Diabetes in American Indians of Washington, Oregon, and Idaho

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The prevalence of diabetes among 29,000 American Indians living on or near 10 reservations in the Pacific Northwest was established from clinical data sources. The age- and sex-adjusted prevalence rate in 1987 was three times higher [95% confidence interval (CI) 2.8–3.1] than the comparable United States rate in 1980. The age-adjusted prevalence for women was 1.3 times that for men (95% CI 1.2–1.4). The prevalence varied by culture area. Reservation communities whose principal tribe came from the Great Basin culture area had 3.6 times more diabetes than found in the U.S. as a whole. Reservation communities whose principal tribe was from the Plateau culture had 3.0 times more diabetes than found in the U.S., and those from the Northwest Coast culture had 1.9 times more diabetes than found in the U.S. The reasons for these variations are unknown and warrant investigation. *Diabetes Care* 12:282–88, 1989

Non-insulin-dependent diabetes mellitus (NIDDM) is a major health problem in many American Indian communities (1). Although diabetes was rare before World War II in Indian communities, since 1940, they have experienced an epidemic of the disease (2). The Pima Indians of southern Arizona now have the highest known prevalence of NIDDM in the world: >50% of Pima Indian adults >35 yr have NIDDM (3).

The Indian Health Service (IHS) of the United States Public Health Service provides an excellent opportunity to study the epidemiology of diabetes in association with the delivery of health care. IHS offers various services to patients through hospitals and clinics, including medical care, dental care, nutritional and mental health counseling, and prescription medicines. IHS also pays for additional services in non-IHS facilities. Clinical and demographic data are collected for each IHS outpatient and inpatient encounter and for outside services paid by IHS. In recent years, a patient registration system has recorded every person who receives any services through an IHS facility or for whom IHS provides payment for care in an outside facility. The availability and quality of the data collected permit community-based studies (4).

Although the prevalence of diabetes has been estimated for some tribes, precise and recent data are not available for most reservation communities, especially those in the Pacific Northwest (5). This study reports the prevalence of diabetes among American Indians living on or near 10 reservations in Washington, Oregon, and Idaho.

Glucose 1 mM = 18 mg/dl

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MATERIALS AND METHODS

We identified 10 reservations in Washington, Oregon, and Idaho where an IHS health center provides medical care to the reservation population and has complete clinical data for the last 4 yr. The study population was a subset of the total population registered at these facilities. With each facility's computer-based patient reg-

istration list, we identified all patients who met the following inclusion criteria: *1*) American Indian or Alaska Native alive at the time of the study (January to February 1987), *2*) recipient of services at the facility within the previous 3 yr, and *3*) residence within 40 miles of the IHS facility according to zip code of home address.

Known diabetic patients in each reservation community were identified from two sources, the IHS clinical data system and each facility's register of diabetic patients. We obtained a list of all patients who had at least one outpatient visit with a diagnosis of diabetes or a hospitalization related to diabetes in the preceding 4 yr. The medical records of all listed patients were then reviewed to confirm the diagnosis of diabetes. Community members of the health-care team and clinicians excluded patients who had moved away, died, or did not meet the inclusion criteria. Reservation communities are close-knit and culturally homogeneous, characteristics that enable community members and the facility's staff to identify patients who have moved or are deceased. We searched registration data by a computer program that excluded all patients who were not American Indian or Alaska Native or were deceased or whose zip code of residence was not within 40 miles from the facility.

All IHS providers used the National Diabetes Data Group (NDDG) criteria for diagnosis (6). We did not verify every diagnosis made before 1980 with a glucose tolerance test. However, the chart reviews showed that all patients were either on medication for diabetes or had plasma glucose values >200 mg/dl in the chart.

A common system for classifying tribes is based on culture areas (i.e., groupings of tribes that shared significant cultural traits within a geographical area before European contact; 7). We analyzed the data by individual reservation community and by culture area of the principal tribe living on the reservation.

We used the 1980 census population of the U.S. to calculate the 1980 U.S. diabetes prevalence rate (8). The estimate of the numbers of diabetic patients in the U.S. came from the 1979–1981 National Health Interview Survey (9). We used the same 1980 population to standardize our prevalence rates for age and sex by the direct method (10). We calculated U.S. diabetes prevalence rate from the basic data so that we could calculate the 95% confidence interval (CI). We calculated variances for directly standardized rates and of ratios of rates by the formulas of Armitage (10). Means ± SE were the square root of the variances. The 95% CI was the rate or ratio ± 1.96 times the SE. CIs may appear asymmetric because of rounding. We defined a difference as statistically significant if $P < .05$. We accounted for multiple comparisons by testing for significance with a smaller α-level (.05 divided by number of comparisons; 11).

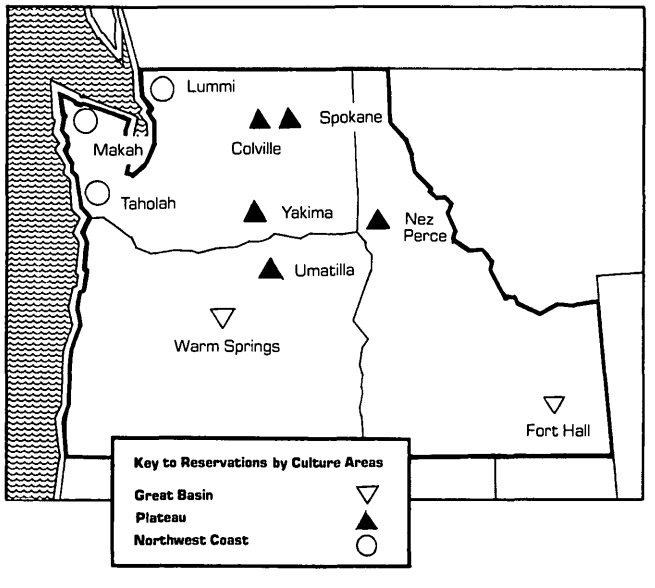

FIG. 1. Location of 10 reservations studied in Washington, Oregon, and Idaho.

RESULTS

The IHS facilities serving the 10 reservations shown in Fig. 1 had 48,791 registered patients. Table 1 lists characteristics of the 28,954 patients who met the criteria for inclusion. Most of those excluded had a zip code of residence outside the geographical limits of the study. Only 15% of the population were >44 yr of age compared with 31% of the 1980 U.S. population, a finding consistent with data showing American Indian populations younger than the U.S. population as a whole (12).

In the study population, 1092 patients with diabetes were identified, giving a prevalence of 3.8%. Table 2 shows that age-specific prevalence rates for women exceeded the rates for men in every age group except 35–44 yr of age. The total number of diabetic patients is shown in Appendix 1.

TABLE 1
Characteristics of selected Indian reservation communities in Washington, Oregon, and Idaho (1987)

Reservation	Principal tribe	Total study population	Culture area
Fort Hall, ID	Shoshone-Bannock	4973	Great Basin
Warm Springs, OR	Warms Springs	3110	Great Basin
Nez Perce, ID	Nez Perce	2076	Plateau
Yakima, WA	Yakima	8119	Plateau
Umatilla, OR	Umatilla	2185	Plateau
Spokane, WA	Spokane	1048	Plateau
Colville, WA	Colville	2268	Plateau
Makah, WA	Makah	1034	Northwest Coast
Toholah, WA	Quinault	1164	Northwest Coast
Lummi, WA	Lummi	2977	Northwest Coast
Total		28,954	

TABLE 2
Prevalence rates of diabetes per 100 population by age and sex for Indian reservation communities in Washington, Oregon, and Idaho (1987)

Reservation community	Sex	Age (yr)					
		0–24	25–34	35–44	45–54	55–64	≥65
Fort Hall	Women	0.3	2.4	5.9	25.3	36.9	35.9
	Men	0.1	1.9	4.5	20.3	17.6	22.8
Warm Springs	Women	0.1	0.6	4.5	21.2	28.6	28.3
	Men	0.0	0.4	3.0	13.3	23.3	17.6
Nez Perce	Women	0.4	2.6	9.5	26.1	46.7	35.1
	Men	0.0	1.4	7.1	12.7	36.1	17.3
Yakima	Women	0.0	1.3	4.4	14.2	23.2	25.4
	Men	0.1	1.0	6.6	18.7	30.7	16.8
Umatilla	Women	0.0	1.2	3.8	16.5	10.9	30.2
	Men	0.2	0.5	0.9	12.8	23.4	20.9
Spokane	Women	0.0	2.0	3.6	10.0	16.0	28.2
	Men	0.0	0.0	6.1	13.0	10.0	13.0
Colville	Women	0.5	0.6	4.8	12.7	15.4	16.7
	Men	0.2	2.3	5.6	12.2	6.2	18.0
Makah	Women	0.0	1.1	0.0	10.0	26.1	23.3
	Men	0.0	0.0	0.0	2.6	13.6	23.8
Quinault	Women	0.0	1.7	5.8	16.7	27.8	14.8
	Men	0.0	2.5	3.7	4.1	8.7	4.5
Lummi	Women	0.3	1.0	1.2	9.0	8.8	15.1
	Men	0.1	0.0	4.6	13.2	8.6	13.2
Great Basin	Women	0.2	1.8	5.4	23.7	33.9	33.3
	Men	0.1	1.4	3.9	17.5	19.5	21.4
Plateau	Women	0.1	1.4	5.1	15.6	22.6	26.1
	Men	0.1	1.1	5.8	15.4	24.6	17.4
Northwest Coast	Women	0.1	1.2	2.1	11.0	15.6	16.9
	Men	0.1	0.6	3.5	8.2	9.7	13.5
Total study	Women	0.1	1.5	4.7	17.0	24.5	26.2
	Men	0.1	1.1	4.9	14.6	20.4	17.7

Age- and sex-adjusted prevalence rates of diabetes in the Indian communities are given in Table 3. The table includes rates for the U.S. population in 1980 and for Pima Indians adjusted to the same age and sex groupings calculated from published data (8,9,13). Diabetes prevalence for the total population was 7.1% (95% CI 6.7–7.5%), a figure significantly higher than the U.S. prevalence of 2.4% but significantly lower than the prevalence of 25.7% (95% CI 24.3–27.0%) for Pima Indians. The prevalance of diabetes in every reservation community was significantly greater than the 1980 U.S. prevalence after accounting for multiple comparisons with a two-tailed α-level of .05/10, $P < .005$.

Ten communities had age- and sex-adjusted diabetes prevalence rates that were significantly different from each other ($P < .00001$), as did the three culture areas ($P = .00001$). For analyzing variation between individual communities, there were 45 possible pairs of comparisons. We adjusted for multiple comparisons with an α-level of .05/45 ($P < .0011$), corresponding to a critical value of 3.259 in the *t* test. The diabetes prevalence rates in the Nez Perce and Fort Hall communities were significantly greater than the rates in other communities except Warm Springs and Yakima. The rate for Yakima was significantly greater than those for Colville and Lummi, and the rate for Warm Springs was significantly greater than that for Lummi. After adjusting for the three pairs of comparisons among the three culture areas (α-level .05/3, $P < .017$), all differences of prevalence between individual culture areas were statistically significant.

The ratios of the prevalence for each community and culture area to the 1980 U.S. prevalence are shown in Fig. 2. Diabetes was three times more prevalent (95% CI 2.8–3.2) in the total study population than in the U.S.

Age-specific rates in this population exceeded the U.S. rates primarily for the middle-aged shown in Fig. 3. Diabetes was 3.7 times more prevalent (95% CI 3.5–4.0) in the study population (aged 45–54 yr) than in the U.S. population of same age. The youngest age group in these reservation communities had a lower prevalence of diabetes than the same age group in the U.S. This finding is consistent with the reported paucity of insulin-dependent diabetes among American Indians (14).

Finally, diabetes was significantly more prevalent in women than in men for this population (Fig. 4). The ratio of the age-adjusted prevalence for women to that for men was 1.3 (95% CI 1.2–1.4). The comparable ratio in the U.S. was only 1.1 (95% CI 1.0–1.1) in 1980.

DISCUSSION

Diabetes is a major affliction for many Indian communities in the U.S. (1,5) and Canada (15–17). Although this study was not a community survey that used glucose tolerance testing, it provided reliable and valid data.

There were several potential biases that are small and have minimal net effect. We avoided underestimating the prevalence by including all diabetic patients. Some patients with diabetes might not have used IHS medical services. Because IHS services are accessible, free of charge, and cover a wide spectrum of health-related care, most patients with diabetes living in the communities studied used at least one IHS service and, thus, registered with the facility. In addition, by restricting our study to people living within 40 miles of the IHS facilities, we increased the likelihood that all diabetic patients of the study population were known to the IHS facilities. A Mayo Clinic study showed that 47% of known diabetic patients did not appear in outpatient and hospitalization data of 1 yr duration (18). We included those diabetic patients who used medical services sporadically by compiling the preliminary list for a 4-yr period. Both the IHS and tribal communities have emphasized diabetes. Thus, even without a formal screening program, there was a lower prevalence of diabetes unknown to the medical care system in these reservation communities than in the U.S. population at large.

TABLE 3
Diabetes prevalence rates per 100 population for reservation communities and culture areas in the Pacific Northwest (1987), Pima Indian reservation community, and U.S. (1980)

Reservation community or culture area	Adjusted prevalence	95% Confidence interval
Fort Hall	9.5	8.4–10.5
Warm Springs	7.5	6.1–8.9
Nez Perce	10.5	8.8–12.1
Yakima	7.5	6.7–8.3
Umatilla	6.5	5.2–7.8
Spokane	5.6	3.8–7.4
Colville	5.2	4.1–6.3
Makah	5.3	3.5–7.2
Quinault	5.0	3.2–6.7
Lummi	4.0	3.0–5.0
Great Basin	8.8	7.9–9.6
Plateau	7.2	6.7–7.8
Northwest Coast	4.5	3.7–5.3
Total study	7.1	6.7–7.5
Pima Indian reservation*	25.7	24.3–27.0
U.S. 1980†	2.4	2.3–2.5

Rates were adjusted by age and sex to the 1980 U.S. population by the direct method. All calculations used method by Armitage (10).
*Calculated from data in Knowler et al. (13).
†Calculated from data in Harris (9).

We avoided overestimating diabetes prevalence in three ways. One way was not to overdiagnose diabetes. The IHS clinicians followed the diagnostic criteria of the NDDG, which minimized overdiagnosis. The second way was not to miss numerous people who were patients but who did not have diabetes. Because a management study by the Portland area found that >90% of the Indian population in each community, as measured by the 1980 census, had registered at the facility within the 3 yr preceding this study (unpublished observations, IHS), this error would reduce the rates by 10% at most. The third way was to eliminate transient and deceased diabetic patients from the numerator. The list of diabetic patients was reviewed carefully by the clinicians and community members of the facility's staff. The diabetic patients who had moved away or died were removed from the list, although their most recent computerized registration data met the inclusion criteria. Because we could not review the entire patient population as carefully, the list of the total population may have included people who did not meet the inclusion criteria. (The latter error would lower the calculated diabetes prevalence.)

The study groups represented the total populations of selected reservations. Because the 10 reservations studied were culturally homogeneous, people living within 40 miles of the IHS facilities were similar to those living on the reservation but beyond the study's geographical limits. We did not include the Indians living in major urban areas or those living on or near the many smaller reservations of the region. Because urban Indians may be more mobile than residents of reservations and have multiple sources of medical care, it is difficult to estimate the number of diabetic patients or the population

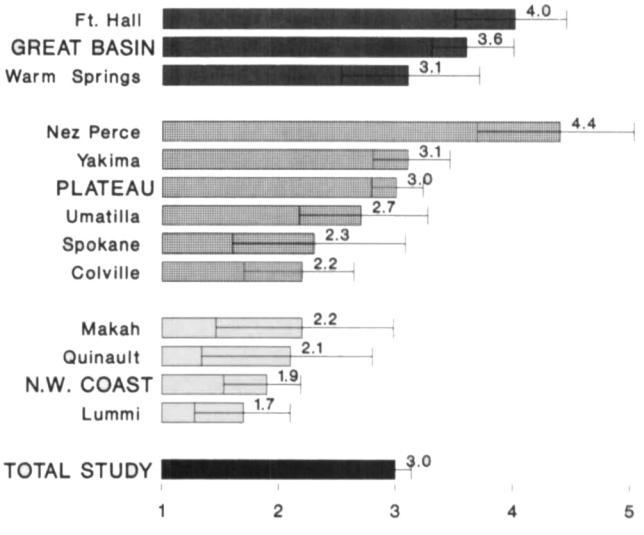

FIG. 2. Ratios, with 95% confidence interval, of prevalence rates of diabetes for Indian reservation communities and culture areas in Pacific Northwest compared to 1980 U.S. rate. Study rates determined in 1987 and directly adjusted to 1980 U.S. population by age and sex. All calculations used method by Armitage (10).

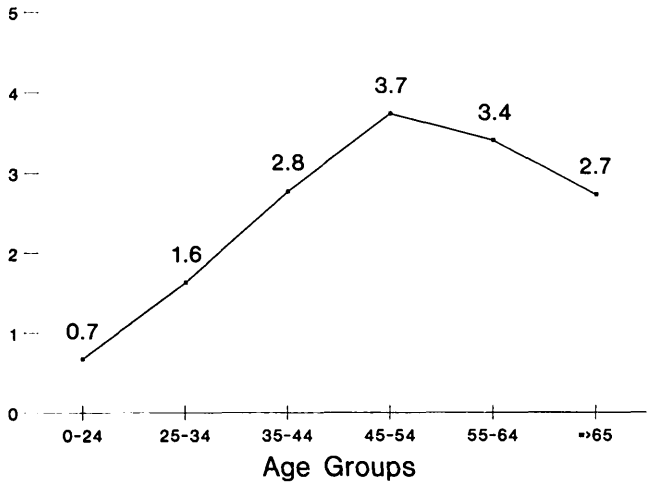

FIG. 3. Ratios, with 95% confidence interval, of age-specific diabetes prevalence rates for combined studied Indian reservation communities of Pacific Northwest to 1980 U.S. rates. Study rates were determined in 1987 and directly adjusted to 1980 U.S. population by sex. All calculations used method by Armitage (10).

accurately. Thus, our study population included only 29,000 of the ~75,000 IHS service population in the three states (12). These findings should apply to the entire populations of the 10 reservation communities studied but not necessarily to urban Indians or those living on or near the smaller reservations in the three states.

The differences among the reservations in the three states of this study are precise because the ascertainment method was the same for all reservations. Because our method of ascertainment of diabetic patients differed from those of the Pima Indian study (13) and National Health Interview Survey (9), comparisons between our results and the U.S. or Pima Indian findings must be made with care. However, as with the Pima Indian study, community health workers verified that diabetic patients met the inclusion criteria.

The causes of the variation of diabetes prevalence observed among culture areas and reservation communities remain obscure. Three potential causes are unlikely to account for the variation. No site had conducted special screening for diabetes. Although studies have reported a higher prevalence of diabetes among Indians who claimed higher percentages of Indian ancestry (blood quantum; 19,20), there was no major variation of self-reported blood quantum among residents of the reservation communities in this study. People living on or near a reservation who were enrolled members of other tribes might have accounted for a distortion of figures for a particular reservation community, but the registration data showed that a small proportion of the population of each community came from another culture area.

Three possible explanations for the variation in diabetes prevalence warrant investigation: obesity, social and cultural changes, and genetic background. We have no data to make any comparison of the prevalence of obesity among the reservation communities and culture areas. We do not know if the tribes experienced different social and cultural changes leading to different patterns of life-style relevant to diabetes. Finally, the genetic predisposition to NIDDM might vary among the culture areas and tribes. Three distinct groups migrated from Siberia to the Americas >10,000 yr ago (21). The tribes with higher prevalence might have come from a migration group different from the tribes with lower prevalence. Unfortunately, detailed genetic information about Indians from these communities is not available. Such information could help us understand the reasons for the variation of diabetes prevalence among American Indians.

Our study found a significantly higher age-adjusted rate of diabetes for women compared with men, a finding also of the Pima Indian study (13). In contrast, diabetes prevalence for women was not significantly higher than for men in the U.S. in 1980. Moreover, a study of the entire population of Rochester, Minnesota, found that the prevalence for men was 1.3 times higher than that for women (22).

Three factors might have contributed to the higher diabetes prevalence for women. Diabetic men in this population may have a lower survival rate than diabetic women, which would decrease the prevalence for men. Diabetes may remain undiagnosed more often in men than women, because women use medical care more often than men. However, this potential bias appears not to occur in the U.S. studies noted above. Finally, the variation of prevalence may reflect true variation of incidence, perhaps due to different patterns of eating and activity.

In conclusion, compiling reliable registers of diabetic patients not only may improve care but can be the basis for describing disease patterns in a community. The age- and sex-adjusted prevalence of diabetes in 10 reservation communities in Washington, Oregon, and Idaho

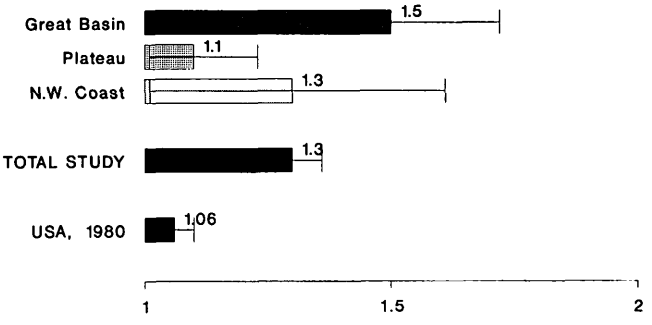

FIG. 4. Ratios, with 95% confidence interval, of diabetes prevalence rates of women compared to men for Indian culture areas in Pacific Northwest in 1987 and for U.S. in 1980. Rates directly adjusted to 1980 U.S. population by age. All calculations used method by Armitage (10).

was three times higher than the comparable rate in the U.S. population. There was a significant variation among the Indian communities and culture areas. Women had a higher age-adjusted prevalence than men. The high prevalence of diabetes found by this study further confirms that diabetes is a severe burden for American Indian communities. Documenting the burden can be an effective first step toward primary prevention of NIDDM at the community level (23). The epidemiology of diabetes in American Indians can help us understand the disease in all people (24).

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APPENDIX 1
Number of diabetic patients in study population

Reservation community	Sex	Age (yr) 0–24	25–34	35–44	45–54	55–64	≥65	Total
Fort Hall	Women	4	13	16	39	41	42	155
	Men	2	9	12	28	15	21	87
Warm Springs	Women	1	2	8	21	18	17	67
	Men	0	1	5	12	10	6	34
Nez Perce	Women	5	11	20	26	22	22	106
	Men	1	5	10	11	13	12	52
Yakima	Women	0	12	21	41	43	48	165
	Men	2	8	28	44	42	22	146
Umatilla	Women	0	3	5	14	6	19	47
	Men	1	1	1	11	11	9	34
Spokane	Women	0	2	2	3	4	11	22
	Men	0	0	4	3	2	3	12
Colville	Women	3	1	7	9	8	13	41
	Men	1	4	9	11	3	11	39
Makah	Women	0	1	0	4	6	7	18
	Men	0	0	0	1	3	5	9
Quinault	Women	0	2	4	6	5	4	21
	Men	0	3	3	2	2	1	11
Lummi	Women	2	3	2	7	6	11	31
	Men	1	0	7	11	5	7	31
Total	Women	15	50	85	170	159	194	673
	Men	8	31	79	134	106	97	455

Total population for each reservation community in same age and sex groups is available from the authors.

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