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A Survey of Chronic Disease and Diet in Seminole Indians in Oklahoma

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THE NAVAHO and Pima Indians have been reported to have a high incidence of diabetes and gallbladder disease and a low incidence of coronary artery disease, hypertension and malignancy.[1–9] Serum cholesterol values were lower in Navaho Indians than in white subjects but were not significantly lower in a group of Pima Indians.[2,10] Pima Indians were reported to ingest a diet slightly lower in fat content but otherwise similar to that consumed by the average white person; Navaho Indians were reported to ingest a "typically American diet."[2,10] Little else has been reported about the dietary habits and incidence of chronic disease of other Indian populations in this country.

Two concentrations of Seminole Indians remain in this country. About 900 Seminole Indians remain isolated on three reservations in Florida. Another 2,400 Seminole Indians are integrated with the white population of Seminole County, Oklahoma. Data on incidence and factors influencing the incidence of chronic, primarily cardiovascular, diseases were gathered on a sample of Seminole Indians and on a control sample of white subjects from Seminole County and compared with data provided on a similar sample of Seminole Indians surveyed in Florida.

METHODS

Of the 302 Seminole Indians surveyed from Seminole County, Oklahoma, about 150 were seen on visits to the Seminole County Health Department or one of its branch offices. Indians specifically attending the diabetes clinic were not included in an attempt to avoid bias of the sample. Another 100 subjects were seen on visits to the outpatient facilities of the Indian Hospital at Shawnee, Oklahoma. The remaining fifty were seen by the Public Health nurses in the schools and communities. All 422 white control subjects were seen in the Seminole

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County Health Department or one of its branch offices. Many of the white subjects visited the health department specifically to obtain the following tests after hearing of their availability. All subjects were fourteen years of age or older.

Age, height and weight were recorded first for each subject. Single blood pressure determinations were obtained by a public health nurse, and a blood specimen was drawn for determination of hemoglobin (Leitz photometric method), serum cholesterol[11] and postprandial blood sugar levels (modified Folin-Wu) and for performance of the serologic test for syphilis. Information concerning the presence of known diabetes also was obtained. All subjects with an elevated or borderline elevated postprandial blood sugar level were asked to return for a glucose tolerance test.

Data on 221 Seminole Indians living on reservations in Florida (Big Cypress, Dania and Brighton) were provided for comparison with our data.[12] Bartlett's test for homogeneity of variances was computed for each of the variables for the three groups. Correcting for differences in the ages of each group by analysis of covariants, the significance of differences in height, weight, systolic and diastolic blood pressures, hemoglobin and cholesterol levels were tested for the three groups.

Interviews about diet were completed on fifty-four Seminole Indian and sixty white subjects from Seminole County. A qualitative and quantitative analysis was made of food ingested during the day prior to the interview, estimating total caloric, protein, carbohydrate and fat intake.[13,14]

Death certificates on all Indian and white subjects over age twenty-five who died in Seminole County between 1950 and 1959 were examined. The numbers of deaths due to coronary artery disease (category 420), stroke (categories 330 to 334), hypertension with and without heart disease (categories 440 to 447), all cardiovascular disease (categories 330 to 334 and 400 to 468), diabetes (category 260), primary lung cancer (category 162) and all other causes were tabulated.[15] Due to the problems encountered because of mixed blood in separating Indians from white subjects in census reports and on death certificates, death rates could not be considered reliable. Therefore, the per cent of all death certificates filed for Indians and for white persons according to disease category is reported.

RESULTS

Considerable difference was found in the mean age of the Seminole Indians as compared to that of the control group of white subjects. The mean age for the Seminole Indians studied in Oklahoma was thirty-three and a half years, for the Seminole Indian in Florida 36.2 years and for the control group 44.2 years. In all three groups, there were more female than male subjects. Of the 302 Oklahoma Indians studied, 203 (67.2 per cent) claimed to be full-blooded Seminole Indians. The remainder claimed to be half Seminole Indian or more.

The mean height, weight, systolic and diastolic blood pressures, and hemoglobin and cholesterol levels in the age groups fourteen to twenty-nine, thirty to forty-nine, fifty to sixty-four and sixty-five and over are shown by sex and race in Figure 1. Data on the Seminole Indians in Florida are included except for cholesterol levels when differences in methods of determination prevented direct comparison.

The mean heights of male and female Oklahoma and Florida Seminole Indians were significantly less than that of their white counterparts ($p < 0.01$). The mean weights, when corrected for height, of both Indian groups also were significantly greater ($p < 0.01$) than those of the white subjects. Table 1 shows the incidence of overweight in the two groups of male and female Indians and male and female white subjects. The mean systolic and diastolic blood pressures were similar in the three groups ($p > 0.05$) except for a slightly lower diastolic pressure of borderline significance ($p < 0.05, > 0.01$) in the female Florida Indians. Actually thirty-three (10.9 per cent) of the 302 Seminole Indians in Oklahoma and twenty-one (9.5 per cent) of 221 Indians in Florida had blood pressures above 160 mm. systolic or 100 mm. diastolic. This compared with an incidence of hypertension of 12.3 per cent in the white subjects. Difference in age distribution in the groups studied could easily account for the difference in incidence of hypertension observed.

The mean hemoglobin levels in both Indian male populations were significantly higher ($p < 0.01$) than in the male white subjects. Since hemoglobin values for Seminole Indians in Florida were determined in a different

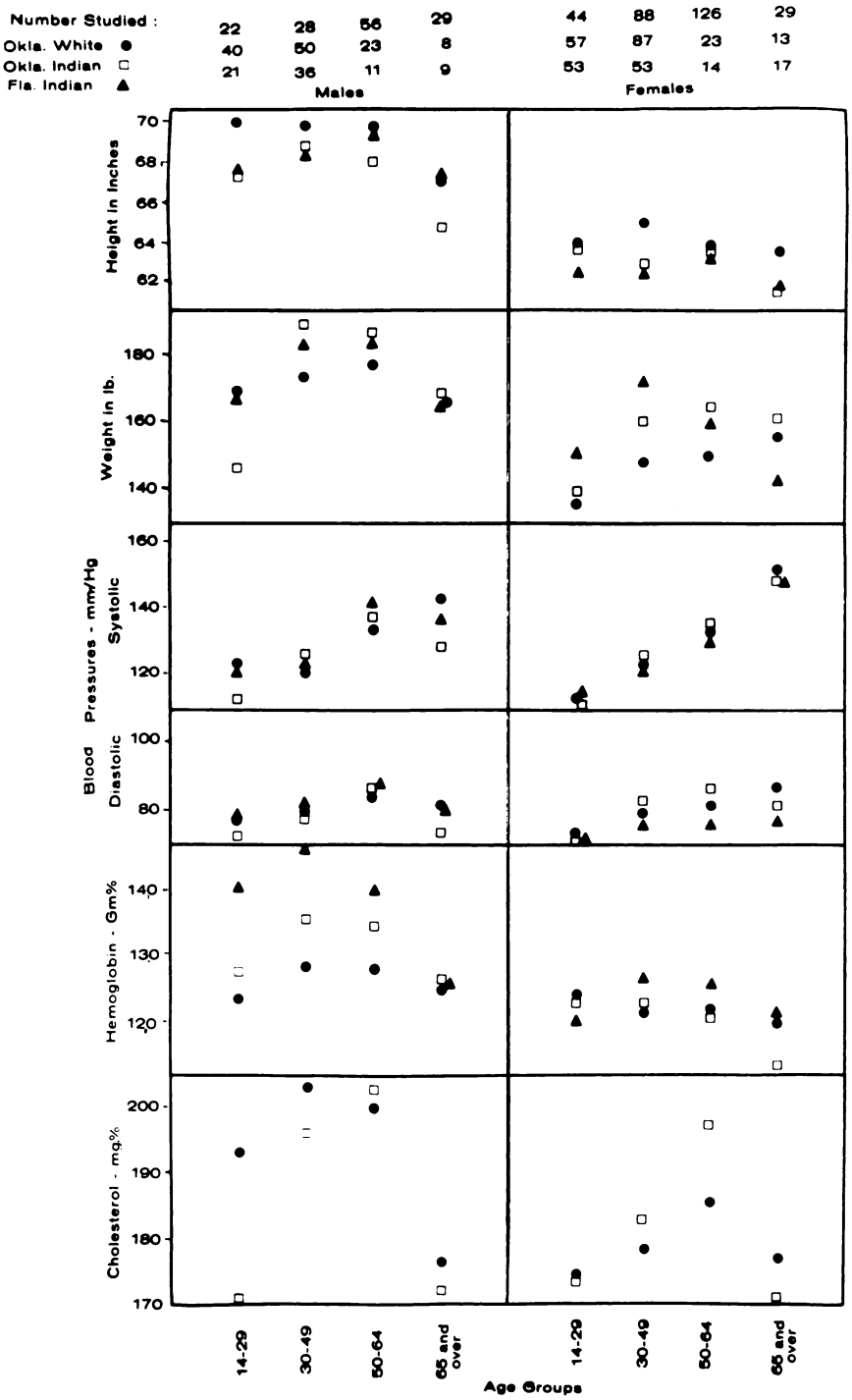

FIG. 1. Comparison of height, weight, systolic and diastolic blood pressures, and hemoglobin and cholesterol levels in Florida and Oklahoma Seminole Indian and Oklahoma white subjects in Seminole County. Data are shown for men and women by age groups.

TABLE I
Incidence of Overweight in Male and Female Seminole Indian and White Subjects*

Subjects	No. Studied	Per Cent of Subjects Overweight	
		25% or More	40% or More
Men			
Oklahoma Indian	121	23.1	8.3
Florida Indian	77	19.5	7.8
Oklahoma white	135	10.4	1.5
Women			
Oklahoma Indian	181	34.3	19.3
Florida Indian	137	39.4	25.5
Oklahoma white	287	16.4	9.8

* Based on height and age.

laboratory, the significance of higher levels in this group may be questioned. In the women, however, the hemoglobin levels were similar in the three groups.

There were no significant differences ($p > 0.05$) in serum cholesterol levels between male and female Oklahoma Seminole Indian and white subjects. The incidence of hypercholesterolemia (above 260 mg. per 100 ml.) was 9.1 and 5.4 per cent in the male and female Oklahoma Indians and 15.6 and 9.1 per cent in the male and female white subjects. Most of this difference in incidence is attributed to the older mean age of the white subjects studied. Although a different method of determining cholesterol levels was used in the Florida study, determination in a small number of samples was carried out by both the Oklahoma and Florida laboratories. The values ran about 10 per cent higher in the Florida laboratory. If this difference could be considered constant in all studies the cholesterol levels in the Seminole Indians in Florida would be similar to those obtained from the two groups in Oklahoma.

The subjects first were asked if they were known to have diabetes and the time interval since their last meal. A blood sugar level was determined in all persons. A blood sugar value of over 210 mg. per 100 ml. up to two hours postprandially or over 160 mg. per 100 ml. after two hours was considered elevated. Blood sugar values of between 180 and 210 mg. per 100 ml. up to two hours postprandially and between 130 and 160 mg. per 100 ml. after two hours were considered to be borderline elevations.

Glucose tolerance tests were carried out on thirty of 113 persons with borderline elevations in postprandial blood sugar levels. Nine of these showed curves consistent with a diagnosis of diabetes (blood sugar levels two hours postprandially greater than 130 mg. per 100 ml.), two showed borderline curves, and nineteen showed no evidence of diabetes. The results of the interviews and postprandial blood sugar determinations are shown in Figure 2. There were fourteen known diabetic Oklahoma Indians and nine known diabetic white subjects in the study. There were also thirteen Indians and ten white persons with definitely elevated blood sugar levels. In the Florida study there were ten known diabetic subjects. There were, in addition, fifteen subjects with a blood sugar value of 130 mg. per 100 ml. or higher two hours postprandially. Of these, glucose tolerance test results confirmed the presence of diabetes in three and excluded the diagnosis in five. The other seven persons were not retested.

Twenty-two Seminole Indians in Oklahoma had positive serologic test results for syphilis as did seven Indians in Florida. Only four of the white control subjects had positive reactions. No confirmatory Wassermann tests were drawn.

Table II shows the mean dietary intake for male and female Indian and white subjects for the day prior to the interview. The Indians had a slightly higher mean total caloric intake than the white subjects. This may be related to the younger mean age of the Indians studied. The per cent of the diet made up of carbohydrate, protein and fat was similar in the Indian and white subjects although the Indians may have ingested a slightly higher ratio of polyunsaturated to saturated fats. The Indians consumed more fat pork and lard. The

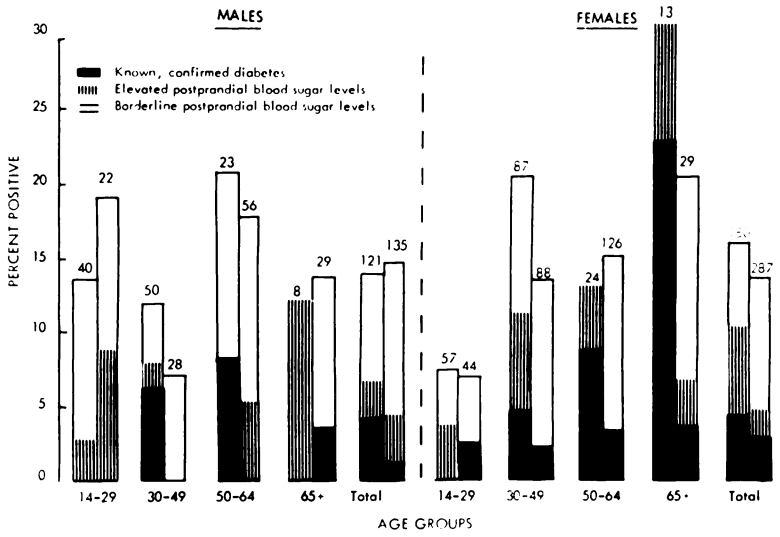

FIG. 2. Incidence of previously known diabetes and elevated and borderline elevated postprandial blood sugar levels in Seminole Indian and white subjects in Seminole County, Oklahoma. Data are shown for men and women by age groups. The bar on the left is for the Seminole Indians and the bar on the right for the white subjects. The value at the top of each bar represents the number of persons studied in that group.

white subjects commonly used milk as a beverage, whereas the Indians rarely did. Use of other meats such as lean pork, beef, chicken and fish was about equal in the two groups. Use of eggs, potatoes, vegetables, legumes, breads and desserts also was similar in the two groups.

Death certificates were filed for 266 Indians who died in Seminole County between 1950 and 1959. The mean age at death of this group was 48.9 years as compared to a mean age at death of 64.8 years for all white persons who died in the state. Much of the shortened life expectancy in the Seminole Indian in Oklahoma was due to the large number of death certificates (19.2 per cent) filed for persons

TABLE II
Comparison of the Daily Food Intake of Indian and White Men and Women

Data	Indian Men		White Men		Indian Women		White Women	
No. of studies	20		17		34		43	
Mean age (yr.)	41		57		39		57	
Diet								
Total calories	2,484		1,861		1,864		1,690	
Carbohydrate (gm.)*	256	(41)	197	(42)	205	(44)	180	(43)
Protein (gm.)*	86	(14)	71	(15)	59	(12)	58	(14)
Fat (gm.)*	124	(45)	88	(42)	90	(44)	82	(44)
Fatty acids								
Total saturated (gm.)*	44	(16)	34	(17)	32	(16)	34	(18)
Unsaturated (gm.)*	58	(20.5)	39	(18.5)	45	(21)	37	(19.5)
Oleic (gm.)*	48	(17)	34	(16)	38	(18)	32	(17)
Linoleic (gm.)*	10	(3.5)	5	(2.5)	7	(3)	5	(2.5)
P:S ratio†	0.23:1		0.15:1		0.28:1		0.14:1	

* Numbers in parentheses = per cent; numbers outside parentheses = mean.
† Polyunsaturated:saturated fat ratio.

TABLE III
Deaths Among Indian and White Subjects Aged Twenty-Five and Over in Seminole County, Oklahoma*

Data	Indian Men		White Men		Indian Women		White Women	
Population†	1,159		11,246		1,184		11,725	
Mean age at death (yr.)	63.1		67.6		64.1		70.4	
Total deaths	116	(100.0)	1,361	(100.0)	90	(100.0)	799	(100.0)
Disease category								
Coronary artery disease	18	(15.5)	422	(31.0)	10	(11.1)	165	(20.7)
Stroke	16	(13.8)	175	(12.9)	7	(7.8)	124	(15.5)
Hypertension	11	(9.5)	69	(5.0)	2	(2.2)	76	(9.5)
Total cardiovascular disease	52	(44.8)	730	(53.6)	28	(31.1)	392	(49.1)
Diabetes	5	(4.3)	22	(1.6)	3	(3.3)	22	(2.8)
Lung cancer	1	(0.9)	39	(2.9)	0	(0)	12	(1.5)

NOTE: Figures outside parentheses = number; figures inside parentheses = per cent.
* Based on death certificates filed between 1950 and 1959.
† Based on the 1960 census reports.

who died during the first five years of life. In order to minimize the effect of this excessive early mortality on the chronic disease statistics, only those death certificates filed on persons age twenty-five years and older were examined. Even so, there still was a younger mean age at death in the Indian (Table III). Table III lists the per cent of all deaths by sex attributed to arteriosclerotic heart or coronary artery disease, stroke, hypertension, all cardiovascular disease, diabetes and lung cancer in the Oklahoma Indian and white subjects over the age of twenty-five occurring in Seminole County between 1950 and 1959.

COMMENTS

Differences in the incidence of certain chronic diseases between Indian and white populations have been described previously.[1-9] The influence of environment is often difficult to separate from racial or hereditary factors. In this study, the relatively isolated, inbred Seminole Indians in Florida and the integrated Seminole Indians in Seminole County, Oklahoma were compared with their white counterpart in Seminole County. Hopefully, some cultural, educational and economic differences might exist in these racially related Seminole Indians showing the effects on the two populations. Differences in methods used in performing the hemoglobin and cholesterol determinations in the two laboratories makes interpretation of these data difficult; however, other comparisons particularly of body build and blood pressure should be valid.

The mean ages of the two Indian groups were significantly less than those of the white group in Oklahoma, making necessary correction for age differences between the three groups. Subjects in the older age groups would be expected to have a higher incidence of hypertension and diabetes and probably obesity and elevated cholesterol levels.

The high incidence of obesity seen in our Indian populations was similar to that reported in other Indian populations. The striking lack of hypertension seen in the Navaho Indians was not seen in either group of Seminole Indians.[8] The hemoglobin levels in the male Seminole Indians were significantly higher than those in the male white subjects. This difference was not apparent in the female subjects. The serum cholesterol levels in both male and female Seminole Indians in Oklahoma were similar to those seen in their white counterparts. This is in contrast to the lower levels reportedly seen in the Navaho Indians.[2] The incidence of diabetes appears to be higher in both Seminole Indian groups than in the white group and is consistent with reports of others that there is a higher incidence of diabetes in Indian populations.[1,5,7]

Four factors then have been evaluated which presumably influence the incidence of coronary artery disease: Obesity and diabetes were more common in the Seminole Indians although

blood cholesterol levels and blood pressure determinations were similar in Indian and white subjects. The diet of the Seminole Indians in Oklahoma was similar to that of their white counterparts. The incidence of coronary artery disease in the Seminole Indians in Oklahoma still was less than that observed in the white subjects even after differences in life expectancy were taken into consideration. Deaths from stroke and hypertension, on the other hand, were higher in the male Seminole Indian than in the male white subject. However, the size of the sample may be too small from which to draw conclusions. The incidence of deaths attributed to coronary artery disease, stroke, hypertension and other cardiovascular diseases is much higher and in striking contrast with the low death rates for the same diseases seen in the Navaho and Pima Indians. Whether racial or hereditary characteristics or environment are responsible for these differences remains to be determined.

The wide variations in death rates existing between the Indians of other counties or tribes in Oklahoma for coronary artery disease and other cardiovascular disease are shown in Table IV, tabulating death certificates filed in these counties for male Indians twenty-five years of age and older. The highest death rates for coronary artery disease were seen in Miami, Kay and Osage counties. These counties all have Indian populations which have integrated extensively with the white populations and have accepted many of their educational standards and cultural influences. Although the Cherokee Indians (Adair, Cherokee and Muskogee counties) have the lowest death rates from coronary artery disease, they have the highest death rates from stroke and hypertension.

The Seminole Indians were found to have a

TABLE IV

Percentage of Male Indian Deaths* From Various Categories of Cardiovascular Disease in Some Counties in Oklahoma with Large Indian Populations

County	Male Indian Population†	Principal Tribes	Male Death Certificate Filed (no.)	Per cent of Total Deaths Attributed to			
				Coronary Artery Disease	Stroke	Hypertension	All Cardiovascular Disease
Adair	1,555	Cherokee	186	15.6	8.6	7.5	41.4
Blaine	451	Cheyenne, Arapaho	43	23.3	9.3	0.0	37.2
Caddo	1,520	Caddo, Wichita, Comanche, Kiowa, Apache	105	15.2	9.5	3.8	44.8
Cherokee	1,529	Cherokee	132	12.1	10.6	9.1	45.5
Comanche	1,272	Comanche, Kiowa, Apache	57	17.5	14.0	1.8	45.6
Delaware	1,067	Cherokee, Delaware, Senecas	83	23.0	14.5	7.2	50.6
Hughes	668	Creeks	47	25.5	4.3	6.4	38.3
Kay	830	Ponca, Oto-Missouri, Kaw, Tonkawa	52	32.7	1.9	1.9	40.4
						1.3	36.8
McCurtain	1,015	Choctaw	76	13.1	11.8	1.3	36.8
Muskogee	890	Cherokee	62	12.9	16.1	8.1	45.2
Osage	835	Osage	114	26.3	5.3	1.8	39.5
Ottawa	558	Quapaws, many northeastern small U. S. tribes	36	33.3	11.1	5.6	61.1
Pottawatomie	839	Shawnee, Pottawatomie, Kickapoo	67	22.4	3.0	3.0	43.3

* Based on death certificates filed between 1950 and 1959.
† Based on 1960 census.

lower death rate from primary lung cancer than their white counterparts in Oklahoma. This same low incidence of lung cancer was also seen in other Indian populations in Oklahoma. Of 1,060 death certificates filed for male Indians in the thirteen counties listed in Table IV, only ten cases of lung cancer (0.9 per cent) were reported. This is consistent with the findings reported in other Indian tribes in this country.[5,9]

Several problems present themselves in evaluating death certificate data. The possibility exists that in some Indians the popular diagnoses of coronary artery disease or stroke were recorded as the cause of death when death was actually due to something else. Clinically, one is impressed, however, that the occurrence of cardiovascular diseases is much more frequent in the Seminole Indians than in the Navaho and Pima Indians.

Another problem in evaluating these death certificate data is determining who represents an Indian. This is left up to the attending physician, as there is no standard definition as to how much Indian blood must be present. A person who has part Indian and part white blood can be listed as either on the death certificate.

SUMMARY

Body build, blood pressure determinations, hemoglobin and cholesterol levels, the incidence of diabetes, dietary habits and causes of death are compared in Seminole Indians and white subjects in Seminole County, Oklahoma. Similar data were made available for comparison on Florida Seminole Indians.

Indians were shorter and heavier than white subjects. Mean blood pressure determinations, serum cholesterol levels and dietary habits were similar in Indian and white subjects. More diabetes was found in the Indian populations. Coronary artery disease as a cause of death was less frequent in the Indian than in the white subject in Oklahoma but much more frequent than that reported for Navaho and Pima Indians. Hypertension, stroke and diabetes ranked relatively high and lung cancer low as causes of death in the Oklahoma Indian.

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