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Lead in Cord Blood of Neonates from Chorzow (Upper Silesia)

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Abstract

Lead levels in cord blood (PbB) of 92 neonates living in the town of Chorzdw (Upper Silesia) have been determined.

The mean PbB concentration was 5.29 µg/dl (SD = 2.24) in the all investigated groups. Mean Pb-CB was higher in preterm babies (x = 6.87 µg/dl, SD = 1.67), especially in boys. Pb-CB concentrations were higher in the neonates born to mothers aged more than 30 years who smoked before and during pregnancy, had bad living conditions, and lived close to gasoline stations.

Keywords: lead, cord blood, smoking habit, living conditions

Introduction

Compared to the amount of information about environmental lead intoxication and its consequences in older children [1, 2, 3] there are relatively few publications concerning lead influence on pregnancy and prenatal development [4, 5].

Low-dose prenatal exposure to lead has been shown to be potentially toxic to the cognitive development of the fetus and young child [4, 6]. Lead has an influence on energetic processes and the synthesis of body proteins. It impaires tissue oxidation processes, mitochondrial enzyme activity, and decreases membrane ATP-ase activity [7].

There is no protective barrier to the transplacental transport of lead during pregnancy. Maternal and cord blood lead levels are strongly correlated [5, 8].

It is generally accepted that cord blood lead level is a good indicator of prenatal exposure. Over 99% of lead in blood is associated with erythrocytes, their mean life-time is about 120 days [9].

Despite smaller emissions of lead to the environment, pollution caused by this metal is still an important problem - especially during pregnancy. Earlier exposure connected with occupational exposure and even high environmental exposure during childhood may influence blood lead concentrations in pregnant women.

Over 90% of lead in tissues of adult subjects is found in bone [10, 11].

Lead deposits in bones have a long half-life of 20-30 years.

During pregnancy the body burden of lead stored in maternal bone can be released [9, 12, 13]. A pregnant woman can be the potential source of lead intoxication for her children during prenatal development. It is important to understand that mother's environment, social background and lifestyle can determine the concentration of lead in a neonatal organism.

The aim of this study was to establish lead levels in mothers and their newborns and assess the influence of selected demographic, social and economic factors on lead levels in cord blood and prenatal child development.

Patients and Methods

The study was conducted during the months from September to November 1994, in the maternity hospital in Chorzow in the Upper Silesia Region of Poland. All women accepted to participate in the study. The mothers were asked about their lifestyles while staying in the obstetric department and neonates underwent clinical examinations. Part of the study was a questionnaire survey concerning mother's past illnesses, occupational exposure to lead, living conditions and smoking habits, living close to traffic motorways.

Cord blood Pb concentration in newborns was measured

Table 1. Lead in cord blood Pb-CB µg/dl) of neonates.

Sex	n	Pb-CB mean	SD ±	Modal mean	Quart 0 (min)	Quart 1	Mediane	Quart 3	Quart 4 (max)
Girls	56	5.59*	2.46	5.6	1.6	3.75	5.45	7.5	11.7
Boys	36	4.84*	1.81	3.1	1.1	3.7	4.4	5.9	8.8
Girls + Boys	92	5.29	2.24	3.1	1.1	3.75	5	7.2	11.7

* statistically significant $p < 0.047$

Table 2. Lead in cord blood Pb-CB µg/dl) in neonates born prematurely.

Sex	n	Pb-CB mean	SD ±	Modal mean	Range of Pb-CB	Statistical differences between born at term and preterm Students t-test
Girls	5	6.22	2.12	7.5	2.8-7.8	n.s.
Boys	5	7.52	0.87	8.3	6.2-8.3	$p < 0.001$
Girls + Boys	10	6.87	1.67	7.5	2.8-8.3	$p < 0.008$

* n.s. - no statistically significant

by atomic-absorption spectrometry (the laboratory participates in international Quality Control and Quality Assurance with satisfactory results).

The results are presented as a mean value. Student's t-test and linear regression equation were used to evaluate statistical differences between groups.

Results

The study involved 92 mother-newborn pairs. 82 were born at term and 10 neonates were born preterm (from 34 to 37 weeks of pregnancy). All the infants were born spontaneously. Mothers were healthy during pregnancy and the newborns were recognized as being healthy, without congenital defects. All examined mothers had no occupational history of lead exposure and have been living all their lives in Chorzow, a large town located in the centre of Upper Silesia outside the area of direct impact of lead smelters and other non-ferrous metal processing entities.

The average gestational age for girls was 39.5 and for boys 39.3 weeks. The mean body mass for girls was 3056.3 g (SD = 495.05) and for boys - 3221.4 g (SD = 599.1). The average lead level in mothers blood was 5.87 µg/dl (SD = 2.71), and the range was from 3.3 to 15.8 µg/dl.

Correlation coefficient between maternal blood lead levels and cord blood lead levels was $r = 0.6$, $p < 0.001$, higher for boys $r = 0.8$, $p < 0.003$ then for girls $r = 0.67$, $p < 0.005$.

Mean cord blood lead level (Pb-CB) in all group of neonates was 5.29 µg/dl (SD = 2.24), ranging from 1.1 to 11.7 µg/dl (Tab. 1).

Significantly higher Pb-CB levels were found in girls (Pb-CB = 5.59 µg/dl) than in boys (Pb-CB = 4.84 µg/dl, SD = 1.81, $p<0.047$).

Pb-CB mean value (Pb-CB = 6.87 µg/dl, SD = 1.67) and modal mean were significantly higher in preterm babies than in newborns born at term (Tab. 2). There were no statistical significances observed between girls born prematurely and at term, but in boys born prematurely the mean

Fig. 2. Parity and Pb-CB in neonates.

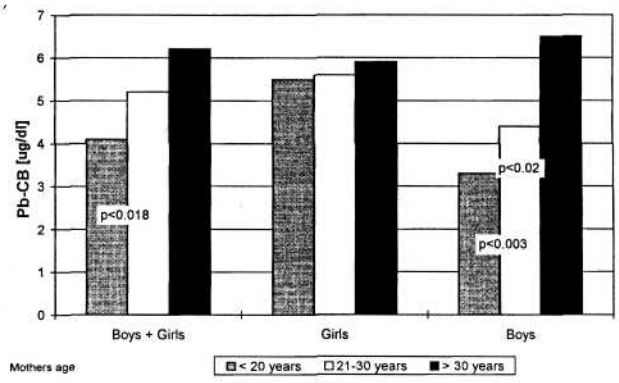
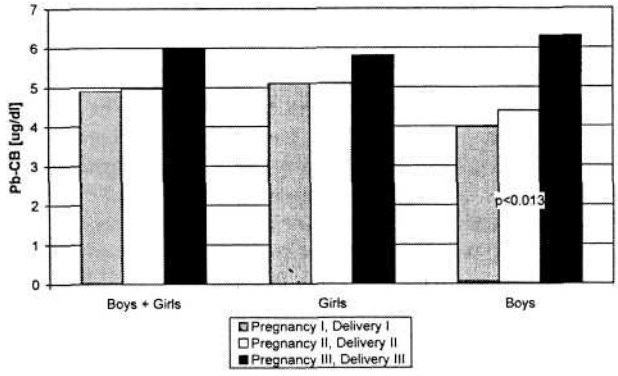


Fig. 1. Age of mothers and Pb-CB in neonates.



values of Pb-CB were significantly higher (x - 7.52 and x = 4.41 µg/dl, respectively; $p< 0.001$). Pb-CB concentrations in the newborns were influenced by the age of the mother (investigated in the following age groups: below 20, 21 to 30 and above 30 years) and parity. Higher lead levels were observed in neonates of mothers more than 30 years old and from the third pregnancy (Fig. 1, Fig. 2).

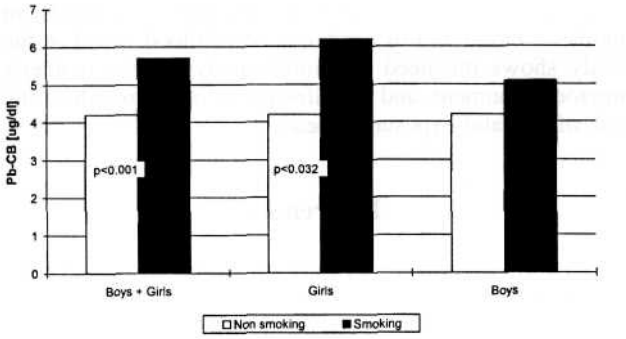


Fig. 3. Smoking habits of mothers begore pregnancy and Pb-CB in neonates.

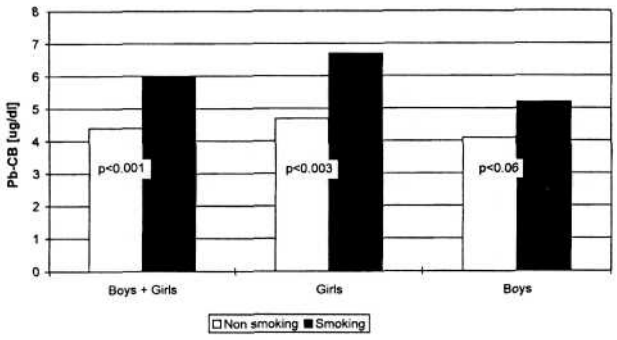


Fig. 4. Smoking habits of mothers during pregnancy and Pb-CB in neonates.

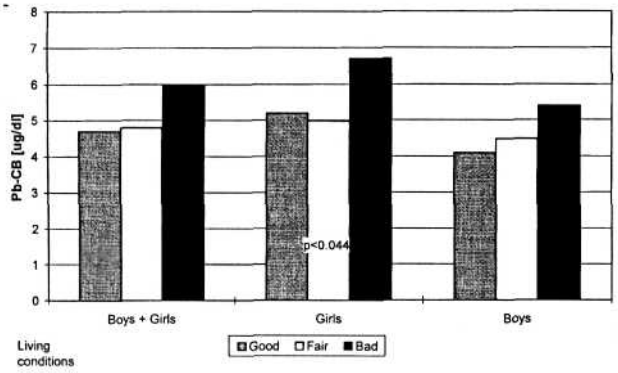


Fig. 5. Living conditions and Pb-CB in neonates.

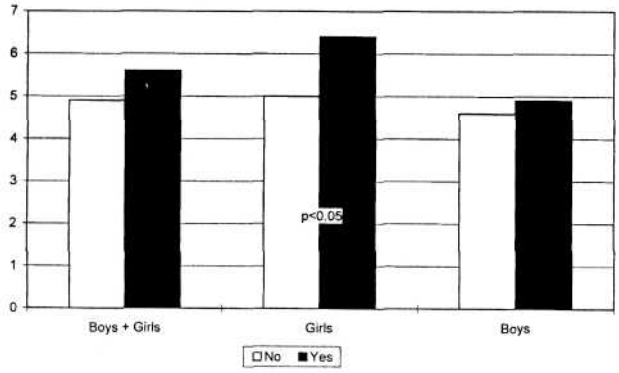


Fig. 6. Gasoline station in close vicinity (< 0.5 km) and Pb-CB in neonates.

Smoking habits of the mothers were investigated. 46 (50%) mothers smoked before pregnancy, 28 of them gave birth to girls and 18 of them gave birth to boys. The mean period of smoking before pregnancy was 6.6 years (SD = 3.7), ranging from 3 to 18 years. Mothers smoked daily on average 13.6 (SD = 6) cigarettes, ranging from 3 to 25. Pb-CB concentrations in the neonates born to mothers smoking before pregnancy were sigificantlly higher than those of woman who did not smoke (Fig. 3).

Smoking habits of the mothers during pregnancy were investigated.

35 (38%) mothers smoked during pregnancy, 19 of them gave birth to girls and 16 of them to boys. Mothers smoked daily on average 11 (SD = 6.3) cigarettes, ranging from 3 to 25. Smoking during pregnancy (Fig. 4) had a significant effect on increased Pb-CB levels in the newborns.

Pb-CB concentrations were shown to be higher when a mother declared having bad living conditions (e.g. having many children, being unemployed, poorly educated, living in a small flat) than of those having average or good living standards (Fig. 5).

Pb-CB of girls were higher when mothers live in the vicinity of a gas station (< 0.5 km) (Fig. 6).

There were no significant differences between the Pb-CB levels in mothers with spontaneous abortion or preterm delivery in obstetrical history and Pb-CB levels of mothers with normal pregnacy outcome.

Discussion

The present research concerned newborns born to mothers who didn't experience occupational exposure to lead. Mothers were environmentally exposed to lead because they lived in a large urban area located in the central part of Upper Silesia. Chorzow belongs to high risk areas of lead contamination in the Katowice region, taking the risk of environmental lead intoxication into consideration.

This statement is made on the basis of results of the Project of Prevention of Environmental Lead Intoxication in Children Living in the Upper Silesian Industrial Zone [14].

Despite the fact that lead emissions from industrial sources have significantly decreased in the last few years (partly due to economic regression and partly because of increasing interest in preserving health environment in the region) the concentration of this harmful metal in soil and in street dust is still very high [14]. Lead remains in the environment for many years.

In this study a high correlation coefficient was found between blood lead concentrations of mothers and cord blood lead levels of neonates, due to the fact that lead easily passes through the placental barrier [6, 8, 15].

Cord blood lead levels of neonates from Chorzow were higher than cord blood lead levels of neonates from Legnica (4.3 µg/dl) [5] or Wroclaw (4.3 µg/dl) [16]. In 1980-81 cord blood lead levels of neonates in England were as high as 4.1 ug/dl [17]. In Sweden the cord blood lead levels were even lower, either in the vicinity of a lead smelter (3.8 µg/dl) or in controls (2.6 µg/dl) [8]. In relation to the data cited above, cord blood lead levels of the neonates from Chorzow are still high, especially for a group of preterm babies. This might be connected with the fact of a less mature placenta.

Higher lead concentrations in cord blood of neonates born to older mothers (> 30 years of age) as well as in cord blood of neonates who came from the second or third pregnancy may be explained by the increased cumulation of this metal in the body of older mothers. Besides, during pregnancy, mobilization of lead bone deposits is possible because of hormonal changes. It was proved that during pregnancy, blood lead levels increase by 15-20% and serum calcium decreases [12].

Gulson [11] in a study based on stable lead isotope methods in adult women immigrating from Eastern Europe indicated that between 45-70% of lead in blood comes from long-term tissue lead stores. He underlined the long-term health risks of environmental lead exposure. During pregnancy mobilization of lead from the maternal skeleton increases. Mobilization of lead from the skeleton is even greater during lactation than during pregnancy. The increased contribution of skeletal lead both during pregnancy and during lactation is consistent with increased bone resorption, and may be associated with inadequate calcium intake [9, 13].

Results from these studies indicates that higher lead levels were observed in neonates of mothers living in bad conditions. Women of low socioeconomic levels are more exposed to environmental lead (behaviors and lifestyles) and consume an inadequate diet. Diet is a factor modifying lead kinetics. Calcium and iron deficiences have been found to enhance the absorption of lead [19]. Adequate calcium dietary intake has a protective role against lead by decreasing absorption of lead in the gastrointestinal tract and by decreasing the mobilization of lead from bone stores during pregnancy and lactation.

In this study higher cord blood lead levels were found in mothers who smoked either before or during pregnancy. The percentage of women who smoked during pregnancy was relatively high. Only a few women gave up smoking during pregnancy. Smoking women are exposed to the absorption of additional amounts of lead. There are 3-12 µg of lead in each cigarette and about 2% out of this amount is absorbed.

Rhainds and Levallois [20] also found a positive association between cigarette smoking during pregnancy and lead levels in newborns. An average increase of about 15 percent in cord blood lead levels was estimated for every 10 cigarettes smoked per day. Higher blood lead levels were also found in newborns of smoking mothers who stopped smoking during pregnancy when compared with nonsmokers.

This is probably connected with the higher body burden of lead in bones.

In this study higher lead levels in cord blood of neonates of mothers living in the vicinity of gasoline stations are due to the combustion of leaded gasoline and the location of residential areas without protecive zones near gasoline stations or heavy automobile traffic.

Conclusion

1. In a polluted environment a pregnant women is a potential source of lead intoxication for babies during prenatal development and her social background and lifestyle can influence the concentration of lead in prenatal development of neonates.

2. The positive correlation between lead levels in mothers' blood and in newborns' cord blood found in the study shows the need of careful analysis of a mother's microenvironment, and her lifestyle in order to reduce the risk of prenatal exposure to lead.

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