Coronary Heart Disease and Hypertension in the White Mountain Apache Tribe

By Nathan J. Clifford, M.D., John J. Kelly, Jr., M.D., Thomas F. Leo, M.D., and Howard A. Eder, M.D.

Death from heart disease is much less common in American Indians than in U.S. citizens as a whole. The death rate in 1953 for all heart disease was 2 1/2 times as high for the general population as for the Indian. Arteriosclerotic heart disease caused three times as many deaths and hypertensive heart disease more than twice as many proportionately. Despite energetic efforts to obtain epidemiologic data on heart disease around the world, little work has been accomplished in this field among American Indians. A few reports have appeared in which hospital records were reviewed. Some preliminary figures have appeared on the incidence of coronary artery disease as part of a comprehensive health study of the Navajo. Plasma lipids and lipoproteins have been determined on a few Navajos. The fat content of the Navajo diet has been a subject of controversy.

Two of us (N.J.C. and T.F.L.) served as medical officers on the Fort Apache Indian Reservation at different times. Our experience and that of other medical officers stationed there by the U.S. Public Health Service has been that coronary artery disease is extremely rare in this Apache tribe. Over an 8-year period, dating from 1952, not a single Apache with angina pectoris or myocardial infarction was treated in the Indian Hospital at Whiteriver, Arizona. During the same period, several Caucasians were treated for acute myocardial infarction at the same hospital. Because of this apparent absence of coronary artery disease, we decided to study these people to attempt to determine what factors might be responsible.

Methods

The study was designed in four parts: electrocardiograms, cholesterol determinations, measurements of blood pressure, and an estimate of the average Apache diet.

1. Electrocardiograms were recorded on almost all patients above the age of 40 hospitalized at the Public Health Service Indian Hospital at Whiteriver, Arizona, during a 10-month period in 1957-58. These totaled 75. In April 1959, 72 more records were obtained in persons over 40 by visiting the various settlements on the reservation. The criteria of the American Heart Association and National Heart Institute were used in determining the presence or absence of myocardial infarction. The criteria for interpretation of the electrocardiograms aside from myocardial infarction were those described by Massie and Walsh.

2. Serum cholesterol and body weight were obtained on 188 persons above the age of 20 as part of another study. These findings have been included to make this report more meaningful. The cholesterol determinations were done in duplicate by the method of Abell.

3. Casual determinations of blood pressure were recorded on 327 different individuals in the first two groups. The criteria of the American Heart Association and National Heart Institute were used in classifying these individuals. These criteria define hypertension as being present when the blood pressure reaches, or exceeds, 160/95 mm. Hg.

4. The composition of the average Apache diet was determined both qualitatively and quantitatively. First, every subject (total 188) in the cholesterol study was questioned about the content of his last six meals. Second, the food purchases of six families composed of 33 individuals were surveyed over periods of from 1 to 4 months. There was a total of 2,413 subject-days. The families surveyed were selected because they were said to buy all of their food at the same trading post and charged virtually everything. An attempt was made to select families who were representa-
HEART DISEASE IN APACHES

The average Apache household, culturally and financially. The calorie content and percentage of calories supplied from protein, fat, and carbohydrate were calculated from Handbook Number 8 of the U.S. Department of Agriculture.

The tribal census and the composition of the various parts of the study are shown in Table 1.

Results

Not one record characteristic of coronary artery disease was obtained. Myocardial infarction, left bundle-branch block, or second- or third-degree atrioventricular block were not seen. Left ventricular hypertrophy was present in 19 records, right ventricular hypertrophy in six, and right bundle-branch block in eight. Significant positive findings are summarized in Table 2.

The mean serum cholesterol in men was 198 ± 42 mg./100 ml., with a standard error of 4.2 mg. The corresponding figure for women was 205 ± 41 mg./100 ml. with a standard error of 4.4 mg. To obtain a comparison with other populations that have been studied, the distribution of cholesterol levels by age and sex was compared with those from the Framingham,12 Chicago Utility,13 and Chicago Low Income Negro13 studies. Tables 3, 4, and 5 summarize this information. Significantly more (p < .003) Apaches had low cholesterol levels than did those in the Framingham and Chicago Utility studies. The distribution is very similar for younger Apaches and Chicago low-income Negroes. The older members of the Apache series, however, have somewhat lower levels than the old Chicago Negroes. A surprising finding was that 86 per cent of Apache men aged 45 to 64 had cholesterol levels below 225 mg./100 ml. as compared to 72 per cent of those aged 25 to 44.

Apache women tend to be obese: 72 per cent of those in this study had a weight/ideal weight ratio of more than 1.015. Only 29 per cent of the men are fat. More obese individuals had elevated blood pressures than those of normal weight. No correlation of obesity with elevated cholesterol was found. There was no relationship between hypertension and high cholesterol levels. In fact, the highest cholesterols were found in normotensive individuals.

Elevated blood pressure is remarkably com-

Table 1
Tribal Census (1957) and Composition of the Separate Parts of the Study

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age group</th>
<th>Population</th>
<th>ECG</th>
<th>Blood pressure</th>
<th>Cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>0-9</td>
<td>646</td>
<td></td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>10-19</td>
<td>463</td>
<td></td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>20-29</td>
<td>408</td>
<td>18</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>286</td>
<td>20</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>40-49</td>
<td>210</td>
<td>16</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
<td>162</td>
<td>16</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>60-69</td>
<td>94</td>
<td></td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>66</td>
<td>18</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Total males</td>
<td>2335</td>
<td>70</td>
<td>163</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0-9</td>
<td>631</td>
<td></td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10-19</td>
<td>501</td>
<td></td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>20-29</td>
<td>418</td>
<td>11</td>
<td>33</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>200</td>
<td></td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>40-49</td>
<td>154</td>
<td>18</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
<td>114</td>
<td></td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>60-69</td>
<td>64</td>
<td></td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;70</td>
<td>60</td>
<td></td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Total females</td>
<td>2142</td>
<td>77</td>
<td>164</td>
<td>86</td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Electrocardiographic Data in Apache Indians above the Age of 40

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>RVH</th>
<th>LVH</th>
<th>RBBB</th>
<th>ST</th>
<th>AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>70</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Women</td>
<td>77</td>
<td>5</td>
<td>10</td>
<td>4</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>147</td>
<td>6</td>
<td>19</td>
<td>8</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Per cent of total number</td>
<td>100%</td>
<td>4.0%</td>
<td>12.9%</td>
<td>5.5%</td>
<td>13.6%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

RVH, right ventricular hypertrophy; LVH, left ventricular hypertrophy; RBBB, right bundle-branch block; ST, isolated ST and T changes; AF, atrial fibrillation.
Table 3
Distribution of Cholesterol Levels by Age and Sex
Comparison of Apache with Framingham Study.

<table>
<thead>
<tr>
<th>Cholesterol level</th>
<th>Apache (47)* Framingham (1333)</th>
<th>Apache Framingham (1621)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;210</td>
<td>70% 34%</td>
<td>47% 27%</td>
</tr>
<tr>
<td>210-244</td>
<td>15% 34%</td>
<td>33% 32%</td>
</tr>
<tr>
<td>&gt;245</td>
<td>15% 32%</td>
<td>20% 41%</td>
</tr>
</tbody>
</table>

*Numbers in parenthesis indicate number of subjects in the study.

Table 4
Distribution of Cholesterol Levels by Age and Sex
Comparison of Apache with Chicago Utility Study.

<table>
<thead>
<tr>
<th>Cholesterol level</th>
<th>Apache (47)</th>
<th>C.U.S. Negro (87)</th>
<th>C.U.S. White (1253)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;225</td>
<td>81%</td>
<td>54%</td>
<td>39%</td>
</tr>
<tr>
<td>225-239</td>
<td>6%</td>
<td>22%</td>
<td>33%</td>
</tr>
<tr>
<td>260</td>
<td>13%</td>
<td>24%</td>
<td>28%</td>
</tr>
<tr>
<td>&gt;300</td>
<td>2%</td>
<td>7%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Our survey of food purchases by six families, comprising 33 individuals and 2,413 subject-days, revealed that their average daily caloric intake was 1,465 calories per person (both children and adults). Of this, 10.2 per cent were supplied by protein and 24.1 per cent by fat. These findings indicate a low nutritional level but the figure for total calories may well be low. Although the families investigated stated that they bought all of their food at one trading post, they may have purchased some without our knowledge at the other two trading posts in Whiteriver.

Discussion
The census (table 1) of the White Mountain Apache Tribe is typical of a primitive population, with 50 per cent of its members being less than 20 years of age. Many of the people live in wickiups, which are teepee-like dwellings covered with a broad, long "bear grass." At the time that this investigation was in progress (1957-59), few of the Apaches had any type of sewage disposal and much of their drinking water was obtained from polluted streams. It is not unexpected in such an environment that respiratory and gastrointestinal infections are the most common diseases. Streptococcal infections and rheumatic fever are frequently seen. Tuberculosis, formerly the leading cause of death, is waning before a vigorous case-finding and treatment program. Cholecystitis is very common and

Table 5
Distribution of Cholesterol Levels by Age and Sex. Comparison of Apache and Chicago Low-income Negro

<table>
<thead>
<tr>
<th>Cholesterol level</th>
<th>Apache (54)</th>
<th>25-44 Negro (322)</th>
<th>45-64 Negro (351)</th>
<th>Apache (41)</th>
<th>25-44 Negro (368)</th>
<th>45-64 Negro (380)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;225</td>
<td>72%</td>
<td>73%</td>
<td>86%</td>
<td>73%</td>
<td>78%</td>
<td>61%</td>
</tr>
<tr>
<td>225-259</td>
<td>11%</td>
<td>18%</td>
<td>5%</td>
<td>17%</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>&gt;260</td>
<td>13%</td>
<td>8%</td>
<td>9%</td>
<td>10%</td>
<td>6%</td>
<td>10%</td>
</tr>
<tr>
<td>&gt;300</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Circulation, Volume XXVIII, November 1963
peptic ulcer almost unheard of—a situation seen in most Indian tribes. Diabetes is unusual, which is striking in view of the high incidence in many tribes. Malignant disease is rare, due probably to the relatively small number of older persons on the reservation.

The absence of the electrocardiographic findings usually associated with coronary artery disease is significant, especially as the diagnosis of myocardial infarction had not been made for at least 8 years in an Apache at the Whiteriver Hospital. With the Framingham Study\(^\text{12}\) as a standard, over this 8-year period 17 men and 3 women aged 40 to 59 should have developed an acute myocardial infarction. The older members of the tribe would be expected to have an even higher incidence.

Studies on the Navajo tribe have shown similar results. A review of the records of the Navajo Medical Center at Fort Defiance, Arizona,\(^3\) revealed not a single proved case of coronary thrombosis in 10,267 admissions over a 4-year period. Preliminary findings of the Cornell group\(^5\) on the Navajo reservation show two deaths in three patients with coronary artery disease in a community of about 2,000 people. A 2-year study of hospital records of Pima Indians found no definite evidence of myocardial infarction or angina pectoris in 2,688 admissions.\(^4\)

Of interest is the number of Apaches who had right ventricular hypertrophy or right bundle-branch block. One electrocardiographic survey of a small Michigan town\(^15\) found a total of seven persons with right ventricular hypertrophy and 10 with right bundle-branch block among 5,137 subjects over 16 years of age. We found six and eight, respectively, in a total of 147 persons above 40. These findings probably reflect the high prevalence of respiratory illness and chronic pulmonary disease on the reservation.

The average cholesterol level found in these people correlates well with the amount of fat they consume as predicted by the graph of Keys et al.\(^16\) The finding that more older Apache men have lower cholesterol levels than the younger men suggests that dietary habits have been changing. A change in the amount of physical exercise is also a possibility, as many Apaches now drive pickup trucks whereas formerly they would walk or ride horseback.

The composition of the Navajo diet has been a subject of some controversy among investigators.\(^5, 6, 16\) It seems likely that Keys' statement that their diets are not high in total fats and are very low in dairy fats\(^16\) reflects the actual situation most accurately. The Pimas, with a similar absence of coronary disease, were found to eat a diet composed of 24 per cent fat, most of which was animal fat.\(^4\)

Extensive epidemiologic investigations into the etiology of coronary artery disease have repeatedly pointed to a diet high in saturated

---

### Table 6

<table>
<thead>
<tr>
<th></th>
<th>U.S.</th>
<th>Grand Bahamas</th>
<th>Nassau</th>
<th>Apache</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>4.8%</td>
<td>35.4%</td>
<td>19.5%</td>
<td>26.4%</td>
</tr>
<tr>
<td>Women</td>
<td>23.0%</td>
<td>34.0%</td>
<td>24.2%</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

---

*Figure 1*

Prevalence of hypertension (B.P. >160/95) obtained from a sample of 327 individuals examined in 1957-59.
fat as the main causative factor.\textsuperscript{16-18} In studying large groups, the level of the serum cholesterol has been found to reflect the amount of saturated fat ingested as well as the incidence of coronary atherosclerosis. An occasional qualified exception has been observed.\textsuperscript{19}

The high prevalence of hypertension among the Apaches was an unexpected finding, as a previous review of records from the Phoenix Indian Hospital, which is a referral center for 44 Indian tribes, disclosed a prevalence of only 1.2 per cent.\textsuperscript{2} As racial and genetic factors seem to be important in the etiology of hypertension,\textsuperscript{14, 20} it will be of interest to compare our results with data that should be forthcoming on the Navajo, as the Apache and the Navajo are the only Southwestern tribes of Athapascan ancestry.\textsuperscript{21}

The predominance of high blood pressure in the younger Apaches, as contrasted with their elders, suggests several possible causes. If environmental stress is postulated, as suggested by Neel,\textsuperscript{22} it may well be that the conflict between tribal and modern culture or the difficulty of making a good living on or off the reservation makes it difficult for the younger men to adapt. If this were true, one might wonder why the other Southwestern tribes with the same problems of adaptation have not developed more hypertension. A second possibility is that the intake of salt may be increasing in the tribe, with changing dietary habits occurring more in the younger than in the older Apaches. We were unable to find any definite evidence of increased salt intake in these people; however, no specific studies of salt consumption were made. A less likely possibility is that there is a high mortality from hypertension, so that few with the disease survive to old age. Clinical experience at the Whiteriver Hospital is not consistent with this idea. Hospitalization for hypertension is rarely necessary, and most persons with high blood pressure are easily controlled with reserpine, phenobarbital, or chlorothiazide.

The association of a high prevalence of hypertension and a low prevalence of coronary disease, as we found in this tribe, is not uncommon.\textsuperscript{23, 24}

Further studies of this Apache tribe would be fruitful. The reservation is a socioeconomic and racial unit that is likely to stay intact for many years because of the reluctance of the people to leave the reservation or to marry those outside the tribe. Practically all of their medical care is received from the U. S. Public Health Service Division of Indian Health, so that medical records should be easy to obtain. The Apaches are willing to cooperate in research studies if they know and respect those conducting them. As civilization slowly moves into their lives, their eating habits, living conditions, and diseases should change.

**Summary**

Investigation of the members of the White Mountain Apache Tribe has confirmed our clinical experience that coronary artery disease is extremely rare in these people. The Apaches eat a diet low in saturated fat and have a correspondingly low mean serum cholesterol level. Older Apache males tend to have lower cholesterol than the younger men. A surprisingly high prevalence of high blood pressure was found, particularly in young men. A brief discussion of similar studies is included. Further investigation of this relatively stable socioeconomic and racial group is needed.

**References**


Circulation, Volume XXVIII, November 1963

Medical Etymology

My thesis is that the history of Medicine is also interesting and is well revealed, when it is approached from the neglected angle of the terminology of the past. The words certain men gave birth to are often more interesting than the men themselves. The individuals lived, worked, sinned and died—but the words they coined have lived on and are used by us today.

Take, for example, the familiar word inoculate. Let us imagine ourself a medical student with enough curiosity to look up the derivation of this word in the medical dictionary. All we find is that it comes from the Latin in = in, and oculus = an eye. This is meaningless unless one knows that in the days of Ovid, oculus meant a bud and inoculatio meant a graft. We express the same concept when we speak of the eye of a potato.—O. H. Perry Pepper, M.D. Opuscula Medica. (Reprinted from Transactions & Studies of the College of Physicians of Philadelphia, 4 Ser., 18: 30, April, 1950).
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Circulation. 1963;28:926-931
doi: 10.1161/01.CIR.28.5.926

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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