

Regional Variation in Cardiovascular Disease Risk Factors Among American Indians and Alaska Natives With Diabetes

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OBJECTIVE — To compare by region risk factors for cardiovascular disease among American Indian populations with diabetes.

RESEARCH DESIGN AND METHODS — Trained providers from 185 federal, urban, and tribally operated facilities reviewed the records from systematic random samples of the patients included in the local diabetes registries in the 1998 Indian Health Service (IHS) Diabetes Care and Outcomes Audit. Selected measures of cardiovascular risk were aggregated by region and adjusted to calculate regional rates for patients <45 years of age ($n = 2,595$) and those aged ≥ 45 years ($n = 8,294$).

RESULTS — Among the younger group of patients with diabetes, the rates of elevated HbA_{1c} ($\geq 9\%$) and tobacco use varied significantly among regions. High rates of obesity (78%) and elevated HbA_{1c} (56%) were found in the Southwest. High rates of tobacco use (55%) but the lowest rates of elevated HbA_{1c} (27%) were found in Alaska. Among patients aged ≥ 45 years, all measures including rates of proteinuria, cholesterol ≥ 200 mg/dl, and mean blood pressure $\geq 130/85$ varied significantly among all regions. Tobacco use was highest in the Great Lakes (44%) and Great Plains (42%) regions and lowest in the Southwest (14%) and Colorado Plateau (8%) regions. Proteinuria was found most frequently in the Southwest (35%), Colorado Plateau (30%), and Pacific regions (35%). Older individuals with diabetes were more likely than younger individuals to have proteinuria and blood pressure $\geq 130/85$.

CONCLUSIONS — American Indians and Alaska Natives with diabetes carry a large burden of potentially modifiable cardiovascular risk factors, but there is significant regional variation.

Diabetes Care 25:279–283, 2002

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Received for publication 9 May 2001 and accepted in revised form 6 November 2001.

D.M.G. or her immediate family holds stock in Pharmacia and Johnson & Johnson, and she has received honoraria from Bayer, Smith Klein Beecham, Aventis, Novartis, Bristol-Myers Squibb, Takeda, and Novo-Nordisk. At the time of this study, she was a consultant for the Indian Health Service Diabetes Program.

Abbreviations: CVD, cardiovascular disease; IHS, Indian Health Service; NHANES, National Health and Nutrition Examination Survey; SHS, Strong Heart Study.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Cardiovascular disease (CVD) is now the leading cause of death in American Indians and Alaska Natives (1). According to the Strong Heart Study (SHS) of CVD in Indians in Arizona, Oklahoma, and North and South Dakota, the high and rising mortality rate of CVD has been closely associated with the recent epidemic of diabetes in the native communities (2). The study found diabetes to be the strongest CVD risk factor among individuals aged 45–74 years (3,4). Of all the incident cases of CVD over a mean of 4.2 years of follow-up, 56% of the events occurred in men with diabetes and 78% in women with diabetes (2). The study also described significant regional variations in the rates of CVD and individual risk factors (3,4).

Other studies of CVD risk factors among selected tribes in the southwest and in the northern and central U.S. also have described multiple CVD risk factors, such as obesity and diabetes, in American Indians as well as marked regional variations in smoking rates (5,6). In Montana, Indian adults reported a history of CVD on a telephone survey twice as frequently as non-Indians from the same state (7). Although CVD was reported infrequently by respondents <45 years of age in the survey, younger Indians reported much higher rates of obesity, smoking, and diabetes than similarly aged non-Indians. Because the SHS did not include individuals <45 years of age, risk factor data for this age group is limited.

Among the Pima Indians in Arizona, CVD has replaced kidney disease as the leading cause of death in people with diabetes in the most recent years of an ongoing epidemiological study (8). In addition, greater degrees of hyperglycemia were associated with increasing CVD mortality in individuals with diabetes (9). Thus, to control the increasing cardiovascular morbidity and mortality in Indian communities, it is particularly important to address the risk factors for heart disease



Figure 1—Geographic regions of analysis for IHS Diabetes Care and Outcomes Audit

in individuals with diabetes. This report describes selected CVD risk factors among American Indians with diabetes collected by the Indian Health Service (IHS) Diabetes Care and Outcomes Audit of 1998 and compares the risk profiles with similar data published for people with diabetes in the general population.

RESEARCH DESIGN AND METHODS

The IHS, an agency of the U.S. Public Health Service, acting through a network of federal, tribal, and urban facilities, has developed and maintained a long-standing clinical and public health focus on diabetes. In 1986, the IHS first formulated standards for diabetes care, and the IHS Diabetes Care and Outcomes Audit has since evolved to measure their implementation. This standardized surveillance system measures both diabetes care and intermediate clinical outcomes (10,11). In recent years, revisions of both the standards of care and the audit measures have increased the emphasis on CVD risk factors. In 1998, the IHS conducted the Diabetes Care and Outcomes Audit at 185 federal, tribal, and urban health care facilities.

As described in a previous published report, participating facilities received written instructions to enable them to draw a random sample of charts of individuals with diabetes and to review selected measures of care and intermediate clinical outcomes (10). The sample was

drawn from the community diabetes registries and thus includes patients with diabetes who may not have received diabetes care at the facility in the past year. The instructions enabled facilities to calculate the local sample using a sample size sufficient to provide estimates of $\pm 10\%$ of the true rates of adherence for measures performed at a rate of 60%. Individuals trained by regional diabetes consultants in accordance with written instructions and definitions conducted the actual chart reviews. Where facilities had the ability to abstract variables from the IHS electronic management information system, they were encouraged to do so, and they were also encouraged to supplement the data by chart review.

CVD risk factors included in the 1998 audit were the three most recent blood pressure readings in the past year; the total cholesterol; the most recent HbA_{1c} value in the past year; smoking history; and results of the most recent urinalysis for protein. Blood pressure values were missing in 4% of records (ranging from 3 to 9% in different regions), total cholesterol in 18% (10–32%), HbA_{1c} in 6% (2–20%), BMI in 10% (3–27%), proteinuria in 18% (10–29%), and tobacco use in 28% (10–57%). Other variables collected included age, sex, duration of diabetes, and height and weight. The mean of the last three blood pressure readings and the BMI were calculated from these data. BMI

$\geq 30 \text{ kg/m}^2$ was used as the cutoff for obesity.

Data from participating facilities were grouped into the geographic regions shown in Fig. 1. Regional and national benchmarks for each item were constructed using aggregate data from all participating sites for those < 45 years of age and for those ≥ 45 years of age. Data for each age group were weighted by the inverses of the sampling rates. The number of patients in the diabetes registry was divided by the number of patients in the sample for each facility. Weighted prevalence rates, standard errors, and χ^2 tests of significance were calculated using PROC Crosstab from the SAS-callable version of SUDAAN, version 7.5 (12).

RESULTS—Of the 10,889 patients with diabetes included in the 1998 IHS Diabetes Care and Outcomes Audit, 24% ($n = 2,595$) were < 45 years of age (ranging from 17 to 31% by region), and 76% (70–83%) were aged 45 years and older ($n = 8,294$). These patients reflected the experience of $\sim 66,500$ diabetes patients who received care nationwide at participating facilities and were included on the local diabetes registries.

Among patients aged < 45 years, selected CVD risk factors are shown in Table 1 by region. The percentage of patients experiencing blood pressures $\geq 130/85$ was lowest in the Pacific region (37%). Obesity rates were higher in the Southwest (78%) and the Pacific (78%). Current tobacco use varied markedly between regions, with the lowest rates in the Southwest (29%) and Colorado Plateau (12%) regions. The percentage with elevated HbA_{1c} was lowest in Alaska (27%). There was no significant regional variation in rates of proteinuria or total cholesterol $\geq 200 \text{ mg/dl}$.

Among patients aged ≥ 45 years, there was significant regional variation for all of the measures (Table 2). Patients in the Southern Plains had the highest rates of blood pressures exceeding 130/85 (76%). Rates of cholesterol $\geq 200 \text{ mg/dl}$ were lowest in the Southwest (38%). Obesity rates were lowest in the Colorado Plateau region (44%). As in the younger groups, tobacco use also varied markedly, with the lowest rates again in the Southwest (14%) and Colorado Plateau (8%) regions. Patients from Alaska had the lowest rates of elevated HbA_{1c} (17%) and also had the lowest rates of proteinuria (19%).

Table 1—Selected cardiovascular risk factors among American Indians and Alaska Natives with diabetes aged, < 45 years by region for 1998

Region	n	Blood pressure ≥130/85 (%)	Cholesterol ≥200 (%) (SE)	BMI ≥30 (%)	Tobacco use* (%)	HbA _{1c} ≥9.0%* (%)	Proteinuria (%)	Mean age (years)
All	2,595	47 ± 1.4	48 ± 1.5	73 ± 1.3	37 ± 1.5	51 ± 1.4	26 ± 1.3	35.4 ± 0.7
Alaska	142	46 ± 4.6	46 ± 5.1	70 ± 4.2	55 ± 5.0†	27 ± 4.6†	19 ± 4.2	37.4 ± 0.4
Colorado Plateau	244	51 ± 3.8	43 ± 4.5	67 ± 3.5	12 ± 2.8†	52 ± 3.8	27 ± 3.8	35.8 ± 0.7
Great Lakes	132	60 ± 5.0	53 ± 5.4	79 ± 4.6	53 ± 5.4†	34 ± 4.9†	17 ± 3.9	35.4 ± 0.3
Great Plains	549	49 ± 2.7	58 ± 3.0†	68 ± 2.6	59 ± 3.0*†	52 ± 2.7	24 ± 2.4	36.6 ± 0.4
Southern ± Plains	261	53 ± 4.0	52 ± 4.1	68 ± 3.7	41 ± 4.0	41 ± 3.8†	28 ± 3.6	36.7 ± 0.3
Pacific	491	37 ± 2.6†	54 ± 3.0	78 ± 2.2	35 ± 2.8	51 ± 2.7	30 ± 2.8	35.3 ± 0.2
Southwest	776	44 ± 2.4	42 ± 2.7†	78 ± 2.2*	29 ± 3.1*	56 ± 2.4†	25 ± 2.2	36.0 ± 0.1

Data are means ± SEM. * $P < 0.0001$ comparison among regions; † $P < 0.01$ compared with all others.

In general, the younger patients were more likely to be obese ($P < 0.0001$), to be current users of tobacco ($P < 0.0001$), and to have HbA_{1c} values $\geq 9.0\%$ ($P < 0.0001$) than the patients aged ≥ 45 years. Older patients with diabetes were more likely to have blood pressure measurements exceeding 130/85 ($P < 0.0001$) and to have proteinuria ($P < 0.0001$). There was no significant difference between the two age groups in the rates of cholesterol ≥ 200 mg/dl.

CONCLUSIONS— The IHS analyses show that American Indians with diabetes carry a substantial burden of modifiable CVD risk factors, but there are differences in patterns of risk factors in regions of the U.S. The SHS investigators described lower smoking rates and lower mean cholesterol values in Arizona than in Oklahoma and the Dakotas (13). Smoking rates found in our study are consistent with this and other studies. The Inter-Tribal Heart Study showed high rates of smoking in the Great Lakes region (5). The Navajo Health and Nutrition Survey found low rates of smoking in the south-

western region of the U.S. (6). The SHS found hypertension to be common among diabetic patients, with the highest rates recorded in Oklahoma (13). Similarly, our analyses found individuals with diabetes in the Southern Plains region to be most likely to have blood pressures exceeding 130/85.

Our study found that the lowest percentage of patients with diabetes, both younger and older, with a total cholesterol of ≥ 200 mg/dl were in the Southwest. Studies from the Pima showed lipid levels to be lower in this southwestern tribe than in the general U.S. population (14). Total cholesterol values in the SHS were lowest among diabetic participants from Arizona compared with other sites (4).

Obesity rates were high in all regions. Similarly, obesity was highly prevalent in the SHS and among American Indians responding to the Behavioral Risk Factor Surveillance surveys nationwide (4,15). Proteinuria varied by region in our study, and patients aged ≥ 45 years in the Southwest and Pacific regions had the highest rates. The SHS also described regional differences in rates of albuminuria, with the

highest rate found in Arizona (16). As in our study, median HbA_{1c} values were highest in the Southwest cohort of the SHS (17). We do not know what effect staffing patterns, the use of new oral agents, or what other possible explanations contribute to the regional variation in metabolic control, but the observation suggests the need for careful analyses to identify what factors can be associated with the variations.

There are important limitations to this study. The data are based on chart review. Individuals who had not registered for any care at a federal, tribal, or urban facility were not included in the samples. However, because care is available without charge and the facilities are often the only source of care in isolated regions, these data probably reflect the risk factors found clinically among American Indians and Alaska Natives with diabetes residing on or near reservations. We were not able to measure all known risk factors, particularly LDL cholesterol and microalbuminuria. However, these measures have been incorporated into more recent versions of the IHS Diabetes Care

Table 2—Selected cardiovascular risk factors among American Indians and Alaska Natives with diabetes aged ≥ 45 years by region for 1998

Region	n	Blood pressure ≥130/85* (%)	Cholesterol ≥200* (%)	BMI ≥30* (%)	Tobacco Use* (%)	HbA _{1c} ≥9.0* (%)	Proteinuria* (%)	Mean age (years)
All	8,294	66 ± 0.7	45 ± 0.8	56 ± 0.8	24 ± 0.7	37 ± 0.7	30 ± 0.8	62.6 ± 0.4
Alaska	689	70 ± 1.9	52 ± 2.2†	71 ± 2.0†	29 ± 2.1	17 ± 1.6†	19 ± 1.7†	61.8 ± 0.3
Colorado Plateau	955	63 ± 1.8	44 ± 2.2	44 ± 1.9†	8 ± 1.2†	39 ± 1.8	30 ± 2.0	59.8 ± 0.5
Great Lakes	415	68 ± 2.6	48 ± 3.0	58 ± 3.2	44 ± 2.9†	36 ± 2.7	24 ± 2.7	59.6 ± 0.2
Great Plains	1,611	63 ± 1.5	51 ± 1.7†	59 ± 1.5	42 ± 1.7†	41 ± 1.5	26 ± 1.4†	60.2 ± 0.3
Southern Plains	1,067	76 ± 1.6†	43 ± 1.9	60 ± 1.9	28 ± 1.8	31 ± 1.7†	28 ± 1.7	60.1 ± 0.2
Pacific	1,813	60 ± 1.4†	56 ± 1.5†	69 ± 1.3†	24 ± 1.3	33 ± 1.3†	35 ± 1.5†	59.7 ± 0.2
Southwest	1,744	64 ± 1.5	38 ± 1.6†	57 ± 1.7	14 ± 1.5†	42 ± 1.6†	35 ± 1.6†	60.3 ± 0.1

Data are means ± SEM. * $P < 0.0001$ comparison among regions; † $P < 0.01$ compared with all others.

and Outcomes audit and are now being measured and recorded frequently enough for the data to be available in the future.

Another limitation of this study was the high rate of missing data about tobacco use in the Southwest and Colorado Plateau regions, which limits comparisons. Providers in these regions may perceive smoking rates to be low and thus chart tobacco history less consistently than others. This could introduce a bias in which patients who are known to smoke have their smoking habits charted, and this would have the effect of falsely elevating the rate. However, the regional tobacco use trends we observed parallel those in studies with more complete ascertainment (4–6,18). BMI data were missing most frequently from the Great Lakes region because of missing height values (25%), but there was no significant difference in the mean weight values of those with and without height values. Cholesterol data were missing in ~25% of records from the Southwest and Colorado Plateau regions. Some of the facilities in these regions are very remote from reference labs. Interestingly, these regions were among those with lower rates of elevated cholesterol. The SHS also found lower cholesterol values in the Arizona cohort (19).

Despite the limitations, these findings support the importance of recognizing the public health implications of CVD risk factors among American Indians and Alaska Natives with diabetes in comparison to the U.S. population. Of the 722 adults aged ≥ 25 years with diabetes reported in the National Health and Nutrition Examination Survey (NHANES) III cohort, only 25% had poor glycemic control (HbA_{1c} value $\geq 9.0\%$), compared with 37–51% in this study (20). In addition, only 39% of the NHANES III cohort had uncontrolled blood pressure ($\geq 140/90$), a rate lower than the 47–56% in our analysis. Similarly, the 7.6% rate of clinical proteinuria in the NHANES subjects was lower compared with the 29% we observed in the American Indians. Only 22% of those with diabetes in the NHANES III study reported current smoking. Comparisons with the overall rate of “tobacco use” of 31% found in American Indians with diabetes are obviously complicated by the marked variations. Nonetheless, American Indians and Alaska Natives with diabetes from all the

regions carry multiple CVD risk factors, and the burden appears to be much greater in these communities than in the general U.S. population.

Because of the large population-attributable risk for diabetes as a CVD risk factor, reducing rates of CVD by focusing on those with diabetes is particularly important for Indian communities. Increased efforts to promote smoking cessation in younger patients with diabetes, and probably youth in general, are especially needed in the Great Lakes, Great Plains, and Alaska regions. Although improving glycemic control is relevant to all regions, special focus on the Southwest is merited. Similarly, the high proportion of patients with poorly controlled blood pressure, elevated cholesterol, and obesity is a concern for all regions, and national programs for hypertension, lipid, and weight control are urgently needed.

Efforts to reduce CVD risk in those with diabetes are not unique to Indian communities (21). Both the American Heart Association and the American Diabetes Association have recently emphasized the necessity of targeting CVD risk reduction efforts toward individuals with diabetes (22). The newly expanded regional/tribal approach to diabetes prevention and control can be enhanced with a focus on preventing heart disease by reducing CVD risk factors (23). Although trends observed in this study can be useful to regional health planners, clinicians at individual facilities should supplement their planning with local data.

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