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Metal Concentrations in Tissues of Dogs Living in an Airport Area

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With the progress of aircrafts as a means of transportation and with the appearance of jumbo jet planes for an increase in transportation capacity, a variety of problems have come to the fore. Among others, when the fuel of the jet engine is burned, various metals contained in it are dispersed into the air. This constitutes one of the major factors for atomspheric contamination, in addition to the exhaust gas of automoblies, attracting attention as one of the public hazards in conjunction with the noise. The state of atmospheric contamination by the exhaust fume of aircrafts has already been reported (SEGAL 1975, ANDERS & BACH 1976). There has not been, however, a paper published on the influence of environmental pollution on organisms. The author has studied the distribution of lead (HAYASHI & TSUKAMOTO 1977a,b) and cadmium (HAYASHI & TSUKAMOTO 1978, HAYASHI 1978) in the body of house-dogs which lived in essentially the same condition as human beings to obtain an index of the degree of invasion of environmental pollutants into the human body. The results obtained indicated that the distribution of these elements in dogs was applicable as a biological index of contamination of human beings. Thus, the present study was conducted to compare the concentrations of metals in the body of pet dogs living in an airport area and those kept in a non-airport area.

MATERIAL AND METHODS

As in the previous study (HAYASHI & TSUKAMOTO 1977a), 20 house-dogs which were destined to be destroyed at the Ownerless Dog Exchange Station, City of Nishinomiya, Hyogo Prefecture, were selected as subjects. Therefore, none of them bore a distinct history. They were all adult dogs from 3 to 6 years, mostly 3 or 4 years. They were divided into two groups of ten each. The dogs of group 1 had been caught near the Osaka International Airport and those of group 2 on

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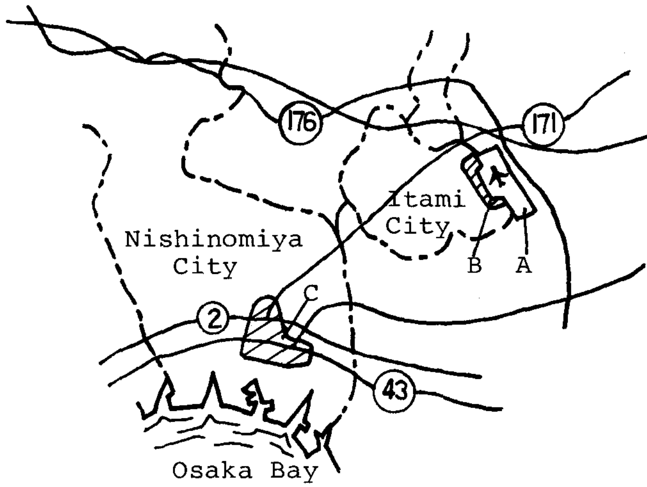

Figure 1. Map showing the locations where
the dogs were collected.
A: Osaka International Airport
B: Group 1 (airport area)
C: Group 2 (non-airport area)

the street in Nishinomiya City about 7 km in a straight line southwest of this airport (Fig. 1). Those of both groups were sacrificed under anesthesia to collect blood, heart, lung, liver, kidney, spleen and sternal ribs.

Blood and rib were stored in at -20 C until use for the analysis of metals. Each organ was homogenized, freeze-dried, and preserved in a desicator. All the tissue samples were subjected to the analysis of seven metals (aluminum, copper, lead, manganese, nickel, vanadium, and zinc). The periosteum and bone marrow were removed with a jet water current and used for analysis. Blood and rib were subjected each to wet ashing in an amount of 40mL and 1.5g, respectively, and freeze-dried organs to low temperature ashing in an amount of 0.5-1.0g for analysis of the metals.

Copper, lead, manganese and zinc were analyzed by flame atomic absorption spectometry with correction for background absorption. Lead in ash was chelated with ammonium pyrrolidine dithiocarbamate. The chelate was extracted with methyl isobutyl ketone which had been

TABLE 1. Metal contents in tissues of dogs in the two groups (mean±S.D. μg/g wet weight)

Group	Tissue	Pb	Zn	Mn	Cu	Ni	Al	V
Group 1	Liver	4.0 ± 4.4	61 ± 11	3.5 ± 0.5[b]	65 ± 15[a]	0.10 ± 0.02[c]	0.75 ± 0.37[c]	0.05 ± 0.01
	Kidney	1.5 ± 1.3[a]	30 ± 6[a]	1.5 ± 0.3	11 ± 3	0.10 ± 0.02	0.32 ± 0.17	0.04 ± 0.01
	Lung	0.43 ± 0.21	20 ± 3[b]	0.36 ± 0.06	2.3 ± 0.9	0.08 ± 0.00[c]	2.8 ± 1.2[b]	0.03 ± 0.00[b]
	Spleen	0.56 ± 0.26	29 ± 4	0.45 ± 0.05	3.9 ± 1.4	0.08 ± 0.01[c]	0.19 ± 0.11	0.03 ± 0.00
	Heart	0.26 ± 0.05	21 ± 2	0.66 ± 0.16	5.3 ± 0.7	0.06 ± 0.01	0.23 ± 0.11[a]	0.02 ± 0.00
	Rib	12 ± 25	61 ± 16[a]	2.0 ± 0.6[c]				
	Blood	0.22 ± 0.04[c]	0.9 ± 0.5[c]	0.02 ± 0.00	0.21±0.06	0.03 ± 0.00	0.02 ± 0.00	0.03 ± 0.00[c]
Group 2	Liver	1.2 ± 0.7	66 ± 14	4.3 ± 0.6	88 ± 28	0.06 ± 0.02	0.26 ± 0.12	0.04 ± 0.01
	Kidney	0.54 ± 0.19	25 ± 2	1.5 ± 0.3	10 ± 2	0.08 ± 0.02	0.23 ± 0.06	0.03 ± 0.00
	Lung	0.30 ± 0.05	24 ± 1	0.30 ± 0.09	2.6 ± 1.3	0.04 ± 0.02	1.5 ± 0.6	0.01 ± 0.00
	Spleen	0.46 ± 0.14	30 ± 3	0.42 ± 0.08	3.4 ± 1.1	0.05 ± 0.01	0.15 ± 0.08	0.02 ± 0.00
	Heart	0.25 ± 0.07	23 ± 2	0.59 ± 0.09	5.7 ± 0.6	0.05 ± 0.01	0.11 ± 0.03	0.02 ± 0.00
	Rib	2.1 ± 0.3	80 ± 18	1.0 ± 0.3				
	Blood	0.14 ± 0.04	2.0 ± 0.4	0.02 ± 0.00	0.22±0.07	0.03 ± 0.01	0.02 ± 0.00	0.02 ± 0.00

[a] $p < 0.05$; [b] $p < 0.01$; and [c] $p < 0.001$ with respect to group 2.

analyzed. Copper, manganese and zinc in ash were dissolved in 0.5 N nitric acid solutions and measured by the direct methods.

Analysis of aluminum, nickel and vanadium was conducted by flameless atomic absorption spectrometry with correction for background absorption.

RESULTS

1. Gross findings of organs. The lung was dark -red in both groups. Heartworms were found in all the dogs of each group. No disease, however, colud be diagnosed clinically in any dog. There was no marked difference in the findings of any organ between the two groups.

2. Metal contents (μg/g wet weight) of tissues. Metal contents in tissues in the two groups are summarized in Table 1. In these groups the lead content was the highest in the rib, which was followed by liver, kidney, spleen, lung, heart and blood. There were statistically significant differences in the content of lead in the kidney and blood between the two groups. In a dog of the airport group 1, the lead content in tissues were 16 in liver, 4.9 in kidney, 0.81 in lung, 1.1 in spleen, 0.30 in heart, 0.31 in muscle, 0.29 in blood and 82 in bone. The levels found would indicate lead poisoning.

The zinc content was higher in kidney and significantly lower in lung, rib, and blood in group 1 animals than in group 2.

The manganese content was significantly higher in the liver in group 2 and in the rib in group 1. There was no significant difference in the manganese content of any other tissue between the two groups.

The copper content of the liver was lower in group 1 thtn in group 2, but there was no significant differences in the cotents of any other tissues between the two groups.

The nickel contents of liver, spleen and lung, and the aluminum contents of lung, liver and heart, and the vanadium contents of blood and lung were significantly higher in group 1 than in group 2.

DISCUSSION

Of various environmental pollutants in the air, the exhaust gas of automobiles and the particulates discharged from factories have been main sources of air pollution. A considerable number of papers have been published on them (MORGAN et al. 1970, GLADNEY et al. 1974, MORI et al. 1976). No comprehensive studies, however, have yet been made on the environmental pollution around airports resulting from the exhaust gas of aircraft engines or on its effect on organisms. Therefore, the present investigation was conducted to determine the contents of Al, Cu, Pb, Mn, Ni, V and Zn in organs and blood of house-dogs living around an airport (group 1) and in an area far from the airport (group 2).

The lead content of each organ in group 2 was consistent with that in urban dogs reported by HAYASHI & TSUKAMOTO (1977a). It was higher in group 1 than in group 2. In one dog, it was the same as the toxic dose of lead reported by WILSON & LEWIS (1963) and ZOOK et al. (1972). The contents of copper, manganese and zinc of each organ were not a finding in which either of the two groups was always high, but were almost the same in both groups as those in normal dogs reported by NISHIYAMA (1969) and SCHROEDER et al. (1976). The average contents of aluminum, nickel and vanadium of each organ were higher in group 1 than in group 2.

FORDYCE & SHEIBLEY (1975) measured the contents of trace elements in jet fuel and reported that aluminum, barium, gold, titanium, uranium and vanadium exceeded the detectable limits and that more than 0.1 ppm aluminum was contained. They also compared the annual average degree of air pollution by the exhaust gas of aircraft engines between the urban and rural areas and found that the amount of aluminum and vanadium in the urban area was two to three times greater than in the rural area. FUJII et al. (1976) studied the relationship between air pollution and the exhaust gas of jet engines in an area around Osaka International Airport. According to them, there is a possibility for the atmosphere around the airport to be polluted by aluminum and vanadium. BASTRESS (1973) pointed out that the greater the distance between an airport and an area, the less remarkable the atmospheric pollution by the exhaust gas of aircraft engine in this area. These findings may lend support to the result of the present study that the contents of aluminum and vanadium of each organ was higher in group 1 than in group 2.

STOCK (1960) mentioned that there was a correlation between vanadium in the air and death rate of bronchitis and pneumonia and that such correlation was particularly strong in the presence of cadmium and nickel. With the results of the present study alone, it was not possible to assume that the components of the exhaust gas of aircraft engines, particularly aluminum and vanadium whcih were related closely to air pollution, might play an important role in the environmental pollution around the airport, or that these metals might exert adverse effect on the organism.

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