The Increasing Incidence of Coronary Artery Disease and Cardiovascular Risk Factors Among a Southwest Native American Tribe

The White Mountain Apache Heart Study

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Background: Rates of cardiovascular disease and its risk factors seem to be increasing in American Indian populations, yet these changes have received little documentation.

Objectives: To evaluate incidence rates of coronary artery disease, acute myocardial infarction, and cardiac events during a 10-year period (1987-1996); to assess cardiac risk factors for an American Indian tribe in Arizona.

Methods: A retrospective medical chart review was performed for tribal members from January 1, 1987-December 31, 1996. Patient records with even minor indications of coronary disease were reviewed independently by 2 cardiologists of the Native American Cardiology Program. Multiple databases were reviewed in an effort to find all diagnoses, and incidence rates were calculated and analyzed for increasing trends. Cardiac risk factors were assessed in a population convenience sample.

Results: From 1987 through 1996, the number of incident cases increased from 3 to 18 for coronary artery disease, 1 to 10 for acute myocardial infarction, and 3 to 26 for cardiac events. Statistically significant increasing trends were calculated for each. Of our youthful convenience sample, 49% had 2 or more cardiac risk factors.

Conclusions: This study confirms increasing rates of coronary artery disease and its comorbidities in this American Indian population and demonstrates high prevalence of cardiovascular risk factors among tribal members without extant coronary disease. This suggests that coronary disease will likely continue to increase as this population ages. To prevent such increases, culturally appropriate, aggressive preventive interventions are needed.

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Despite recent, large-scale efforts to eliminate health disparities in minority populations, current clinical impressions and studies suggest that the incidence of cardiovascular disease (CVD) and its associated risk factors may be increasing among American Indian populations. This is in distinct contrast to the historically held belief that American Indian groups have low rates of CVD.

Numerous studies dating from the early 20th century through the early 1990s have documented an exceedingly low incidence and prevalence of coronary artery disease (CAD) and acute myocardial infarction (AMI) in American Indian populations relative to the general US population. According to a 1963 study, the rate of death from heart disease in the general US population was 2.5 times greater than the rate for American Indians. A more recent study found that among Navajo patients, the rate of discharge for AMI from major tertiary care medical facilities in and around the reservation between 1976 and 1983 was relatively low (0.6 and 1.8 cases per 1000 persons per year for patients aged 45-64 years and ≥65 years, respectively) compared with the general US population (4.3 and 9.4 cases per 1000 persons per year, for the same age groups). As recently as 1993, research has continued to show lower rates of AMI among American Indians and Alaskan natives relative to the general US population (11.8 hospital discharges per 10000 population for American Indians and Alaskan natives vs 29.1 per 10000 population for the general US population). Of particular interest is a publication demonstrating a previously low rate of CAD among the White Mountain Apache Tribe (WMAT), the group under consideration in the current research; between 1952 and 1960, not a single case of CAD was identified at the Indian Hospital on the White Mountain Apache Reservation. Concordant with these previously low rates of CAD and AMI were low rates of car-
METHODS

This study involved a determination of the incidence rates for CAD, AMI, and cardiac events during a 10-year period and a determination of the current cardiovascular risk factor prevalence in a convenience sample of WMAT members.

INCIDENCE DETERMINATION

A retrospective medical chart review was performed of WMAT members aged 45 to 79 years who initially presented to the Whiteriver Public Health Service Hospital (WPHSH) from January 1, 1987 through December 31, 1996, including transfers and referred admissions to the cardiovascular referral hospital, the University Medical Center (UMC) in Tucson, Ariz. Because almost every cardiac referral from WPHSH is sent to UMC, referrals to any other hospitals were determined to be too infrequent for the purposes of this study.

The following databases were reviewed for potential cases: the emergency department log, inpatient admissions log, and transfer log from WPHSH; the Indian Health Service Death Log for patients with nontraumatic mortality; and the database of inpatients transferred from WPHSH to UMC. From these sources, a list of patients with possible CAD was generated and available medical records were reviewed; patients with even minor indications were reviewed as well. The following indicators were used to select potential cases: chest pain, shortness of breath, congestive heart failure, arm pain, jaw pain, indigestion, and back pain, as well as diagnoses of AMI, angina, unstable angina, or CAD. Trained field abstractors evaluated all records and identified probable cases. Final diagnoses were subsequently made independently by 2 cardiologists of the Native American Cardiology Program at the University of Arizona (E.A.B. and J.M.G.).

A diagnosis of AMI required at least 2 of the following criteria: prolonged cardiac pain, cardiac enzyme levels greater than twice the upper limit of normal range, or evolving, diagnostic resting electrocardiograms. A diagnosis of new CAD required a cardiac catheterization revealing at least 50% stenosis in 1 or more coronary arteries or their major branches or, in the absence of a cardiac catheterization, a classic AMI presentation with positive isoenzymes and evolving, diagnostic electrocardiograms. It was also required that the patient have no history of CAD before the presentation investigated. A diagnosis of a cardiac event was a definite or possible AMI as commonly defined by other researchers,11 a diagnosis of unstable angina (a clinical syndrome of chest pain of increasing frequency, increasing severity, or chest pain at rest confirmed by cardiac catheterization with at least 70% stenosis in a major or branch epicardial vessel), or a non-Q-wave myocardial infarction confirmed by cardiac catheterization.

Annual population estimates were provided by the WMAT Office of Vital Records and serve as denominators for incidence calculations. Incidence was calculated for CAD, AMI, and cardiac events per 100000 population for 2-year intervals, and 95% confidence intervals were calculated using the Poisson distribution.

RISK FACTOR PREVALENCE DETERMINATION

To provide a conservative estimate of risk factor prevalence, a convenience sample of 70 WMAT members aged 18 to 46 years (mean age, 27.3 years) was selected for persons applying for an occupation requiring sustained, vigorous physical activity. A physician interviewed and examined each participant. Recorded data included age, weight, body mass index (calculated as weight in kilograms divided by the square of height in meters), sex, personal and family history of CVD, smoking history, and presence of diabetes mellitus, hypertension, and dyslipidemia. Laboratory analyses included lipid profiles, urinalysis, and serum glucose, blood urea nitrogen, and creatinine measurement. Resting electrocardiograms were also performed.

Six cardiovascular risk factors were evaluated to create cardiovascular risk profiles. Obesity was defined as a body mass index of 30 or more. Hypertension was defined as medical chart–documented diagnosis of hypertension with 3 consecutive blood pressure measurements of 140/90 mm Hg or higher or hypertensive medication use. Dyslipidemia was defined as total cholesterol level of more than 240 mg/dL (6.22 mmol/L), low-density lipoprotein cholesterol level of more than 160 mg/dL (+.14 mmol/L), high-density lipoprotein cholesterol level of less than 40 mg/dL (1.04 mmol/L), triglyceride levels of more than 250 mg/dL (2.83 mmol/L), and/or lipid medication use. Diabetes mellitus was defined as medical chart–documented diagnosis of diabetes mellitus, use of medications for diabetes, or fasting glucose levels of more than 126 mg/dL (6.99 mmol/L). Personal history of smoking was defined as any reported long-term cigarette use within the past year. Family history of CVD was defined as having any blood family member with premature CAD or cardiac event history.

DATA ANALYSIS

To determine whether the changing incidence rates of CAD, AMI, and cardiac events were statistically significant, we used the Mantel extension of the $\chi^2$ test for trend using the Epi Info statistical program (version 6; Centers for Disease Control and Prevention, Atlanta, Ga), which provides an extended Mantel-Haenszel $\chi^2$ figure and $P$ value.19 Poisson confidence intervals were calculated because of the relatively low ratio of cases to total population. A variety of descriptive statistics are reported for the risk factor prevalence determination, including percentages and means. Because a relatively young and healthy participant sample was taken, we believe the calculated prevalence rates most likely underestimate the true prevalence rates for the general WMAT adult population.
Hypercholesterolemia was also less common historically among American Indians than in the general US population. In 1986, Coulehan et al suggested that cholesterol levels among American Indians averaged 20% to 40% lower than comparable white groups. More recent studies, however, have revealed that lipid levels among American Indians are increasing. In 1992, 33.8% of Navajo men aged 25 to 74 years studied had significantly elevated total cholesterol levels (>240 mg/dl [6.22 mmol/L]), whereas only 27.6% of the general population surveyed in the Second National Health and Nutrition Examination Survey had levels this high.

The most profound recent trend has been the increasing rates of diabetes mellitus and obesity among many American Indian populations, often to epidemic proportions. Although surveys of tribal members have supported low rates of diabetes in prior generations, recent data from the Strong Heart Study identified prevalence rates of diabetes ranging from 25% to 67% among participants aged 45 to 74 years. Among these Strong Heart Study participants, diabetes conferred a 3.8-fold increased likelihood of definite myocardial infarction and 4.6-fold increased likelihood of definite CAD compared with nondiabetes. Furthermore, in a 1993 study, Justice found evidence supporting recent increases in diabetes rates among American Indians; a study of the Tohono O’odham Tribe in Arizona found that most patients with diabetes (62.8%) had a duration of disease of less than 10 years, and 42.4% of the patients with diabetes had a duration of disease of less than 5 years. Finally, although the age-adjusted diabetes-related death rates increased 5% (to a rate of approximately 40 per 100000 population) for the general US population between 1988 and 1993, they increased by 15% (to a rate of approximately 60 per 100000 population) for American Indians, the largest increase of any ethnic group.

In accordance with increasing cardiovascular risk factors, increasing rates of CAD and cardiac events among American Indians are beginning to be documented. Data from the Indian Health Service (CAD death rate of 135.6 per 100000 population from 1992-1994) and the American Heart Association (CAD death rate of 102.2 per 100000 population for 1998) identify CAD as the leading cause of death among American Indians. In fact, age-adjusted death rates for CAD and all cardiovascular diseases are now higher for the American Indian than for the general US population. Death rates for American Indians in 1992 through 1994 were 137.6 per 100000 population and 194.6 per 100000 population for CAD and CVD, respectively.

Death rates for the general US population for these same diseases in 1993 were 145.3 per 100000 population and 181.8 per 100000 population. Furthermore, the Strong Heart Study found current cardiovascular incidence rates for American Indians to be almost twice those of the general US population. Incidence of CVD (fatal and nonfatal) was 7 and 16 per 1000 person-years for American Indian women and men, respectively, whereas rates for the general US population were 3 and 9 per 1000 person-years. Data on the cardiovascular health status of American Indians necessary to develop broad and effective preventive intervention strategies are limited. Specifically, the recent and marked changes in CVD epidemiology have not been well documented. The White Mountain Apache Heart Study was thus developed to study the incidence of CAD, AMI, and cardiac events and the prevalence of cardiovascular risk factors in the WMAT of Arizona.

### RESULTS

The number of new CAD diagnoses increased from 3 in 1987-1988 to 18 in 1995-1996. The number of AMIs increased from 1 in 1987-1988 to 10 in 1995-1996. The number of cardiac events increased from 3 in 1987-1988 to 26 in 1995-1996. The WMAT population of persons aged 45 to 79 years increased from 2813 in 1987-1988 (average, 1406.5 per year) to 3522 persons in 1995-1996 (average, 1761 per year). Incidence rates for new CAD diagnosis increased from 106.65 per 100000 population in 1987-1988 to 18 in 1995-1996. The number of AMIs increased from 1 in 1987-1988 to 10 in 1995-1996. The incidence of CAD increased from 35.55 per 100000 population in 1987-1988 to 283.93 per 100000 population in 1995-1996. The incidence rates for cardiac events increased from 106.65 per 100000 population in 1987-1988 to 26 in 1995-1996. All trends produced statistically significant extended Mantel-Haenszel $\chi^2$ values, despite overlap between some confidence intervals. These results provide evidence for an increasing trend in incidence of CAD, AMI, and cardiac events. Table 1 and Figures 1, 2, and 3 provide further details and confidence intervals.

The convenience sample of 70 job applicants consisted of 41 men (39%) and 29 women (41%), ranging in age from 18 to 46 years, with a mean age of 27.3 years, all but 3 subjects were 40 years or younger. The most prevalent risk factors found were obesity (51%), tobacco use (44%), dyslipidemia (21%), and hypertension (20%). Nearly one third of subjects had 2 risk factors, and nearly 30% had

### Table 1. Incident Cases and Incidence Rates of CAD, AMI, and Cardiac Events for Periods Investigated*

<table>
<thead>
<tr>
<th>Year Range</th>
<th>No. of New CAD Diagnoses</th>
<th>CAD Incidence per 100 000 Population (95% CI)</th>
<th>No. of AMIs</th>
<th>AMI Incidence per 100 000 Population (95% CI)</th>
<th>No. of Cardiac Events</th>
<th>Cardiac Event Incidence per 100 000 Population (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987-1988</td>
<td>3</td>
<td>106.65 (21.99-311.67)</td>
<td>1</td>
<td>35.55 (0.90-198.07)</td>
<td>3</td>
<td>106.65 (21.99-311.67)</td>
</tr>
<tr>
<td>1989-1990</td>
<td>3</td>
<td>100.47 (20.72-293.61)</td>
<td>4</td>
<td>133.96 (36.59-342.99)</td>
<td>9</td>
<td>301.41 (137.82-572.16)</td>
</tr>
<tr>
<td>1993-1994</td>
<td>8</td>
<td>237.88 (102.70-468.72)</td>
<td>5</td>
<td>148.68 (48.28-346.96)</td>
<td>10</td>
<td>297.35 (142.59-546.85)</td>
</tr>
<tr>
<td>1995-1996</td>
<td>18</td>
<td>511.07 (302.89-807.72)</td>
<td>10</td>
<td>283.93 (136.16-522.16)</td>
<td>26</td>
<td>738.22 (482.23-1081.66)</td>
</tr>
</tbody>
</table>

*The extended Mantel-Haenszel $\chi^2$ values were 12.52 for coronary artery disease (CAD) incidence ($P<.001$), 4.75 for acute myocardial infarction (AMI) incidence ($P<.03$), and 13.62 for cardiac event incidence ($P<.001$). CI indicates confidence interval.
Several decades, the observed increasing adoption of many Southwest American Indian tribes during the past and lifestyle changes that seem to have occurred among the population ages. Likely contributors are the significant dietary increases found, and, given the high risk factor prevalence among our convenience sample, it is likely that CVD and mortality rates will continue to increase as this generation aging. However, we did not analyze mortality from CVD in this study, these increasing disease rates are in stark contrast to the declining mortality rates from CVD seen in Arizona and the United States in general from 1989 through 1998. Although we did not analyze mortality from CVD in this study, these increasing disease rates are in stark contrast to the declining mortality rates from CVD seen in Arizona and the United States in general from 1989 through 1998.

The marked increase in CAD and AMI and the high prevalence of cardiovascular risk factors among the White Mountain Apache in recent years requires aggressive intervention at a fundamental level. Primary prevention efforts should optimally begin in grade school to prevent, or at least delay, the onset of obesity and the subsequent development of diabetes, hypertension, and dyslipidemia. Educational efforts should focus on disseminating information about cardiac risk factors, their consequences, means of modifying risks, and current disease trends. To be effective, these efforts must be developed in conjunction with community health leaders and must integrate the cultural ideals and beliefs of the White Mountain Apache.

Table 2. Summary of Cardiovascular Risk Factors in a Group of White Mountain Apache Tribal Members Applying for a Physically Intense Occupation*

<table>
<thead>
<tr>
<th>Demographic or Risk Factor</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. surveyed</td>
<td>70</td>
</tr>
<tr>
<td>Age range, y</td>
<td>18-46</td>
</tr>
<tr>
<td>Mean ± SD age, y</td>
<td>27.3 ± 7.5</td>
</tr>
<tr>
<td>F/M, %</td>
<td>41/59</td>
</tr>
<tr>
<td>Average ± SD body mass index†</td>
<td>30.6 ± 6.2</td>
</tr>
<tr>
<td>Average ± SD total cholesterol, mg/dL‡</td>
<td>188.6 ± 39.4</td>
</tr>
<tr>
<td>Average ± SD high-density lipoprotein cholesterol, mg/dL‡</td>
<td>54.5 ± 16.4</td>
</tr>
<tr>
<td>Average ± SD triglycerides, mg/dL‡</td>
<td>131.7 ± 77.3</td>
</tr>
<tr>
<td>Risk factor prevalence, No./Total No. (%)</td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>36/70 (51)</td>
</tr>
<tr>
<td>Smoking</td>
<td>31/70 (44)</td>
</tr>
<tr>
<td>Family history of cardiovascular disease</td>
<td>5/70 (7)</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>14/70 (20)</td>
</tr>
<tr>
<td>Dyslipidemic‡</td>
<td>8/39 (20)</td>
</tr>
<tr>
<td>Diabetic</td>
<td>0/70 (0)</td>
</tr>
<tr>
<td>Risk factor combinations, %‡</td>
<td></td>
</tr>
<tr>
<td>2 Risk factors</td>
<td>31</td>
</tr>
<tr>
<td>&gt;2 Risk factors</td>
<td>18</td>
</tr>
<tr>
<td>≥2 Risk factors‡</td>
<td>49</td>
</tr>
</tbody>
</table>

*To convert cholesterol values from milligrams per deciliter to millimoles per liter, multiply by 0.0259. To convert triglyceride values from milligrams per deciliter to millimoles per liter, multiply by 0.0113.

†Weight in kilograms divided by the square of height in meters.

‡Excludes 31 participants lacking lipid profiles.

We have demonstrated that there exists among the WMAT a statistically and clinically significant, yet previously undocumented, increase in the incidence of CAD, AMI, and cardiac events during the 10-year span of 1987 through 1996. Although the high prevalence of cardiovascular risk factors and risk factor clustering most likely accounts for the increases found, and, given the high risk factor prevalence among our convenience sample, it is likely that CVD and mortality rates will continue to increase as this generation ages. Likely contributors are the significant dietary and lifestyle changes that seem to have occurred among many Southwest American Indian tribes during the past several decades. The observed increasing adoption of a Western, more sedentary lifestyle among some tribal groups contrasts sharply with traditional occupations that require moderate-to-heavy daily physical activity, and this is often accompanied by suboptimal access to healthful food options. This combination is recognized as contributing to coronary risk factors in some American Indian populations and has resulted in a significant increase in obesity, diabetes, and the metabolic syndrome. Although it has been proposed that there may be a genetic predisposition toward diabetes among some tribes, lifestyle factors seem to be a more significant contributor.

The marked increase in CAD and AMI and the high prevalence of cardiovascular risk factors among the White Mountain Apache in recent years requires aggressive intervention at a fundamental level. Primary prevention efforts should optimally begin in grade school to prevent, or at least delay, the onset of obesity and the subsequent development of diabetes, hypertension, and dyslipidemia. Educational efforts should focus on disseminating information about cardiac risk factors, their consequences, means of modifying risks, and current disease trends. To be effective, these efforts must be developed in conjunction with community health leaders and must integrate the cultural ideals and beliefs of the White Mountain Apache. Lifestyle interventions must be adaptable and relevant to the unique economic and geographic conditions found on the White Mountain Apache reservation.
The Native American Cardiology Program was developed in 1993 as a specific response to Indian Health Service clinicians' belief that the incidence of CVD was increasing in American Indian populations and that more emphasis needed to be placed on this area of American Indian health. The advent of the program likely resulted in increased awareness of CVD among practitioners in American Indian populations and may therefore have resulted in increased referrals to UMC and hence increased catheterizations and diagnoses of CAD, AMI, and cardiac events. The increased availability of cardiologists as a result of the program might also have resulted in increased diagnoses. However, such influences on actual incident numbers would likely be small; furthermore, the bulk of our study covers periods before 1993, yet still demonstrates increasing trends. Clearly, though, this may contribute to the sharp increase in events during that period. Changes in diagnostic practices of physicians, cardiac catheterization thresholds, and/or catheterization facilities at UMC could also contribute to overestimation of trends. However, no significant changes were made in any of these areas during this period, and such factors are not thought to contribute significantly.

The use of facilities other than UMC for patients with cardiovascular concerns would be extremely uncommon; however, if this occurred, it would result in an underestimation of the rates of CAD, AMI, and cardiac events. In the risk factor analysis, we recognize that our youthful convenience sample assessed was not representative of the general WMAT population, but this would likely result in an underestimation of true prevalence rates. In particular, our convenience sample significantly underestimated the actual rates of diabetes mellitus among the WMAT. Indian Health Service data from the diabetes educator at WPHS indicate that, as of February 2001, the prevalence of type 2 diabetes mellitus among WMAT patients aged 45 to 79 years was 26.7% for men, 38.1% for women, and 33.1% for both sexes combined (P. Lundgren, RN, EdD, written communication, February 27, 2001). These rates are clearly higher than those for the general US population of comparable age.

Finally, the large confidence intervals calculated for the incidence trends are largely due to the fact that the analysis is based on a small tribal population with small numbers of incident events. Although the analysis is certainly driven to a degree by the large differences between the first and last periods studied, all plots show evidence of increasing trends for the incidences of CAD, AMI, and cardiac events in this population, and there is no evidence that these rates will decrease on their own in the future.

In conclusion, this study demonstrates dramatically increasing incidence rates of CAD, AMI, and cardiac events and high prevalence of cardiovascular risk factors in the WMAT. These rates are evidence of a problem whose solution requires appropriate prevention funding, policy formation, and intervention. We also believe it is clearly indicative of a need for urgent action to promote improved health of American Indian populations in the Southwest and throughout the United States. Through appropriate intervention and further study, we hope that future efforts will shift the trends in CAD and AMI among American Indians in the opposite direction and foster improved outcomes in this population.

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The opinions expressed in this document are those of the authors and do not necessarily represent those of the Indian Health Service.

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