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Physiologic and Morphologic Studies on Atherosclerotic Pigeons.* (30457)

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White Carneau pigeons develop both aortic and coronary artery atherosclerosis in their natural environment on grain diets(1). The lesions begin developing as microscopic "fatty streaks" in the aortas of birds 2-3 weeks of age(2). By 3 years of age at least 95% of the birds have aortic lesions. Coronary artery atherosclerosis occurs in about 75% of mature White Carneau pigeons(3). Myocardial infarction has been reported in birds over 10 years of age(4). Distinct variations can be seen in the extent of both aortic and coronary artery atherosclerosis among mature birds. The purpose of this paper is to report the results of an experiment designed to determine the importance of blood pressure, serum cholesterol, and serum triglycerides in accounting for this variability seen in mature birds.

Materials and methods. One hundred and forty-six White Carneau pigeons were obtained from the Palmetto Pigeon Plant at Sumter, S. C. Their mean age was 8 years; 63 were male and 83 were female. The birds had been maintained by Palmetto Pigeon Plant from hatching until they were obtained for the experiment. During this period they were fed a free choice of corn, milo, peas, and wheat, along with a grit supplement. They were maintained in a similar fashion in our laboratory for periods up to one month.

White Carneau pigeons are quite docile and it was possible to obtain blood pressure measurements without general anesthesia. The birds were restrained on their backs by secur-

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TABLE I. Mean Values for Variables Studied.*

Variables	% A. I.	Gm. Ht. Wt.	Ht. Rate	mg % S. Chol.	mg % S. Trig.	C.A.L.P.I.	mm Hg. A.B.P.M.	mm Hg. Sys. B.P.	mm Hg. Dia. B.P.	Gm. Body Wt.
Both Sexes	12.88 ±0.71	6.59 ±0.07	225 ±4.51	313 ±7.19	217 ±11.83	6.6 ±0.85	167 ±1.73	204 ±2.33	140 ±1.54	545 ±4.69
Males	13.55 ±1.16		223 ±6.33	297 ±7.23	205 ±8.77	7.8 ±1.4	166 ±2.46	-	-	-
Females	12.41 ±0.89		227 ±6.28	325 ±10.97	225 ±19.13	5.7 ±1.05	167 ±2.4	-	-	-

* Mean Followed by the Standard Error of the Mean

A. I. - Atherosclerotic Index
Ht. Wt. - Heart Weight
Ht. Rate - Heart Rate
S. Chol. - Serum Cholesterol
S. Trig. - Serum Triglyceride
C.A.L.P.I. - Coronary Artery Lesion Prevalence Index
A.B.P.M. - Arterial Blood Pressure Mean
Sys. B.P. - Systolic Blood Pressure
Dia. B.P. - Diastolic Blood Pressure
Body Wt. - Body Weight

ing both feet and wings to a restraining board. A hood over the bird's head was found to be effective in preventing struggling. After subcutaneous infiltration of a 1% procaine hydrochloride solution over the alar artery, an incision was made to expose this artery and a 20 gauge needle with polyethylene tubing was attached to a Statham transducer,† which was connected to a Brush recorder.‡ After the blood pressure was measured, a blood sample was obtained from the cannulated vessel for serum cholesterol and triglyceride determination and the birds were killed with sodium pentobarbital solution.

Body weights were recorded at autopsy. The hearts were removed, weighed, and fixed in 10% buffered formalin. The aortas were removed, opened longitudinally, and the extent of atherosclerosis determined in the unstained specimen and expressed as an "atherosclerotic index"(5).

Five frozen sections of ventricular and septal myocardium, stained with Sudan IV-hematoxylin, were prepared from each of three 0.5 cm blocks. The extent of coronary artery atherosclerosis was determined by calculating the percent of arteries with atherosclerotic lesions seen in all of the sections and was recorded as a coronary lesions prevalence index (C.A.L.P.I.). Total serum cholesterol was determined by a procedure modified for the Technicon autoanalyzer(6). Serum triglycerides were determined by the procedure of Van Handel(7).

The relationships between the variables measured and aortic and coronary artery atherosclerosis were studied, using simple and partial correlation analysis, with the aid of an International Business Machine Corp. Model 1620 digital computer.

Results and discussion. The mean values for aortic atherosclerotic index (A.I.), heart weight (ht. wt.), heart rate (ht. rate), serum cholesterol (S. Chol.), serum triglyceride (S. Trig.), coronary artery lesion prevalence index (C.A.L.P.I.), arterial blood pressure mean (A.P.B.M.), systolic blood pressure (Sys. B. P.), diastolic blood pressure (Dia. B. P.), and body weight (Body wt.) are presented in Table I. The means for the 2 sexes were compared for A. I., ht. rate, S. Chol., S. Trig., C.A.L.P.I., and A.B.P.M. No significant differences were found. Despite the fact that mean values for male and female pigeons in this study were not different, it is possible to show in certain cases that the sexes were not alike in all aspects observed in these studies. By applying partial correlational analysis, which removes variability due to all other observed parameters except the two being correlated, certain significant relationships appear which may be of importance in atherosclerosis, but which differ in the two sexes.

Expected strong correlations were found between body weight and heart weight and between heart weight and blood pressure. No significant correlations could be found be-

† Statham, Hato Rey, Puerto Rico 0-75 cm Hg Model P23c.

‡ Brush Recorder Model B2-360.

TABLE II. Partial Correlation Coefficients for 63 Male White Carneau Pigeons.
Variables — A.I., C.A.L.P.I., A.B.P.M., heart rate, S. Chol., S. Trig.

Variable	r	p
A.I./S. Chol.	.363	<.01
C.A.L.P.I./S. Chol.	.191	—
A.I./S. Trig.	-.010	—
C.A.L.P.I./S. Trig.	-.182	—
r = .263 .340 .426		
p = .05 .01 .001		

TABLE III. Partial Correlation Coefficients for 83 Female White Carneau Pigeons.
Variables — A.I., C.A.L.P.I., A.B.P.M., heart rate, S. Chol., S. Trig.

Variable	r	p
C.A.L.P.I./S. Chol.	.439	<.001
C.A.L.P.I./S. Trig.	.345	<.01
A.I./S. Chol.	.194	—
A.I./S. Trig.	-.045	—
r = .217 .283 .357		
p = .05 .01 .001		

tween either aortic or coronary artery atherosclerosis and systolic, diastolic, or mean arterial blood pressure. No statistical relationship could be found between body weight and the atherosclerosis parameters studied.

The partial correlation coefficients for male White Carneau pigeons related to the atherosclerotic process are presented in Table II. Only the relationship between aortic atherosclerosis and serum cholesterol ($r = 0.363$) was significant ($p<0.01$) and at this magnitude accounts for about 10% of the variability in aortic atherosclerosis in this sex. It is of interest that no significant correlation could be found between either serum cholesterol or triglyceride, and the amount of coronary artery atherosclerosis.

The partial correlation coefficients for female White Carneau pigeons which may be related to the extent of atherosclerosis are presented in Table III. The coronary artery lesion prevalence index was correlated with serum cholesterol ($r = 0.439$ $p<0.001$) and with serum triglyceride ($r = 0.345$ $p<0.01$). In the case of females no correlation could be found between aortic atherosclerosis and either the serum triglyceride or serum cholesterol levels. Of possible significance is the fact that the female pigeon transports cholesterol principally in the beta lipoprotein fraction during a significant part of her reproductive life; while the male pigeon transports cholesterol in the alpha lipoprotein fraction for his entire life(8).

The data were also subjected to multiple regression analysis on a linear basis. No significant correlations were found that were not evident with partial correlational analysis.

Summary. Middle-aged White Carneau pigeons were found to have mean systolic blood pressures of 204 ± 2.3 mm of Hg and diastolic pressures of 140 ± 1.5 mm of Hg. Serum cholesterol levels were found to be 313 ± 7.19 mg% and serum triglyceride levels were 217 ± 11.83 mg%. The aortic atherosclerosis of these birds involved 12.88 ± 0.71% of the intima of the thoracic aorta. The mean per cent of arteries with atherosclerotic lesions in 15 frozen sections of left ventricle and septum of the heart were 6.6 ± 0.85%. The levels of blood pressure among White Carneau pigeons were found to account for very little of the variability in either aortic or coronary artery atherosclerosis. No sex difference could be found in the amount of coronary or aortic atherosclerosis. Serum cholesterol levels were found to be correlated with aortic atherosclerosis among male but not female birds. Serum cholesterol and triglyceride levels were correlated with coronary artery atherosclerosis among female but not male White Carneau pigeons.

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