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Health Risk Assessment of Children in the Environmental Pollution Region of Kardzhali for the Period 1991-2013

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Abstract

For more than 55 years is the environmental pollution region of Kardzhali in Bulgaria has been due to intense emissions from mining-processing, smelter plant and processing of nonmetallic minerals. The main source of pollution in those years is smelter plant (Lead and Zinc Complex), but from 2011 to 2012 respectively, lead and zinc production was gradually stopped.

One of the mechanisms to assess the health risk among the population is to conduct biological monitoring, to make biological materials to determine the concentration of heavy metals in them. The most vulnerable group is children.

The aim of this study is to benchmark the results of the biological monitoring of children aged between 9 to 14 years in the city of Kardzhali for the 1991-2013 periods. Biological monitoring includes determination of lead in the blood of 356 children from two schools in the city of Kardzhali (located near and far away from OCK-AD) and one in Krumovgrad (for control).

In accordance with the methodology in Bulgaria (included children), drawing of USA methodology received results in the following:

According to the individual results for the period 1991-2002, when smelter plant has worked, in 71% of the children in Kardzhali values of lead in the blood are below 100 µg/l, in 24% between 100 and 200 µg/l and in 5% over 200 µg/l.

In 2013, when the company ceased operation in 92% of surveyed children the levels of lead in the blood is below 100 µg/l, in 7% from 100 to 200 µg/l and in 1% above 200 µg/l.

The results indicate a link between air pollution with lead aerosols and the level of lead in the blood of children:

In the intensive work of the plant during 1991-2002 years in 29% of children amounts of lead in the blood is above 100 µg/l.

In 2013 (when closed proceedings) only 8% of children are with lead content in the blood of more than 100 µg/l.

The blood of the children in the control group demonstrated no lead content at 100% of children.

Methods

Within the scope of the study during the period 1991-2013 included 356 children aged from 9 to 14 years old from two schools in the town of Kardzhali (located on near and distant off OCK) and one in the town of krumovgrad.

According to data of the Executive Agency for the environment, the area of the town of Krumovgrad is rated as an area in which the levels of pollutants are below the lower assessment threshold [1,2]. The share of industry in the economy of the municipality of Krumovgrad is too limited. In the area there is no significant organized emission source of harmful substances, which is designated as a control for the purposes of the study.

For ease of benchmarking data schools are labeled as follows:

School "St. Kliment Ohridski", Kardzhali, which is situated near the sources of contamination – with code 1.

"St. St. Cyril and Methodius, Kardzhali, which is remote from sources of pollution - with code 2.

"Vasil Levski" secondary school, the town of Krumovgrad (control) – with code 3.

Every child is a venous blood sample taken to detect the presence of lead using a closed vacuum-system (S-Monovette ® for trace metal analysis) for one-time use, containing aditiv-LH (Lithium heparin).

The biological material has been studied in clinical laboratory of University Hospital "Alexandrovska" EAD-Sofia.

The concentration of lead in the blood is measured by Atomic absobrcionna spectrometry with graphic atomizator.

For a comparison of the average values of the variables used the criterion of the Mann-Wh Whitney and Kruskal-Wallis test.

Results

Summary statistical characteristics of the indicator of the research lead for the period 1991-2013, traced in the dynamics in the three educational institutions are shown in **Table 1.**

Table 1: Average values and standard deviations of PbK in µg/l for the period 1991-2013.

School codes/parameters		1991	2002	2013
1	Average value	152,1750	98,4160	60,0820
	Number of pupils	40	50	50
	Standard deviation	31,3384	41,0767	29,4095
2	Average value	156,9333	87,0373	74,1352
	Number of pupils	30	51	54
	Standard deviation	78,6638	47,7561	21,1673
3	Average value	-	57,8257	47,9667
	Number of pupils	-	35	46
	Standard deviation	-	15,1611	11,0172

Data processing of biological monitoring in 1991 shows that average values of RbK are not statistically significant different (P corresponding values were 0.43 and 0.108). Found medium-group results are within the cited literature then (below 200 µg/l).

Statistically significant differences in average values of lead in schools (P<0.0001), monitored in 2002 are found by the Kruskal-Wallis test. A difference between the averages in schools 1 and 2 (P=0.02 and P<0.0001) is found by test the Mann-Whitney. The same applies to schools 1 and 3 (P<0.0001 and P<0.0001), as well as for 2 and 3 (P<0.0001 and P<0.0001).

According to the individual results of the study in 2002, when Lead and Zinc Complex (LZC) worked, the average level of lead in blood of children from Kardzhali was 92.7 ± 44.7 µg/l, (median 82 µg/l), with registered individual values from 30 to 259 µg/l. The mean PbK concentration of children from Krumovgrad was 57.9 ± 15.1 µg/l, (median 58 µg/l) and results ranging from 30 to 93 µg/l. The level of lead in blood of children from Kardzhali is statistically significantly higher than that of the children from Krumovgrad (P<0.0001).

In 2013, when the activity of the enterprise is discontinued, the average level of lead in blood of children from Kardzhali was 67.1 ± 25.3 µg/l, (median 63 µg/l), with registered individual values from 31 to 211 µg/l. The mean PbK concentration of children from Krumovgrad was 48.0 ± 11.0 µg/l, (median 46 µg/l) and results ranging from 31 to 78 µg/l.

The test of Kruskal-Wallis reveals that the educational institutions differ statistically significant (P<0.0001). In order to be found exactly between which schools there are significant differences, an appropriate post-hoc test is used. Which shows difference between School 1 and School 2 (P<0.05), between School 1 and School 3 (P<0.05) and between School 2 and School 3 (P<0.05), i.e., three schools differ significantly in terms of the indicator Lead. According to the Center for Disease Control (CDC) in the United States (ATSDR, 1997), children with levels of lead in blood [3]:

- From 100 to 200 µg/l - are subject to periodic examinations
- Above 200 µg/l - needed further medical tests
- Above 400 µg/l - undergo medical treatment.

The results on the percentage split for the period 1991-2002 year show that values of lead in the blood in 71% of surveyed children in Kardzhali are below 100 µg/l, 24% from 100 to 200 µg/l and 5% 200 µg/l **(Table 2).**

In 2013 at 92% of the studied children, the levels of lead in the blood are below 100 µg/l, 7% from 100 to 200 µg/l and 1% over 200 µg/l.

Table 2: Percentage distribution according to the individual results in children of PbK Kardzhali for the period 1991-2013.

Period	Proportion lead/Pb/%			
	The normal	Excess		
	Up to 100 µg/l	100-150 µg/l	150-200 µg/l	more 200 µg/l
1991-2002	71	21	3	5
2013	92	7	0	1

The results indicate a link between environmental pollution by lead aerosols and the level of lead in blood of children:

- In the intensive work of the plant in the period 1991-2002 year in 29% of children the values of lead in the blood are above 100 µg/l.

- In 2013 (in closed proceedings) only 8% of children have lead content in blood above 100 µg/l.

- The blood of the children in the control group did not prove lead content at 100% of children.

Conclusion

The research on the content of lead in the blood of children from both villages does not prove the increased intake of metal in the body. Children of Kardzhali with values of PbK under 200 µg/l represent 99.0 percent sample, which is above the recommended 98.0% of the WHO [4,5].

According to the requirements of the CDC-United States, at 7.0% of surveyed children from Kardzhali regular testing for lead content in the blood. About 1.0% of children, with values of over 200 g PbK µ/l, there is a risk to health from the increased intake of metal in the body and requiring further medical research [6-8].

Analysis of the results obtained clearly finds correlation between environmental pollution by aerosols of lead and heavy metal levels in the blood while the exposure of the surveyed children.

Data show lower values of PbK in children from the town of Kardzhali in both different remote from polluter schools in 2013 compared with the same in 1991.

The confirmation of the link control group-children from environmentally endangered area is established absence of PbK in the studied blood samples in children from the town of Krumovgrad.

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