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Twenty Years of Diabetes on the Warm Springs Indian Reservation, Oregon

JAMES W. JUSTICE

INTRODUCTION

The prevalence of metabolic glucose disorders in American Indians has been investigated by community survey techniques since the early 1960s for tribes located in the southwestern United States, e.g., Arizona,¹ Oklahoma,² New Mexico,³ Colorado.⁴ Very few survey results were published for tribes in other locations.^{5, 6, 7, 8, 9, 10, 11} In the northwestern United States, only one unpublished survey report from the Warm Springs Reservation exists.¹² The incidence and/or prevalence of diabetes in the tribes studied varied with the specific decade, the specific methods used for the survey, and the tribes involved; therefore, comparisons between decades and tribes are impossible, and generalizations are difficult.

The problem during the early years of surveys for diabetes among American Indian groups was to distinguish between two explanations for the comparatively high rates of diabetes. Either the disease was a new epidemic response of a population rather suddenly exposed to a constant food supply, or somehow American Indians had developed a resistance to the effects of hyperglycemia and therefore did not exhibit the same frequency of symptoms and common complications of prolonged diabetes

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found among other populations. Indeed, early investigators were hesitant to label persons "diabetic" with plasma sugar levels that averaged over 250 mg. percent two hours following a glucose load of 75 grams in spite of confirmation by standard glucose tolerance tests. Such early titles in the literature as "The High Prevalence of *Abnormal Glucose Tolerance* in the Cherokee Indians of North Carolina,"¹³ and "*Hyperglycemia* in Pima Indians"¹⁴ (emphasis mine) reflect this bias. These early papers reflect the viewpoint that a "special Indian" diabetes existed, presumably devoid of the complications of blindness, renal failure, amputations, and acidotic coma, although Miller et al. in 1968 did find evidence of early retinal changes, cataract formation, kidney function decrease, and other secondary complications from diabetes of long duration.

Most investigators today consider that the most likely explanation for the much higher rates of type II diabetes in Indians than in non-Indians is the so-called "thrifty gene."¹⁵ Neel suggested that an hereditary condition as common as diabetes among all tribes must have had a selective breeding advantage at some time in the past. The gene or genes that enhance the ability of a population to store energy in the form of carbohydrates when food supply was abundant would have helped ensure survival during occasions when food was scarce. This selective advantage during times when food supply was variable would become a disadvantage to good health after food became constantly available.

Now after twenty years of continuous study of the Pima and repeated surveys of other Indian groups, the predictions regarding complications have been confirmed in many tribes.^{16, 17, 18} As this first diabetic generation aged and did not achieve normal blood sugars as a result of diet and drug therapy, the expected secondary complications appeared. The conclusion accepted now is that in 1965 Indian diabetes had existed less than fifteen years, and therefore a large enough group of adults had not been found who had diabetes of sufficient duration to result in complications.

As mothers with high, uncontrolled blood sugars during pregnancy gave birth to the next generation, the children they gave birth to became obese at younger ages, were at higher risk for developing diabetes, and developed this disease at a younger age than did their parents.¹⁹

Changing environmental factors perhaps helped increase both

obesity and the rate for new cases of diabetes in the population. The most important change was probably the constant availability of food. Some other factors may have been the increasing use of prepared foods high in sugars and calories (e.g., soda pop, ice cream, candy, refined granulated sugar, and snack foods) and the decreasing amount of regular physical effort formerly spent in hunting or in desert agricultural practices.

WARM SPRINGS (See Figure 1, Location Map)

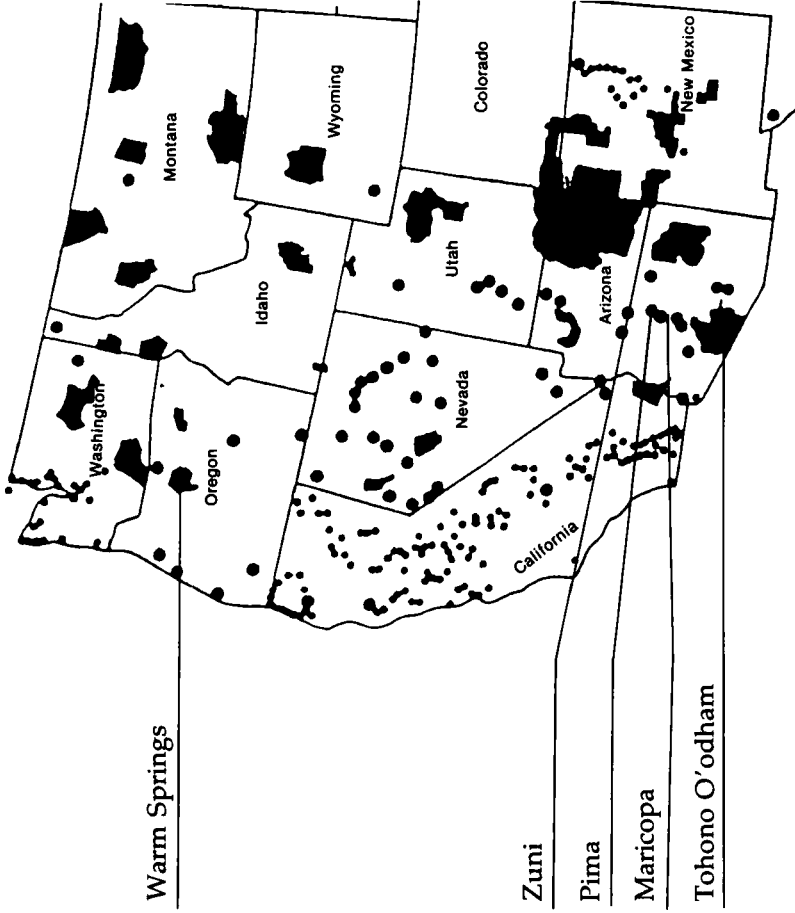
History

Several Indian tribes have resided since ancient times along the Columbia River in the vicinity of Celilo Falls. There is no record of their life before the white man came. Their written history commences with their first mention by explorers in the region, particularly in the journals of the Lewis and Clark expedition. Clark describes how the members of the expedition encountered Indian groups almost continuously as the explorers went down the Columbia River in the late autumn of 1805. "Received us with great kindness," William Clark wrote of Indians met near the mouth of the John Day River. The land along the Columbia was home to these Indians, because it was the source of the salmon, one of their primary food sources, but they ranged to the south and east, gathering berries along the slopes of the Cascades and roots over a broad area.

The tribes living near Celilo Falls were initially called by settlers the Indians of Middle Oregon and later the Confederated Tribes. They were members of several small bands of Walla Wallas and of the Wascos. These people claimed as their land the country from the Cascades eastward to the Blue Mountains and from the Columbia southward beyond the present site of Bend, Oregon. The area that was to become Warm Springs Reservation was not particularly well known to these people, although they had considerable familiarity with the eastern part of the area.

The first white men to cross the present-day reservation area were probably in a Hudson's Bay Company supply party led by Finan McDonald and Thomas McKay in 1825, but they, too, followed the Indian Trail. Not until 1855, when a railroad survey party led by Lt. Henry L. Abbott investigated the country close

FIGURE 1—Federally Recognized Indian Reservations



Source: Native American Science Education Association, 1986.

to the Cascades, are whites known to have seen the western area of the reservation, although it is possible that gold prospectors had followed some of the rivers—without success.

The office of superintendent of Indian affairs, Oregon Territory, was established in 1848, and a few years later the United States government was in the midst of a great treaty-making program. On 23 June 1855, after three days of discussion, a treaty was signed that established the Warm Springs Reservation of about 600,000 acres.

The present day reservation is located in north central Oregon on the eastern slopes of the Cascades, just east of the Pacific Crest Trail. The Mount Hood National Forest forms the northern boundary of the reservation. The reservation is bordered on the east by the Deschutes River and on the south by the Deschutes National Forest. The Confederated Tribes of the Warm Springs Reservation consist of Warm Springs, Wasco, and Paiute.²⁰ Total population in 1985 was 2,481: 1,025 males and 1,016 females.

Diabetes and the CWST

In 1984, a nutritionist at the Warm Springs Health Center (WSHC), employed by the Indian Health Service (IHS), expressed concern regarding what she perceived as an increasing problem with obesity, especially among young persons, and an apparent increase in the incidence of diabetes. Consultations were provided by the IHS epidemiologist in Tucson, with suggestions for a study of obesity. This study was completed and submitted for publication.²¹ In the spring of 1985, the Warm Springs service unit and health center was selected as a training site for a course in health service research that has been offered for the past twenty years by the Division of Health Systems Development (formerly the Office of Research and Development) of the IHS in Tucson, Arizona.

Those participating in this training (i.e., 20 federal or tribal employees from Indian Health Service facilities and American Indian governments throughout the United States) were presented various problems in health service delivery at the Warm Springs Reservation by the IHS staff. They selected one problem area to be investigated further between 10 May and 15 May 1985: an analysis of those who were the most frequent users of health services.

While the training in the use of field research techniques progressed, one of the IHS staff from Tucson (James W. Justice) also proceeded to study the prevalence of diabetes. The purpose of the study was to compare two points of time (1965 and 1985) for the incidence/prevalence of diabetes at the Warm Springs Reservation in order to (1) describe the population at risk, (2) determine if the Warm Springs Reservation resembles a first or a second generation diabetic population, and (3) compare data for the same time period (1965 and 1985) for other tribes.

METHODS AND DATA SOURCES

The unpublished 1964–65 survey at Warm Springs Reservation by Drs. Jay Stein and C. Spurgeon consisted of two parts. First, all records at the Warm Springs clinics were examined for evidence that a diagnosis of diabetes had been recorded. The diabetes criteria used were not reported for this record review. The blood testing portion of the survey was performed by taking blood from volunteers two hours after administering an oral dose of 75 grams of glucose in the form of a carbonated beverage (glucola). Those with a blood sugar over 130 mg. percent, as tested in the Oklahoma laboratory of the State Health Department, were advised to undergo a standard three-hour glucose tolerance test. All the subjects so advised did undergo the second test.

In 1985, the service unit director and chief nutritionist at the Warm Springs Indian Health Service Health Center reviewed all records and produced a list of those with diabetes reported by a physician. Population estimates were taken from the Warm Springs tribal rolls for 1959 for all Indians resident on the reservation²² and in 1985 for enrolled members only of the Confederated Warm Springs Tribes (CWST). The names on the list of reported diabetic patients were checked against a computer print-out of enrolled CWST members for January 1985, provided and notarized by a CWST official.

For the study of frequent health service utilizers, the IHS service unit's computerized data base provided a list of 332 health records for patients who had used clinic facilities at least 15 times during the year 1984. By the use of a table of random numbers, 108 records (32.5 percent) were identified, located, and analyzed.

Only those frequent users of IHS facilities who were also on the 1985 diabetic register are included in this report.

RESULTS

Of the 108 records reviewed, 34 patients with prior diagnosis of diabetes in 1965 and an additional 8 new cases that were confirmed following diagnosis using the recommended glucose tolerance test were still alive in 1984. It is not clear how extensive was the search in 1965 for complications in these 42 patients, but at that time only one patient—an obese 57-year-old male—was noted as having “nephrosclerosis.” One case of arthritis and another of alcohol abuse were also noted. Of the 34 patients with diabetes, 25 had been treated with oral drugs (21 with orinase), one with diet alone, and one with insulin. Seven patients did not receive any prescribed treatment. No cases were found under 25 years of age. Presumably, all the diabetics had type II diabetes, i.e., non-insulin dependent diabetes mellitus (NIDDM).

All 42 patients were assumed to be residents of the Warm Springs Reservation for the prevalence rate calculations (as shown in Table 1) based on the 1959 population.²³ Since their tribal status was not identified, the enrolled and the non-enrolled CWST Indian population were combined to arrive at a total number for the population.

In 1964, diabetes was recorded in only 2.6 percent of the total population (1.5 percent of the males and 3.6 percent of the females). For the total population of those 25 years or older, the diabetic rate was 4.3 percent for males and 9.9 percent for females. These rates were almost the same as the all races rate (2.04 percent) reported in the United States in 1973.²⁴

The results of the 1985 record survey are also presented in Table 1 and Figures 2 and 3 for comparison. All patients diagnosed as having NIDDM are included in this table. For males (Figure 2), the overall rate from 1965 to 1985 has increased 165 percent; for those over 25 years, the increase is 169 percent over the 1965 rates. For females (Figure 3), the rates have increased by 149 percent. For those females 25 years and over, there was a 133 percent increase. These total rate increases are not statistically significant at less than the .05 level of probability for all categories

**TABLE 1: Diabetes Reported Prevalence Rates (Per 1,000)
1965² Compared to 1985² by Age and Sex
Warm Springs Reservation, Oregon**

Ages	Males				Females			
	1965		1985		1965		1985	
	D.M.	12	D.M.	26	D.M.	30	D.M.	55
0-24	0	0	0	0	1	1.9	0	0
25-34	1	11.0	0	0	3	29.1	0	0
35-44	1	12.4	3	33.3*	4	47.6	9	91.8
45-54	1	20.0	13	214.9*	6	146.3	16	273.5*
55-64	6	187.5	6	206.9	6	187.5	15	365.9*
65+	3	136.4	4	228.6	10	294.1	15	337.1
Totals 25 years	12	43.5	26	73.2	30	98.6	55	131.3
All Ages		15.4		25.4		36.2		54.1*
Mean Age (Year)		56.3		54.0		54.8 ¹		57.8
(± S.D.)		± 12.1		± 9.7		± 14.7		± 13.5

¹Note: Including 3 whose ages were unknown, except that they were females over 65 years and were assigned a value of 70 years each; and one female aged 55-64 was assigned a value of 60 years.

²Only Warm Springs Reservation residents, members of all tribes for 1965. For 1985, only Warm Springs Reservation, only CWST enrolled members.

*1985 rate more than two standard errors of 1965 rate ($p = < .05$).

except females over age 25 years. The mean ages of reported patients with diabetes showed no statistically significant differences, but did increase by an average of three years for females in 1985.

At the time that the first list was compiled in November 1964, three additional names were crossed out with the notation "died." These patients were females aged 50, 72, and 89 years. Neither the cause nor the date of death was recorded.

Of the 42 patients alive in 1965, only 5 were found listed in the

FIGURE 2—Diabetes Reported Prevalence
Male 1965-1985
Warm Springs Reservation, Oregon

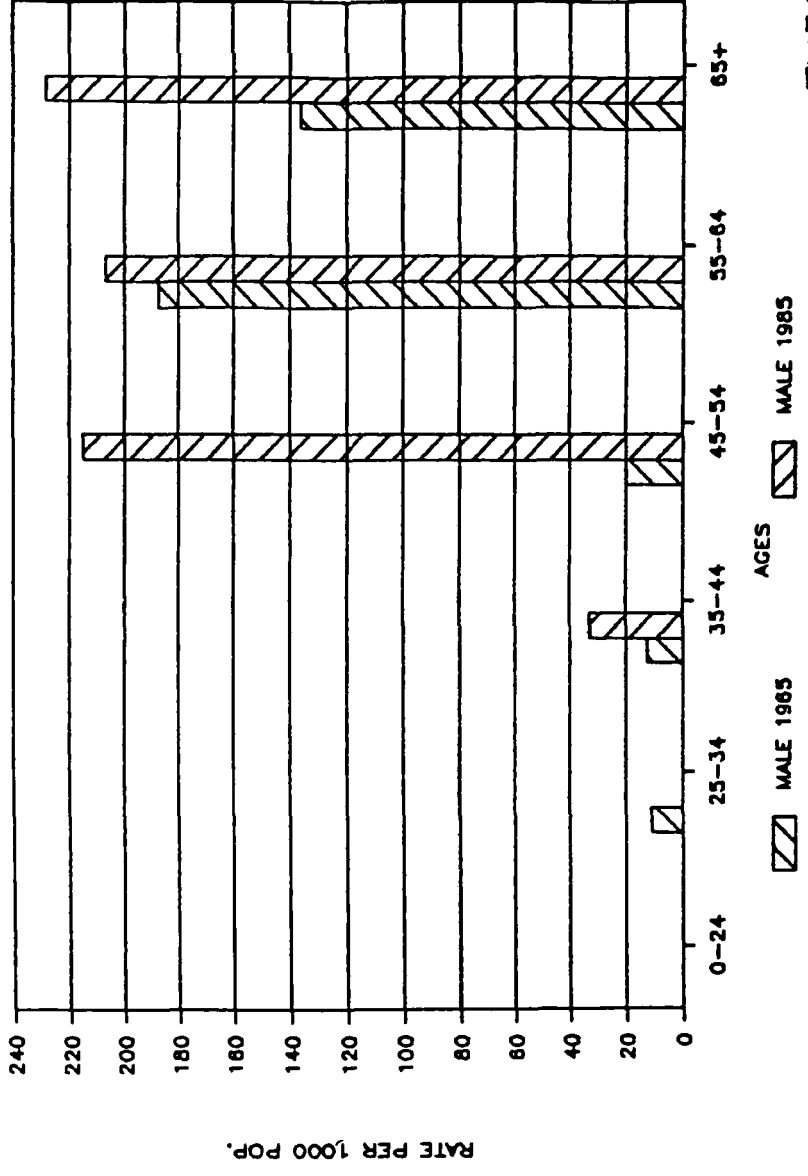
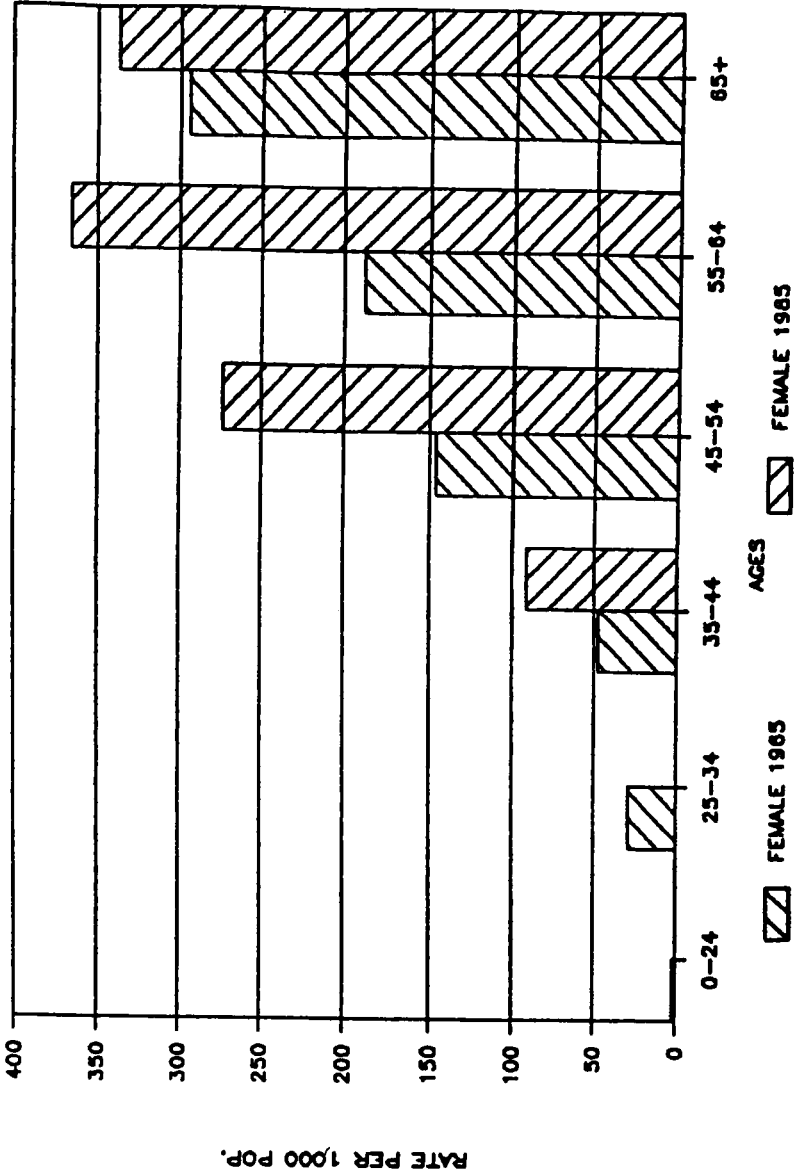


FIGURE 3—Diabetes Reported Prevalence
Female 1965-1985
Warm Springs Reservation, Oregon



1985 diabetic register. There is no way to determine how long the 1965 diabetic patients had been exposed to high blood sugars, but if we assume that the absence of data about complications signifies a low rate of complications, then we could also assume that few had had this condition for more than twenty years. In the 1985 chart survey, the length of duration of diabetes from the earliest date was recorded in the clinic records and is shown in Table 2. These dates were corrected for 2 patients by information from the 1965 survey.

The majority (56 percent) of those now known to have diabetes have had the disease for less than ten years' duration. Two other members of the CWST who today are not resident within reservation boundaries were added to the 80 patients tallied in Table 1. There may be considerably more patients with diabetes for over ten years (52.7 percent) than is shown in Table 2, because the circumstances of the diagnosis are not known. Their diabetes may have been first recorded following similar community-wide surveys conducted in 1965, or it could have been confirmed after glucose tolerance tests or by other diagnostic criteria.

**TABLE 2: Duration of Reported Diabetes
in 82 Warm Springs Tribal Members Only
As of 5/85, by Age Group (Total, 82)**

Duration (in years)	Less than 5	5 to 9	10 to 19	20+	Unknown
Dates (inclusive)	1981-85	1975-80	1966-74	Before 1966	
Age					
25-44	8	4	2	0	0
45-54	11	3	14	1	1
55-64	5	7	6	3	0
65-74	3	2	5	2	0
75+	2	3	1	1	0
Total	27	19	28	7	1
Percent	32.9	23.2	34.2	8.5	1.2

In order to see if there was any evidence of repeated surveys, we tallied all patients by the year of their first diagnosis. From 1960 through 1968, only 1 to 2 new patients were reported each year except for 5 new ones in the 1965 survey year. From 1969 to 1989, the reported new cases varied from 3 to 4, except for 5 in 1976 and 10 in 1972. The latter may have been a year of a special survey. From 1980 through 1984, the reported cases show an increase over previous years, averaging 8 per year, with a sharp jump to 13 in 1981. In the last two complete years (1983–1984), 7 and 8 new cases of diabetes, respectively, were reported. With the possible exception of 1972 and 1981, it appears that the majority of patients were evaluated for diabetes because of symptoms or heightened clinical suspicion on the part of the health care providers. The present health staff recalled no community-wide diabetes surveys in the ten-year period 1975 to 1985.

There are no data regarding diabetic patients who have died since the 1965 survey, so the total numbers found and recorded in the Warm Springs clinical records each year cannot be accurately tabulated. The total register for 1985 also included 26 Indians who belonged to tribes other than the CWST. Of these, 20 resided on the Warm Springs Reservation and 6 resided in the surrounding counties. Among those who were listed as Warm Springs tribal members, only 3 resided away from the Warm Springs Reservation. Of the total 9 non-reservation residents, 6 lived in the nearby town of Madras.

All those reported in this study are thought by the clinical staff to have type II non-insulin dependent diabetes. One other diabetic patient on the register, who has iatrogenic Cushing's syndrome from treatment with steroids, is not included in this report. Rates were calculated only for CWST members resident on the Warm Springs Reservation, because data on the population by age and sex were not available for the total service unit nor for other geographic areas.

Other total diabetic population prevalence rates that could be estimated are for the entire Warm Springs service unit population of 4,403. As of January 1984, the rate was 24.8 per 1,000 (109 total) for all residents within the service area on the register list. One diabetic patient was resident on another IHS service unit reservation.

If we restrict the diabetic count to only the Indian population of counties near the Warm Springs clinic (Wasco and Jefferson

Counties, 2,601 American Indians in the 1980 United States census), then the rate per 1,000 would be less than 41.9, because the population would probably have increased since that time, if correctly and completely counted. However, the United States census counts for the Warm Springs Reservation in 1960 and in 1970 showed a total increase of only 10 persons, which is a negligible increase. Total population in 1980 was 2,004, representing an annual increase of 42.9 persons (2.7 percent) since the 1970 census. The rate of type II diabetes for those 25 years and older would be about 106.7 per 1,000, reflecting the youthfulness of the Indian population in these counties. In 1985, the projected number of residents, assuming the same level of population growth recorded from 1970 to 1980, would be 2,277. The diabetes prevalence rate would therefore be 43.9 per 1,000.

The prevalence rate of diabetes among Indian reservation residents other than those enrolled in CWST would be approximately 95 per 1,000, if the total population estimate ($N=200$) by the IHS director is correct. Other tribes represented on the register include Hoopa, Yakima, Nez Perce, Grande Ronde, and Muckleshoot, plus members of various tribes from Oklahoma, Idaho, and Arizona. However, this rate for non-CWST Indians resident on the Warm Springs Reservation appears to be too high to be correct.

Rates of Diabetic Complications

In 1985, the known complications of long-standing diabetes appear to have increased since 1965, but overall the rate of complications is low. One diabetic patient with kidney failure is being treated with dialysis, and 3 others have had lower limb amputations, presumably from peripheral vascular disease and infection. As in 1965, complications do not appear to have been searched for and diligently recorded.

Results of Health Record Review

In order to shed more light upon the prevalence of complications from diabetes, the results of the random sample study of high frequency clinic users (i.e., 15 or more visits per year during 1984) was accessed for those who had diabetes.

The sample included 19 diabetic patients who had 17.3 percent

of the total number of visits listed. All were listed on the 1985 diabetic register. All patients confirmed as diabetic from the record review were also known to the nutritionist and entered on the list of diabetics. Two others had only one visit for "diabetes" but were not diagnosed by a physician during their many other visits for that year, and therefore were not included. Thirteen (2 male, 11 female) of the 19 patients (12.9 percent of high frequency clinic users) were enrolled CWST members resident on the Warm Springs Reservation. These figures represented 7.7 percent of the Warm Springs male diabetics and 20.4 percent of the female diabetics. The mean age for the females in the sample was 56.4 ± 8.9 (compared with a population mean age of 57.8 ± 13.5 for females). This difference in mean ages was not significant.

These 13 enrolled CWST patients used the Warm Springs clinic on a total of 333 occasions; in 37 percent of these cases, diabetes was listed as the primary reason for the visit. After diabetes, the most common primary diagnoses for those with diabetes who visited the Warm Springs clinic more than 15 times per year were hypertension (7), fungal infections (4), urinary tract infections (4), ischemic heart disease (4), glaucoma (1), and cataracts (2). Two patients had visits for other reasons (arthritis, injuries, etc.) ostensibly not related to their diabetes, but these other effects might have been related if more information had been abstracted from the records.

The only reasons that were definitely linked to long-standing diabetes found by the health record search were for 2 patients with cataracts, one of whom also had glaucoma. The former had diabetes recorded for ten years and the latter for at least fifteen years. All other reasons for using clinic services could have been related to either short-term or long-term diabetes (e.g., urinary tract infections).

History of Health Care, Health Status, and Diabetes at Warm Springs Reservation

An effort was made to locate other publications and health data for the Warm Springs Reservation to determine (1) if diabetes was diagnosed before 1965, and (2) if diabetes has been regarded as a serious problem since 1965. The earliest health reports about the Warm Springs Reservation that were readily found were by

Foster and Zenter (1960) in the Oregon University report. Their data originally came from official reports of the Bureau of Indian Affairs during the 1950s.

Although it is not clear today just what proportion of persons who died in the 1950s among the Warm Springs tribe had certificates filed with the cause of death diagnosed, it does seem that there has been a change in the relative frequency of causes of death beyond what one could usually attribute to changes in reporting practices alone. Table 3 shows some differences. Infectious disease deaths have declined proportionately, and chronic conditions have increased (i.e., heart disease, cirrhosis of liver, etc.). A similar trend has been observed throughout reservations in the United States. The deaths from 1975 through 1977 in this table were for the entire IHS service area of the Warm Springs service unit (Indians in Jefferson, Wasco, Linn, Clackamas, and Marion Counties), not just the Warm Springs Reservation. The more detailed listing of causes of death is from a tribal health planning document²⁵ and most likely includes deaths of only Warm Springs Reservation residents, or perhaps of Warm Springs enrolled members, regardless of their residence. However, the categories chosen by Sahme do not fit those from either the Oregon University report or the Public Health Service report.²⁶ If diabetes had been a cause of death at Warm Springs during 1972-77, then these deaths would have been listed in the combined category of "endocrine, metabolic, and nutritional" diseases.

Diabetes is not mentioned in the 1960 health status report, nor is any health problem that may have been the result of undiagnosed diabetes. Major concern at that time was for safety, sanitation, dental care, tuberculosis, and various respiratory diseases. Mental health was judged as "good or better than in other nearby communities." However, abuse of alcohol was thought to be a problem of concern, although alcohol abuse was not conceptually related to "mental health" in the 1960s.

Nutrition was not noted as a problem area in the data in the 1950s, but in the chapter about dental health it was noted in passing that "large amounts of refined carbohydrates in the form of candy and soft drinks" were causing tooth decay in both children and adults.²⁷

Anthropologists who lived on the Warm Springs Reservation during the 1950s reported that the condition of diabetes did not

**TABLE 3: Changing Percentage for Causes of Death,
Warm Springs Reservation, 1954¹ to 1977² Service Unit**

Site	W.S.R. ¹	W.S.R. ³	W.S.S.U. ²			
Rank 1954	Underlying Causes of Death	Percent of All Deaths 1954-56	1972-76	1975-77	Ranks	Change in Proportion Cols. 1 & 3
1	Accidents	30.7	27	21.1	1	- 9.6
2	Heart Disease	11.5	26*	12.7	2	+ 1.2
3	Pneumonia	8.9	3	2.8	4	- 6.1
4	Cancer	3.7	3	N.A.	N.R.	
5	Conditions Early Infancy	2.5		N.A.	N.R.	
N.R.	Cirrhosis, Liver	N.A.	1.8*	21.1	1	+21.1
N.R.	Homicide	N.A.	N.A.	4.2	3	+ 4.2
Total Percent Accounted for		57.3	77	61.9		+ 4.6
Total Number Reported		N.A.	101	71		

¹Reference: Warm Springs Research Project, Vol. 1, Oregon State University, Corvallis, OR.

²Reference: Page 80, DHEW Pub. No. (HSA) 79-1005.

³Other Causes 1972-76

Signs, Symptoms, Ill-defined	6%	Central Nervous System	6%
Mental	1%	Perinatal Conditions	1%
Endocrine	2%	Congenital	2%

*Actually, these were labeled "circulatory diseases" and "digestive diseases," categories that each include more conditions than only "heart disease" and "cirrhosis, liver."

seem to elicit any concern among their friends and neighbors (French and French, 1985). They point out that there was no word in the native language (Sahaptin) for "sugar diabetes," or "blood sugar," nor even for "fat" or "obesity." However, there were words for "lean" and "withered." They had also reviewed reports in BIA files by physicians and nurses for the period 1910 to about 1920 and do not remember any mention of diabetes. One of these anthropologists had a special interest in ethnobotany and reported that he didn't know of any local use of herbs for treating diabetes.

According to French and French (1985), one resident was known to them in 1954 who was overweight and had diabetes. They recall that many men and women at about age 40 years and older were "heavy" (in excess of 180 lbs.), but they do not recall any obese children.

Very few vital statistics, health-related statistics, or other health-related data from the early 1960s have been found. Three Public Health Service federal reports^{25, 29, 30} did contain some health data specific to the Warm Springs service unit, which includes the Warm Springs Reservation. Two deaths from diabetes were tallied in 1967, none in 1968, and one from disease of the "endocrine, nutritional, or metabolic" category in 1969. At most, three deaths attributed to diabetes may have been known, or 3.2 percent of total deaths from 1967 through 1969. In the 1969 health plan, two deaths during the total five-year period were reported in the category that includes diabetes. This represents at most 2 percent of the total deaths.

Diabetes during pregnancy can lead to newborns with birth weights nine lbs. or over, and this statistic has been tracked for the Warm Springs Reservation in some studies and routine reports. During 1967 and 1968, four newborns (or 1.5 percent) were born at nine lbs. or more; 37.6 percent were over 7.8 lbs. This compares with 14.5 percent over 7.8 lbs. birth weight in the total Portland IHS area (i.e., Indians in states of Oregon, Washington, and Idaho). In 1969, Warm Springs service unit newborns weighed more (median, 3,387 gms.) than those in the other five service units (median, 3,315 gms.) that comprised the Portland area, and both were heavier when compared to the entire United States (3,303 gms.). Of those Indian parents using the IHS, both parents were Indians and resident in the Warm

Springs service unit in 58.1 percent of births, the second highest proportion in the Portland area. This percent was higher in 1968 (71.8 percent) and 1967 (67.5 percent). From 1972 to 1977,³¹ 46.55 percent of Warm Springs service unit birth weights were in the group of 3,501 gms. (7.8 lbs.) or more compared with 39.3 percent for all IHS Indian beneficiary births, and 42.3 percent of Indian births in the Portland area.

There are a number of possible reasons in addition to diabetes or gestational hyperglycemia to explain why the Consolidated Warm Springs Tribes give birth to babies that are heavier than those of surrounding Indian groups and the national Indian average (e.g., genetic predisposition, prolonged gestation time). However, since there has been no detailed reporting of newborns weighing nine lbs. and over, the relationship to an increasing rate of diabetes or abnormally high blood sugars during pregnancy cannot be proven.

Finally, diabetes is mentioned as a health problem of concern in the Warm Springs Reservation health plan, but only indirectly in association with a concern for obesity. In the section on community health services nutrition, Sahme (1979) quotes an IHS official as observing that "obesity, an underreported malnutritional manifestation, has become a major health concern on the Warm Springs Reservation associated with an increased risk of coronary heart disease, hypertension, diabetes mellitus, and iron deficiency anemia."

The section on chronic disease in the Warm Springs Reservation health plan does not mention diabetes *per se*, even though the second largest diagnostic category for clinic visits in 1977 and 1978 was labeled "endocrine, nutritional, metabolic." This category was ranked tenth for hospital admissions in 1978, but it also includes obesity and anemia.

Today, concern for the prevalence of diabetes "above national norms"³² and as a problem for research has been definitely expressed by IHS health providers at the Warm Springs clinic.³³

Warm Springs Reservation Compared for Diabetes Rates with Other Reservation Areas

All evidence gathered to date indicates that many residents of the Warm Springs Reservation probably did not experience problems

with control of their blood sugar metabolism until ten to twenty years prior to 1965, the first year in which the Warm Springs Reservation population was surveyed.

In 1965, the estimated diabetes prevalence rate (26/1,000) at Warm Springs Reservation was 126 percent of the rate estimated for all races, all ages, in the United States (20.5/1,000);³⁴ however, considering the smaller population at Warm Springs Reservation, these rates are approximately equal. Nevertheless, if one compares the rates of diabetes for those aged 25 years and above (see Table 4) on the Warm Springs Reservation with comparable age groups for the United States, all populations, the excess of cases of diabetes among adult Warm Springs residents becomes evident.

In order to make this comparison, the United States all races

TABLE 4: Diabetes Prevalence Rates for Warm Springs Reservation 1965, Compared with U.S. All Races—Rates per 1,000 Population

Ages	Warm Springs Reservation	U.S.		Rate Differences
		(1)	(2)	W.S. — U.S.(1)
0-24	0.96	2.0	1.3	- 52%
25-44	25.1	12.2	8.9	+ 106%
45-54	76.9	34.1	42.6	+ 126%
55-64	187.5	63.8		+ 194%
65-74	285.7	78.8	78.5	+ 263%
75+	142.9*	75.7		+ 89%
Total	25.9	20.5	20.4	+ 26%
Population	1,619**	N.A.	120,000	

* Three patients with diabetes were assigned to this age group, but ages were known only to be above 65 years.

** Includes 11 with age unknown.

(1) See McDonald and Fisher (1967) for years 1960-62.

(2) See Vital and Health Statistics Data (1977). The breakdown was 0-17, 17-44, 45-64, 65 years and over, for 1973.

rate was calculated by McDonald and Fisher (1967), who combined those estimated as known diabetics with a derived number of unknown diabetics based upon several population surveys conducted in the early 1960s. In addition, a carefully selected group of 120,000 completed a questionnaire in 1973 for the National Health Survey project of the Public Health Service.³⁵

One of the great difficulties of comparing diabetes prevalence in different populations in the past has been the various laboratory test methods, sampling procedures, and criteria used to determine diabetes. Therefore several diabetologists have insisted that comparisons among different populations are not possible and are apt to be misleading. Notwithstanding these objections, comparison of Warm Springs Reservation residents with other American Indian tribes in the 1960s can be instructive and help to clarify the phase of development of diabetes among the Warm Springs tribe. Table 5 compares diabetes prevalence rates for the Warm Springs Reservation with the Pima,³⁶ Tohono O'odham (prior to a legal name change in 1985, this tribe was known as Papago),³⁷ Zuni,³⁸ and Maricopa people,³⁹ all residents of reservations (see also Figure 4).

All numbers were derived from a health record survey and a postprandial (glucose load of 75 grams) plasma or blood sugar sample taken from one to three hours later, except for the later Tohono O'odham studies⁴⁰ and the Zuni study,⁴¹ which were based upon health record review only. Also, the Pima prevalence data were based upon data collected from 1965 through 1967, and the Zuni study was based on data collected in 1975 and 1976.

These results show that residents of the Warm Springs Reservation—both sexes and almost all age groups—had lower prevalence rates for diabetes than those found in other tribes. Their 1965 rates were similar to the 1975 Zuni rates, and by 1985 (see Table 5) their prevalence rates for diabetes in most age groups and for both sexes were almost the same as those found in Zunis for 1975.

What has happened to the diabetes prevalence rate patterns in other tribes during the 15 to 20 years since the rates shown in Table 5?

For the most part, the diabetes prevalence rates for those aged 45 and over have not changed significantly, but rates of diabetes have increased in the age group 15 to 35 years, especially among the younger group, 15 to 25 years. The total number of people

TABLE 5: Prevalence of Diabetes Circa. 1965 for Five American Indian Tribes by Age and Sex—Rates per 1,000 Population

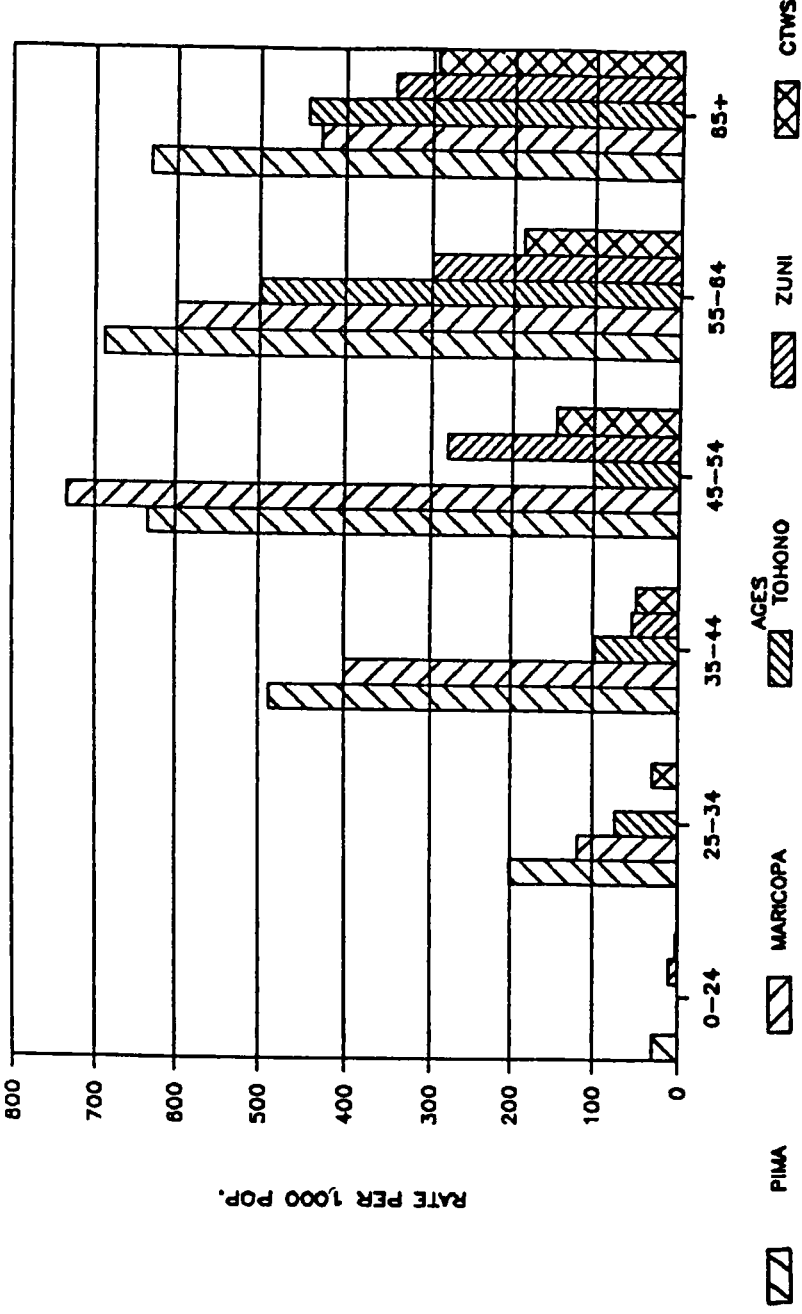
Tribes Ages/Years	Male					Female				
	W.S.R.	Papago*	Maricopa	Pima	Zuni	W.S.R.	Papago*	Maricopa	Pima	Zuni
	1	1	1	1	1	1	1	1	1	1
0-24	0	31.4	11.0	8.0	10	1.9	0	0	29.0	10
25-34	11.0	83.3	133.3	174.0	69	29.1	73.5	117.6	201.0	53
35-44	12.4	222.2	250.0	330.0	203	47.6	97.6	400.0	487.0	279
45-54	20.0	66.7	400.0	429.0	194	146.3	100.0	733.3	634.0	300
55-64	187.5	307.7	222.2	419.0	205	187.5	500.0	600.0	688.0	343
64+	136.4	117.6	500.0	444.4	205	294.1	444.4	428.6	632.0	343
Total Cases	12	23	18	154	128	30	22	27	288	139
Rate All Ages	15.4	83.3	122.5	166.9	41	36.2	5.8	209.5	236.3	44
Rate ≥25 Yrs.	43.5	153.9	303.6	357.1	126	98.6	144.7	508.2	477.8	132.0
Sex Ratio, Rates, Female/Male						2.3	0.9	1.7	1.3	1.1

*Papago now called Tohono O'odham.

1. Diabetes diagnosed by plasma glucose of 180 mg. per 100 dg or more, one hour after 75 gm. glucose load

(J. Niswander, "Prevalence of Diabetes on the Papago Indian Reservation," Annual Project Report of NAIMD 1967-68 [Bethesda, MD: U.S. Public Health Service, National Institute of Health, 1966], 807-808).

FIGURE 4—Prevalence of Diabetes for Five American Indian Tribes, Females



in all age groups has also increased, and many more than twice as many persons with diabetes are now known to the IHS medical systems.^{42, 43} This increase in total numbers has been influenced by (1) better medical care and treatments for those with diabetes complications, (2) a declining death rate since 1955, (3) an increased birth rate since 1960, and (4) changing risk of death from 1955 to 1985, by age groups.

Table 6 compares the prevalence rates for the Warm Springs tribe and the Tohono O'odham for 1985. In both studies, health records were analyzed for those now alive and recognized as

TABLE 6: Reported Diabetes Prevalence Rates per 1,000 Population Compared for Warm Springs and Papago* Tribes, 1985, by Age and Sex

Ages	Male			Female		
	Papago**	W.S.	C.L.(1) 95%	Papago**	W.S.	C.L.(1) 95%
0-24	2.7*	0	± 2.2	6.5*	0	± 3.4
25-34	106.8*	0	± 26.9	136.8*	0	± 30.6
35-44	307.1*	33.3	± 38.5	292.0	91.8	± 183.9
45-54	427.1*	214.9	± 118.2	616.4*	273.5	± 308.2
55-64	341.8	206.9	± 168.9	546.2	365.9	± 188.9
65-74	281.7	285.7	± 314.9	586.2*	301.9	± 213.5
75+	242.1	142.9	± 333.4	500.0	388.9	± 294.0
Total All Ages	113.4*	25.4	± 10.0	169.1*	53.2	± 14.5
Age ≥ 25 yrs.	257.8*	73.2	± 28.8	373.0*	128.7	± 35.0

(1) C.L. (95%) = $\pm 2(\text{S.E.})$; plus or minus 2 standard errors,

S.E. = $\frac{r \text{ (rate per 1,000)}}{n \text{ Cases, square root}}$

When no cases at Warm Springs, the confidence limits were calculated for Papago cases. Otherwise, all C.L.'s are for Warm Springs cases.

* Difference in rates more than 2 standard errors, which is equivalent to a probability less than 0.05 that difference is not due to chance alone.

**Papago now called Tohono O'odham.

members of their respective tribes. These records reflect, of course, diagnoses that followed both routine surveillance and periodic mass screening over the years since 1965, plus any results of changing risks of death by age and sex during the twenty-year period 1965–85 in favor of prolonged longevity for diabetics.

More serious than the total increase in the numbers of diabetic patients has been the increased proportion of those with diabetes for 10 or more years, and the secondary complications that necessarily follow poorly controlled hyperglycemia. In 1985, at least 37.2 percent of the Tohono O'odham diabetes patients had been diabetic for 10 or more years. In repeated and continuing studies of the Pimas and Tohono O'odham since 1965, certain conditions related to prolonged diabetes (with obesity) that were previously uncommon have now become epidemic, including end-stage renal disease and the need for renal dialysis treatments;⁴⁴ adenocarcinoma of the uterus;⁴⁵ blindness due to diabetic retinopathy and cataracts; loss of lower limbs from peripheral vascular disease; total coronary heart disease; and, for those on dialysis whose immune systems have been depressed, death from sepsis, systemic fungus infections (in southern Arizona, from "Valley Fever," or coccidioidomycosis), and miliary tuberculosis.⁴⁶

All the other tribes listed in Table 5, in addition to the Yuman speaking groups along the Colorado River and the Yavapai groups in Northern Arizona, have now reached the phase where secondary complications from diabetes and related treatment have caused a crisis in funding for health services as well as personal crises in the families of those affected.

Discussion: Phases of Diabetes in American Indian Communities

From the data presented and the studies referenced, it seems that there are four phases related to the development of diabetes in the Indian community. Briefly, these will be described as follows and the features of each phase generalized:

- (1) During Phase I, food supplies are sometimes scarce; food production such as from small family gardens, wild food gathering, hunting and fishing, takes much energy to accomplish; prepared or refined foods high in carbohydrates are not available. During this phase, type II diabetes is practically absent except perhaps for a few thin persons over 65 years of age.

(2) Phase II commences when there is an increase in food supply, i.e., food is available to be eaten every day, and periods of food scarcity affect only a minority of the extended families in the community. Energy output begins to decline. Snack food, soda pop, candy, refined flour, and sugar begin to be sold in stores accessible to the community, which means that most families receive cash in order to make these purchases. Adults in mid-life begin to gain weight rapidly, especially women following menopause, and diabetes appears first in the 45-year and older age groups in people who are obese. Finally, school age children begin to gain weight, and abnormally high blood sugars begin to appear in obese women of childbearing age.

(3) Phase III appears when infants born to obese, diabetic mothers survive their increased risk of injury at birth (due to their increased birth weight) and risk of death from congenital defects, and grow up to be obese primary school children. As these generational changes occur, the proportion of those adults with uncontrolled diabetes for 10 or more years increases. Amputations, cataracts, renal disease, and arteriosclerotic peripheral vessel disease appear in this group for the first time.

Food supply has remained constant, cash income has increased, energy use decreases, and high caloric foods are available to all (especially the children) during this phase.

(4) The factors contributing to onset of type II diabetes remain and increase as Phase IV begins; Phase IV characterizes the present situation of the Pima, Tohono O'odham, Zuni, and Maricopa. This phase is marked by the constancy of prevalence rates for diabetes for those 45 years and older and increasing rates for younger age groups, 15 to 35 years. There is also an increase in numbers and rates of diabetic complications and conditions associated with obesity and diabetes, including uterine cancer, end-stage renal diseases, amputations, and hypertension. From the data presented in this report, the Warm Springs tribe is now in Phase III, and may enter Phase IV in the next 10 years.

Economic improvements such as constant employment and greater cash flow started in the early 1900s for the Pimas and in the late 1930s for the Tohono O'odham, and increased dramatically for both tribes in the 1940s, when farming corporations leased Indian land to increase crop production during World War II, and there was a rapid response to the draft by almost all young men and a few women. For the Zunis, cash income increased

and caloric energy output decreased most drastically about 1949, when almost all families first became involved in jewelry production as a major source of income. This manner of employment has continued to the present.

The economic history of the Warm Springs tribe is not known in great detail, because the relevant records were not available at the Warm Springs tribal office or at the BIA office in Portland. There are some very brief, incomplete reports^{47, 48, 49, 50, 51} suggesting that economic changes, availability of food for all families, and high caloric food accessibility⁵² did not affect a majority of residents until the mid-1950s or early 1960s. The diabetes survey in 1965 suggests that Warm Springs Reservation had entered into Phase II at this time, compared to the Pimas, Tohono O'odham, and Zunis, who had entered Phase III. Warm Springs, therefore, was about 10 years behind these other tribes.

Table 7 attempts to correlate these theoretical phases of diabetes in the communities with the brief, and so far incomplete, economic changes for the Warm Springs tribe. The first reported tribal business venture was the sale of pine timber to a non-Indian who built a sawmill on the Warm Springs Reservation in 1941. Tribal profits were paid of \$20 to \$40 per capita per year during the 1940s. Since 1967, over \$1 million per year has been paid to the Warm Springs tribe; by 1977, over \$9 million per year was being received.⁵³

The largest income in the 1950s came from the Portland General Electric Company, based upon the amount of electricity produced by the use of tribal lands and water. By the 1980s, \$1 million to \$3 million per year was paid. Sale of alfalfa and other grains started in the 1950s and remained a constant but small income source until the 1960s, when income declined. In 1967, the sawmill and a plywood manufacturing company that had employed Consolidated Warm Springs members was bought by the tribe, and profits were shared in the form of yearly family payments. In 1956, the federal government paid a \$4 million indemnity to the Warm Springs tribe for the loss of land flooded by power dams. Some of this money was distributed per capita, but most was used to invest in development of recreational properties, such as the site of the hot springs.

By 1964, a swimming pool and resort camping site were built and operated by the tribe. To this was added a luxury hotel in 1972. For all enterprises, per capita payments of \$60 to \$300, paid

**TABLE 7: Diabetes Phases in the Warm Springs Reservation Community—
Estimated Dates and Durations of Each Phase**

Community Diabetes	Description	Start-End	Duration Years	Historical Notes
Phase I	No diabetes Type II. Food not constant. Active.	(Before) 1855-1944	89	W.S.R. started 1855. W.W.II start of commercial logging 1942. Armed Services salaries 1941-45.
Phase II	Middle aged obesity. Few diabetics. Less active.	1944-1958	14	Route through W.S.R. 1949. Settlement of claims 1958. Surplus commodity foods 1955(?) start.
Phase III	More obesity in younger. Diabetes high. Heavy babies and school children. Activity less.	1960-1985	25	Economic development. Hotel 1964, sawmill 1967. Hunting, fishing, and family gardens decrease. Per capita funds from tribe 1972 start. High caloric foods increase.
Phase IV	High rates of diabetes in 15-35 year-olds. Complications; also congenital defects, uterine cancer, septicemia increase.	1986		Concern with tribal fitness, obesity, diabetes, and general health, 1983-85.

once or twice a year during the 1950s and early 1960s, rose in 1967 to \$75 per month. Since then the monthly share has been steadily increasing by yearly bonuses ranging from \$300 to over \$600 (see Table 7).⁵⁴

More research is required about tribal per capita earnings, tribal gross income, and earnings from off-reservation employment. The numbers and types of jobs worked off the reservation, as well as trading post records of the quantity and types of food sold, may change these dates and the duration of each phase. Further analysis of physical findings among people with diabetes may show that complication rates (Phase IV) actually started to increase prior to 1985.

RECOMMENDATIONS FOR CONTROL OF DIABETES

For each diabetes phase as described, specific recommendations for a diabetic control program for the entire community can be made. Almost every article or textbook about diabetes advocates early detection, rigorous treatment by diet and hypoglycemic drugs, repeated physical examinations to detect complications, and thorough control of blood sugar levels. For years many similar references have recommended community mass screenings to aid in early diabetic detection; more recently these recommendations have been modified to apply screening only to certain high-risk groups within a community.⁵⁵

If early detection and the special training and experience of the health care providers were important, then those American Indian groups who had established the first diabetic registers, the first specialty clinics, and the first community-wide education campaigns should have had the greatest success in preventing the disabilities resulting from diabetic complications.

Such resources were made available to both the Pimas on the Gila River Indian Reservation (GRIR) and the Tohono O'odham of the San Xavier Reservation, and they have participated in all of those activities since 1965. Today both groups have the highest rates of complications of diabetes of almost any American Indian group (there are very few groups known that have higher rates for end-stage renal disease and amputations),⁵⁶ as well as associated health conditions such as congenital defects and uterine cancer.

One physician who has been studying the GRIR health status since 1965 recently suggested that early detection and treatment of type II diabetes have failed there.⁵⁷ This failure was mentioned in the context of trying to improve the health of a community where diabetes is a highly prevalent disease. Of course, individual diabetics have benefited greatly from proper treatment. Death from diabetic coma and even instances of diabetic acidosis have rarely been reported from these reservations.

Clearly, another or different approach needs to be taken now in order to halt or at least to slow the progression of the Warm Springs tribe through Phase III to Phase IV. The recommended approach is threefold:

(1) Provision of specialists in diabetology to study each person who has been diagnosed as diabetic for 8 years or more, and to *provide an individual treatment plan to prevent complications* (emphasis mine).

(2) Concentration upon the prompt recognition and treatment of both diabetes and glucose intolerance in pregnant women using the definition of each from the National Diabetes Advisory Board.⁵⁸

Treatment should include home blood glucose monitoring and variable insulin doses for as many pregnant women as possible who will benefit from this approach. Early prenatal visits need to be stressed when the initial screening is done. At the twenty-fourth week of gestation, screening should be repeated.

(3) A community-wide campaign must be promoted with enthusiasm to accomplish the following:

a. Weight reduction for all ages, all ethnic and tribal backgrounds, both sexes, and involving the whole family and *all* families. Techniques such as community-wide days of fasting should be considered.

b. Increased caloric expenditures through recreation and through physical exertion and fitness programs for both children and adults. A full-time recreation director is needed, with a budget to promote fitness programs for all age groups, for schools, for tribal businesses, for all employees.

c. Reduction in the availability of high caloric foods on the reservation, including alcohol. Consideration of a special tribal tax as one approach to this problem.

d. Promotion of the best diet consistent with the cash income of most families. An expert in nutrition who is experienced with

the Warm Springs tribe should be involved full time with the IHS and tribal programs, to work with the full-time clinical nutritionist at the IHS clinic.

e. Establishment of a register for diabetic patients and a system of tracking the height and weight of as many people as possible who enroll in fitness programs. These registers should be used for clinical research purposes and—more importantly—as a motivational tool to continue the community fitness activities outlined above.

The recommendations described in items 3a through 3d above are made especially for the Warm Springs tribe, because this group possesses characteristics that would contribute to the success of these suggestions: a strong group identity, support of their tribal government, a willingness to forego immediate gratification to achieve future benefits (as in the distribution of the land settlement money), and a commitment to the future, as evidenced by their economic reports and published concerns.

At present, it is not known whether a community diabetes Phase V could be defined as a return to the era when diabetes rates were so low as to be considered absent from the community; such a progression should take place without the high mortality and morbidity from epidemic diseases that afflicted all ages during those difficult earlier years.

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