

Lead Microintoxication in Children Living in Bytom

I. Norska-Borowka, J. Behrendt

II Chair and Department of Pediatrics, Silesian Medical Academy, 41-800 Zabrze, 3 Maja 13/15, Poland

Received 16 December, 1998

Accepted 16 March, 1999

Abstract

The aim of our study was to assess blood lead levels in children to find correlations between blood lead levels and physical and psychological development, and behaviour and learning progress of children living in Bytom, a town in an ecologically disastrous region.

In 1996-97 we examined 2000 children (about 4% of the general population) in different age groups. A preliminary questionnaire was used to select the children at the highest risk of intoxication. Blood samples were analyzed using atomic absorption spectrophotometry. Psychological tests were performed using the Denver scale, Short Intelligence scale, Kohs test and the Monachium method.

The average blood lead levels in examined groups of children were:

- newborns - 3.65 ug/dl \pm 1.31
- mothers of newborns - 5.42 ug/dl \pm 1.8
- 6-24 month old children - 4.97 ug/dl \pm 2.25
- 3 year olds - 4.6 ug/dl \pm 1.68
- school-aged children - 4.96 ug/dl \pm 2.16

We found significantly higher blood lead concentrations in the group of mothers and their newborns with perinatal complications in comparison to healthy ones. Our data show that children's activities essentially influence blood lead levels from the age of 12 months.

In industrial regions such as Bytom, lowered grades in school are be an indicator that blood lead concentrations should be tested.

Keywords: microintoxication, blood lead concentration, children

Introduction

Monitoring of blood lead levels in children is one of the best markers indicating the influence of polluted environments on the human body, especially when long-term exposure to toxic substances is noted.

Lead causes important toxic changes in organs of children and their intellectual status [1, 2]. According to many authors, chronic lead microintoxication with blood lead levels below 10 μ g/dl (according to CDC Atlanta indicators) correlates with difficulties in learning, behavioral disturbances, and lower IQs in Danish and German children [3, 4, 5, 6, 7].

Aim

The aim of our study performed in Bytom was to examine the following parameters in children:

- 1) Blood lead levels (PbB).
- 2) Psychical and psychomotorical development, behaviour and school performance in correlation with PbB.

Material and Methods

Our examinations in 1996-97 were conducted on 2000 children (about 4% of the general population) divided in four age groups:

I - 148 pairs of mothers and their newborns,
 11-152 cases of 6-12-18-24 month olds,
 III - 71 cases of 3 year olds,
 IV - group comprised of 1529 children aged 7-11 years.
 We used the following methods:

1. identification of children by means of a special questionnaire [8]
2. indication of PbB using AAS (atomic absorption spectrophotometry)
3. general pediatric examination
4. special clinical evaluation in cases of PbB above 10
5. psychological examination using the Monachium Method [9] and Denver Scale, Short Intelligence Test, and Kochs test
6. statistical analysis using Chi square test, T-test and Person correlation analysis
7. preventative activities addressed to parents, children and teachers concerning prevention of lead intoxication [2].

Results

In the first group we estimated PbB in umbilical newborns' blood and in mothers' venous blood. We found significantly higher PbB in mothers' blood (5.42 µg/dl) in comparison to umbilical blood of their newborns (3.65 µg/dl), $p < 0.001$. Furthermore, the average PbB of mothers with perinatal complications was much higher than PbB of mothers without any problems during pregnancy (10.6 µg/dl vs. 4.7 µg/dl), $p < 0.0001$. Similar statistically significant differences were also found in umbilical blood (8.2 µg/dl vs 3.02 µg/dl), $p < 0.0001$.

The average PbB of newborns weighing less than 2500 g at birth did not differ from the level of newborns with birth weight above 2500 g.

We did not see any influence of socio-economic factors on blood lead levels.

In the second group of children from randomly chosen pediatric outpatient departments in different districts of Bytom we estimated PbB in 152 children. Psychomotor development and socio-ecological factors were evaluated. These showed:

- a) significantly lower mean PbB in 6 month old infants in comparison to the 12-18-24 month old ones,
- b) higher mean PbB in children from outpatient departments situated in the most polluted districts (Bobrek and Szombierki),
- c) birth weights of examined children did not influence their PbB.

After taking into account parental smoking and location of employment no difference in PbB was found.

The average blood lead level among 3 year old children from four randomly chosen nurseries in Bytom was between 3.53 µg/dl and 5.89 µg/dl (group III). Only one case with PbB above 10 µg/dl (11.3 µg/dl) was found. A high exposure to passive smoking among those children was revealed. Seasonal morbidity of infectious disease was noted in 59% of children. Only 13% had had a chance to leave Bytom for a short period of time during vacation, 39% had never left Bytom.

In 11 cases deviation from the Polish norm of weight and height was observed.

Among 1529 children 7-11 years old from randomly chosen primary schools from different parts of Bytom, the

Table 1. Mean blood lead levels of children from 15 randomly chosen primary schools in Bytom.

| No of school | No of children | Mean PbB ug/dl | Standard deviation | Geometric mean. |
|--------------|----------------|----------------|--------------------|-----------------|
| 9 | 60 | 5.44 | 2.01 | 5.04 |
| 11 | 165 | 5.73 | 3.27 | 5.23 |
| 12 | 85 | 4.88 | 1.67 | 4.62 |
| 15 | 54 | 4.97 | 1.96 | 4.63 |
| 20 | 123 | 4.40 | 2.03 | 3.97 |
| 21 | 141 | 4.97 | 2.25 | 4.56 |
| 23 | 25 | 4.09 | 1.20 | 3.93 |
| 25 | 41 | 5.04 | 2.23 | 4.65 |
| 26 | 216 | 4.48 | 1.95 | 4.18 |
| 33 | 105 | 4.66 | 2.03 | 4.30 |
| 34 | 55 | 4.40 | 1.71 | 4.13 |
| 36 | 191 | 6.05 | 2.02 | 5.71 |
| 38 | 19 | 4.41 | 1.65 | 4.27 |
| 46 | 119 | 5.1 | 1.89 | 4.75 |
| 51 | 130 | 4.84 | 1.70 | 4.56 |
| total | 1529 | 4.96 | 2.17 | 4.55 |

highest mean PbB was noted in children from Primary School No 36 situated in the center of the town, and Primary School No 11 in Radzionkow. The lowest one was found in Primary School No 23 in Stroszek (4.092 µg/dl) (Table 1).

Average PbB was 5.64 µg/dl, 6 children exceeded 10 µg/dl, and 86 exceeded 8 µg/dl (17%). We found that 26% of fathers and 6% of mothers of the children had professional contact with Pb. These families predominantly resided near heavy road traffic and coal mines, 55% admitted to living within 5 km of a metallurgical plant.

We noted a 55% incidence of parental smoking with mothers smoking less frequently (26%).

We evaluated physical development, health status, school performance and behaviour in 505 children from schools with the highest average PbB. A questionnaire completed by school staff was used. We found a close negative correlation between PbB and behaviour grades (Fig. 1). The same relation was found grades for Polish and mathematics.

Discussion

The statistically confirmed relationship between blood lead levels and incidence of complications during pregnancy and labor is shown in our study. We found no influence of analyzed socio-economic parameters on blood lead levels in mothers and newborns. The risk of lead intoxication in the population of mothers and newborns correlated with living near industrial lead emitters and heavily trafficked roads.

Our results of blood lead levels in 6, 12, 18, 24 month old children also confirmed the importance of location of residency in cases with increased blood lead levels.

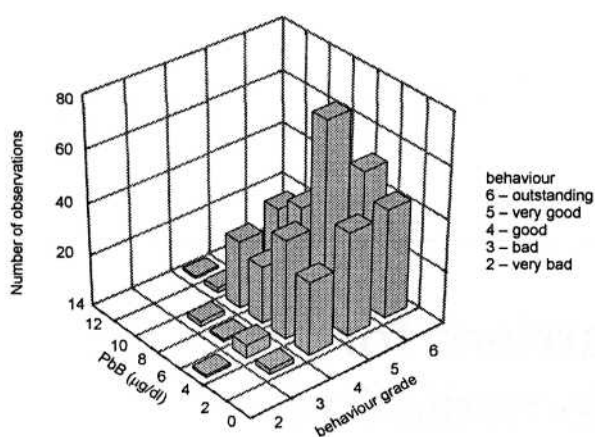


Fig. 1. Correlation between PbB (ug/dl) and behaviour grades ($p < 0.001$).

Psychological examinations according to the Hellbrugge method [9] conducted in children under 2 years old did not show any impairment.

Place of residency also influenced average blood lead levels of 3 year old children. The highest PbB was noted in children living close to metallurgical plants. There were no differences in physical development, psychological development and pediatric evaluation according to blood lead levels in these children.

The most interesting results were found in the population of school-age children. There were significant correlations between blood lead levels and school performance in grades of Polish language, mathematics and behaviour [10]. We did not observe differences according to sex and age in this large group. According to our study and also bibliographic data we state that blood lead levels permissible in children (10 ug/dl according to CDC Atlanta) should be taken into critical consideration [3, 4, 6, 7, 11]. It should be stressed that the blood-brain barrier in small children is not completely developed, allowing increased penetration of lead into the central nervous system. Small children have the habit of putting hands into mouths and are likely to play on the floor. It is very difficult to apply to them proper sanitary-hygienic patterns. Three year old children eat and drink relatively more per weight unit than adults. The higher risk of lead intoxication, increased vitamins and nutritional deficiency (for example iron deficiency, vitamin D), and thus higher lead absorption from the intestinal tract were observed. Individual sensitivity of children to even low lead concentrations might cause disturbances of the central nervous system, such as behavioural deficits and cognitive impairments. A decreasing IQ might be the first sign of lead microintoxication.

Conclusions

1. Increased blood lead levels found in pairs of mothers and newborns with perinatal complications showed the necessity of routine lead evaluation in populations living in polluted areas.
2. Residing metallurgical plants influences blood lead levels in children aged 0 to 11 years.
3. Lowered school grades of mathematics, languages and impaired behaviour are related to increased blood lead levels above 8 ug/dl in children living in Bytom.

References

1. NORSKA-BOROWKA I., BURSA J., KASZANIA-KOCOT In fluence of degraded environment on health status of Silesian children. Ecological Foundation "Silesia" Katowice **1992**.
2. NORSKA-BOROWKA I., BURSA J., KEMPA M., LUKAS W. How to avoid lead intoxication. Ecological Foundation "Silesia", Katowice **1996**.
3. LYNGBYE T. Methodological Problems in Assessing Health Related Neuropsychological Effects of Lead Absorption in Very Low-Level Exposed Area. *Centr. Eur. J. Publ. Hlth*, **5**, 70, **1997**.
4. NEEDLEMAN H.L., GATSONIS C.A. Low-level lead exposure and IQ of children: metaanalysis of modern studies. *JA MA*, **263**, 673, **1990**.
5. NOWAK A., CZERWIONKA-SZAFLARSKA M. Mikrointoksykacja ołowiem- nowy problem zdrowotny pediatrów i dzieci u schyłku XX wieku? *Przegląd Pediatryczny* **27**, 194, **1997**.
6. SCHWARTZ J. Societal benefits of reducing lead exposure. *Environ. Res.*, **66**, 105, **1994**.
7. WINNEKE G., KRAMER U. Neurobehavioral aspects of neurotoxicity in children. *Centr. Eur. J. Publ. Hlth*, **5**, 65, **1997**.
8. NORSKA-BOROWKA I., BARANOWSKI J., LUKAS W. What questions predict lead poisoning in ecologically endangered in Poland? Abstracts SECOTOX 96 Fourth European Conference on Ecotoxicology and Environmental Safety. Metz France 102, 25-28 August **1996**.
9. HELBRUGGE Th. (editor). *Monachium Functional Developmental Diagnostics*. Antykwa, Kraków **1994**.
10. NORSKA-BOROWKA I. Children health condition as the indicator of environmental disaster, Proceedings of the International Symposium on Environmental Epidemiology in Central and Eastern Europe: Critical Issues for Improving Health 100-102, 24-27 Sept. **1997**.
11. BELLINGER D., DIETRICH K.N. Low-level lead exposure and cognitive function in children. *Pediatr. Ann.* **23**, 600, **1994**.