Diabetes Mellitus Among the Florida Seminoles

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IN some Indian tribes, the frequency of diabetes mellitus greatly exceeds that of the U.S. white or black population (*1–3*). Other tribes have been found to have a prevalence comparable to that of more recent U.S. settlers (*4*). Still others have a relatively low prevalence (*5*). Within these groups, variations in frequency may occur between those with full Indian blood and those with mixed blood (*6*). These observations have tended to reinforce the concept of a hereditary basis for diabetes.

The Seminoles of Florida are descendants of members of the Oconee tribe who joined the Creek Confederacy and migrated to Florida in the 1700's. These people were later joined by a number of other groups with different languages and, following the Creek-American War of 1813–14, their numbers were tripled by the addition of refugees from many tribes. Runaway slaves were welcomed by the Seminoles and contributed to the amalgam that gave rise to the Seminole "tribe." Two language groups emerged, the numerically dominant Muskogee-speaking people (Cow Creek Seminoles) and the Hitchiti-speaking people who supplied the leadership (Mikasuki Seminoles). During the Seminole wars (1830–58), a band of predominantly Mikasuki Seminoles escaped into the swamps of south Florida to avoid forced settlement in Oklahoma (*7*). From approximately 150 persons, the Florida tribe has increased to a current census of 1,300 to 1,400; there has been considerable inbreeding (*8*).

Subjects of Study

Most Seminoles in Florida live on the three reservations in the southern part of the State; the rest live in small groups along the Tamiami Trail or in towns (*7*). Big Cypress Reservation, a marshy area just north of the Everglades, was the site of our study, which was done in August 1969.

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Mrs. Claudia Wilson, a registered nurse, Hendry County Health Department, Clewiston, Fla., was responsible for notification and scheduling. Dr. Alfredo F. Mendez of Miami, an Indian Health Service physician, provided guidance and advice. Edith Rosenbloom, research assistant, and Dr. Jose Buhain, pediatric resident, helped obtain and process specimens. Mary Law, Bureau of Indian Affairs, Hollywood, Fla., provided mortality data.

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Movement in and out of the area is brisk so that the size of the total population is difficult to specify.

The diet of the study population is similar to that of the surrounding non-Indian people except for a somewhat higher carbohydrate content and excessive consumption of soft drinks. Many of the Indians use foods from the surplus commodity program, including flour, rice, instant mashed potatoes, corn syrup, powdered milk, evaporated milk, grapefruit juice, raisins, cheddar cheese, powdered eggs, peanut butter, lard, and canned foods such as corn, beans, chopped meat, and salt pork. There is also a small store on the reservation where many of the usual supermarket items may be purchased.

We tested the glucose tolerance of 118 persons aged 2 to 98 years, who represented approximately 54 percent of the total population. The age and sex distribution of the 118 is shown in table 1.

Methods

Plasma glucose was analyzed by the ferricyanide method with the AutoAnalyzer. Specimens were obtained before, and 2 hours after, ingestion of an oral carbohydrate (Glucola, supplied by the Ames Company, Elkhart, Ind., Division of Miles Laboratories, Inc.—1.75 gm. per kilogram of body weight up to a 75 gm. maximum). All subjects were tested in the morning after an overnight fast. Abnormality was interpreted according to the criteria recommended by the American Diabetes Association (*9*), that is, 130 mg. of glucose per 100 ml. of plasma after fasting and 140 mg. per 100 ml. 2 hours after glucose ingestion. The data were analyzed by age groups and by sex for variance as the test of significance.

A listing of the name, age, sex, date of death and the probable cause (as noted on the death certificate) of Florida Seminoles who died during the 10-year period 1958–67 was furnished by the tribal office. Medical records of patients residing on Big Cypress who were known to have diabetes mellitus were reviewed at the Indian Health Service clinic.

An estimate of obesity for each of our subjects was obtained in two ways: (*a*) by calculating an obesity index (*10*)—namely, the person's weight in pounds divided by the square of his height in inches multiplied by 100 and (*b*) by expressing the person's weight as a percentage of his ideal weight, based on data from the Metropolitan Life Insurance Company.

Results

Plasma glucose values after fasting and 2 hours after ingestion of the carbohydrate are shown in the figure for 114 of the 118 subjects we studied; the values for four subjects with known diabetes are excluded. The only abnormal fasting levels were in these four persons with known

Table 1. Age and sex distribution of 118 persons tested

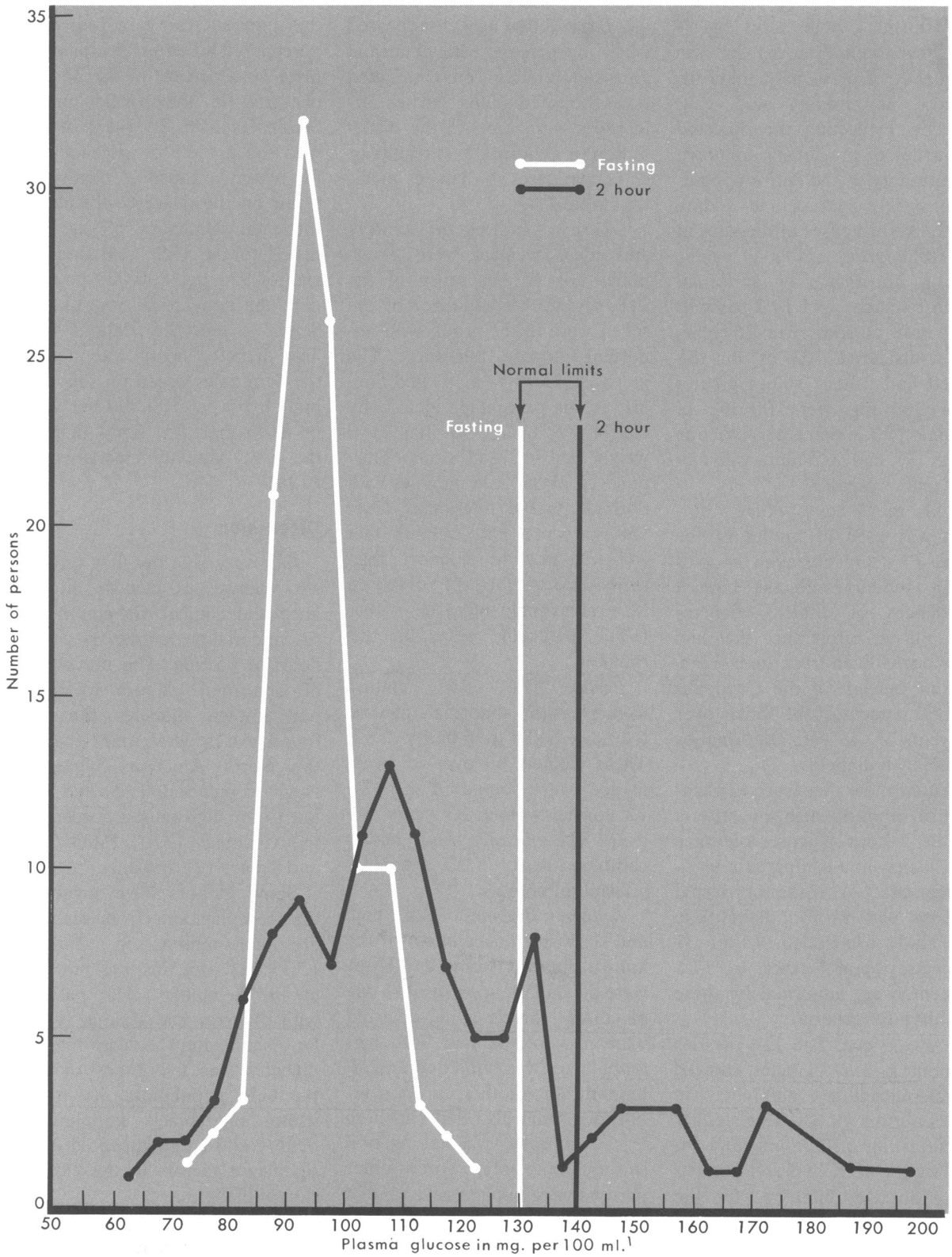
Age group (years)	Males	Females	Cumulative percent
2–9	22	19	34.8
10–19	7	18	56.0
20–39	5	14	72.1
40–59	7	13	89.0
60–79	7	4	98.3
80–98	1	1	100.0
Total	49	69	.....

Table 2. Sex and age of 15 persons with abnormal glucose tolerance tests and no known diabetes mellitus and of 12 persons with previously diagnosed diabetes mellitus

Age group (years)	Males		Females	
	Number	Percent[1]	Number	Percent[1]
Abnormal GTT but no known diabetes:				
2–19	0	....	1	2.7
20–39	0	....	1	7.1
40–59	1	17.7	4	40.0
60–98	5	62.5	3	60.0
Total	6	12.5	9	13.4
Previously diagnosed diabetes:[2]				
2–19	0	....	0	....
20–39	1	....	0	....
40–59	3	....	4	....
60–98	2	....	2	....
Total	6	....	6	....

[1] Percent of total tested in sex and age group.
[2] Among entire population of Big Cypress. Percentages cannot be calculated because age and sex distribution of entire Big Cypress population is unknown.

Distribution of plasma glucose values after fasting and 2 hours after glucose loading



[1] Groupings are by 5 mg. increments.

diabetes. Fifteen subjects, again excluding the four with diabetes, had values of 140 mg. or greater per 100 ml. 2 hours after ingesting the carbohydrate so that the frequency of previously unknown glucose abnormality was 13.2 percent. Projecting the detected frequency of previously unknown abnormality to the entire population of Big Cypress and adding the 12 known cases of diabetes in the whole group (table 2) generates a prevalence of abnormal glucose tolerance of 19.7 percent.

If only persons over 35 years are considered, 10 of the 33 tested had 2-hour values greater than 160 mg. per 100 ml. of plasma (30.3 percent). No one under 35 had a 2-hour value of 160 mg. or greater.

This more conservative criterion was used in studies of the Pima (*1*) and Cocopah peoples (*11*), Indians with the highest incidences of clinical diabetes and glucose intolerance that had previously been recorded. Thirty-four percent of the Cocopahs and 50 percent of the Pimas over 35 years of age were abnormal or had known diabetes.

Among the Senecas, application of similarly stringent criteria to the 1-hour glucose tolerance test has given a comparable prevalence rate (*2*). If the four tested persons with known diabetes in our study are added, 14 of 37 subjects over 35 years, or 37.8 percent, were abnormal by these conservative criteria.

Sex and age. The 114 persons without known diabetes showed no significant sex differences in mean plasma glucose levels either after fasting or 2 hours after ingesting the carbohydrate; nor was there an age difference for the glucose values after fasting. The glucose levels 2 hours after ingestion of the carbohydrate were, however, significantly higher for the oldest age groups (40 years and over) than for those under 40. These differences disappeared when the persons with abnormal glucose tolerance were eliminated from the calculations. No sex differences were seen in the distribution of abnormal test results or of known cases of diabetes mellitus (table 2).

Obesity. Indices of obesity and ideal weights were determined for all but seven of the 118 persons tested; three of the seven were in the group with abnormal glucose tolerance. The index of obesity was related linearly to the percentage ideal body weight for height so that ideal weight can be used alone. Thirty-seven of the 95 Seminoles with normal glucose tolerance values (39 percent) had weights that were 20 percent or more than their ideal weights; 11 of the 15 with abnormal tolerance values (73.3 percent) were in this range.

Parity. The 11 mature women with abnormal glucose tolerance had a total parity of 54. These women, all over 36 years of age, were compared with the 12 normal women 35 years and over. The normal group had a combined parity of 50, not a significant difference.

Known diabetes. Six men and six women accounted for the known diabetes (table 2). Three were dependent upon insulin; one of these three, a 52-year-old woman who had had both legs amputated, was blind and had albuminuria. Another, a 75-year-old man, who also had had both legs amputated, was taking oral sulfonylurea only. Three other persons were hypertensive, one of whom had diabetes and was dependent upon insulin.

Review of mortality data. Of 83 deaths reported among the Seminoles in Florida from 1958 to 1968, diabetes was given as the apparent cause in four (4.8 percent). These four deaths comprise 10.5 percent of the 38 that occurred in the period among Seminoles over 20 years of age who did not die of violence and for whom a cause of death was given on the death certificate. If the total deaths of 83 are adjusted to the U.S. annual death rate of 951 per 100,000 population, the population base for the Seminole mortality data is 870. The diabetes death rate among the Seminoles based on this estimate is 95 per 100,000 per year, or more than five times that for the U.S. population as a whole (*12*).

Discussion

Our survey is the first systematic analysis of glucose intolerance and clinical diabetes mellitus undertaken among the Seminoles of Florida. The prevalence of abnormal glucose tolerance and known diabetes that we found was several times that of the North American white or Negro populations (*12*) and similar to the high rates recorded for the Cocopah (*11*), Pima (*1*), and Seneca (*2*) Indians.

Some authors have suggested that complications from diabetes are uncommon in Indians (*5,11,13*), but this was not true of the Seminoles. The patients with diabetes had serious vascular disease, and the death rate for diabetes was five times that of the U.S. population. As in the white and black populations, obesity and aging appeared to be significant factors in the expression of diabetes.

An exceptionally high frequency of hyperglycemia and clinical diabetes in the survivors

of Indian nations might provide clues to the natural selection of the diabetic genotype. Neel (*14*) has suggested that the diabetic genotype—associated with unusually efficient lipogenesis—was ideally suited to the feast or famine existence of a hunting and gathering society. Insulin serves as a storage hormone, catalyzing the assimilation of ingested food into fat stores. A person with greater than normal insulin responses might have been able to store more fat for starvation periods. This capability would confer a selective advantage during periods of want. With the advent of plenty, insulin hyper-responsiveness would be inappropriate and could lead to obesity, peripheral insulin resistance, and in some instances, to pancreatic exhaustion. The early stages of diabetes are associated with hyper-insulinemia, and obesity is common.

The "thrifty" genotype of diabetes would have served well the hapless American Indian banished to lands barren of game and vegetation. The remnants of the Seminoles have survived only after great privation in the wilds of Florida. Now well-fed and in many cases obese, the Seminoles may be disadvantaged by a genotype that once aided survival.

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WESTFALL, DAVID N. (University of Florida College of Medicine), and ROSENBLOOM, ARLAN L.: *Diabetes mellitus among the Florida Seminoles. HSMHA Health Reports, Vol. 86, November 1971, pp. 1037–1041.*

Two-hour oral glucose tolerance tests were performed on 54 percent of the Florida Seminoles over 2 years of age who resided on a single reservation; data from clinic records and from death certificates were also analyzed. A frequency of previously unknown glucose intolerance of 13.2 percent was found among those tested. Known diabetes mellitus was present in 6.5 percent of the population on the reservation. Applying conservative criteria (160 mg. glucose per 100 ml. plasma 2 hours after glucose ingestion), 37.8 percent of those over 35 years were found to be abnormal. This prevalence resembles that reported among the Pima, Cocopah, and Seneca Indians.

Abnormality was not related to sex or parity. Obesity, however, was nearly twice as frequent in those with abnormal glucose tolerance as in those with normal (73.3 percent compared with 39). Clinical diabetes was severe in most of the 12 known cases, as indicated by dependence on insulin and vascular complications. The estimated diabetes death rate was five times that for the U.S. population as a whole.

The reasons for the high prevalence of diabetes mellitus among American Indian populations are not known.