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Correlation Between Blood Lead Level and Hemoglobin Level in Mitrovica Children

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ABSTRACT

Introduction: Lead toxicity is a serious health threat, especially in developing countries due to environmental pollution. It was thus aimed to investigate correlation between blood lead level and concentration level of hemoglobin in the blood of children involved in research. **Material and methods:** The research included 250 children of which 31(12.4%) kindergarten children, 166 (66.4%) of primary school pupils in Mitrovica and 53(21.2%) of primary school pupils in Shtime as control group. From the 250 children included in the survey 129 or 51.6% were female children and 48.4% male children. Children were selected randomly, while tests for concentration of Pb and blood hemoglobin were done at the National Institute of Public Health. **Results:** The average value of blood lead level of Mitrovica pupils was 2.4 μg/dL (SD±1.9μg/dL), range 0.5 to 16.3μg/dL. The average value of blood lead level of Shtime pupils was 2.3μg/dL (SD±0.7μg/dL), range 1.2 to 5.2 μg/dL with no statistical difference (P = 0.191). The average value of blood lead level in kindergarten children of Mitrovica was 3.8μg/dL (SD±1.3μg/dL), range 2.2 to 7.7μg/dL with significant difference between the average values of blood lead levels of pupils and kindergarten children of Mitrovica (P <0.0001). The average value of hemoglobin in the pupils of Mitrovica was 14.0g/dL(SD±3.7g/dL), range 9.4 to 25.6 g/dL. The average value of hemoglobin to pupils of Shtime was 11.4g/dl(SD±0.8 g/dl), range 9.2 to 13.0 g/dl with significant difference between mean values of hemoglobin pupils of Mitrovica and Shtime (U '= 6440.0, P <0.0001). With Spearman correlation is found significant correlation of a medium scale (r = -0.305, df = 248, p <0.0001) between blood lead levels and hemoglobin level in the blood.

Key words: Blood lead level, Blood hemoglobin, Correlation.

1. INTRODUCTION

Lead exposure in children has received increasing attention from scientists and public health institutions worldwide.(1). There are many publications and information available concerning the effects of lead on human health. In fact, the toxic effects of lead have been known for centuries, but it has been discovered in recent decades, that the levels of exposure although to levels of lead in the blood (<20μg/dL) are associated with negative effects in the body, are concerning (2, 3). In terms of public health, the issue of lead is an inevitable topic because the effects of lead are very harmful and toxic to our health. Lead has toxic effects in our brain, blood and kidneys. Children are the most vulnerable age group for exposure, because the exposure to high lead levels causes the impairment to their intellectual development.

Use of lead dating from ancient time. Lead is found naturally in the earth's crust composition. However, most of the high levels found in the environment coming from human activities. Environmental levels of lead have risen more than 1000 times over the past three centuries as a result of industrial development where the use of lead is present (4).

At lower levels of exposure, which cause no obvious symptoms and that previously were considered safe, lead is now known to produce a spectrum of injury across multiple body systems. In particular, lead affects brain development in children, resulting in reduced IQ, behavioral changes such as shortening of attention span and increased antisocial behavior and reduced educational attainment. These effects are believed to be irreversible. Adults are at increased risk of kidney disease and raised blood pressure. CDC actually recognize <10μg/dL even less as it possible (2).

Kosovo is landlocked and possesses many mineral resources, mainly coal, lead, zinc, chromium, and silver. Current industrial activity and a legacy of former practices have heavy health and environmental impacts and generate economic losses (5, 6, 7). These environmental issues relate to air pollution, lead and other contamina-

tion from mining, water pollution and availability, degradation of forests and land, and untreated municipal and hazardous waste. Lead-related health concerns in Kosovo are associated with:

a) Lead emissions to air and water by lead and zinc mines and lead-processing facilities, in particular former lead smelters. Emissions have spread over areas several kilometers wide, known as hot spots.

b) Release of lead to air by vehicles fueled by leaded gasoline and possibly other indoor exposure sources such as lead-based paint and lead water pipes. This exposure is likely higher in urban areas (8, 9). Kosovo has several lead and zinc mines, most north of Mitrovica. A lead smelter operated for several decades in Zvecan (a few kilometers north of Mitrovica) until it closed in late 2000. Thus, Zvecan and northern Mitrovica are lead hot spots (10, 11).

Air emissions of lead have fallen dramatically since Zvecan's smelter was shut, but lead mines and their tailings still contaminate the air (wind-borne dust), water, and soil (runoff and dust deposition). Similarly, the soil around Zvecan, still heavily contaminated by deposition of leaded particles, is a major source of lead exposure. The use of leaded gasoline was authorized during the former Yugoslav period and has been regulated in Kosovo only very recently by an administrative instruction issued in September 2011. Other sources of lead exposure (paints and pipes) are not documented (12).

2. OBJECTIVE

Lead toxicity is a serious health threat, especially in developing countries due to environmental pollution. It was thus aimed to investigate correlation between the blood lead level and concentration of hemoglobin in the blood of children involved in the research.

3. MATERIAL AND METHODOLOGY

The study is trans-sectional, prospective and analytical observer type. The research included 250 children of which 31(12.4%) kindergarten children, 166 (66.4%) of primary school pupils in Mitrovica and 53 or 21.2% of primary school pupils in Shtime as control group. From the 250 children included in the survey 129 or 51.6% were female children and 48.4% male children. Selection of children is made with randomization, while tests for Lead blood level and hemoglobin's level are done at the National Institute of Public Health. Determination of lead in blood is done with the method Graphite furnace atomic absorption spectrometry (GFAAS). Hemoglobin was determined by the method of cyanmethemoglobin with reagents from the German company "Human" [13] Anthropometric measurements were made by training teams on field on the day of examination and in the same conditions with weigher and anthropometer. Children and their parents were informed that they would be included in the study after obtaining permission from the Municipal Departments of Education and Health as well as after prior approval of the protocol by the Ethics Committee of the Faculty of Medicine. Data processing was done with the statistical package Instat 3. From statistical parameters are calculated index structure, arithmetic mean, standard deviation, minimum and maximum value. Testing parametric data was done with T-test and non-parametric data was done with Mann-Whitney test. With Spearman correlation is calculated correlation between blood lead level and the level of hemoglobin in the blood. The difference is significant if $P < 0.05$.

4. RESULTS

The research included 250 children of which 31(12.4%) kindergarten children, 166 (66.4%) of primary school pupils in Mitrovica and 53 or 21.2% of primary school pupils in Shtime as control group. From the 250 children included in the survey 129 or 51.6% were female children and 48.4% male children.

Age (years)	Pupils Mitrovica	Pupils Control group	Kindergarten Children Mitrovica
N	166	53	31
Average	8.1	9.2	5.1
SD	1.4	1.7	0.2
Min	5.0	6.0	5.0
Max	11.0	12.0	6.0
P. Mitrovica/P. Control group	Mann-Whitney test	U'=6037.5	P<0.0001

Table 1. Age parameters of children involved in the research by groups

The average age of pupils of Mitrovica was 8.1 years (SD ± 1.4 years), range 5 to 11 years. The average age of pupils of control group was 9.2 years (SD ± 1.7 years), range 6 to 12 years. With Mann-Whitney test we have gained difference with important statistically significance between the average age of pupils of Mitrovica and control group (U '= 6037.5, P <0.0001). Pupils of Shtime/control group were older than pupils of Mitrovica. The average age of kindergarten children in Mitrovica was 5.1 years (SD ± 0.2vjet), range 5 to 6 years (Table 1).

Length (cm)	Pupils Mitrovica	Pupils Control group	Kindergarten Children Mitrovica
N	166	53	31
Average	130.5	136.2	110.4
DS	8.9	10.5	5.3
Min	113.0	113.8	100.7
Max	153.2	160.3	124.9
P. Mitrovicë/P. Control group	T–testi	T=3.81	P=0.0001

Table 2. The length parameters of the children involved in the research by groups

The average length of Mitrovica pupils was 130.5 cm (SD ± 8.9 cm), range 113 to 153.2 cm. The average length of control group pupils was 136.2 cm (SD ± 10.5 cm), range 113.8 to 160.3 cm. With T test we have gained difference with important statistically significance between the average length of Mitrovica and control group pupils ($T = 3.81$, $P = 0.0001$). Pupils of control group were greater length than pupils of Mitrovica. The average length of kindergarten children in Mitrovica was 110.4 cm (SD ± 5.3 cm), the range 100.7 to 124.9 cm (Table 2).

Weight (kg)	Pupils Mitrovica	Pupils Control group	Kindergarten Children Mitrovica
N	166	53	31
Average	28.5	32.0	19.0
SD	6.9	8.4	3.6
Min	17.9	20.5	14.9
Max	56.8	53.2	32.0
P. Mitrovic/P.Control group	Mann-Whitney test	U'=5519.5	P=0.0053

Table 3. Weight parameters of the children involved in the research by groups

The average body weight of Mitrovica pupils was 28.5 kg (SD ± 6.9 kg), range 17.9 to 56.8 kg. The average weight of Control group pupils was 32.0 kg (SD ± 8.4 kg), range 20.5 to 53.2 kg. By Mann Whitney test we have gained difference with important statistically significance between the average weight of pupils of Mitrovica and Control group (U '= 5519.5, P = 0.0053).Control group pupils were with body weight greater than pupils of Mitrovica. Average weight of kindergarten children in Mitrovica was 19.0 kg (SD ± 3.6 kg), range 14.9 to 32.0 kg (Table 3).

Thickness of subcutaneous tissue	Pupils Mitrovica	Pupils Control group	Kindergarten Children Mitrovica
N	166	53	31
Average	8.4	9.2	8.3
SD	3.2	3.6	2.4
Min	2.0	4.9	4.9
Max	22.3	22.1	14.5
P. Mitrovicë/P.Control group	Mann-Whitney test	U'=4845.0	P=0.160
P.Mitrovica/Kindergarten Ch	Mann-Whitney test	U'=2552.5	P=0.8856
KindergartenCh /P.Control group	Mann-Whitney test	U'=910.5	P=0.412

Table 4. Thickness of subcutaneous tissue parameters of children involved in the research by groups

The average thickness of the subcutaneous tissue of pupils of Mitrovica was 8.4 mm (SD ± 3.2 mm), range 2.0 to 22.3 mm. The average thickness of the subcutaneous tissue of pupils from control group was 9.2 mm (SD ± 3.6 mm), range 4.9 to 22.1 mm. By Mann Whitney test we have not gained difference with important statistically significance between the average thickness of the subcutaneous tissue of pupils of Mitrovica and Shtime (U '= 4845.0, P = 0.160). The average thickness of the subcutaneous tissue of kindergarten children in Mitrovica was 8.3 mm (SD ± 2.4 mm), range 4.9 to 14.5 mm. By Mann Whitney test have not gained difference with important statistically significance between the average thickness of the subcutaneous tissue of pupils of Mitrovica and kindergarten children (U '= 2552.5, P = 0.8856). By Mann Whitney test we have not gained difference with important statistically significance between the average thickness of the subcutaneous tissue of pupils of Shtime and kindergarten children in Mitrovica (U '= 910.5, P = 0.412). (Table 4).

Lead (µg/dl)	Pupils Mitrovica	Pupils Control group	Kindergarten Children Mitrovica
N	166	53	31
Average	2.4	2.3	3.8
SD	1.9	0.7	1.3
Min	0.5	1.2	2.2
Max	16.3	5.2	7.7
P.Mitrovicë/P. Control group	Mann-Whitney test	U'=4925.0	P=0.191
P. Mitrovicë/ Kindergarten Ch.	Mann-Whitney test	U'=4348.5	P<0.0001
Kindergarten Ch. /P.Control group	Mann-Whitney test	U'=1465.5	P<0.0001

Table 5. Lead parameters of children involved in research by groups

The average value of blood lead level of Mitrovica pupils was 2.4 µg / dl (SD ± 1.9 µg / dl), range 0.5 to 16.3 µg / dl. The average value of blood lead level of Control group pupils was 2.3 µg / dl (SD ± 0.7 µg / dl), range 1.2 to 5.2 µg / dl. By Mann Whitney test we have not gained difference with important statistically significance between average values of blood lead level to pupils of Mitrovica and control group pupils (U '= 4925.0, P = 0.191). The average value of blood lead level in kindergarten children of Mitrovica was 3.8 µg / dl (SD ± 0.7 µg / dl), range 2.2 to 7.7 µg / dl. By Mann Whitney test we have gained difference with important statistically significance between the av-

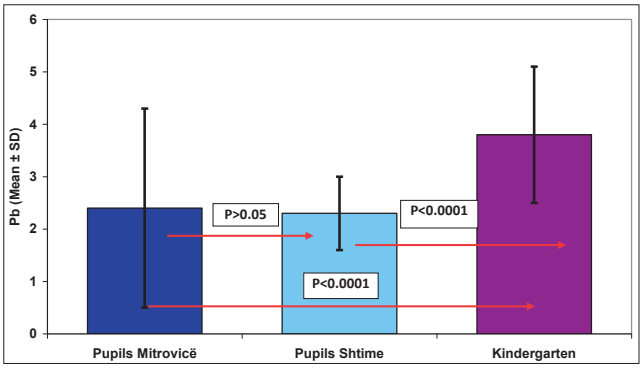

Chart 1. Lead parameters of children involved in research by groups

HgB	Pupils Mitrovicë	Pupils Control group	Kindergarten Children Mitrovicë
N	166	53	31
Mean	14.0	11.4	10.6
SD	3.7	0.8	0.7
Min	9.4	9.2	8.9
Max	25.6	13.0	12.1
P. Mitrovicë/P. Control group	Mann-Whitney test	U'=6440.0	P<0.0001
P. Mitrovicë/ Kindergarten Ch	Mann-Whitney test	U'=4554.5	P<0.0001
Kindergarten Ch/P.Control group	T–testi	T=4.50	P<0.0001

Table 6. Hemoglobin parameters of the children involved in the research by groups

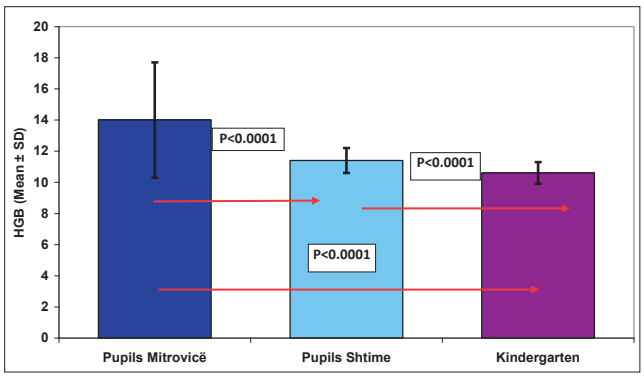

Chart 2. Haemoglobin parameters of the children involved in the research by groups

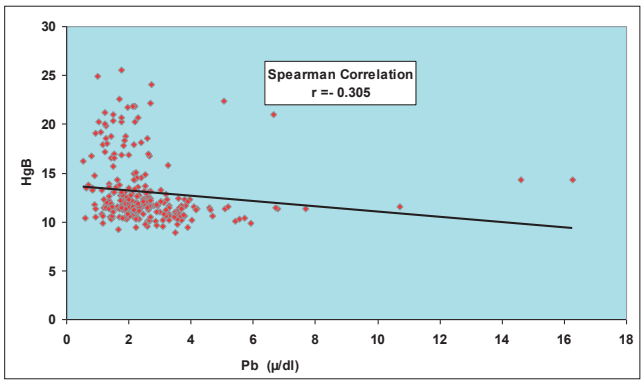

Chart 3. Correlation between Lead and Haemoglobin level of all children involved in research

erage values of blood lead levels pupils and kindergarten children of Mitrovica (U '= 4348.5, P <0.0001). By Mann Whitney test we have gained difference with important statistically significance between the average values of blood lead level of pupils of control group and kindergarten children of Mitrovica (U '= 1465.5, P <0.0001) (Table 5 and Chart 1).

The average value of hemoglobin to pupils of Mitrovica was 14.0 g / dl (SD ± 3.7 g / dl), range 9.4 to 25.6 g / dl. The average value of hemoglobin to pupils of Shtime was 11.4 g / dl (SD ± 0.8 g / dl), range 9.2 to 13.0 g / dl. By Mann Whitney test we have gained difference with important statistically significance between mean values of hemoglobin pupils of Mitrovica and control group (U '= 6440.0, P <0.0001). The average value of hemoglobin of kindergarten children in Mitrovica was 10.6 g / dl (SD ± 0.7 g / dl), range 8.9 to 12.1 g / dl. By Mann Whitney test we have gained difference with important statistically significance between mean values of hemoglobin pupils and kindergarten children of Mitrovica (U '= 4554.5, P <0.0001). With T test we have gained difference with important statistically significance between mean values of hemoglobin pupils of control group and kindergarten children of Mitrovica (T = 4:50, P <0.0001) (Table 6 and Chart 2).

Specifically is analyzed the degree of correlation between the blood lead level and Hemoglobin level of all children involved in the research. With Spearman correlation is found significant correlation of a medium scale (r = -0,305, df = 248, p <0.0001). So, the alternative hypothesis is confirmed (H1) degree of reliability P = 0.001, according to which there is a significant correlation between HgB and lead levels (Chart 3).

5. DISCUSSION

Mining and metallurgic economic activities have a long history in the municipalities of

Mitrovica and Zvecan. Since 1926, Trepca mining company (14) significantly contributed to the development of Mitrovica town, which grew up around the factory. In 1999, the factory employed approximately 15,000 workers. However, the factory lead smelter and three huge tailing dams dramatically increased the environmental pollution in the town and surroundings. From the end of the 1970s to the 1990s, the Division of Epidemiology and Public Health of Columbia University conducted several studies about the level of contamination of the population living near the smelter. According to other research and surveys(5), the population of Mitrovica had markedly elevated blood lead levels (BLL, or alternatively called PbB) due to the industrial air lead emissions (15). The investigations underline that the zone of residence as well as the employment of family members in the lead smelter, bringing back home dust from the mine on their clothes, were relevant factors for the increase of blood lead levels. Moreover, nutritional and hygiene factors associated with specific ethnic groups, in this case the Roma community, have a critical impact in the level of contamination (16). The smelter was closed down by UNMIK, with KFOR assistance, in 2000 in order to reduce health risks caused by pollution. However, lead does not decompose and remains in the top layers of soil. Therefore, the tailing dams and smelter sites have continued to spread around lead contaminated dust, which is brought by the wind to Mitrovica, Zvecan and the surrounding areas. Further health risk assessments carried out by WHO and the United States Centers for Disease Control and Prevention (CDC) between 2004 and 2007 (17), show that, while the Roma population remains the most affected, 40% of the tested non-Roma population living in the same area have blood levels of 10 µg/dL and above. Earlier research shows (5, 6, 7, 8, 9, 10) the level of lead in blood in Mitrovica was >40 µg / dl which is much higher than average concentration of lead in blood in China 13 µg/dL (1), 15 µg/dL in Bangladesh(18,19) and 11 µg/dL in India(20). In our research the average of lead in blood at pupils of Mitrovica was 2.4 µg/dL, at pupils of control group was 2.3 µg/dL while at kindergarten children of Mitrovica was much higher 3.8 µg/dL which is much higher than the children in the USA 1.9 µg/dL(21).

Pb attack every system and organ in the body. The main targets of lead toxicity are the nervous, cardiovascular, hematologic system and kidney (17). Chronic lead intoxication may affect children because they have more hand-to-mouth activities and they absorb lead in small intestine more efficiently than adults (22, 23, 24). A significant inverse correlation between PbB and HbB levels was observed for the group of 88 children (r = -0.292, p = 0.006) at the Counter at al research (25). A decreasing trend in the hemoglobin content with increasing blood lead levels was observed for Mumbai children (26). Also in our research we have gained decreasing trend in the hemoglobin content with increasing blood lead levels which is in accordance with other authors.

6. CONCLUSION

- Based on these results, pupils of control group were greater with body weight and length than pupils of Mitrovica;
- Blood lead level is higher at kindergarten children of Mitrovica than the pupils of Mitrovica and control group pupils;
- The results show that hemoglobin is lower at kindergarten children than the pupils of Mitrovica and control group pupils;
- We have inverse correlation between blood lead concentration and hemoglobin level in the children.

CONFLICT OF INTEREST: NONE DECLARED

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