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INFLUENCE OF SEX, AGE, HABITAT, AND FEED TYPE ON HEAVY METAL CONCENTRATIONS IN DOGS

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Abstract

Heavy metal contamination poses a significant environmental and public health concern due to the biomagnification process, together with their toxic effects on living organisms. This researched aimed to assess the concentrations of Pb, Cd, Hg, and Ni using dogs' hair as a bioindicator, while also taking into consideration the sex, age, living and feeding conditions of the dogs. The hair samples were analysed by ICP-MS. Dogs that lived outdoors had higher Pb, Cd, and Ni concentrations, compared to indoor dogs, although the difference was not statistically significant. No statistical significance was either found when assessing heavy metal concentrations in dog hair based on feed type, however there were higher concentrations of Pb and Ni in dogs consuming commercial food, of Hg in dogs consuming home-cooked food, and of Cd in dogs having a mixed diet. The findings of this research support the assumption that dogs which are raised outdoors, in a polluted environment, accumulate higher levels of some heavy metals, and that the duration of the environmental exposure may also play a role in the amount of accumulated heavy metals.

Key words: *lead, cadmium, mercury, nickel, dogs.*

INTRODUCTION

Heavy metal contamination poses a significant environmental and public health concern due to the biomagnification process, together with their toxic effects on living organisms. In domestic canines, exposure to heavy metals can occur through multiple pathways, including dietary intake or inhalation and ingestion of particles coming from a polluted environment (Park et al., 2005). Variations in commercial food and home-cooked meals may differentially contribute to heavy metal exposure. Given the close association of the living environment between dogs and humans, understanding the factors influencing heavy metal bioaccumulation in canine populations is essential for assessing potential health risks.

Numerous studies have demonstrated the use of hair as an adequate sample type for dosing mineral elements and heavy metals, given its non-invasive and non-perishable characteristics (Badea et al. 2023; Michalak et al., 2012; Kosla et al., 2011; Kosla et al., 2010).

The present study aims to examine the influence of age, sex, habitat, and feed type on heavy metal concentrations in dogs.

MATERIALS AND METHODS

A total of 57 dogs were included in the study (Table 1). All studied dogs were clinically healthy. The dogs were further divided into study groups based on their age, sex, habitat, and consumed feed type. Thus, the research evaluated the concentrations of heavy metals in males (n = 18) and females (n = 39), dogs under the age of 5 years old (n = 35) and over the age of 5 years old (n = 22), dogs raised indoors (n = 29) and dogs raised outdoors (n = 28), and in dogs eating commercial food (n = 25), home-cooked food (n = 5), and a mixed diet of both commercial and home-cooked food (n = 27).

Table 1. Number of individuals divided into study groups based on sex, age, habitat, and feed type

Sex	Male	18
	Female	39
Age	Over 5 years	35
	Under 5 years	22
Habitat	Indoors	29
	Outdoors	28
Feed type	Commercial food	25
	Home-cooked food	5
	Mixed diet	27
Total		57

From each dog, a hair sample was collected from the flank area. Hair samples were disintegrated by cold wet mineralization using 0.5 g hair, 5 ml HNO_3, and 1 ml HCl. Heavy metals (Pb, Cd, Hg, and Ni) were dosed using Inductively Coupled Plasms Mass Spectrometry (ICP-MS). Statistical analysis was carried out using SPSS software; Mann-Whitney and Kruskal-Wallis tests were used to evaluate the potential influence of age, sex, habitat, and feed type on heavy metal accumulation in dogs.

RESULTS AND DISCUSSIONS

Mean heavy metal concentrations for all studied dogs (ppm) are presented in Figure 1. The analysed dog hair samples had 1.10 ppm Ni, 0.89 ppm Pb, 0.05 ppm Cd, and 0.01 ppm Hg.
Badea et al. (2018) evaluated the concentrations of various heavy metals and mineral elements in the hair of dogs with mammary neoplasms compared to healthy controls; heavy metal concentrations in clinically healthy animals were similar compared to the concentrations found in the present study.
Ni, Pb and Cd concentrations were higher in the present study compared to the concentrations found by Badea et al. (2024) in the hair of clinically healthy cats (0.08 ppm Ni, 0.06 ppm Pb, and 0.02 ppm Cd) that were used to study the concentration of heavy metals in cats with gastrointestinal lymphoma compared to healthy controls; Hg concentrations were similar (0.01 ppm Hg) between the two studies.

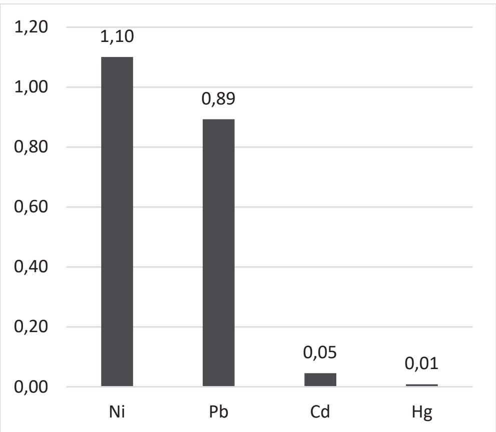

Figure 1. Mean heavy metal concentrations for all studied dogs (ppm)

Mean heavy metal concentrations in male and female dogs (ppm) are presented in Figure 2. Males had higher levels of Ni and Cd (1.24 ppm Ni, 0.07 ppm Cd) compared to females (0.84 ppm Ni, 0.04 ppm Cd). Females had higher levels of Pb (0.91 ppm Pb) compared to males (0.67 ppm Pb), while Hg concentrations were similar in both groups (0.01 ppm Hg). Statistical analysis however showed that the influence of sex on the accumulation of heavy metals in dog hair was not significant ($p > 0.05$).

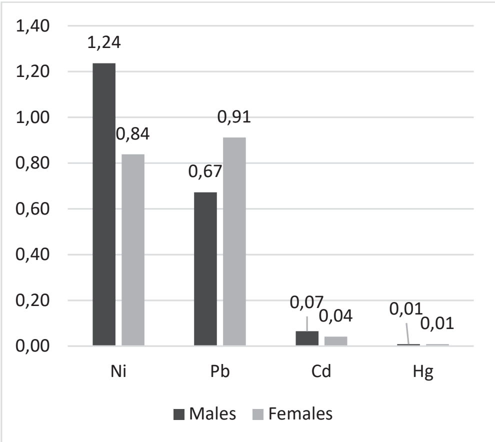

Figure 2. Mean heavy metal concentrations in male and female dogs (ppm)

The influence of sex on the levels of Pb, Cd and Hg in dog hair was also investigated by Park et al. (2005) in urban Korea, who identified concentrations of 0.98 ppm Pb, 0.09 ppm Cd and 0.25 ppm Hg in males, and 1.06 ppm Pb, 0.05 ppm Cd and 1.08 ppm Hg in females, but did not identify statistically significant differences between heavy metal concentrations in males and females. The heavy metal concentrations in the study of Park et al. (2005) are generally slightly higher in males compared to the concentrations found in males in the present study. Hg however was much higher compared to the dogs studied in the present research, especially in females.
Sakai et al. (1995) also conducted a study on the influence of sex on the level of Hg in dog hair. Hg had concentrations of 0.99 ppm in males and 0.66 ppm in females (without statistically significant differences between the two groups), the concentrations being higher compared to the Hg concentrations in the present study.

Mean heavy metal concentrations in dogs over and under 5 years of age (ppm) are presented in Figure 3. Dogs below 5 years of age had higher levels of Ni (1.15 ppm), Pb (0.96 ppm) and Cd (0.05 ppm) compared to older dogs (0.81 ppm Ni, 0.82 ppm Pb, 0.04 ppm Cd). Hg concentrations were similar in dogs below and over the age of five (0.01 ppm Hg). There was no statistical significance between the concentrations of heavy metals in the studied age groups ($p > 0.05$).

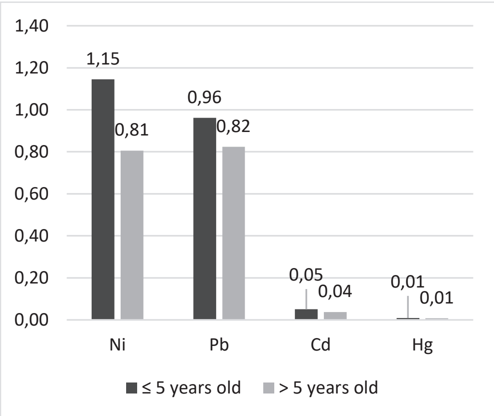

Figure 3. Mean heavy metal concentrations in dogs over and under 5 years of age (ppm)

Park et al. (2005) also investigated the influence of age on the accumulation of Pb, Cd and Hg in the hair of dogs. Park et al. (2005) identified that the Pb concentration in dogs under 1 year was 0.85 ppm, in dogs between 1 and 2 years old it was 1.21 ppm, and in dogs over 2 years old it was 1.35 ppm. Regarding the Cd concentrations, dogs under 1 year old had 0.03 ppm, dogs between 1-2 years old had 0.07 ppm, and dogs over 2 years old had 0.14 ppm. The Hg concentration was 0.33 ppm, 0.67 ppm, and 0.73 ppm, respectively. Thus, in the present study, Pb and Cd concentrations were similar, while Hg concentrations were lower compared to those found by Park et al. (2005). Additionally, just as the present study found, Park et al. (2005) identified no statistically significant differences in the concentrations of heavy metals between the age groups.

Mean heavy metal concentrations in indoor and outdoor dogs (ppm) are presented in Figure 4. The influence of the habitat on the accumulation of heavy metals in dog hair was not statistically significant ($p > 0.05$). However, Pb and Cd had higher concentrations in the hair of dogs that were raised outdoors (1.04 ppm Pb, 0.06 ppm Cd) compared to dogs that were raised indoors (0.62 ppm Pb, 0.04 ppm Cd). Ni concentrations were slightly higher in dogs raised indoors (1.14 ppm) compared to outdoor dogs (1.09 ppm), while Hg concentrations were similar between the two groups (0.01 ppm).

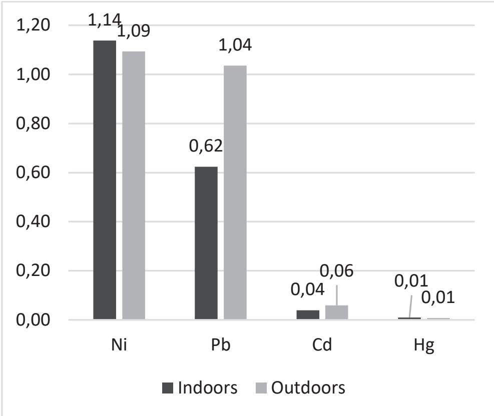

Figure 4. Mean heavy metal concentrations in indoor and outdoor dogs (ppm)

The heavy metal concentrations based on habitat found by the present study were generally similar (only Hg was different between the two studies, having lower concentrations in the present study) to those identified by Park et al. (2005) in their research on the influence of habitat on the levels of Pb, Cd and Hg in hair in dogs raised indoors, outdoors (cement) and outdoors (sand), respectively. Thus, the Pb concentrations were 1.12, 0.77, and 0.85 ppm, respectively. The Cd concentrations were 0.05, 0.07, and 0.15 ppm, respectively. The Hg concentrations were 0.75, 0.17, and 0.19 ppm, respectively. Neither Park et al. (2005) did not identify statistically significant differences when analysing the influence of the habitat on the heavy metal accumulation in dog hair.

Mean heavy metal concentrations in dogs based on consumed feed type (ppm) are presented in Figure 5.

Ni concentrations were the highest in the hair of dogs eating home-cooked food (1.31 ppm), and the lowest in dogs consuming commercial food (0.84 ppm). Dogs receiving a mixed diet had 1.24 ppm Ni. Statistical analysis showed that the feed type does not influence Ni accumulation ($p > 0.05$).

Pb had the highest concentration in dogs consuming home-cooked food (1.44 ppm). Dogs consuming commercial food had the lowest concentration (0.71 ppm), while dogs receiving a mixed diet had 0.88 ppm Pb. Statistical analysis showed that feed type had no influence ($p > 0.05$) on Pb accumulation in dog hair.

Cd concentrations were highest in dogs receiving a mixed diet (0.10 ppm). Dogs eating commercial food and dogs consuming home-cooked food had similar Cd concentrations (0.04 ppm, and 0.03 ppm, respectively), the difference between the three study groups not being statistically significant ($p > 0.05$).

Hg had the highest concentration in dogs eating home-cooked food (0.10 ppm). Dogs consuming commercial food and dogs consuming a mixed diet had 0.01 ppm Hg. The difference between the Hg concentrations between groups was not statistically significant ($p > 0.05$).

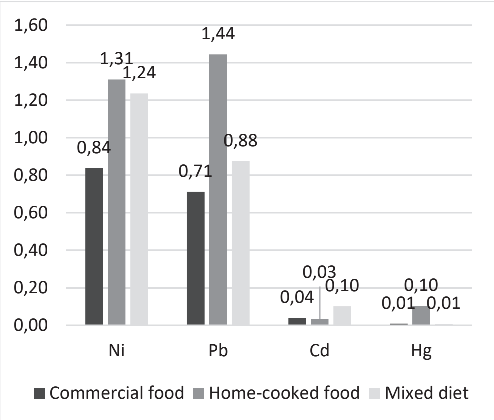

Figure 5. Mean heavy metal concentrations in dogs based on consumed feed type (ppm)

Park et al. (2005) also studied the influence of the feed type on the concentrations of heavy metals in dog hair. Dogs fed commercial food had 1.15 ppm Pb, 0.09 ppm Cd, and 0.83 ppm Hg, and dogs fed a mixed diet had 0.93 ppm Pb, 0.02 ppm Cd, and 0.32 ppm Hg. Park et al. (2005) found that dogs fed commercial food had significantly higher Cd levels ($p < 0.01$) compared to those fed a mixed diet. The present study found similar concentrations of Pb and Cd, and much lower Hg concentrations compared to the findings of Park et al. (2005).

CONCLUSIONS

Age, sex, habitat, and feed type do not statistically significantly influence the accumulation of Ni, Pb, Cd, and Hg in dog hair.

Pb and Cd had higher concentrations in dogs living outdoors, which suggests the fact that environmental exposure may lead to an accumulation of higher concentrations of heavy metals.

Ni, Pb and Hg had higher concentrations in dogs consuming home-cooked food, a finding that may suggest a possible contamination of food via cookware or water used during the cooking process.

The heavy metals concentrations of the present research are generally similar to those found by other studies.

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