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Distribution of Environmental Pollutants in Pet Animals. VI. Heavy Metals in Hair of House-Dogs

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Pet dogs live in relatively similar conditions to those of man. Therefore, they are considered to be available for monitoring the influence of environmental pollutants on the organism. One of the authors has determined the tissue concentrations of lead [HAYASHI 1977], cadmium [HAYASHI 1978] and zinc [HAYASHI 1979] in dogs. He confirmed that these concentrations were considerably consistent with those reported in man. On the other hand, the heavy metal contents of the hair can be used in evaluating the magnitude of the heavy metal contents of the body of man [CORRIDAN 1974, MACHIDA & MATSUBARA 1979], rat [KELLO & KOSTIAL 1978] and cow [DORN et al. 1974]. No studies, however, have been made on the levels of heavy metals in the hair of pet dogs. Therefore, the present investigation was conducted to clarify the concentrations of cadmium, copper, lead, manganese and zinc in the hair of 40 house-dogs of both sexes.

MATERIALS AND METHODS

Hair samples were collected from 20 male and 20 female house-dogs from 1/2 to 10 years of age living in Tokyo. They were divided into four age groups: group 1 of 1/2 to 1 year, group 2 of 2 - 4 years, group 3 of 5 - 7 years and group 4 of 8 - 10 years. Of the 40 samples, 18 were colored. Each sample was washed successively with acetone, 95% alcohol, and distilled water, and then dried overnight in the oven at 60°C. Portions of 100 to 200 mg each were burnt to ashes at a temperature of between 450°and 550°C in the muffle furnace and dissolved in 3mL of HNO_3:Hcl:deionized water (1:1:2) mixture. The resulting solutions were analyzed by atomic absorption spectrophotometry (Perkin-Elmer model 2100).

RESULTS

The concentrations of the heavy metals in the hair of male and female house-dogs are presented in Table 1. Of the heavy metals, zinc showed the highest

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TABLE 1

Heavy metal cocnetrations in canine hair by sex (mean ±S.D.,μg/g)

	Male (20)	Female (20)	Both sexes (40)
Zn	205.4 ± 39.7	210.2 ± 44.6	207.4 ± 41.9
Cu	30.5 ± 10.3	36.1 ± 14.5	32.9 ± 11.9
Pb	1.77 ± 1.05	2.06 ± 1.14	1.89 ± 1.08
Mn	1.30 ± 0.88	1.20 ± 0.57	1.25 ± 0.75
Cd	0.46 ± 0.19	0.38 ± 0.31	0.39 ± 0.24

No. of dogs is indicated in parentheses.

TABLE 2

Heavy metal concentrations in canine hair by age group (mean±S.D.,μg/g)

	Age group (years)			
	1/2 - 1(6)	2 - 4(14)	5 - 7(12)	8 - 10(8)
Zn	145.8±10.7	216.1±41.2**	223.2±41.2	227.0±32.2
Cu	24.1± 7.6	33.0±11.9	30.0± 9.3	38.8±18.4
Pb	0.81±0.25	1.91±0.74**	2.20±1.02	2.00±1.02
Mn	1.39±0.70	0.91±0.44	1.11±0.77	1.96±1.03
Cd	0.39±0.15	0.44±0.29	0.56±0.26	0.22±0.11*

No. of dogs is indicated in parentheses.
*,**
Significantly different from the values of the previous column (*$p < 0.005$; **$p < 0.001$).

concentration in the hair, regardless of the sex. It was followed by copper, lead, manganese and cadmium. The concentrations of lead, copper and zinc in the hair were higher in the females than in the males, while the manganese concentration was higher in the males than in the females. There were, however, no statistically significant differences in the concentrations of any

TABLE 3

Heavy metal concentrations in white and colored hair (mean±S.D., μg/g)

	White hair (22)	Colored hair (12)[a]
Zn	219.9 ± 32.2	223.4 ± 13.1
Cu	32.3 ± 11.9	40.6 ± 13.2
Pb	2.02 ± 0.93	2.37 ± 1.28
Mn	0.94 ± 0.40	1.87 ± 1.03*
Cd	0.40 ± 0.25	0.40 ± 0.28

[a] Age group of 1/2 to 1 year is excluded from the table.

* Significantly different from the value of white hair ($p < 0.01$).

TABLE 4

Correlations among heavy metals in canine hair

	Zn	Cd	Pb	Cu
Cd	0.038			
Pb	0.477*	0.049		
Cu	0.384*	0.298	0.566**	
Mn	0.176	0.158	0.116	0.140

* $p < 0.025$: ** $p < 0.005$

metal between the male and female dogs. Table 2 shows the heavy metal concentrations of the hair in all the age groups. Zinc increased gradually in concentration with the advance in age. Cadmium and lead increased in concentrations up to 5 - 7 years of age and decreased thereafter. Copper and manganese did not change markedly in concentration with the advance in age.

Copper, lead, manganese and zinc were higher in

concentration in the colored hair than in the non-colored hair (Table 3). There was, however, a significant difference in manganese concentration alone between the two types of hair. Group 1 was excluded from Table 3, because all the dogs of this group were of colored hair.

Correlations among the heavy metal concentrations in the hair of the house-dogs are summarized in Table 4. From them, the following conclusions are drawn: Zinc concentration is related to lead ($r= 0.477$) and to copper ($r= 0.384$) concentration. There is a high degree of correlation ($r= 0.566$) between lead and copper concentration.

DISCUSSION

Analysis was made on cadmium, copper, lead, manganese and zinc concentrations in the hair of house-dogs. The order of concentration of these heavy metals in the canine hair agrees with that in the human reported by YAMADA et al. [1975] and TERAOKA & KOBAYASHI [1976]. Furthermore, the mean concentrations of cadmium, copper, manganese and zinc in the hair of house-dogs were within the ranges of those in the human hair reported by TERAOKA & KOBAYASHI [1976] and UMOTO et al. [1979]. The mean lead concentration in the canine hair was lower than that in the hair of human beings living in Tokyo [NISHIMA et al. 1972] and other metropolis [UMOTO et al. 1979]. These results seem to indicate that the high lead levels in the human hair may be due to long exposure to metallic lead, to motor-vehicle exhaust and urban dust.

In this study there were no significant sex differences in the level of any heavy metal. Similar results have been obtained from the human hair [REEVES et al. 1975, IMAHORI et al. 1978]. Lead and cadmium increased in concentration in the hair of house-dogs up to 5 - 7 years of age and decreased thereafter. These results agree with those obtained by PETERING et al. [1973] who reported that cadmium and lead increased in level in the human hair up to 40 - 50 years of human age, which corresponds to 5 - 7 years of canine age. COTZIAS et al. [1964] showed that the manganese level was significantly lower in the white hair than in the black or brown hair in man and dogs. Experimental data were compared between the present investigation and the previous ones.

Since the black or brown hair occupaied about 90% of the samples in this study, it may be necessary

to collect hair samples of other colors to an adequate degree for further studies on the differences in heavy metal concentrations of hair.

From the results mentioned above, it is suggested that analysis of heavy metals in the hair of house-dogs may be valuable as a means of biological monitoring of heavy metal burden on the human body.

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