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Coronary and Aortic Atherosclerosis in New Orleans

II. Comparison of Lesions by Age, Sex, and Race

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The mean extent of coronary and aortic atherosclerotic lesions at autopsy among age, sex, and race subgroups in New Orleans are compared. The comparisons are made within similar broad cause-of-death categories, accidents, and other natural deaths after excluding persons dying of coronary heart disease and related conditions. Using this basal group of cases reduces some of the effect of selective bias due to cause of death in this autopsy population.

Fatty streaks are present in the youngest age group included (10 to 14 years) and are more extensive in blacks than whites as reported in previous studies. In the aorta, fatty streaks are replaced by fibrous plaques and more advanced lesions in subsequent decades. Raised atherosclerotic lesions in the aorta are most extensive in white men. White women, black men, and black women, on the average, have fewer aortic raised lesions than white men; the differences among these three subgroups are not striking nor consistent.

Raised lesions in the coronary arteries are most extensive in white men followed by black men, black women, and white women in order of decreasing involvement. Sex differences in extent of lesions are striking in the white race and minimal in the black race.

These findings and mortality data suggest that in the 1960s white men were unusually susceptible to coronary atherosclerosis and coronary heart disease as compared to the other sex-race subgroups.

Additional key words: Coronary arteries, Aorta, Fatty streaks, Raised atherosclerotic lesions.

The New Orleans sample of the International Atherosclerosis Project, a large scale study of the geographic pathology of atherosclerosis, is the only United States community used in a comparison of populations from various parts of the world (6, 14). New Orleans white men ranked first in extent of advanced coronary atherosclerotic lesions among the 19 distinct location-groups in the International Atherosclerosis Project. Furthermore, the New Orleans black men and white women ranked medium-high or medium in comparison with other populations throughout the world. Inasmuch as this New Orleans sample is the only one from the United States, we have attempted to make the data from it as meaningful as possible by studying and defining potential sources of bias in the autopsy sample.

The preceding paper (11) presented the effect of sampling bias in New Orleans autopsy studies of atherosclerosis with emphasis on source of specimens (Charity Hospital of Louisiana at New Orleans and the Office of the Coroner of Orleans Parish). We confirmed the generally accepted and previously reported finding (8, 12) that persons dying of coronary heart disease (CHD) or conditions closely related to CHD (such as hypertension, stroke, diabetes mellitus, etc.) have more extensive atherosclerotic lesions than persons dying of other causes, and that these conditions are present in unequal numbers in age, sex, race, and source subgroups. Therefore, any comparisons among race or sex subgroups should be made after excluding CHD and CHD-related cases if even the most general reference to the living population is an objective. This previous report (11) indicated that the mean extent of fatty streaks and raised atherosclerotic lesions did not differ significantly in two broad cause-of-death categories defined as accidents and other natural deaths (after excluding cases of patients dying of CHD and CHD-related conditions). We concluded, therefore, that it would be reasonable to combine the two cause-of-death categories to form a basal group for making age, sex, and race comparisons of coronary and aortic atherosclerosis.

Previous reports by investigators in this laboratory (4, 6, 9, 10, 13) described the natural history of atherosclerosis in New Orleans and compared atherosclerosis between the races and among geographically distinct human populations. The material to be presented in this report, however, originates from the largest collection of

autopsy cases from New Orleans ever reported. The findings presented are similar to those of previous studies, but they are based on a much larger sample. Furthermore, since there is reason to suspect that the long existing racial differences in extent of atherosclerosis between black and white may be changing, we are now collecting new and independent autopsy material which will be compared later with results included in the present report. We predict that the racial differences reported in this and previous reports will have diminished or perhaps will have disappeared by the end of the decade. Such a change, if detected, will imply that environmental factors contributing to atherosclerotic disease are changing in the two racial groups.

MATERIALS AND METHODS

This report is based on 2700 persons, 10 to 64 years of age, who underwent autopsy because of external violence or natural causes other than CHD and CHD-related diseases. Approximately 70 per cent of the cases were collected from the Office of the Coroner of Orleans Parish and 30 per cent from the Charity Hospital of Louisiana at New Orleans. Arterial specimens and data were collected from autopsies performed between May 1, 1960 and December 31, 1968. The race, sex, and age distribution of the cases is shown in Table 1.

Details of the methods have been published (2). Briefly, aortas and coronary arteries were removed, opened longitudinally, fixed in 10 per cent buffered formalin, stained with Sudan IV, and sealed in plastic bags with formalin for preservation. A team of specially trained pathologists visually estimated the percentage of intimal surface involved with each type of atherosclerotic lesion (fatty streaks, fibrous plaques, complicated lesions, and calcified lesions) without knowledge of race, sex, age, or clinical information. The term raised lesions is a combined measurement comprising fibrous plaques, complicated lesions, and calcified lesions.

A long term controlled study of the method of unaided visual estimation of atherosclerotic lesions has indicated that the error of measurement inherent in this method is sufficiently small to permit statistically valid comparisons of lesion involvement among different population groups in terms of fatty streaks and raised lesions (2). Biologic variability in amount of atherosclerosis "swamps" unavoidable measurement error of the grading system (3).

Investigators coded the cause of death based on postmortem findings and clinical information. The comparisons of atherosclerosis between the two racial groups represented in New Orleans are made on the basal group of cases, pooling accidents and other natural deaths. Means and standard deviations of percentage of involvement of the arterial intima with fatty streaks (FS) and raised lesions (RL) were computed for the aorta and the three main branches of the coronary arteries (combined) in every race-sex-age subgroup.

Inasmuch as racial comparisons within the same sex (black *versus* white men; black *versus* white women) were of great interest, the statistical significance of differences between the racial groups in each sex was determined by *t*-tests. More sophisticated statistical techniques are not reported; the results of comparing means of extent of lesions by sex and race indicate obvious interactions.

RESULTS

The major sex-specific race comparisons were made within the 10-year age groups between 15 and 64 years of age because these age groups had the largest number of cases. However, results for the 10- to 14-year age group, in spite of extremely limited number, further document the early involvement of aorta and coronaries with FS in cases from New Orleans; also, as reported previously (4, 9, 14), involvement with FS in this age group is greater in black than in white cases (Table 2). Involvement with fatty streaks is less extensive in the coronary arteries than in the aorta. RL are only seen in the coronary arteries of black persons 10 to 14 years of age with actual mean extent of 0.8 and 0.4 for males and females, respectively.

Race Differences in Lesion Involvement

Aortic Lesions. In Figure 1 are shown the means of the percentage of intimal surface involvement with FS and RL in the aortas of white and black men and women aged 15 to 64 years. In Table 3 are contained the corre-

Table 2. Means of Percentage of Intimal Surface Involvement with Fatty Streaks (FS) and Raised Atherosclerotic Lesions (RL) in Children 10 to 14 Years of Age by Race and Sex (Basal Group, New Orleans, 1960–1968)

Race and sex	No. of cases	Aorta		Coronary arteries	
		FS	RL	FS	RL
White male	7	6.5	0	0.4	0
White female	4	4.8	0	0.2	0
Black male	20	21.5	0	1.4	0.8
Black female	16	17.3	0	1.8	0.4

Table 1. Number of Autopsies Performed on Persons Dying from Accidents and Other Natural Deaths by Race, Sex, and Age Group (New Orleans, 1960–1968)

Race and sex	Age group						
	10–14	15–24	25–34	35–44	45–54	55–64	All ages
White male	7	102	148	203	288	265	1013
White female	4	32	34	65	65	54	254
Black male	20	176	228	228	248	214	1114
Black female	16	39	54	73	77	60	319
Totals	47	349	464	569	678	593	2700

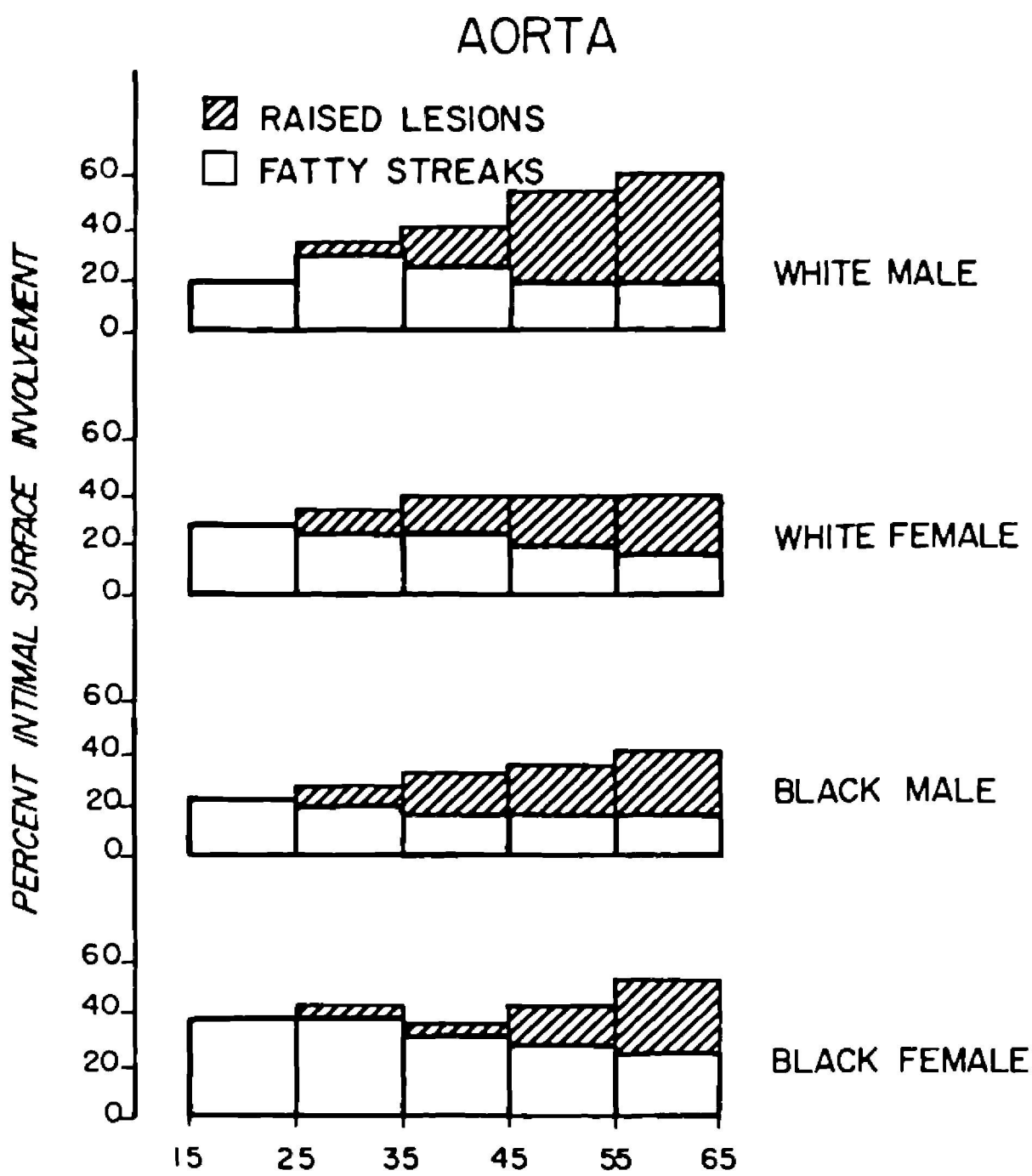

FIG. 1. Mean involvement of aorta by fatty streaks and raised atherosclerotic lesions by age, sex, and race (Basal group, New Orleans, 1960–1968).

TABLE 3. MEANS OF PERCENTAGE OF INTIMAL SURFACE INVOLVEMENT WITH FATTY STREAKS (FS) AND RAISED ATHEROSCLEROTIC LESIONS (RL) IN THE AORTA BY RACE, SEX, AND AGE (BASAL GROUP, NEW ORLEANS, 1960–1968)

Race and sex	Age group											
	15–24		25–34		35–44		45–54		55–64		All ages	
	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL
White male	18.4	0.4	29.5[a]	3.3	26.0[a]	13.8	18.8[a]	32.6[a]	16.5	41.9[a]	21.9[a]	18.4[a]
White female	26.3[b]	0.5	23.1[b]	5.7	24.5[b]	15.4[b]	19.5[b]	21.1	16.4[b]	34.3	22.0[b]	15.4[b]
Black male	21.8	0.2	20.5[a]	4.4	17.0[a]	11.8	16.6[a]	21.0[a]	15.7	26.4[a]	18.3[a]	12.7[a]
Black female	37.5[b]	0.6	36.5[b]	6.3	30.8[b]	7.5[b]	26.7[b]	15.3	23.6[b]	29.6	31.0[b]	11.9[b]
Unweighted means	26.0	0.4	27.4	4.9	24.6	12.1	20.4	22.5	18.1	33.0	23.3	14.6

[a] Significant differences between white and black males, $p < 0.05$.
[b] Significant differences between white and black females, $p < 0.05$.

sponding age-race-sex specific numerical data and the results of the statistical tests for race comparisons.

Aortas of all persons are involved to some extent with FS by age 10. Mean involvement with FS in the 15- to 24-year age group does not differ significantly in black and white men. Black women, however, consistently have greater mean involvement of the aorta with FS than white women. In general, involvement with FS reaches a maximum during the 25- to 34-year age span decreasing in extent thereafter, as FS are gradually replaced by involvement with more advanced lesions (fibrous plaques, complicated lesions, and calcified lesions).

The mean extent of aortic RL increases progressively with age in white and black persons of both sexes. Sex and race differences in mean extent of aortic involvement with RL between sex-race specific subgroups are not significant before 35 years of age. After age 35, the greatest involvement with RL generally occurs in white men. In decreasing order of involvement, white women, black men, and black women, on the average, have less aortic RL than white men.

Coronary Lesions. Mean atherosclerotic involvement of the coronary arteries with age is shown in Figure 2. In Table 4 are contained the numerical values of the various age-race-sex specific means and results of the tests of significance for the various comparisons between races.

Fatty streaks in the coronary arteries are generally more extensive in black men and women than in white men and women in all age groups. The involvement with FS increases with age in the coronary arteries of men and women of both races. In black men coronary involvement with FS reaches a maximum value in the 45- to 54-year age interval, while in white men this occurs earlier. On the other hand, in women of both races, involvement of the coronaries with FS tends to increase progressively with age from 15 through 64 years. Thus, FS are not replaced as rapidly by RL in the coronary arteries as in the aorta except in the white male group.

Involvement with RL increases with age in white men more rapidly than in the other race-sex subgroups. Over the age span included in this report, mean involvement of the coronary arteries with RL is greatest in white men, followed in decreasing order by black men, black women, and white women.

Sex Differences in Lesion Involvement

Race-specific male to female ratios for describing sex differences in aortic and coronary lesion involvement were calculated using the means included in Tables 3 and 4. Results of these calculations are presented in Table 5.

FIG. 2. Mean involvement of the three main branches of the coronary arteries by age, sex, and race (Basal group, New Orleans, 1960–1968).

TABLE 4. MEANS OF PERCENTAGE OF INTIMAL SURFACE INVOLVEMENT WITH FATTY STREAKS (FS) AND RAISED ATHEROSCLEROTIC LESIONS (RL) IN THE THREE MAIN BRANCHES OF THE CORONARY ARTERIES BY RACE, SEX, AND AGE (BASAL GROUP, NEW ORLEANS, 1960–1968)

Race and sex	Age group											
	15–24		25–34		35–44		45–54		55–64		All ages	
	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL
White male	4.2	1.4	8.8	5.7[a]	12.1	14.3[a]	11.7[a]	26.3[a]	10.3[a]	30.6[a]	9.4[a]	15.6[a]
White female	3.6[b]	0.6	8.1	1.9	13.7	7.7	16.5	10.6	21.5	17.6	12.7[b]	7.7[b]
Black male	5.2	0.9	10.2	2.9[a]	14.0	10.5[a]	15.0[a]	15.5[a]	15.5[a]	24.0[a]	12.0[a]	10.8[a]
Black female	8.6[b]	0.3	10.6	2.5	17.5	5.9	19.8	16.0	19.8	24.8	15.3[b]	9.9[b]
Unweighted means	5.4	0.8	9.4	3.2	14.3	9.6	15.7	17.1	16.8	24.3	12.3	11.0

[a] Significant differences between white and black males, $p < 0.05$.

[b] Significant differences between white and black females, $p < 0.05$.

TABLE 5. MALE TO FEMALE RATIOS OF MEANS OF PERCENTAGE OF INTIMAL SURFACE INVOLVEMENT WITH FATTY STREAKS (FS) AND RAISED LESIONS (RL) IN THE AORTA AND CORONARY ARTERIES BY AGE AND RACE (BASAL GROUP, NEW ORLEANS, 1960–1968)

Artery and race	Age group											
	15–24		25–34		35–44		45–54		55–64		All ages	
	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL	FS	RL
Aorta												
White	0.70	0.80	1.28	0.58	1.06	0.90	0.96	1.54	1.01	1.22	0.99	1.19
Black	0.58	0.33	0.56	0.70	0.55	1.57	0.62	1.37	0.66	0.89	0.59	1.07
Coronary												
White	1.17	2.33	1.09	3.00	0.88	1.86	0.71	2.48	0.48	1.74	0.74	2.03
Black	0.60	3.00	0.96	1.16	0.80	1.78	0.76	0.97	0.79	0.97	0.78	1.09

Aortic Lesions. The male to female ratios included in Table 4 show that the means of FS involvement of the aorta are larger in white women than in white men in the 15- to 24-year age interval, while the converse is true in the next decade. No sex differences in FS are evident in white persons beginning at age 35. Involvement with RL in the aorta is greater in white women than in white men up to 44 years of age, while thereafter white men show greater involvement with RL. Over all ages, the male to female ratio of the unweighted means of involvement with RL among white persons is 1.19, indicating moderately greater involvement with aortic RL in white men than in white women.

On the other hand, larger means of aortic involvement with FS prevail in black women in comparison with black men, as illustrated by male to female ratios below 1. Black women aged 15 to 34 years show greater mean involvement of the aorta with RL than black men of the same age. This sex difference is reversed in the two age intervals included between 35 and 55 years; in these years black men have larger mean involvement with RL than black women. In the last age interval of this study (55 to 64 years), there is more extensive aortic RL involvement in black women than in black men.

Coronary Lesions. Sex variations in coronary atherosclerotic lesions differ from those described for the aorta. White men show greater means of FS involvement than white women up to the age of 34 years, but the opposite occurs afterward. The coronary arteries of white men consistently have substantially more extensive RL involvement than white women of the same age. Over the age range considered in this study, the coronary involvement of white men is twice that of white women. Involvement with FS in the coronary arteries of black persons in New Orleans follows the pattern described for the aorta indicating consistently larger means of involvement in black women than in black men. On the other hand, involvement with RL is more extensive in the coronaries of young black men up to the age of 44 years, while thereafter the coronary involvement with RL is greater in black women.

DISCUSSION

This descriptive report on the natural history of coronary and aortic atherosclerosis in New Orleans provides documentation of the average extent of lesions among age, sex, and race subgroups for the 1960s. The data in this report can be compared with previous information on the natural history of atherosclerosis and also can be related to mortality rates from the clinically significant end stages of atherosclerosis—namely, coronary heart disease and other ischemic vascular disease. Furthermore, these base line data may be useful in detecting future changes in the distribution of atherosclerosis among the different sex and race groups in New Orleans as an indication of changing environmental conditions.

In general, the results of this study confirm previous reports (4, 6, 9, 10, 13) of atherosclerosis among deceased persons in the biracial community of New Orleans. The precocious development of aortic fatty streaks in blacks, most prominent under the age of 15 years, was first observed in material collected between 1952 and 1959 (4, 13). This finding is also evident in the small numbers of cases in the 10- to 14-year age group included in the present study.

Estimates of mean extent of fatty streaks in this report should be interpreted cautiously when coinciding with more advanced lesions since these develop from progression of fatty streaks (or at least develop in sites previously occupied by fatty streaks). The problem of interpreting quantitative data on fatty streaks has been discussed by Guzmán *et al.* (2).

Raised atherosclerotic lesions (fibrous plaques, complicated lesions, and calcified lesions) are the clinically significant lesions of atherosclerosis. White men develop raised atherosclerotic lesions in the aorta earlier and more extensively than the other sex-race groups, a confirmation of findings in previous reports (6, 9). Except for the more extensive involvement of white men, however, race and sex differences in the advanced lesions of aortic atherosclerosis are not striking or consistent.

The findings in this report concerning coronary atherosclerosis are similar to studies reported previously (9, 14). White men are most extensively involved with RL followed by black men, black women, and white women in order of decreasing involvement. Thus, the most striking racial differences are: (1) more advanced coronary atherosclerosis in white men than in black men, and (2) more advanced coronary atherosclerosis in black women than in white women. The largest sex difference occurred in the white race: much more extensive coronary RL in white men than in white women. The sex difference in coronary lesions in the black race is small and inconsistent.

The results of black-white and male-female comparisons of advanced coronary artery lesions generally parallel results from comparisons of coronary heart disease incidence of mortality rates in the United States (1, 5, 7, 15). A major epidemiologic concern in these investigations has been to determine whether risk factor status accounts for the sex and race differences. The findings have usually led to the conclusion that females of both races and blacks of both sexes respond to similar levels of risk factors with lower rates of CHD than white men. The present data suggest that sex and race differences in clinically manifested disease are probably due to similar differences in advanced coronary artery lesions. We may interpret these parallel findings as indicating that the peculiarly high rates of CHD in white men are due to an unusual degree of susceptibility of the coronary arteries of white men to atherogenesis. Investigation, therefore, should also be directed to differences in the structure and physiology of the artery wall in addition to the current emphasis on the role of other risk factors such as serum lipoproteins, blood pressure, and cigarette smoking habits.

Future comparisons among these subgroups as well as comparisons of current and future data will be important in understanding relationships with clinical disease, especially in view of reported decreases in mortality from coronary heart disease in the United States. We plan to monitor the natural history of coronary and aortic atherosclerosis in New Orleans at least through the 1970s.

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