvist *et al.* (1992)**, the cadmium levels in the umbilical cord blood were reported to be about 70% of those in the mothers. The researches made in Sweden showed that the average content of Cd in cord blood was lower than average contents of this metal in mother's blood. It means that placenta is an effective barrier for cadmium **(Osman *et al.*, 2000)**. The similar result received **Sakamoto *et al*. (2010)** and **Baranowska (1995)**.

Our researches show that the iron level in umbilical cord blood of newborns is similar both within nulliparous and multiparous women. Average content of iron in cord blood did not decrease with parity - it indicates that this element is preferentially taken up by the child.

Srivastava *et al.* (2001) say that decrease availability of iron in cord blood might cause a reduction in birth weight and also preterm delivery of baby. Preterm delivery could also be result decreasing level of copper in cord blood. Reduced availability of iron and copper could be the result of maternal malnutrition and inappropriate transfer to the fetus, possibly caused by certain pathological conditions or the endogenous availability of environmental chemicals.

Low birth weight babies, prenatal and neonatal death, neonatal and long-term developmental defects in the offspring are the result of action of cigarette smoke on the developing fetus **(Cliver *et al.*, 1995; Kendrick *et al.*, 1996; Wen *et al.*, 1990)**. There are many reasons of low birth weight like diabetes, malnutrition, hypertension, renal and heart diseases and preterm cases have no obvious etiology, and environmental factors are suggested to be involved **(Srivastava *et al.*, 2001)**.

In this study we noticed that average levels of Mg, Cu and Fe in cord blood were higher in group of nulliparous than in multiparous mothers. Reduced availability of iron and copper could be the result of maternal malnutrition or inappropriate transfer to the fetus, possibly caused by certain pathological conditions or the endogenous availability of environmental chemicals **(Srivastava *et al.*, 2001). Barker *et al.* (1990)** and **Hales *et al.* (1999)** found that $(Mg)^{2+}$ measured in umbilical cord correlated significantly with infant birth weight and birth length. As $(Mg)^{2+}$ plays a promotive role in fetal growth, low $(Mg)^{2+}$ may partly be responsible for SGA.

Placenta is a barrier for copper because the level of this metal in maternal blood is higher than in cord blood **(Krachler *et al.*, 1999; Rossipal, 2000)**.

Ahokas *et al.* (1979) and **Baranski (1979)** found that cooper and iron levels were higher in cord blood of normal-birth-weight babies than in the low-birth-weight babies. It indicates a diminished transfer of three elements from mother to the fetus via placenta in the low-birth-weight group and could be one of several etiological factors responsible for reduced birth weight of newborns. There may be numerous reasons for possible diminished transfer of essential elements in the lower-birth-weight newborns. It is well established that maternal exposure to heavy metals may cause placental damage and change the transportation of essential trace metals to the fetus.

The role of environmental chemicals in altering the transfer of essential elements from the mother to the fetus during pregnancy might be of toxicological significance. Actual dietary intake of copper, and iron together with monitoring of environmental toxicants like cadmium in the blood of the mother and babies may be needed to elicit the importance of the status of essential metals as modified by the certain pathological conditions, and chemical toxicants in the growth and development of the fetus **(Srivastava *et al.*, 2001)**.

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