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LEAD IN THE BLOOD OF DOGS LIVING IN VARIOUSLY CONTAMINATED ENVIRONMENT

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Abstract

The aim of the study was to evaluate the concentration of lead in blood of dogs from Polish urban polluted areas including the Lower Silesia Region (LSR; 102 dogs), KGHM Polish Copper Region (PCR; 102 dogs), and Upper Silesia Industrial Region (USIR; 102 dogs). Moreover, it was investigated whether age, height, gender, and weight influence blood lead concentrations in the dogs. The mean concentrations of lead in dogs from LSR, PCR, and USIR were 16.18 µg/L, 31.82 µg /L, and 32.53 µg /L, respectively. In the same age groups of dogs, the concentrations of lead were the smallest and significantly lower in LSR than those reported in PCR and USIR. Mean blood concentrations of lead demonstrated a decreasing tendency in regard to the height of the examined dogs – 30.00 µg /L (low dogs), 27.37 µg /L (medium dogs), and 25.12 µg /L (high dogs).These findings indicate that blood lead concentrations mainly depend on lead contamination of the dogs' habitat. In all regions examined, lead concentrations significantly increased with the length of the dogs' life. Height, weight, and gender had no significant effect on lead content.

Key words: dog, blood, lead, contamination, Poland.

The presence of lead in food and feed, ambient air, water, cosmetics, plastics, batteries, gasoline, insecticides, pottery glaze, soldered pipes, and paint may pose a health risk to people and animals. It is considered that about 10% of ingested lead is absorbed. Inhalation may markedly contribute to lead body burden, especially in urban areas and vicinity of smelters. This toxic element binds with haemoglobin in red blood cells and slowly accumulates in the soft tissues including the brain, spleen, liver, kidneys, and skeleton, and readily crosses the placental barrier from mother to foetus (15, 18, 26, 27).

People and animals living in the areas contaminated with lead consume enhanced quantities of lead with inspired air along with dirt, soil, and house dust, and also contaminated food and water. Dogs chewing inedible objects, sometimes comprising lead additives contribute to concentration of lead in their body. Moreover, dogs by licking their fur and digging in the yard to bury bones or other objects expose themselves to lead contained in dust and soil deposited on the fur (7, 12).

The purpose of the study was to measure the concentration of lead in the blood of dogs living in areas with various levels of the heavy metal pollution (10, 11, 22, 25). Measurement of blood or hair lead concentrations is the most widely used biomarker of lead exposure (4, 9, 13, 16, 19–21, 24). In addition, dog's age, height, gender, weight, and breed were included to evaluate the influence of these factors on the concentration of lead in blood. Since humans and animals often share the same environment, the concentrations of blood lead (BPb) in dogs may serve as markers of lead content in people living together with their pets (1, 5, 6, 14, 17).

Material and Methods

The study involved dogs from the vicinity of three Polish regions varying in the degree of industrial contamination: Lower Silesia region (LSR, Southwest Poland), KGHM Polish Copper region (PCR, Southwest Poland), and Upper Silesia Industrial Region (USIR, South Poland). None of the dogs had clinical signs of lead poisoning. The total number of the dogs tested in the three regions was 102, 104, and 101, respectively. The dogs were selected by the height at the withers: 12 to 26 cm (small), 27 to 52 cm (medium) and 53 to 80 cm (high), body weight 3.75–37.50 kg (light) and 37.60–75.00 kg (heavy), age, gender, and breed. Blood samples were collected from the antebrachial vein to lead–free tubes containing EDTA (5 mL). The blood was collected routinely in veterinary clinics in 2007-2009.

Measurements of lead in the blood were performed in the Department of Internal Medicine (accredited laboratory) of the Medical University in Wroclaw. Blood samples were deproteinised with a 5% nitric acid at 4° C, centrifuged, and then placed in a graphite cuvette. The presence of lead was determined using a flameless atomic absorption spectrophotometry (ET–ASA) at a wavelength of 283.3 nm with Zeeman background correction. The concentrations of lead were read using the camera's Thermoelemental Solar M6 with a light–beam cathode (HCL) as a radiation source.

The obtained results were statistically analysed using Student's *t*–test at $P \leq 0.05$ and $P \leq 0.01$.

Results and Discussion

The mean concentrations of lead in the blood of dogs from LSR, PCR, and USIR were 16.18 µg/L, 31.82 µg /L, and 32.53 µg /L, respectively (Table 1). Statistically significant increase was found between mean lead concentrations in the blood of dogs from LSR and PCR or USIR (Table 1).

The results indicated that dogs from the vicinities of PCR and USIR, which are highly contaminated by mining and metallurgical industry, demonstrated a significantly higher content of lead in the blood in comparison to the dogs from LSR, which is less contaminated with this metal (10, 11, 22, 25). Previous studies performed more than two decades ago in a highly contaminated vicinity of a copper smelter in Poland revealed that a mean lead concentration in the blood of dogs attained a level of 109 µg/L (16). Comparison of the mean lead concentrations in the blood of dogs from the two areas showed a nearly four-time decrease within 14 years (16). It may be assumed that the drop in lead concentrations in blood (BPb) resulted from reduction of lead emissions by introduction of innovative technologies for environmental protection. It is worth to emphasise that the data (16) are comparable with background values obtained from dogs living in developing countries (24). Much higher BPb concentrations, ranging from 300 µg/L to 1,800 µg/L, were found in accidentally poisoned dogs with typical symptoms of lead poisoning (28).

Lead concentrations in the blood of dogs in relation to their age are shown in Table 2. It was found that mean concentrations of lead increased significantly with a life span, regardless of the region in which the animals lived. Concentrations of lead in the dogs of the same age were the smallest and significantly lower in LSR than those in dogs from PCR and USIR (Table 2). It clearly indicated the contribution of polluted areas to BPb concentrations in dogs. Comparison of values for lead measured in dogs from PCR with those for dogs from USIR also indicates significant differences, except for dogs aged 8 to 9 and 11 to 12 years. The results also demonstrate the relationship between the age of dogs and lead concentrations in their blood in each region examined. Moreover, findings indicated a constant increase in BPb concentrations with age. Similar findings were reported earlier (16). An increasing accumulation of BPb with age was also demonstrated by others. The authors stressed that a longer exposure to lead may increase lead body burden in older dogs (4, 5, 24). On the other hand, it was proposed that increased BPb concentrations may be also a consequence of loss of lead from bone with age and its redistribution within the body (8). In contrast, measurements of BPb concentrations in men and women indicated a decrease in lead level for the age group of 50 to 70 years. The authors suggested that this drop may reflect a decreased energy intake by the elderly people (2).

Earlier studies carried out in PCR area in 1997 (15), reported that lead concentrations in the blood of dogs from different age groups were as follows: 89.36 µg/L (under 3 years), 102.34 µg/L (4–8 years), and 138.35 µg/L (10–16 years). The present study, included the same age groups of animals, and showed that lead concentrations in the blood of dogs from PCR were lower in each age group examined – 11.78 µg/L (under 3 years), 27.38 µg/L (4–8 years), and 64.87 µg/L (10–12 years). Assuming that the age, rearing, and feeding were similar, a decrease in lead concentration should be connected with the reduction of lead emission to the environment. The most visible decrease (sevenfold) in blood lead concentration was reported in the youngest group of dogs.

Considering the influence of height at the withers of dogs on BPb accumulation, all examined dogs were divided into three groups: low (12–26 cm, N=55), medium (27–52 cm, N=128), and high (53–80 cm, N=124). Mean blood concentrations of lead demonstrated a visible decreasing tendency with the height of the dogs; however, the differences were not statistically significant (Table 3).

Table 1
Mean lead concentrations in the blood of dogs from the tested regions

Region and number of dogs (N)	Lead (µg/L)
Lower Silesia region (LSR), N=102	16.18 ± 12.94
KGHM Polish Copper region (PCR), N 102	31.82 ± 15.27 *
Upper Silesian Industrial region (USIR), N=102	32.53 ± 15.24 *

* $P<0.05$, differences between lead concentrations in the blood of dogs from LSR and those from PCR or USIR; ± SD.

Table 2
Age-dependent blood lead concentrations in µg/L (mean ± SD)

Age and number (N) of dogs from each region	Lower Silesia region (LSR)	KGHM Polish Copper region (PCR)	Upper Silesia region (USIR)	P (between LSR and PCR or USIR)	P (between PCR and USR)
Under 1 (12)	3.31 ± 0.92	7.41 ± 2.36	12.90 ± 3.95	**	**
1– 2 (11)	5.60 ± 0.65	12.05 ± 1.28	20.10 ± 1.50	**	**
2 – 3 (5)	7.33 ± 0.20	15.88 ± 0.59	22.63 ± 1.75	**	**
3 – 4 (14)	8.39 ± 0.56	17.61 ± 0.60	26.97 ± 1.09	**	**
4 – 5 (8)	10.02 ± 0.46	20.63 ± 1.87	28.03 ± 1.39	**	**
5 – 6 (6)	11.26 ± 0.62	24.96 ± 0.72	31.32 ± 1.54	**	**
6 – 7 (6)	12.74 ± 0.43	28.83 ± 1.15	35.22 ± 1.69	**	**
7 – 8 (5)	13.56 ± 0.30	35.10 ± 1.97	37.92 ± 1.09	**	**
8 – 9 (9)	15.10 ± 0.69	41.04 ± 1.30	40.58 ± 1.51	**	NS
9 – 10 (8)	20.49 ± 2.70	50.88 ± 6.31	45.84 ± 3.96	**	*
10 – 11 (9)	32.19 ± 5.27	61.62 ± 1.49	54.61 ± 2.27	**	**
11 – 12 (9)	44.49 ± 3.84	68.12 ± 4.22	64.10 ± 2.19	**	NS

NS – not significant
* P≤0.05; ** P≤0.01.

Table 3
Blood lead concentrations in dogs in relation to their height

Height at the withers (cm)	Number of dogs	Lead (µg/L) mean ± SD
Low (12–26)	55	30.00 ± 5.47
Medium (27–52)	127	27.37 ± 5.23
High (53–80)	124	25.12 ± 5.01

Table 4
Blood lead concentrations in relation to dogs' weight

Weight (kg)	Number of dogs	Lead (µg/L) mean ± SD
Light (3.75–37.5)	231	27.27 ± 5.22
Heavy (37.6–75.0)	75	24.77 ± 4.97

Table 5
Blood lead concentrations in female and male dogs

Gender	Number of dogs	Lead (μg/L) mean ± SD
Female	146	26.59 ± 5.15
Male	160	27.04 ± 5.2

Others' findings demonstrated that a lower dog's height at the withers may increase lead exposure *via* soil and dust (7). The current results may support the above view although no statistically significant evidence was obtained. Earlier studies performed in the 1990's were also consistent with the hypothesis of decreased BPb levels with the height of dogs (11). The authors demonstrated a significantly enhanced ($P \leq 0.01$) mean concentration of lead (123.39 mg/L) in low dogs as compared to that in high ones (98.50 mg/L) (16).

Results indicating a relationship between BPb concentrations and the weight of dogs showed noticeably lower values of BPb levels in heavy dogs but the differences were not statistically significant (Table 4). It may be assumed that the observed differences are attributed to increased deposition of fat tissue in heavy dogs. Unfortunately, no studies involving the relation of weight with lead burden were found.

Data presented in Table 5 show no marked differences in mean blood concentrations in female and male dogs. While studies on people indicated that men have higher blood lead concentrations than women because of a higher exposure and higher blood haematocrit levels (3). The presented findings indicate that female and male dogs seem to be at a similar risk of lead contamination. Similarly, no gender differences in BPb concentrations between young and older children were reported (23).

To conclude, lead concentration in the blood of dogs mainly depends on lead contamination of the environment. The age of dogs significantly affects blood lead concentrations, regardless of the environment in which they live, whereas height, weight, and gender have no significant effect. Purebred dogs and mixed breed dogs do not reveal significant differences in blood lead concentrations. Lead concentrations in dogs vary significantly in relation to their assistance in human activities. Within the same breed, working dogs revealed significantly higher blood lead concentrations than those not involved in the activity. Lead concentrations in the dogs examined decreased markedly since 1997. It seems reasonable to assume, that the decrease may result from the reduction of lead emission by the copper works (PCR).

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