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BIOMONITORING OF LEAD EXPOSURE IN THE CZECH REPUBLIC*

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Abstract. The systematic and long-term efforts to protect the environment may be successful also in the country in the period of transition from centrally planned to free market economies. The basic requirement is to disseminate reliable information on the exposure levels and expected health effects. The need for high quality information underscores the importance of the quality assurance and quality control systems in the context of good laboratory as well as epidemiologic practices. Each monitoring study should be planned in the way facilitating its use for the evaluation of long-term trends. Besides scientific issues, the communication of risks is of crucial importance. According to our experience, only an involvement of formal as well as informal local authorities and co-operation between all relevant stakeholders can ensure the success.

Key words:
Biomonitoring, Lead, Smelter, Soil contamination

INTRODUCTION

The biological monitoring of lead in occupational settings has been carried out in the former Czechoslovakia since the late 1930s, when Prof. Jaroslav Teisinger, the founder of the Center of Industrial Hygiene and Occupational Diseases at the National Institute of Public Health in Prague, acknowledged the crucial importance of the determination of blood lead level (B-Pb) for monitoring of human exposure to lead, and developed a polarographic method of determination of lead concentration in human blood. In spite of the fact that today we use much more sophisticated laboratory methodology, the idea of Prof. Jaroslav Teisinger established the fundamentals for developments in this field.

The issue of environmental lead contamination and biomonitoring of lead in environmentally exposed populations has also been addressed in the former Czechoslovakia since the early 1970s. In the past, the Czech Hygiene Service focused mainly on an apparent point source of contamination, the lead smelter located near the town of Pribram, where the most serious consequences of environmental lead contamination were expected. In parallel, the levels of lead contamination in other parts of the Czech Republic were studied as well. In the 1980s a more systematic approach to study the lead exposure in children, living in areas with different levels of lead contamination, was adopted. Since 1992 the System of Monitoring the Environmental Impact on Population Health of the Czech Republic has become the most reliable source of knowledge on current levels of exposure and trends in exposure to an array of xenobiotics, including lead.

The aim of this paper is to summarize the current knowledge on the levels of the child population exposure to

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Table 5. Blood lead levels found in the vicinity of Pribram Lead Smelter, 1976–1977

Distance from smelter	No.	Mean (μg/100 ml)	Standard Deviation	Standard Error	95% CI		Minimum (μg/100 ml)	Maximum (μg/100 ml)
					Lower	Upper		
<3 km	54	9.0	0.5	0.1	7.9	10.2	3	30.5
3–5 km	598	4.8	0.4	0.0	4.6	4.9	1.5	22.3
>5 km	438	4.3	0.5	0.0	4.1	4.5	1.5	28.5
Total	1090		0.485303	0.014699			1.5	30.5

Program on Environment and Health in the Czech Republic [7]. The following were the principal objectives of the program:

- to define the extent and geographic limits of the area in which the level of environmental contamination caused by the smelter in Pribram poses an actual health hazard;
- to evaluate the level of lead exposure in children living in this area;
- to evaluate the level of lead exposure in children living in other parts of the Czech Republic not burdened by the smelter;
- to identify risk factors of exposure of the children population to lead; and
- to estimate the contribution of identified sources/pathways of exposure with respect to the current level of children's exposure.

A more thorough description of the program can be found elsewhere [7,8]. The most important finding was that the suspected laboratory bias in the previous investigations had been confirmed. In the random sample of the children living permanently within the distance of less than 3 km from the lead smelter, the B-Pb geometric mean of 11.4 μg/100 ml was found, which is in a good agreement with the results of control analyses of B-Pb performed under the framework of the study carried out in 1986–1990. In the control, "clean" area, the B-Pb mean of 4.7 μg/100 ml was reported. As to the T-Pb levels the values of 4.0 μg/g and 1.4 μg/g were found in the most contaminated and control areas, respectively (Table 4).

The National Integrated Program on Environment and Health in the Czech Republic gradually developed into the Intervention Program to Reduce Environmental Exposure to Lead [9]. The objectives of the Intervention Program are as follows:

- to establish an organizational structure that would make possible the free of charge voluntary screening of blood lead levels in children living within 6 km from the lead smelter;
- to identify children with elevated B-Pb and the regime-based intervention in the family;.
- to evaluate the prenatal exposure of children; and
- to confirm the previously developed exposure model and to evaluate the importance of the sources/pathway of exposure.

During the years 1995–1997, 1229 children were examined and 1863 blood lead test were performed. The survey covered about 80% of eligible children aged from 1 to 14 years. The B-Pb levels recorded in children were generally somewhat lower than those in the previous study. In the most polluted spot (the distance of less than 3 km from the smelter), the mean B-Pb of 9.0 μg/100 ml was found (Table 5). However, in the children, living in the distance of more than 5 km from the smelter, the observed mean B-Pb of 4.3 μg/100 ml was still apparently higher than the mean value for the general Czech population, which is about 3.5 μg/100 ml [10–12].

Besides the effectiveness of the regime-based intervention and exposure levels, the effects of air pollution, soil contamination, traffic density, and other factors related to the environmental lead exposure on logarithmically transformed B-Pb were investigated. The results of the multivariate regression analyses were in a very good agreement with the model derived from the random sample of children investigated in 1992. The soil contamination with lead, the distance of residency from the smelter, the traffic density, the employment of family members in the smelter, tobacco smoking, the gender, the season of sampling, the educational level of mothers, the consumption of water

Table 6. Intervention Program, 1995– 1997. Exposure risk factors

Risk factors		Regression coefficients	Sig.
Soil contam. >5000 mg/kg		0.217	0.000
Distance from smelter (km)		-0.013	0.008
Traffic density			
	cars/24 hr (centered)	-0.0002	0.007
	(cars/24 hr)2	0.000	0.008
Employment in smelter		0.119	0.000
Smoking			
	<10 cigarettes	0.038	0.025
	10–19 cigarettes	0.035	0.008
	>20 cigarettes	0.052	0.001
Gender		0.026	0.016
Sampling in the first quarter of the year		-0.067	0.000
Educational level of mothers			
	high school	-0.050	0.000
	college/university	-0.104	0.000
Local wells		0.059	0.004
Kind of residency		0.059	0.000
Home pets		0.027	0.000
Taking objects into mouth		0.011	0.072
Nationality		0.563	0.000

Dependent variable = Ln (concentration of lead in blood ug/100 ml) R = 0.603, R^2 = 0.364

from local wells, the kind of residency, keeping home pets, taking objects into mouth and nationality were factors positively associated with elevated blood lead levels (Table 6).

From 1992 to 1998, practically all blood lead examinations performed on the children living in the Pribram area were performed in the atomic absorption spectrometry laboratory of the Center of Industrial Hygiene and Occupational Diseases at the National Institute of Public Health. So, we could analyze exposure trends in this area (Fig, 1). All three curves representing the mean blood lead levels in different zones around the smelter (distance <3 km, distance 3–5 km, distance >5 km) plotted against the calendar year exhibited downward trends. Even in the most polluted zone the mean blood lead level dropped below the value of 10 μg/100 ml. In the more distant zones the curves have been approaching the level of 3.5 μg/100 ml, common in children in the Czech Republic [10–12].

Several factors can be attributed to the positive developments observed around the lead smelter. The most important one is a new, environmental sparing production strategy of a new management, implemented after privatization of the plant. This strategy reflects the needs to meet

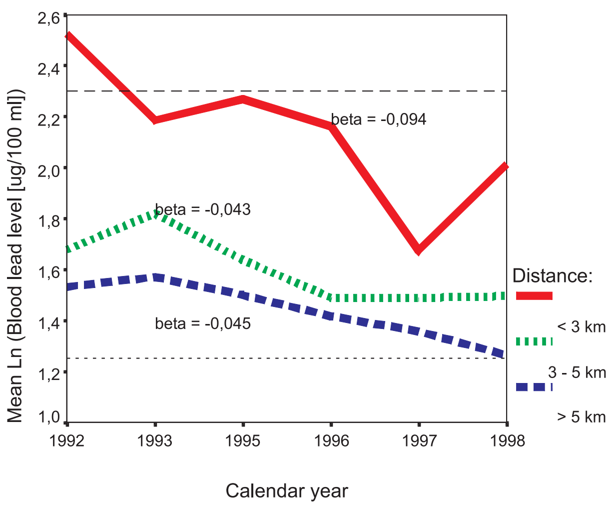

Fig. 1. Trends in blood lead levels in the vicinity of the lead smelter, 1992–1998.

the production standards of the European Union, as well as the results of the long-term policy of the local public health authorities.

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