# Diabetes in the Cocopah Indians

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SUMMARY

One hundred and eighty-two Cocopah Indians, aged five years and over and representing 81 per cent of the study population, were given a 75 gm. glucose equivalent load and determinations were made two hours later of plasma glucose levels. Seventeen per cent of the population at the time were either receiving hypoglycemic therapy or had plasma glucose levels of at least 160 mg. per 100 ml., which was considered indicative of "diabetes." In those aged thirty-five years and over, the prevalence was 34 per cent, similar to that reported in the Cherokee but lower than that in the Pima Indians.

The frequency of obesity in those aged fifteen and over was higher in the Cocopah than in the Pima Indians but, as the prevalence of "diabetes" was lower in the Cocopah, the frequency of obesity did not appear to account for the difference in the prevalences of diabetes between these tribes. DIABETES *18*:33-37, January, 1969.

Studies of the prevalence of diabetes in American Indians in the past have yielded conflicting results. Joslin stated that diabetes mellitus was as frequent in American Indians of the Southwest as in other inhabitants of this region.[1] From his inquiries of Indian hospital personnel and physicians in Arizona he found that the ratio of diabetic to nondiabetic subjects among the Indians was not unlike that found among the other inhabitants of the state. Cohen[2] found that the admission rate for Indians with diabetes to the Indian hospital facilities in Arizona, Utah, and Nevada was 1.5 per cent and, when grouped according to tribe, the rate was highest among the Pima (3.2 per cent) and the Yuma (3.1 per cent) and least among the Apache (0.3 per cent). In 1961, the prevalence of known diabetes in the Pima Indian was reported by Parks and Waskow to be 4.1 per cent based on Bureau of Indian Affairs clinic records.[3] These findings suggested that differences in the prevalence of diabetes might exist among the Indian tribes of the Southwest.

Recently, the use of more precise diagnostic tests has revealed that the prevalence of "diabetes," as shown by the hyperglycemia, in Indians was much higher than previous estimates. In 1965, Miller, Burch, Bennett and Steinberg[4] reported that 49 per cent of the Pima Indians, aged thirty and over residing on the Gila River Indian Reservation, had *plasma* glucose levels over 160 mg. per 100 ml. two hours after a 75 gm. glucose equivalent load. In the same year, Stein et al.[5] reported that the prevalence of "diabetes" in the Cherokee Indians of North Carolina, aged thirty-five and over, was 29 per cent. In the latter study a two-hour *blood* glucose level of 150 mg. per 100 ml. or greater after a 1 gm. per kilogram oral glucose load was judged indicative of diabetes. The question arises whether the extraordinarily high prevalence of "diabetes" in the Pima and Cherokee is peculiar to these tribes, or whether it is also high in other Indian groups which have not been studied as intensively.

The Cocopah Indians are a small group of Yuma Indians living in a desert environment in the extreme southwestern tip of Arizona on the Mexican border. They were formerly natives of Mexico, having extensive homelands in the delta region of the Colorado River, but with the Gadsden Purchase of 1853 a small part of their territory came under United States control. Eighty-four Cocopah were registered with the Bureau of Indian Affairs,[6] but a census taken in 1965 revealed nearly 300 Indians living on the East and West reservations, lots 5 and 6 of the Bureau of Reclamation and in the town of Somerton.

The economic status of these people is quite poor, the men being employed as farm laborers on the irrigated land in Yuma County as well as being subsistence farmers and raising small amounts of cotton. As little

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was known about the health status and needs of these people, the Division of Indian Health with the cooperation of the State and County Health Departments, planned a four-day survey to up-date the census, take chest X rays and serological tests for syphilis, and to perform routine immunizations. The Clinical Field Studies Unit of the National Institute of Arthritis and Metabolic Diseases was invited to perform glucose tolerance tests, the results of which are presented.

## METHOD

The tribe, quantum of Indian blood and pedigree of each Indian was determined by interview. One hundred and eighty-two Indians aged five and over who were at least one-quarter Cocopah and who lived in the study area were examined. They had no reported Pima ancestry, and they represented 81 per cent of the Cocopah population aged five and more. They were given a 75 gm. equivalent glucose load[7]* irrespective of the time of the last meal. Two hours later a sample of blood was collected in a tube containing sodium fluoride and plasma glucose levels were determined on the Auto-Analyzer by the modified Hoffman Method.[8] Plasma glucose levels of 160 mg. per 100 ml. or greater at two hours were judged indicative of "diabetes." Height and weight were measured and per cent desirable weight was calculated.[9] The data were compared to those from similar studies among the Pima, an unrelated tribe living in a similar environment in south central Arizona.[4,10]

*Obtained from Ames Co., Elkhart, Ind. (Glucola) and Custom Lab, Baltimore, Md. (Dexcola).

## RESULTS

Tables 1 and 2 show the distribution by age and sex of the two-hour plasma glucose results and the prevalence of known diabetes. Ten of the Indians examined were known to have diabetes prior to the survey, and twenty-one new cases were found bringing the total to thirty-one.* Seventeen per cent were thus considered to have "diabetes." The prevalences were 20 per cent in the females and 13 per cent in the males, but the difference was not significant ($p = 0.2$).

*One male, aged fifty-two, had a two-hour plasma glucose level of 127 mg./100 ml. while taking oral hypoglycemic therapy. The remaining nine known diabetic patients all had two-hour plasma glucose levels in excess of 160 mg./100 ml.

TABLE 1

Two-hour plasma glucose levels (mg. per 100 ml.) in Cocopah Indians by age and sex

| Plasma glucose level | Males | | | | | | | | Females | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5-14 | 15-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | Total | 5-14 | 15-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | Total |
| 50- | | | | 1 | | | | 1 | | | | | | | | |
| 60- | 3 | 1 | | 1 | | | 1 | 6 | 1 | 1 | 1 | | 1 | | | 4 |
| 70- | 4 | 2 | 1 | 1 | 1 | | | 9 | 3 | 2 | 1 | | 1 | | | 7 |
| 80- | 6 | 4 | | | 2 | 1 | | 13 | 5 | 4 | 2 | 1 | 1 | | 1 | 14 |
| 90- | 7 | 1 | | 1 | | | | 9 | 11 | 1 | | 1 | 1 | | | 14 |
| 100- | 1 | 2 | | 1 | 4 | 1 | | 9 | 6 | 3 | 2 | 2 | | | | 13 |
| 110- | 3 | 1 | | | | 1 | 2 | 7 | 3 | 1 | 3 | 1 | 1 | 1 | 1 | 11 |
| 120- | 1 | | | | 1 | 1 | 3 | 6 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 9 |
| 130- | 1 | 1 | 1 | 1 | 2 | | | 6 | | 1 | | 1 | | 3 | 2 | 7 |
| 140- | | | | | | | | | 1 | 1 | | 1 | | | | 3 |
| 150- | 1 | | | | | | | 1 | | 1 | | | 1 | | | 2 |
| 160- | | | | | | | | | | | | | | | 1 | 1 |
| 170- | | | | | | | | | 1 | | | 1 | 1 | 1 | | 4 |
| 180- | | | | | | | 2 | 2 | | | | 1 | 1 | | | 2 |
| 190- | | | | | | | | | | | | | | | | |
| 200- | | | | | 1 | | | 1 | | 1 | | 1 | 1 | | | 3 |
| 250- | | | | | 1 | | | 1 | | | | | | | | |
| 300- | | | | | | | | | | | | 1 | | | | 1 |
| 350- | | | | | | | | | | | | | | | | |
| 400- | | | | | | | | | | | | | | | | |
| 450- | | | | | | 2 | | 2 | | | | 1 | | 1 | | 2 |
| 500+ | | | | | | | | | | | 1* | 1† | | | | 2 |
| Known diabetic | | 1 | | 2 | 1 | | | 4 | | | | 2 | 1 | 1 | 2 | 6 |
| Total | 27 | 13 | 2 | 8 | 13 | 6 | 8 | 77 | 32 | 17 | 12 | 17 | 11 | 8 | 8 | 105 |

*700 mg. per 100 ml.
†624 mg. per 100 ml.

TABLE 2

Age and sex specific prevalence of "diabetes" in Cocopah Indians

| Age | Male No. exam. | Male New* and known diabetics No. | Male Per cent | Female No. exam. | Female New* and known diabetics No. | Female Per cent |
|---|---|---|---|---|---|---|
| 5-14 | 27 | 0 | 0.0 | 32 | 1 | 3.1 |
| 15-24 | 13 | 1 | 7.7 | 17 | 1 | 5.9 |
| 25-34 | 2 | 0 | 0.0 | 12 | 1 | 8.3 |
| 35-44 | 8 | 2 | 25.0 | 17 | 8 | 47.1 |
| 45-54 | 13 | 3 | 23.1 | 11 | 4 | 36.4 |
| 55-64 | 6 | 2 | 33.3 | 8 | 3 | 37.5 |
| 65+ | 8 | 2 | 25.0 | 8 | 3 | 37.5 |
| Total | 77 | 10 | 13.0 | 105 | 21 | 20.0 |
| 15-34 | 15 | 1 | 6.7 | 29 | 2 | 6.9 |
| 35+ | 35 | 9 | 25.7 | 44 | 18 | 40.9 |

*Plasma glucose ≧ 160 mg. per 100 ml. at two hours.

The prevalence of "diabetes" increased with age in both sexes, and in those aged thirty-five and over the prevalence was 34 per cent.

TABLE 3

Mean plasma glucose levels (mg. per 100 ml.) in Cocopah Indians by age and sex*

| Age (yrs.) | 5-14 | 15-34 | 35-54 | 55+ | Total |
|---|---|---|---|---|---|
| Males | | | | | |
| No. exam. | 27 | 14 | 18 | 14 | 73 |
| Mean | 94.0 | 93.9 | 115.8 | 170.9 | 114.1 |
| Standard Error of Mean | 4.1 | 5.3 | 12.9 | 33.2 | 8.2 |
| Females | | | | | |
| No. exam. | 32 | 29 | 25 | 13 | 99 |
| Mean | 98.8 | 126.2 | 172.0 | 157.7 | 133.0 |
| Standard Error of Mean | 3.6 | 21.1 | 25.2 | 26.9 | 13.4 |

*Excluding individuals receiving hypoglycemic therapy.

The mean plasma glucose values for each age group were compared and were found to rise with age in both sexes* (table 3). The mean glucose value for all the females was higher than for the males but the difference was not significant ($p > 0.1$).

The frequency of "diabetes" was examined in relation to the degree of obesity in each sex and each age group as shown in table 4. Those who weighed 126-150 per cent of their desirable weight were called moderately obese and those who weighed more than 150 per cent were called grossly obese. Of the 104 subjects whose weights were obtained 29 per cent were moderately obese and 37 per cent were grossly obese. In none of these groups was a significant association of "diabetes" with obesity found.

*Plasma glucose values of individuals receiving hypoglycemic therapy excluded.

TABLE 4

"Diabetes" and obesity in Cocopah Indians

| Males | Age (yrs.) | Per cent desirable weight ≦ 125 No. exam. | Diabetic No. | Diabetic Per cent | 126-150 No. exam. | Diabetic No. | Diabetic Per cent | ≧ 151 No. exam. | Diabetic No. | Diabetic Per cent | Total No. exam. | Diabetic No. | Diabetic Per cent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15-34 | 8 | 0 | 0.0 | 2 | 0 | 0.0 | 2 | 0 | 0.0 | 12 | 0 | 0.0 |
| | 35+ | 14 | 4 | 28.6 | 13 | 3 | 23.1 | 4 | 1 | 25.0 | 31 | 8 | 25.8 |
| | Total | 22 | 4 | 18.2 | 15 | 3 | 20.0 | 6 | 1 | 16.7 | 43 | 8 | 18.6 |
| Females | | | | | | | | | | | | | |
| | 15-34 | 7 | 0 | 0.0 | 6 | 0 | 0.0 | 11 | 1 | 9.1 | 24 | 1 | 4.2 |
| | 35+ | 7 | 3 | 42.9 | 9 | 6 | 66.7 | 21 | 7 | 33.1 | 37 | 16 | 43.2 |
| | Total | 14 | 3 | 21.4 | 15 | 6 | 40.0 | 32 | 8 | 25.0 | 61 | 17 | 27.9 |
| Total | | | | | | | | | | | | | |
| | 15-34 | 15 | 0 | 0.0 | 8 | 0 | 0.0 | 13 | 1 | 7.7 | 36 | 1 | 2.8 |
| | 35+ | 21 | 7 | 33.3 | 22 | 9 | 40.9 | 25 | 8 | 32.0 | 68 | 24 | 35.3 |
| | Total | 36 | 7 | 19.4 | 30 | 9 | 30.0 | 38 | 9 | 23.7 | 104 | 25 | 24.0 |

TABLE 5

Age and sex specific prevalence of "diabetes" in Pima Indians*

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | | New† and known diabetics | | | New† and known diabetics | |
| Age (yrs.) | No. exam. | No. | Per cent | No. exam. | No. | Per cent |
| 15-24 | 21 | 0 | 0.0 | 32 | 0 | 0.0 |
| 25-34 | 15 | 2 | 13.3 | 30 | 5 | 16.7 |
| 35-44 | 24 | 9 | 37.5 | 40 | 18 | 45.0 |
| 45-54 | 23 | 13 | 56.5 | 36 | 17 | 47.2 |
| 55-64 | 27 | 8 | 29.6 | 44 | 29 | 65.9 |
| 65+ | 36 | 18 | 50.0 | 50 | 27 | 54 |
| Total | 146 | 50 | 34.2 | 232 | 96 | 41.4 |
| 15-34 | 36 | 2 | 5.6 | 62 | 5 | 8.1 |
| 35+ | 110 | 48 | 43.6 | 170 | 91 | 53.5 |

*From Comess et al., 1967.[10]
†Plasma glucose ≧ 160 mg. per 100 ml. at two hours.

## DISCUSSION

The Cocopah and several other North American Indian tribes have been shown to have a prevalence of new and known "diabetes" remarkably higher than that found by Wilkerson and Krall[11] in Oxford, Mass. (2.0 per cent) and more recently, by O'Sullivan[12] and co-workers in Sudbury, Mass. (1.8 per cent). Both of these communities are predominantly Caucasian. West[13] has examined South American populations in Uruguay and Venezuela and reported that the prevalence of "diabetes" in those aged thirty or over was 6.9 and 7.3 per cent, respectively, higher than the U.S. groups, but lower than the prevalence reported for the North American Indian tribes. In contrast Mouratoff and co-workers[14] have found that the prevalence of "diabetes" among Alaskan Eskimos was less than 1 per cent.

Because of the differences in the methods and criteria used for determination of diabetes in these studies it is possible to make only approximate comparisons among them. We were, however, able to make direct comparisons between the Cocopah and Pima data,[10] since the methods of testing were similar.

The prevalence of "diabetes" in the Cocopah aged fifteen and over was compared to that of an age and sex stratified random sample of the Pima population between the ages of fifteen and seventy-four years[10] (table 2, 5) and was found to be significantly lower in the Cocopah when adjustments were made for differences in sex and age composition of the two samples[15] ($p = 0.05$). The prevalences in the two tribes were similar below thirty-five years of age in each sex, but above this age the Cocopah had a lower prevalence. The prevalence of "diabetes" in the Cocopah was comparable to that reported in the Cherokee by Stein et al.[5]

TABLE 6

Diabetes and obesity in Pima Indians

| | | Per cent desirable weight | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ≤ 125 | | | 126-150 | | | ≧ 151 | | | Total | | |
| Males | Age (yrs.) | No. exam. | Diabetic No. | Per cent | No. exam. | Diabetic No. | Per cent | No. exam. | Diabetic No. | Per cent | No. exam. | Diabetic No. | Per cent |
| | 15-34 | 20 | 2 | 10.0 | 10 | 0 | 0.0 | 4 | 0 | 0.0 | 34 | 2 | 5.9 |
| | 35+ | 68 | 23 | 33.8 | 30 | 15 | 50.0 | 11 | 9 | 81.8 | 109 | 47 | 43.2 |
| | Total | 88 | 25 | 28.4 | 40 | 15 | 37.5 | 15 | 9 | 60.0 | 143 | 49 | 34.3 |
| Females | | | | | | | | | | | | | |
| | 15-34 | 19 | 0 | 0.0 | 24 | 2 | 8.3 | 15 | 3 | 20.0 | 58 | 5 | 8.6 |
| | 35+ | 36 | 17 | 47.2 | 57 | 32 | 56.1 | 53 | 24 | 45.3 | 146 | 73 | 50.0 |
| | Total | 55 | 17 | 30.9 | 81 | 34 | 42.0 | 68 | 27 | 39.7 | 204 | 78 | 38.2 |
| Total | | | | | | | | | | | | | |
| | 15-34 | 39 | 2 | 5.1 | 34 | 2 | 5.9 | 19 | 3 | 15.8 | 92 | 7 | 7.6 |
| | 35+ | 104 | 40 | 38.5 | 87 | 47 | 54.0 | 64 | 33 | 51.6 | 255 | 120 | 47.1 |
| | Total | 143 | 42 | 29.4 | 121 | 49 | 40.5 | 83 | 36 | 43.4 | 347 | 127 | 36.7 |

Obesity has often been implicated in the pathogenesis of diabetes and was found to be common in both sexes of the Cocopah and Pima tribes (tables 4 and 6). When adjustments were made for age and sex composition of the two samples by the Mantel-Haenszel Procedure,[15,16] there was an association of obesity and "diabetes" in the Pima ($p = 0.05$) but not in the Cocopah ($p = 0.30$). The frequency of moderate and gross obesity was somewhat higher in the Cocopah than in the Pima ($p > 0.05$) yet the prevalence of diabetes in the Cocopah was lower. Differences in the frequency of obesity do not appear to account for the difference in the prevalence of "diabetes" between these tribes.

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