PHIME project in Slovakia
Public health impact of long-term, low level mixed element exposure in susceptible population strata

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No of contract: FOOD-CT-2006-016253
Duration: 1. March 2006 – 2011
Performance in Slovakia: Pillar III. and work package WP III. 1. Sensitive population biomonitoring in selected areas
Gestor in Slovakia: Regional Authority of Public Health in Banská Bystrica, Central Slovakia
Biomonitoring WP III. 1 is realized in: Slovenia, Lithuania, Czech republic, Croatia, Slovakia, China, Poland, Switzerland, Morocco, Ecuador, Sweden

LEAD

Lead is a well-known neurotoxin. Lead exposures have developmental and neurobehavioural effects on fetuses, infants and children. Food is the predominant source of lead uptake in the general population. Ingestion of contaminated soil, dust and old lead-based paint due to hand-to-mouth activities may also be important regarding lead intake in children. When tap-water systems with leaded pipes are used, lead intake via drinking-water can be an important source (1,2).

MERCURY

Chronic exposure of low levels of anorganic mercury vapour is associated to adverse effects on central nervous system, kidneys and thyroid.

Metylmercury is a potent neurotoxic chemical. Exposure to methylmercury is more dangerous for young children than for adults, because of the lower thresholds for neurological effects from methylmercury and the higher levels of distribution of methylmercury to the developing brains. Emissions of mercury to the air from both anthropogenic and natural sources are in inorganic forms that can be converted biologically to methylmercury in soil and water. Methylmercury bioaccumulates and enters the human body readily via the dietary route. Children are the most susceptible population group, the exposure being mainly from fish in the diet. The major route of non-occupational exposure to inorganic mercury is via dental amalgam fillings. (1,2).

CADMIUM

Cadmium exposures are associated with kidney and bone damage. The main critical effect includes an increased risk of osteoporosis. Cadmium has also been identified as a potential human carcinogen, causing lung cancer. Food is the main source of cadmium exposure in the general population (representing >90% of the total intake in non-smokers). Dust resuspension can constitute a substantial part of the crop contamination and exposures via inhalation and digestion (1,2).

OBJECTIVES

Main objective

To evaluate the health effects of toxic metals and their source, benefits and toxicity.

Specific objectives

To improve the integrated public-health risk assessment of environmental exposure to toxic and essential metals via food, addressing the complexity of exposures, interactions, risk groups (including women and children), nutrition and mechanisms of action.

To increase the understanding of mechanisms for uptake of metals in plants, and thus into the human food chains.

To establish a new, high-quality sampling and analysis strategies for monitoring of exposure to toxic metals, in particular in Eastern Europe, and its determinants.

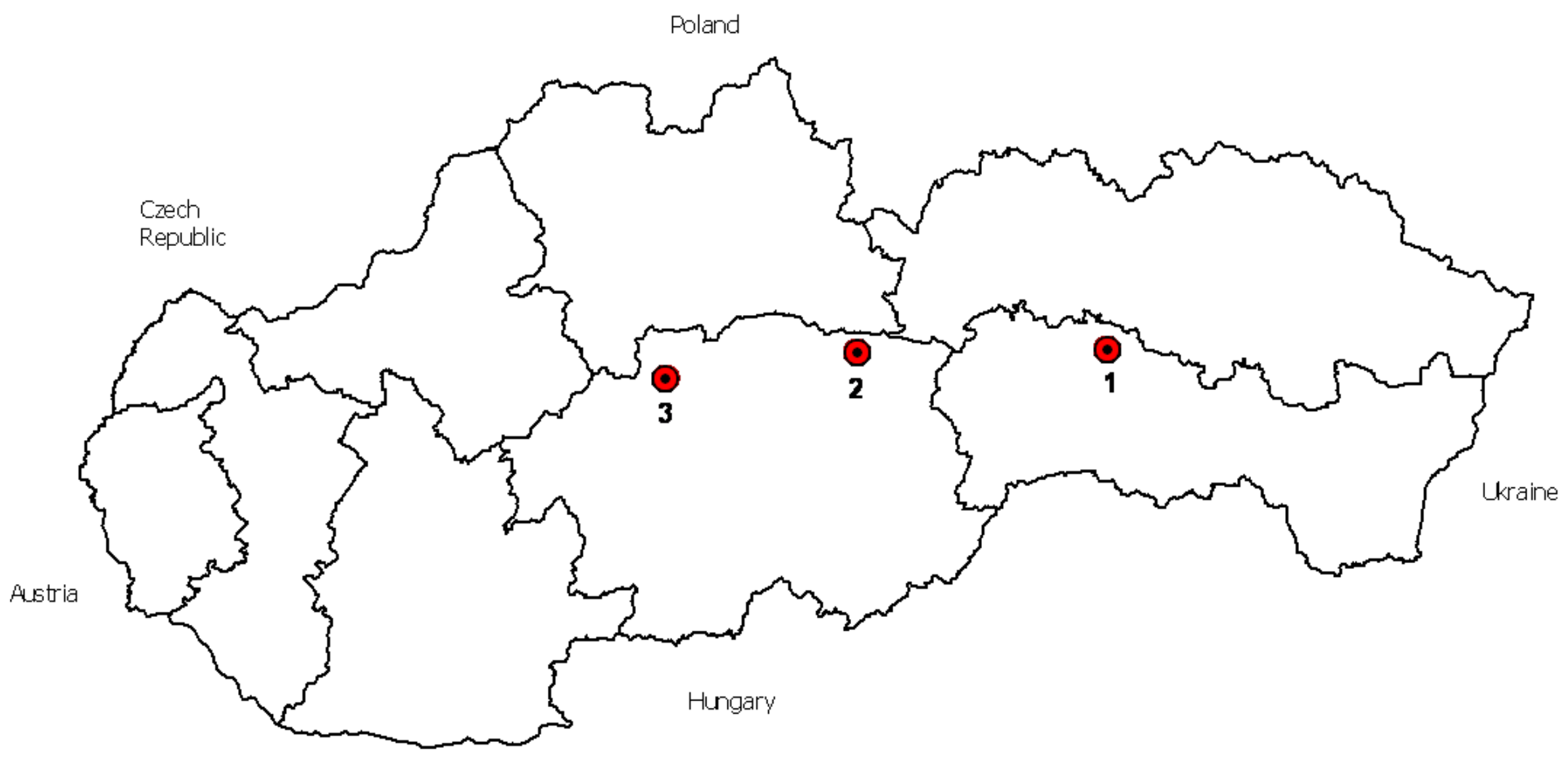
To map geographical patterns of exposure to, in particular, Cd, Hg, Pb in these parts of Europe.

METHODS

Studied areas

Three areas in Slovakia were chosen:

1. Industrial area – close to source of heavy metals emissions – smelter industry (city Krompachy and Rudnany, Eastern Slovakia).
2. Rural area – village with agricultural activities (village Polomka, Central Slovakia),
3. Urban area – city with metropolitan type of settlements (city Banská Bystrica, Central Slovakia)

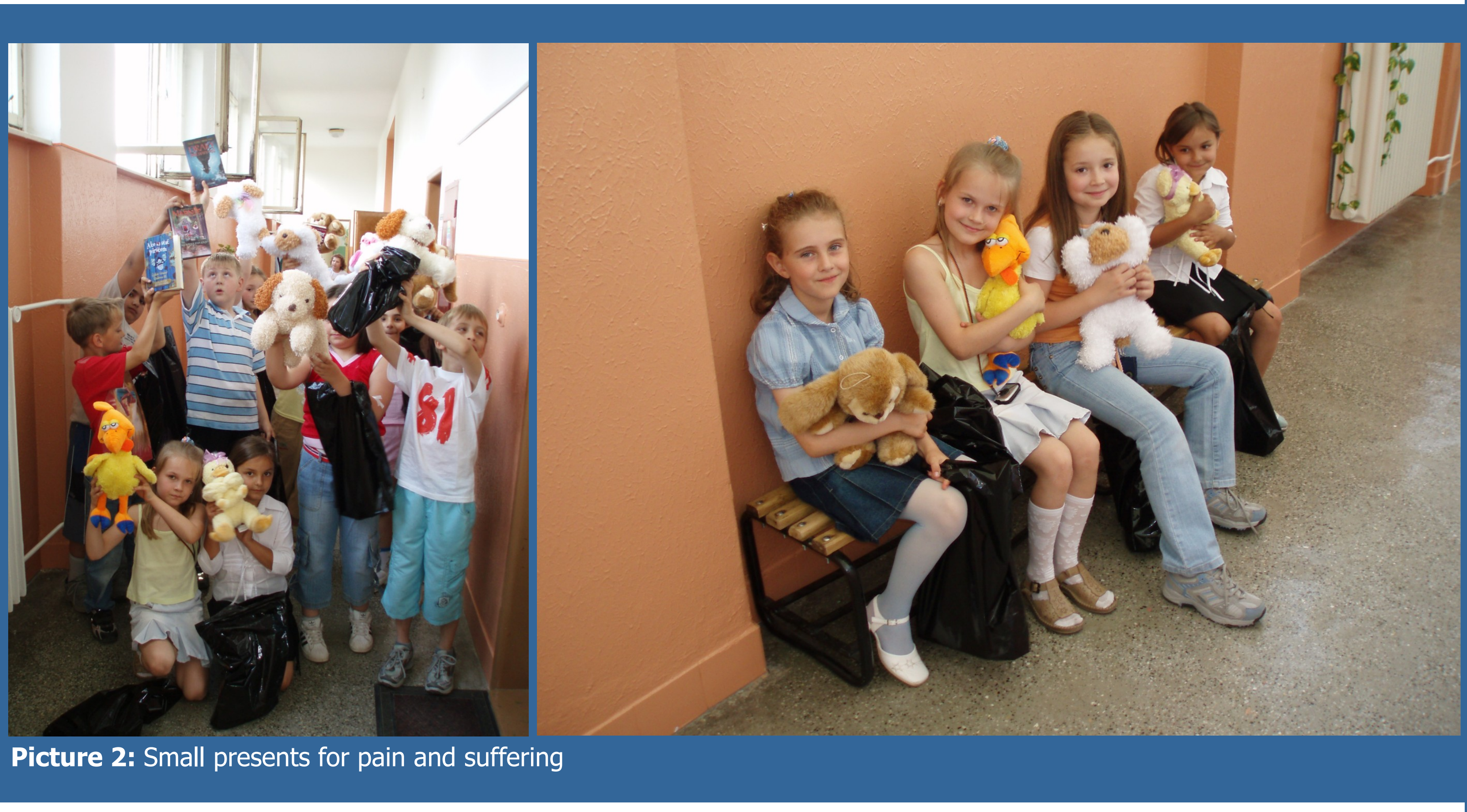


Picture 1: Studied areas

Studied population

The monitored population consisted of 50 children in age 7-10 years old in each of the chosen areas (157 children together. In urban area there were 57 children sampled). Blood samples were taken by health professionals. The person carrying out the sampling also has interviewed the child and has filled out a short questionnaire. Questionnaires and samples were coded. Children were gifted for pain and suffering with small presents.

A more comprehensive information about children and their family, living conditions, nutrition habits, possible professional exposure of parents were gathered by questionnaires filled by parents. Information about school environment and food served in schools were filled by heads of the schools.



Picture 2: Small presents for pain and suffering

Biologic samples

Sampling was done during one month, May 2007, to avoid seasonal variations. Approximately 5 ml blood was sampled by venous sampling from the arm after cleaning with an ethanol swab. For each child, two heparinised 6 ml evacuated tubes were filled to almost half their volume. The reason for using two tubes was facilitate quality control and in some cases for logistic reasons (different laboratories for different analyses). Samples were frozen at -20°C within 24 hours after sampling.

Blood sample analyses

The concentrations of heavy metals in blood samples (Pb, Cd, Hg) were determined in laboratory of Lund University Hospital, Sweden. The concentrations of Cd and Pb in the blood samples were determined by inductively coupled plasma-mass spectrometry (ICP-MS; Thermo X7, Thermo Elemental, Winsford, UK). A sample volume of 500 µl was diluted 10 times with an alkaline solution (3). Using the dilute solution as a carrier/rinsing fluid, the samples were introduced in a segment-flow mode. The samples were analyzed in peak-jumping mode, 75 sweeps and 1 point per peak, 30 ms dwell time for 114Cd and 118Sn, 20 ms for 206Pb, 207Pb and 208Pb and 10 ms dwell time for the internal standards 115In, 205Tl and 209Bi. Interference corrections were made for 114Cd for the spectral overlap of Sn. Since the isotopic composition of Pb may vary, the sum of the tree isotopes of Pb was used. The determination of Hg was made in acid-digested samples using cold vapour atomic fluorescence spectrometry (4).

The detection limits, calculated as 3 times the standard deviation (SD) of the blank were for Cd, Pb and Hg 0.02, 0.02 and 0.08 µg/l, respectively. All samples were prepared in duplicate and the method imprecision (calculated as the coefficient of variation for duplicate preparations measurements) was 5.7, 2.5 and 8.6 %, respectively.

Statistical analyses

All data from sampling sheet, short child questionnaire, parent questionnaire and blood sample analyses were entered to Excel sheet twice, then compared and corrected for typing errors. For data analyses and evaluation the statistical package Stata (version 10.0) was used (5).

CONCLUSIONS

Results evaluation proved:

- the highest lead blood level in group of children living in industry area, the highest mercury and cadmium blood level in group of children living in urban area,
- the higher level of lead blood concentration in group occasionally smoking and offal eating children,
- the higher level of mercury blood concentration in group of children with amalgam fillings and offal eating children.

All statistical analyses used univariate analyses only. Other relationships might be found after multivariate modelling.

RESULTS

Table 1: Concentrations of lead (µg/l) in blood by area

	N	mean	SD	median	range	p
Urban	**57**	**20.5**	**6.8**	**20.4**	**8.1-47.1**	
Rural	50	22.8	6.6	22.1	11.4-40.2	n.s.
Industrial	50	36.9	10.1	36.6	18.9-63.3	<0.001
Urban	**57**	**20.5**	**6.8**	**20.4**	**8.1-47.1**	
Rural	50	+11.0%		+8.6%		n.s.
Industrial	50	+80.0%		+79.3%		<0.001

The **highest lead blood** concentration was recognized in group of children living **in industry area** (mean concentration 36,9 µg/l, range 18,9 - 63,3 µg/l).

The **lead blood concentration** of **children living in industry area** was **significantly higher** comparing to lead blood concentration of children living in urban area.

Table 2: Concentrations of mercury (µg/l) in blood by area

	N	mean	SD	median	range	p
Urban	**57**	**0.64**	**0.44**	**0.51**	**0.12-2.34**	
Rural	50	0.34	0.22	0.28	0.07-0.88	<0.001
Industrial	50	0.37	0.25	0.30	0.07-1.21	<0.001
Urban	**57**	**0.64**	**0.4361**	**0.51**	**0.12-2.34**	
Rural	50	-46,6%		-44.8%		<0.001
Industrial	50	-41.6%		-40.4%		<0.001

The **highest mercury blood** concentration was recognised in group of children living **in urban area** (mean concentration 0, 64 µg/l, range 0,12 - 2,34 µg/l).

The mercury blood concentration of children living in urban area was **significantly higher** comparing to mercury blood concentration of children living in industry area and rural area.

Table 3: Concentrations of cadmium (µg/l) in blood by area

	N	mean	SD	median	range	p
Urban	**57**	**0.1539**	**0.0628**	**0.1430**	**0.0815-0.1420**	
Rural	50	0.1325	0.0517	0.1255	0.0715-0.4085	0.014
Industrial	50	0.1507	0.0537	0.1410	0.0680-0.3085	n.s.
Urban	**57**	**0.1539**	**0.0628**	**0.1430**	**0.0815-0.1420**	
Rural	50	-13,9%		-12.2%		0.014
Industrial	50	-2.1%		-1.4%		n.s.

The **highest cadmium blood** concentration was recognised in group of children living in urban area (mean concentration 0,153 µg/l, range 0, 0815 – 0, 1420).

The highest cadmium blood concentration was recognised in children living in urban area, significantly higher comparing to children living in rural area.

Table 4: Concentrations of lead (µg/l) in blood - impact of gender, smoking habits, smoking at home, water supply, offal eating

		N	mean	SD	median	p
Gender	M	73	27.8	11.8	**24.8**	
	F	84	25.2	10.0	**23.7**	0.303
Smoking	Never	144	25.8	10.7	**23.5**	
	Occasionally	13	32.9	11.1	**30.0**	**0.021**
	Yes	0				
Smoking home	No	137	25.9	10.5	**24.2**	
	Yes	20	29.8	12.9	**24.4**	0.240
Water supply	Public	147	25.5	10.1	**23.0**	
	Private	9	42.2	13.7	**46.9**	**<0.001**
Offal eating	No	122	25.4	10.2	**23.2**	
	Yes	35	30.3	12.5	**27.4**	**0.029**

Significantly higher mean concentration of lead in blood was recognised in occasionally smoking group of children comparing to never smoked children.

Significantly higher mean concentration of lead in blood was recognised in group of children supplied from private water sources comparing to children supplied from public water supply system.

Significantly higher mean concentration of lead in blood was recognised in group of children eating the offal comparing to children who never eat the offal.

Further evaluation of results in connection with findings of significantly higher blood lead level in group of children supplied from private drinking water sources comparing to children supplied from public water supply system is needed. All nine private water sources were sampled for Pb, Hg, Cd analyses. The content of metals in analysed samples were under the limit of detection and the limits of Pb, Hg and Cd established for drinking water quality in European Union were not exceeded.

Table 5: Concentrations of mercury (µg/l) in blood - impact of gender, smoking, smoking at home, amalgam fillings, chewing gum, water supply, fish and offal eating

		N	mean	SD	median	p
Gender	M	73	0.40	0.30	**0.32**	
	F	84	0.50	0.38	**0.44**	0.077
Smoking	Never	144	0.45	0.35	**0.38**	
	Occasionally	13	0.53	0.29	**0.45**	0.157
	Yes	0				
Smoking home	No	137	0.47	0.36	**0.39**	
	Yes	20	0.36	0.19	**0.34**	0.429
Amalgam	No	69	0.32	0.23	**0.24**	
	Yes	88	0.57	0.39	**0.49**	**<0.001**
Chewing gum	Daily	29	0.53	0.36	**0.45**	
	Not daily	128	0.44	0.35	**0.36**	0.204
Water supply	Public	147	0.45	0.35	**0.37**	
	Private	9	0.52	0.30	**0.49**	0.285
Fish eating	No	51	0.44	0.41	**0.35**	
	Yes	106	0.46	0.32	**0.38**	0.294
Offal eating	No	122	0.43	0.34	**0.35**	
	Yes	35	0.56	0.36	**0.48**	**0.031**

Significantly higher mean mercury blood concentration was recognised in group of children with amalgam fillings comparing to group without amalgam fillings.

Significantly higher mean mercury blood concentration was recognised in group of children eating the offal comparing to children who never eat the offal.

Table 6: Concentrations of cadmium (µg/l) in blood - impact of gender, smoking habits, smoking at home, water supply, offal eating

		N	mean	SD	median	p
Gender	M	73	0.136	0.036	**0.131**	
	F	84	0.154	0.069	**0.139**	0.252
Smoking	Never	144	0.145	0.058	**0.133**	
	Occasionally	13	0.154	0.043	**0.154**	0.239
	Yes	0				
Smoking home	No	137	0.148	0.058	**0.134**	
	Yes	20	0.133	0.045	**0.128**	0.176
Water supply	Public	147	0.145	0.057	**0.133**	
	Private	9	0.165	0.054	**0.163**	0.138
Offal eating	No	122	0.147	0.061	**0.132**	
	Yes	35	0.143	0.038	**0.143**	0.513

The remarkable impact of gender, smoking, smoking at home, water supply, offal eating to the cadmium concentration in blood of children was not recognised.

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