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HEAVY METAL CONCENTRATIONS IN THE KIDNEYS OF WHITE-TAILED DEER IN OKLAHOMA[1]

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Abstract: Concentrations of renal lead, arsenic, mercury and cadmium from 64 free-ranging adult white-tailed deer *(Odocoileus virginianus)* were determined. The mean concentrations in ppm wet weight and standard deviations for the metals were: lead, 0.574 ± 0.646; arsenic, 0.189 + 0.320; mercury, 0.176 ± 0.114; and cadmium, 6.968 ± 9.215. Variations in heavy metal concentration in deer collected from differing ecoregions within Oklahoma are discussed.

INTRODUCTION

Although the white-tailed deer *(Odocoileus virginianus)* is one of North America's most numerous big game animals, information is absent on heavy metal concentrations in this species. This report provides data on concentrations of lead, arsenic, mercury and cadmium in the kidneys of free-ranging white-tailed deer in Oklahoma.

MATERIALS AND METHODS

Sixty-four adult white-tailed deer were collected for research purposes from 10 locations in Oklahoma. The kidneys were removed and frozen at -70 C.

Kidneys were thawed and analyses were performed using a Perkin-Elmer model 460 atomic absorption spectrophotometer equipped with a PE HGA-2100 graphite furnace, and using deuterium arc background correction. The conditions used are given below.

A wet-weight basis was used in weighing the aliquots of kidney tissue, utilizing a 1.0 gram sample for the lead and arsenic determinations, a 0.5 g for the cadmium, and a 2.0 g aliquot of

	Lead	Arsenic	Cadmium	Mercury
Wavelength	283.3nm	193.7nm	228.8nm	253.7nm
Dry temp/time	100 C/45 sec	100 C/30 sec	110 C/20 sec	(Cold vapor technique used for analysis)
Char temp/time	525 C/40 sec	1000 C/40 sec	200 C/15 sec	
Atomization temp/time	2300 C/10 sec	2540 C/10 sec	2100 C/8 sec	

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slurried tissue for the mercury analysis. Samples were digested at 150 C for approximately 2 h in 10 ml of 7.5 N HNO_3 for the lead and cadmium test, and 2 ml of $NiNO_3$ (0.5% Ni) was added to the digestion solution for the arsenic determinations. The digested solution was then filtered and diluted to 100 ml with deionized water. The results are recorded in parts per million (ppm) and represent the average of the two readings. Mercury levels were determined using a sulfuric acid digestion and a flameless cold vapor atom absorption technique. Students-T test was used to detect significant differences between the groups. Four ecoregions (negative types) comprised the habitats of the collection sites.[2]

RESULTS AND DISCUSSION

The heavy metal concentrations in the kidneys of 64 adult free-ranging white-tailed deer are shown in Table 1. The authors are unaware of baseline values to which the findings of this study can be compared. A similar study in raccoons *(Procyon lotor)* from Florida, showed comparable renal lead levels (0.47 ppm) but lower levels for cadmium (2.46 ppm).[5] By comparison, lead and cadmium levels from the kidneys of gray squirrels *(Sciurus carolinensis)* in several areas in Florida showed overall averages much higher than those reported in this study.[6] Liver concentrations of lead in free-ranging raccoons in or around Connecticut averaged 6.2 ± 5.4 ppm.[2]

When deer were grouped by the ecoregion from which they were collected, significant differences were noted (Table 2). Deer collected from the Southeastern mixed forest ecoregion had significantly higher levels of kidney lead than deer from the other three regions ($P<0.05$). The deer from the bluestem-grama ecoregion had significantly lower renal lead levels than the deer from the other three ecoregions ($P<0.05$). This, however, may be an artifact of our data since only two animals were analyzed from this ecoregion. Renal lead levels in deer from oak-hickory and oak-bluestem parkland ecoregions were not significantly different from each other.

Renal arsenic levels from deer collected in the southeastern mixed forest, oak-hickory and oak-bluestem parkland ecoregions were not significantly different from each other. Animals

TABLE 1. Heavy metal concentrations in kidneys of free-ranging white-tailed deer in Oklahoma.

		Average Concentration (PPM) wet weight			
Area	Examined	Lead	Arsenic	Mercury	Cadmium
Cherokee Co.	(n=15)	0.476	0.142	0.176	3.931
Atoka Co.	(n=16)	0.507	0.148	0.227	1.921
McCurtain Co.	(n=9)	0.920	0.163	0.117	1.536
Leflore Co.	(n=5)	0.900	0.420	0.200	ND
Sequoyah Co.	(n=5)	0.010	0.110	cND*	10.920
Delaware CVOM	(n=5z	0mx36	0.016	ND	8.640
Major Co.	(n=2)	0.010	0.350	ND	3.350
Okmulgee Co.	(n=1)	0.020	0.300	0.600	9.750
Pushmataha Co.	(n=5)	0.577	0.000	ND	18.820
Adair Co.	(n=1)	0.010	0.050	ND	21.000
Total		x=0.574 sd=0.646	x=0.189 sd=0.320	x=0.176 sd=0.114	x=6.968 sd=9.215

*Not determined.

TABLE 2. Heavy metal concentrations in kidneys of free-ranging white-tailed deer in Oklahoma from differing ecoregions.

Ecoregion	No. of Deer Examined	Concentrations (PPM) wet weight) Lead	Arsenic	Mercury	Cadmium
Southeastern Mixed forest (Oak-Pine)	19	0.824 SD=0.760	0.188 SD=0.300	0.147 SD=0.104	11.310 SD=13.640
Oak-Hickory	26	0.339 SD=0.474	0.109 SD=0.164	0.188 SD=0.150	7.710 SD=8.880
Oak-Bluestem Parkland (Post Oak, Blackjack oak)	17	0.478 SD=0.591	0.145 SD=0.176	0.258 SD=0.149	2.680 SD=2.910
Bluestem-Grama	2	0.010 SD=0.010	0.355 SD=0.346	ND* —	3.350 SD=3.740

*Not determined.

collected from the bluestem-grama ecoregion had significantly higher renal arsenic levels than those from other three ecoregions ($P<0.05$). Again caution is required in interpretation because only two animals were collected from this ecoregion.

Renal mercury levels from deer collected in the southeastern mixed forest, oak-hickory and oak-bluestem parkland ecoregions were not significantly different from each other.

Renal cadmium levels were significantly higher in the animals collected from the southeastern mixed forest and the oak-hickory ecoregions than those from the oak and bluestem parklands and bluestem-grama ecoregions ($P<0.05$). Renal cadmium levels in the animals collected from the southeastern mixed forest and the oak-hickory ecoregions were not significantly different from each other.

Although sources of heavy metal contamination may vary depending on geographic region, land use, and industrial development, the results of this study indicate that the ecoregion the animals occupy may also be an important factor in heavy metal acquisition. It should be noted that land use differences and industrial development may vary as to ecoregion and contamination may be directly related to these variables.

To determine if elevated concentrations of heavy metals in the kidneys of deer could be attributed to increased exposure, over time, animals from all ecoregions were grouped according to age (Table 3). Analysis showed that, in the age groups examined, no significant differences existed for lead, arsenic, or mercury levels. Renal cadmium concentrations were, however, significantly different between each age group ($P<0.01$) indicating that exposure, over time may be an important aspect of cadmium concentrations.

The determination of "normal" data for heavy metal concentrations in free-ranging animals is important in evaluating suspected toxicity cases and for evaluating trends in environmental contamination. Additionally, the role that wildlife species may play in adding to the acquisition of heavy metals by human beings should be determined. Although the mean lead levels observed in the deer in the present study were within the acceptable levels established for beef cattle in Oklahoma (1.0 ppm), 14 of 64 deer had renal lead levels in excess of 1.0 ppm and 9 of 43 had cadmium

TABLE 3. Heavy metal concentrations in kidneys of free-ranging white-tailed deer in Oklahoma by age class.

Age Group	No. of Deer Examined	Concentrations (PPM) wet weight Lead	Arsenic	Mercury	Cadmium
1 year or less	20	0.530 SD=0.705	0.224 SD=0.325	0.163 SD=0.130	1.689 SD=1.087
2-3 years	26	0.352 SD=0.491	0.119 SD=0.189	0.231 SD=8.247	6.004 SD=8.247
4 years and older	18	0.479 SD=0.544	0.115 SD=0.188	0.151 SD=0.160	14.347 SD=11.377

levels in excess of 10.0 ppm. By comparison, a recent study of lead concentrations (ppm, wet tissue basis) of randomly selected beef samples from supermarkets in Oklahoma showed slightly lower kidney lead levels (0.45 ± 0.135) than were recorded for the deer in this study (0.574 ppm).[3,2] Lead content of cattle tissue from other locations within the United States has shown levels of 0.636, 0.25, and 1.0 ppm (Spaulding, J.E., pers. comm.) Lead concentrations from cattle in Oklahoma suspected of being exposed to forage contaminated with lead showed kidney levels of 1.331 ppm (sd =0.351).[4]

This study provided baseline data on heavy metal concentrations for free-ranging white-tailed deer from different ecoregions. Further evaluation is warranted to determine the role of free-ranging game species as a contributing source of heavy metal concentrations in humans.

LITERATURE CITED

1. BAILEY, R.G. 1978. A description of the ecoregions of the United States. U.S.D.A. Forest Service, Ogden, Utah, 77 pgs.
2. DITERS, R.W. and S.W. NIELSEN, 1978. Lead poisoning of Raccoons in Connecticut. J. Wildl. Dis. 14: 187-192.
3. EDWARDS, W.C., B.R. CLAY and W.B. BUCK. 1976. Detection of lead levels in beef randomly selected from supermarkets. Vet. Toxicol. 18: 70-72.
4. —— and ——. 1977. Reclamation of rangeland following a lead poisoning incident in livestock from industrial airborn contamination of forage. Vet. & Human Toxicol. 19: 247-249.
5. HOFF, G.L., W.J. BIGLER and J.G. MCKINNON. 1977. Heavy metal concentration in kidneys of Estuarine Raccoons from Florida. J. Wildl. Dis. 13: 101-102.
6. MCKINNON, J.G., G.L. HOFF, W.J. BIGLER and E.C. PRATHER. 1976. Heavy metal concentrations in kidneys of Urban Gray Squirrels. J. Wildl. Dis. 12: 376-371.

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