Polish Journal of Environmental Studies Vol. 7, No. 5 (1998), 285-288

Pb Concentration in Dog Blood as an Indicator of Environmental Pollution

J. Monkiewicz, H. Geringer, K. Bas

Department of Genetics and Animal Husbandry, Department of Horse Breeding,
Agricultural University, 51-631 Wrocław, Kożuchowska 7, Poland

Received 26 February, 1998
Accepted 18 May, 1998

Abstract

This study aimed at determining Pb concentration in the blood of dogs raised in the environment polluted by copper industry. The dogs were divided into groups by age and height. The results show that there is a strong relationship between the age of dogs and Pb contents of canine blood. Besides, Pb content of small dogs was markedly higher than that of large dogs. Comparative studies by other authores on Pb contents of blood in children, adolescents and adults living under the same environmental conditions indicate that there is a close relationship between Pb contents of human and canine blood.

Taking into account the observations mentioned above, the authors of the present study came to the conclusion that canine blood can be a good indicator showing to what extent human health can be threatened by lead. Analyzing Pb concentration in human and dog blood, the conversion factor for the comparison of dogs' and human ages was used.

Keywords: dogs, humans, Pb, blood, environmental pollution

Introduction

Overly high concentrations of heavy metals (especially lead) are toxic to humans and animals. Environmental pollution is steadily increasing as a result of inadequate utilization of natural resources, the development of the chemical industry, non-ferrous metal processing, and traffic congestion. For these reasons, constant toxicological surveillance is a necessity. Compared to other European countries, total Pb emissions in Poland are at comparable levels; but there are areas where emission of this metal is much higher [11]. Many researchers, biologists, chemists, physicians and toxicologists agree that lead is one of the most hazardous culprits, the more so that no positive impact of this metal on metabolic processes has ever been reported [3]. There are 199 minerals known to contain lead. Lead ore resources world-wide are estimated to 100 million tonnes.

Pb concentration in the natural environment has been studied extensively. There are many interesting reports in animal science, in which the researchers focus their attention on finding such animal organisms that would be suitable bioindicators of the toxicological threat. For these reasons, Pb concentrations were measured in farm animals (cattle, horses, sheep and pigs), bees and microorganisms. Pb concentrations inform us about the presence or absence of this element in the evironment, but they do not show the relationships between Pb concentrations in humans and animals. It is worth noting that animals used for this purpose must live in the same environment as people, and besides, their diets should be comparable as well. This directed our attention to dogs, as they are often treated as family members. Their owners often give them the remains from their table and they are also exposed to the same environmental conditions. The dog is known to be the oldest pet animal, as human-dog friendship is about 12,000 years old.

Pb compounds are absorbed by human and animal bodies through alimentary and respiratory systems. They can also be absorbed by intact skin. As has been estimated, non-nutritional sources of lead intake (e.g. dust and soil) by children can account for 75% [3, 9]. Exposure to Pb in urban environments is much higher due to traffic combustion and dusts containing tetraethyl lead. Other sources of Pb are chimney fumes of local furnaces in which poor quality coal is used as fuel. As has been reported, the amount of Pb released during coal and coke burning (in

Poland as much as 75% of energy is obtained from coal) is comparable to that emitted by traffic vehicles [6]. Moreover, the mining industry and non-ferrous metal processing plants are responsible for Pb emissions. In Poland, copper plants are major culprits.

Pb concentration in blood is the only indicator of its absorption, so interpretation of its effects on human and animal health is possible provided that Pb contents of blood are known [4, 7, 12].

The purpose of the present study was to determine Pb concentrations in canine blood with respect to animals age and height. The results obtained in the study were compared with mean Pb concentrations in the blood of children and adults living in the same environmental conditions, in order to find whether dogs can be used as indicators of the toxic effects of Pb in pollution-stricken areas.

Material and Methods

The investigation was conducted on dogs (mainly mongrels), raised in Glogow, a town situated 2-3 km (in straight line) from the copper plant. In total, 45 dogs were selected for the study and divided into 3 groups by age (A - between 6 months and 3 years, B - 4-8 years and C - 10-16 years of age). The age groups were subdivided into 2 subgroups by height (1 - small dogs up to 35 cm; 2 - dogs of 35-80 cm in height). The dogs were kept by their owners in households,

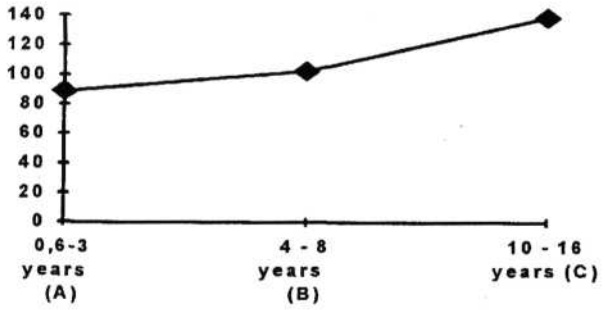

Fig. 1. Pb concentration (µg/l) in canine blood in relation to dog's age.

Table 1. Pb concentration (µg/l) in canine blood in relation to dog's age.

Age	Means	Standard deviation	Statistical differences
6 months to 3 years (A)	89.36	20.80	Cb
4-8 years (B)	102.34	12.07	aC
10-16 years (C)	138.35	36.11	AB
Total mean	109.90		

* Common letters (a, b, c) indicate statistical differences at $p < 0.05$.

* Uppercase letters (A, B, C) indicate statistical differences at $p < 0.01$.

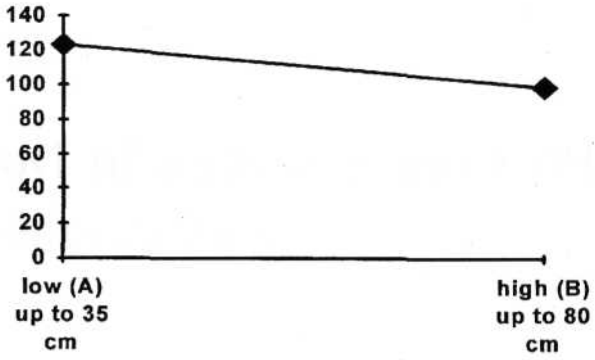

Fig. 2. Mean Pb concentration (µg/l) in relation to dog's height.

Table 2. Pb concentration (µg/l) in canine blood in relation to dog's height.

Height	Means	Standard deviation	Statistical differences
low (A) up to 35 cm	123.39	37.15	b
high (B) from 35 up to 80 cm	98.51	21.00	a

* Common letters (a, b, c) indicate statistical differences at $p < 0.05$.

were in normal physical condition and their diets were similar to those of their owners, as they received scraps from the table.

Pb contents of blood were determined by AAS (atomic absorption spectrophotometry) using a Pye-Unicam SP-9. Pb content of blood was determined at organic phase after extraction of Pb complex from ammonium pyrolydindithiocarbamate (APDC) with isopropyloacetone (MIBK) at wavelength = 217 µm, with deuter lamp for background correction. The data were converted into µg/l. The blood of the same dogs was collected four times at 20-day intervals, in the summer months (June-September) of 1997. The data were analyzed statistically using an Excel programe.

Results and Discussion

Table 1 and Fig. 1 show Pb concentrations in canine blood according to dogs' ages. Table 2 and Fig. 2 show mean Pb concentrations in canine blood, depending on height. Table 3 shows mean Pb concentrations in relation to age and height. Table 4 shows mean Pb concentrations in children's blood reported by different authors. As can be seen in Table 1, the differences in Pb concentration in canine blood of different age groups are statistically significant, or highly significant. Pb concentrations averaged 89.36 µg/l in the youngest age group (6 months to 3 years), 102.34 µg/l in the group of animals between 4 and 8 years of age, and 138.35 µg/l in the oldest group, between 10 and 16 years of age. Highly significant differences in Pb contents of canine blood were observed between the youngest and the oldest animals and between medium-aged and the oldest group. The differences between the youngest and medium-aged groups were significant. It can, therefore, be

Table 3. Pb concentration (μg/l) in canine blood in relation to dog's age and height

Age	Height	Mean	Standard deviation	Statistical differences
young 0.6-4 years	low (A)	117.87	10.46	B
	high (B)	79.00	11.38	A
mean 4-8 years	low (A)	99.18	11.61	
	high (B)	104.56	12.49	
old 10-16 years	low (A)	150.50	46.47	
	high (B)	124.18	9.48	

* Uppercase letters (A, B) indicate statistical differences at $p<0.01$.

concluded that there is a relationship between Pb content of canine blood and age. The highest Pb concentration was found in blood of the oldest animals, whereas Pb concentration in blood of the youngest dogs was at the lowest level (Table 1, **Fig.** 1).

Relationships in humans are different, which can be seen in the investigations carried out by Jakubowski [4, 5]. Pb contents of human blood were the highest in men (87.57 μg/l), next in children (66.71 μg/l) and the lowest in women (55.14 μg/l). This is likely due to the fact that the majority of men are employed in industry, where the exposure to Pb is severe. In children, Pb absorption from the digestive system is five-fold higher than in adults and, besides, the food conversion ratio in children is higher than in adults [9]. Children often put various inedible objects in their mouths, lick their fingers, and in this way introduce Pb into their bodies. The lowest Pb concentrations were found in women, whose lifestyles and habits are different from those of men and children. These factors do not apply to dogs, therefore, it seems very likely that Pb concentration in dogs depends on the time of exposure.

Comparison of Pb concentrations in dogs in relation to their height shows significant differences. Pb concentrations in small dogs (up to 35 cm in height) amounted to 123 μg/l, as compared to 98.5 μg/l in large dogs (Table 2, Fig. 2). The explanation is simple-small dogs walking in the streets breathe in the air, which is low above the ground, and thus, absorb more dust containing lead. Larger dogs breathe in less polluted air, hence significant differences in Pb concentrations between the two groups (Table 2, Fig. 2). The analysis of Pb concentrations by age groups (subdivided into small and large dogs) shows that significant differences occurred only in young animals (Table 3). Pb contents of canine blood in the medium-aged group were approximately the same. Mean Pb concentration in the oldest group of small dogs was higher (150.5 μg/l) than that of large dogs (124.1 μg/l), so the tendency had been maintained, albeit no significant differences were found.

Bearing in mind the fact that animal and human diets are similar and so are the environmental conditions in which they live, an attempt has been made to compare average Pb concentrations in canine and children's blood. Table 4 shows mean Pb concentrations in children's blood (residents of Glogow and nearby villages). The results obtained by various authors [1, 2, 13, 15, 16] in 1991-1996 indicate that the mean Pb concentration in children's blood amounted to 102.5 μg/l (Table 4). In 1997 Pb concentration

Table 4. Pb concentration (μg/l) in children's blood (Glogow and nearby villages)

No	Mean	Region	Author	Ref.
1	171	Żukowice 1991	Jakubowski 1991	2
2	96	Grodziec Mały 1991	Jakubowski 1991	2
3	156	Głogów 1991	Rudkowski & Pietraszkiewicz 1992	11
4	131	Żukowice 1992	Zaręba & Rudkowski 1994	16
5	92	Żukowice 1993	Zaręba & Rudkowski 1994	16
6	80	Kotla 1993	Zaręba & Rudkowski 1994	16
7	69	Głogów 1994	Pietraszkiewicz et al., 1994	13
8	88	Żukowice 1994	Zaręba & Rudkowski 1994	16
9	80	Kotla 1994	Zaręba & Rudkowski 1994	16
10	81	Rudna 1994	Bakońska-Pacoń et al., 1994	1
11	82	gm. Żukowice 1996	Strugała-Stawik et al., 1996	15
12	75	gm. Kotla 1996	Strugała-Stawik et al., 1996	15
mean total	102.9			
mean 1993--1996	80.87			

in blood of all the age groups of dogs averaged 109.9 μg/l. These values are approximate and comparable.

However, it is worth noting that in recent years Pb concentration in the vicinity of the copper plant of Gtogow has markedly decreased [2, 8], which has been confirmed in Pb contents of children's blood [14]. If we compare Pb contents of children's blood in 1993-1996 [1, 10, 14, 15, 16] (which decreased and averaged 80.8 μg/l) to the means obtained for young dogs in 1997 (x - 89.3 μg/l), then we shall see that the values are approximate to each other. Pb concentration in older dogs averaged 120.3 μg/l (Table 1), which corresponds to the mean Pb concentration in adults (117.5 μg/l) [4]. Life expectancy of dogs is much shorter than that of people, but the age of dogs can be converted into the corresponding human age. Assuming that the dogs in the age group between 6 months and 3 years correspond to humans at 10 to 20 years of age, the dogs aged 4 to 8 years correspond to humans at 28-48 years of age and the dogs aged 10 to 16 years correspond to humans at 52 to 80 years of age. Taking into acount what has been said heretoforth, Pb concentration found in dogs aged 6 months to 3 years corresponds to that found in children and adolescents, Pb concentration of older dogs (4-8 years of age) corresponds to that of adults, while the values found in dogs aged 10-16 years correspond to those of elderly people.

In summary, we can conclude that Pb content of canine blood can be considered a reliable indicator of the threat caused by this metal to human health.

Conclusions

1. Domestic dogs raised in areas polluted by lead can be considered good indicators of the threat caused by this me tal to human health.
2. Pb content of canine blood depends on the time of a dog's exposure to this metal and increases significantly with the animal's age.
3. Pb concentration in canine blood depends on the dog's height, as this is connected with the contents of air breathed in by the animal.

References

1. BAKONSKA-PACON et al. Biochemiczne wskazniki srodowiskowego narazenia dzieci zamieszkujacych rejon Zagtebia Miedziowego. Pediatria Polska **4,** 111, **1996.**
2. DOBRZANSKI J., BYRDZIAK H. KGHM Miedi S.A. Mat. Konf. Oddzialywanie przemyslu miedziowego na produkty zywnosciowe pochodzenia zwierzecego w swietle prowadzonych badan monitoringowych, Legnica **1995.**
3. DUTKIEWICZ T., SWIATCZAK J. Ot6w w srodowisku w Polsce. Medycyna Pracy **6,** 53, **1993.**
4. JAKUBOWSKI M. Poziomy biologiczne olowiu u mieszkancow Polski. Medycyna Pracy 6, 15, **1993.**
5. JAKUBOWSKI M. Narazenie srodowiska na ot6w w Polsce. Pediatria Polska **4,** 15, **1993.**
6. KITTEL M. Toksodynamika przewleklych zatruc malymi dawkami olowiu. Post. Hig. Med. Dosw. **37,** 325, **1983.**
7. MAREK K. Zagrozenie olowiem w przemysle polskim. Me dycyna Pracy **6,** 35, **1993.**
8. MONKIEWICZ J. Uzytkowanie bydla w rejonie huty „Gtogow". Konf. „Swiatowy Dzien Ochrony Srodowiska" Lublin **1997.**
9. URBANEK-KARLOWSKA B. Olow w produktach spozywczych. Medycyna Pracy 6, 43, **1993.**
10. PIETRASZKIEWICZ T. et al. Stezenie olowiu we krwi u dzieci z wojewodztwa legnickiego. Pediatria Polska **4,** 95, **1996.**
11. Raport Komisji Toksykologicznej Rady Sanitarno-Epidemiologicznej. Medycyna Pracy **6,** 5, **1993.**
12. RAZNIEWSKA G., TRZCINKA-OCHOCKA B. Monitoring biologiczny olowiu: system i kontrola jakosci. Medycyna Pra cy **6,** 127, **1993.**
13. RUDKOWSKI Z., PIETRASZKIEWICZ T. Dziecko w srodo wisku przemyslowym Zaglebia Miedziowego. Mat. Konf. Naukowej „Dziecko w skazonym srodowisku". Legnica 1992.
14. STRUGALA-STAWIK H. Narazenie na o!6w dzieci z woje wodztwa legnickiego w latach 1991-1996 w badaniach Fundacji na Rzecz Dzieci Zaglebia Miedziowego. Mat. Konf. Naukowej „Dziecko w skazonym srodowisku problemy ekologiczne i zdrowotne". Legnica **1997.**
15. STRUGALA-STAWIK H. et al. Stezenie olowiu we krwi dzieci z wojew6dztwa legnickiego badanych w latach 1995-1996. Mat. Konf. Naukowej. „Dziecko w skazonym sro dowisku problemy ekologiczne i zdrowotne. Legnica **1997.**
16. ZARE.BA A., RUDKOWSKI Z. Przeglqd wynikow badan oto wiu we krwi dzieci w Legnicko-Glogowskim Okregu Miedziowym (LGOM) w latach 1974-1994. Pediatria Polska **4,** 73, **1996.**