Cerebrovascular Disease in the Bi-Racial Population of Evans County, Georgia

BY A. HEYMAN, M.D., H. R. KARP, M.D., S. HEYDEN, M.D., A. BARTEL, M.D., J. C. CASSEL, M.D., H. A. TYROLER, M.D., J. CORNONI, PH.D., C. G. HAMES, M.D. AND W. STUART, M.D.

Abstract: Cerebrovascular Disease in the Bi-Racial Population of Evans County, Georgia

An epidemiological study was made of cerebrovascular disease in a bi-racial Southern community. The study population comprised about 3,000 men and women aged 15 to 75 years at the time of entry into the study. During the 87-month period between the initial and second examinations, 94 persons developed their first cerebrovascular event.

The incidence of stroke among white men (4.7/1,000/year) was almost four times that in white women and more than twice that reported for white men in other sections of the country. The incidence rates of stroke in Negro men and women were equal (5.8/1,000/year).

The risk factors predisposing to stroke in white men appeared to be severe hypertension, obesity, high hematocrit levels, and antecedent electrocardiographical abnormalities. These factors were not as prominent among the other race-sex groups.

The high incidence of cerebrovascular disease found in this semirural population of Georgia supports previous reports of increased mortality rates for stroke in this section of the country and represents a unique situation, the exact cause for which remains to be determined.

ADDITIONAL KEY WORDS stroke morbidity risk factors race factors epidemiology ischemic heart disease

Mortality studies in the United States indicate that death rates from cerebrovascular disease are greater among Negroes than Caucasians and higher in both races in the Southeastern section of the country. Recent studies designed to authenticate these death...
rates have shown that the high mortality for cerebrovascular disease as appears on death certificates is probably an accurate indication of an increased incidence of stroke in the Southeastern United States.\(^1\)\(^2\) There is a need, therefore, for further studies to determine the clinical and environmental factors which may be responsible for this unique racial and geographical problem. This report presents our findings on the prevalence and incidence of cerebrovascular disease in Evans County, Georgia, a small rural community with a 60% white and 40% Negro population. This report also describes the relationship between cerebrovascular disease and the presence of conditions thought to favor its development such as hypertension, hypercholesterolemia and obesity. Previous epidemiological studies of this community have described the sampling techniques and the socioeconomic and population characteristics of the study area.\(^3\) The prevalence of ischemic heart disease and hypertension as related to race, social class and occupational groups in this community has also been reported.\(^4\)\(^5\)

**Methods**

The first survey examination of this study population (3,102 persons) was carried out between August 1, 1960, and June 1, 1962, and consisted of a history of heart disease, stroke and other illnesses, a physical examination, electrocardiogram, roentgenogram of the chest, urinalysis, and laboratory studies of the blood for cholesterol and hematocrit. The second survey examination of this cohort was made by two of the authors (A. B. and S. H.) between August 1, 1967, and August 31, 1969, in a clinic established for this purpose. During this seven-year to nine-year follow-up period (average 87 months), 320 persons had died and 252 had either migrated away from the community or refused to return for the second examination (table 1). The examination of the remaining 2,530 persons (90.9% re-examination rate) again consisted of a history and physical and laboratory studies, but also included a detailed questionnaire for evidence of cerebrovascular disease and symptoms of transient cerebral ischemia, a sociological questionnaire, and a physical activities questionnaire. All persons with a history or physical findings of any type of neurological disorder and particularly those whose response to the questionnaire suggested transient cerebral ischemia or stroke were referred to the neurologists (A. H., H. K. and W. S.) for further evaluation. In addition, the records containing the questionnaire responses of all 2,530 persons were reviewed by one of the authors (A. H.) and all persons having neurological symptoms suggesting even a remote possibility of cerebrovascular disease were called back for neurological evaluation. Examinations were conducted in the home of the subjects who were unable to visit the clinic because of disability due to stroke or other illnesses. Members of the subject's family were also interviewed if an adequate history could not be obtained because of aphasia, confusion or memory loss due to brain damage.

A review was made by the neurologists of the clinical records to confirm the cause of death in each of the subjects whose death certificate listed stroke as a causative factor. Although autopsies were made in approximately 30% of the 320 deaths during this interval, the brain was usually not included in the postmortem examination. Spinal fluid and neuroradiological diagnostic studies were rarely part of the clinical examination during the subject's terminal illness. For these reasons, differentiation of cerebral hemorrhage from cerebral infarction was generally not possible and no such distinction has been made in the individual subjects.

Criteria for the diagnosis of cerebrovascular disease were established for those examined by the neurologists and for the cases listed as having a stroke on death certificates. In both groups, the subject was considered to have a definite stroke if there was a history of sudden onset of aphasia or hemiparesis and the appropriate neurological or

---

**TABLE 1**

**Distribution of Sample Population by Age and Sex in the Two Survey Examinations**

<table>
<thead>
<tr>
<th>Cases in first examination (1960 to 1962)</th>
<th>White male</th>
<th>White female</th>
<th>Negro male</th>
<th>Negro female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Died 1960 to 1967</td>
<td>947</td>
<td>972</td>
<td>537</td>
<td>646</td>
<td>3,102</td>
</tr>
<tr>
<td>Migrated, refused, etc.</td>
<td>120</td>
<td>65</td>
<td>73</td>
<td>62</td>
<td>320</td>
</tr>
<tr>
<td>Cases in second examination (1967 to 1969)</td>
<td>771</td>
<td>855</td>
<td>386</td>
<td>518</td>
<td>2,530</td>
</tr>
<tr>
<td>Percentage of eligible cases in second examination (1967 to 1969)</td>
<td>93.2%</td>
<td>94.3%</td>
<td>83.2%</td>
<td>88%</td>
<td>90.9%</td>
</tr>
</tbody>
</table>

*Stroke, Vol. 2, November-December 1971*
physical abnormalities were noted during the neurologists' examination or during the subject's terminal illness. Arteriographical, spinal fluid or autopsy findings of cerebral thrombosis or hemorrhage were also considered to be evidence of definite cerebrovascular disease. Subjects were classified as having a probable stroke if, at the time of his examination, the neurologist obtained a definite history of sudden onset of aphasia or unilateral arm or leg weakness in vascular distribution, but no residual signs could be found on his examination. There were no instances in which the patient showed residual neurological findings of a stroke but denied a history of this event. A diagnosis was made of death probably caused by cerebrovascular disease if the death certificate listed stroke as the underlying or contributing cause and if the clinical records indicated that the terminal illness began with sudden loss of consciousness without other explanation even though there was no mention in the clinical records of hemiplegia or focal neurological deficits. Patients with transient cerebral ischemia only, i.e., neurological deficit less than 24 hours' duration, were not included in the present study but will be considered in a subsequent report.

The prevalence rate of stroke is the frequency and distribution of the disease found in the 2,530 persons re-examined in 1967 to 1969. The incidence rate of cerebrovascular disease is based on the number of persons developing a fatal or nonfatal stroke in the seven-year to nine-year follow-up period among the 3,048 subjects who were judged free of the illness at the initial examination in 1960 to 1962.

Results

PREVALENCE OF CEREBROVASCULAR DISEASE

During the second examination in 1967 to 1969, 75 persons were diagnosed as having a definite or probable stroke (57 and 18 cases respectively). Of these, 53 had developed a stroke during the interval between the two survey examinations, and 22 had a history of cerebrovascular disease prior to the first examination in 1960 to 1962. The age-adjusted rates were higher in men than in women and were higher in Negroes than in Caucasians (table 2). Negro women had almost three times the rates of white women. Although the prevalence of stroke generally increased with age, this tendency was not as marked among Negro men who had moderately high rates in middle age (45 to 65 years). The diagnosis in almost every case was thought to be cerebral thrombosis since those with cerebral hemorrhage were not likely to have survived to be included in this re-examination. One subject, however, a Negro male, gave a good history of subarachnoid hemorrhage, and two other subjects (both white men) had a diagnosis of cerebral embolism.

These prevalence rates are not likely to be in error due to the inaccessability of persons who refused re-examination or migrated out of the community. This group consisted largely of young individuals, under the age of 35, in whom the likelihood of cerebrovascular disease is quite small.

INCIDENCE OF CEREBROVASCULAR DISEASE

During the interval between the two examinations (an average of 87 months) cerebrovascular disease developed in 94 persons, in whom the diagnosis was definite in 65 cases and

TABLE 2

Age-Specific Prevalence Rates of Stroke (per 1,000) Found in Examination 1967 to 1969

<table>
<thead>
<tr>
<th>Age at time of first exam</th>
<th>White male</th>
<th>White female</th>
<th>Negro male</th>
<th>Negro female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pop exam</td>
<td>No cases</td>
<td>Rate</td>
<td>Pop exam</td>
</tr>
<tr>
<td>&lt; 35</td>
<td>198</td>
<td>—</td>
<td>—</td>
<td>196</td>
</tr>
<tr>
<td>35-44</td>
<td>152</td>
<td>3</td>
<td>19.7</td>
<td>175</td>
</tr>
<tr>
<td>45-54</td>
<td>223</td>
<td>9</td>
<td>40.4</td>
<td>221</td>
</tr>
<tr>
<td>55-64</td>
<td>138</td>
<td>7</td>
<td>50.7</td>
<td>161</td>
</tr>
<tr>
<td>≥ 65*</td>
<td>60</td>
<td>9</td>
<td>150.0</td>
<td>102</td>
</tr>
<tr>
<td>Total</td>
<td>573</td>
<td>28</td>
<td>659</td>
<td>10</td>
</tr>
<tr>
<td>Age adj rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>771</td>
<td>28</td>
<td>855</td>
<td>11</td>
</tr>
</tbody>
</table>

*Only 11 persons were more than 75 years of age, two of whom had cerebrovascular disease.
probable in 29 others (table 3). Fifty-three of the 94 cases were alive at the time of the second examination. The remaining 41 died shortly after onset of their stroke. Twenty-three other subjects may also have had a stroke in the 1960 to 1967 interval, but were excluded from this incidence table because of insufficient clinical information. They consisted of nine subjects who were said to have had a stroke, but died of other causes. These cases were excluded because the clinical evidence for the diagnosis of stroke prior to death was poorly documented, particularly among the Negroes. In 14 additional subjects stroke was listed on the death certificates as the underlying or contributory cause, but the information which was available in their medical records was not sufficient to confirm this diagnosis.

The age-adjusted incidence rates for cerebrovascular disease were highest among the Negro men (6.0 per 1,000 per year). The rates for white men, however, were only slightly lower (5.3 per 1,000 per year). It should be noted that these age-adjusted rates underestimate the Negro-Caucasian differences. The white male population has a higher proportion of men aged 65 years and over than the Negro population. At all other ages the Negroes have a higher incidence rate than the Caucasians and particularly at the 55 to 64-year age group the Negroes have a twofold excess. The rates for white and Negro women were 1.7 and 5.0 per 1,000 per year respectively. After adjusting the county's age distribution to that of the 1950 United States populations, the estimated rates for white men was 4.7, white women 1.2, and Negro men and Negro women 5.8 each.

As shown in table 3, the age-specific rates increased generally with advancing age. The white and Negro men, however, tended to have relatively high rates in their middle ages as well as in older age groups. The slight decreases in the incidence of stroke in white men age 55 to 64 and in Negro men 65 years or older probably represent artifacts resulting from inadequate documentation of the terminal illness of several men in these age-race groups. Although their clinical records suggested the possibility of stroke, the rigid criteria established in this study for the diagnosis of cerebrovascular disease did not permit their inclusion in the stroke category.
CEREBROVASCULAR DISEASE IN EVANS COUNTY, GA.

TABLE 4

Age-Specific Annual Incidence Rates (per 1,000) for Stroke in Five U.S. Population Studies

<table>
<thead>
<tr>
<th>Age</th>
<th>Evans County, Ga.</th>
<th>Middlesex County, Conn.</th>
<th>Rochester, Minn.</th>
<th>Framingham, Mass.</th>
<th>Mid-Missouri</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 34</td>
<td>0</td>
<td>0</td>
<td>0.03</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>35-44</td>
<td>2.5</td>
<td>0</td>
<td>0.5</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>45-54</td>
<td>6.4</td>
<td>1.2</td>
<td>1.8</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>55-64</td>
<td>5.8</td>
<td>4.6</td>
<td>3.9</td>
<td>3.7</td>
<td>3.9</td>
</tr>
<tr>
<td>65-74</td>
<td>14.9</td>
<td>11.9</td>
<td>12.6</td>
<td>5.8</td>
<td>7.4</td>
</tr>
<tr>
<td>75-84</td>
<td>35.0</td>
<td>24.3</td>
<td>22.5</td>
<td>—</td>
<td>23.5</td>
</tr>
</tbody>
</table>

*Adjusted to age distribution U.S. population 1950.

Data from references 7 to 10.

COMPARISON WITH OTHER STUDIES

The annual age-specific incidence rates found in our white study population are compared in table 4 with those found in other small population studies. It is apparent that the incidence of stroke in white men for all ages in Evans County is more than twice that found in other sections of the country. In contrast, the incidence figures for white women in our sample population are compatible with those found in the other studies. The only published report of the incidence of stroke in Negro men and women is the Mid-Missouri Stroke Survey which is based on small numbers of cases. Nevertheless, the annual age-adjusted incidence rate obtained in three rural counties in Mid-Missouri was 5.9 (per 1,000 for all ages) for Negro men and 3.5 for Negro women, figures similar to those found in the Evans County Negro population.

RISK FACTORS

The incidence rates for the initial episodes of either stroke or ischemic heart disease during the 87-month study period were determined in the sample population stratified according to the presence or absence of certain "risk" factors observed on entry into the study. An analysis was made of the following clinical and laboratory characteristics: arterial blood pressure, serum cholesterol and hematocrit levels, electrocardiographical findings, and body weight. The criteria for the diagnosis of ischemic coronary heart disease have been described elsewhere, and include patients with acute myocardial infarction, angina pectoris and other clinical evidence of arteriosclerotic heart disease.

RISK OF STROKE OR ISCHEMIC HEART DISEASE ACCORDING TO BLOOD PRESSURE

The age-adjusted incidence of cerebrovascular or ischemic heart disease according to the level of blood pressure on entry into the study is shown in figure 1. The study population was classified into three blood pressure categories: those with normal or borderline pressures (equal to or less than 159/94); those with moderate hypertension (160 to 179/95 to 109); and those with severe hypertension (180/110 or greater). While the gradient between level of blood pressure and disease was clearer in the case of stroke than in ischemic heart disease, hypertension clearly increased the risk of both diseases in all four race-sex groups.

Stroke, Vol. 2, November-December 1971

513
BLOOD PRESSURE

- ≤159/≤94 mm Hg
- 160-179/95-109
- ≥180/≥110

Risk of stroke or ischemic heart disease according to blood pressure on entry—age adjusted. In this figure and in the subsequent ones, the numbers within each bar indicate the population at risk in the denominator and the cases developing either stroke or ischemic heart disease in the numerator.

RISK OF STROKE OR ISCHEMIC HEART DISEASE ACCORDING TO SERUM CHOLESTEROL LEVELS

The incidence of cerebrovascular disease in our subjects according to their level of serum cholesterol on entry into the study is shown in figure 2. For the entire age range, the percentage of men or women (Negro or Caucasian) developing stroke was not significantly different in the subjects with low or intermediate cholesterol levels as compared with those with high cholesterol levels (260 mg % or greater). An analysis of the cholesterol levels among the stroke cases in the younger age groups (less than 55 years) likewise failed to show any significant relationships. In contrast, there is a modest relationship between ischemic heart disease and elevated serum cholesterol levels for Caucasians, both male and female, and for Negro males though not for Negro females.

RISK OF STROKE OR ISCHEMIC HEART DISEASE ACCORDING TO ELECTROCARDIOGRAPHICAL ABNORMALITIES

In white men, the presence of antecedent electrocardiographical abnormalities (such as Q-waves, first-degree block and ST-T abnormalities) was associated with a definite increase in susceptibility to stroke as well as ischemic heart disease (fig. 3). A slightly increased risk of developing cerebrovascular disease was also observed in Negro men and women with prior electrocardiographical changes. The association of electrocardiographical abnormalities with subsequent ischemic heart disease was also noted in white women, but not in Negro men or women.

RISK OF STROKE OR ISCHEMIC HEART DISEASE ACCORDING TO BODY WEIGHT

The degree of overweight in our subjects was determined by the Quetelet Index (weight in...
CEREBROVASCULAR DISEASE IN EVANS COUNTY, GA.

ELECTROCARDIOGRAM

<table>
<thead>
<tr>
<th>No EKG ABN</th>
<th>EKG ABN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td></td>
</tr>
</tbody>
</table>

Risk of stroke or ischemic heart disease according to EKG abnormalities on entry—age adjusted.

Risk of stroke or ischemic heart disease according to degree of obesity (by tertiles)—age adjusted.

pounds divided by the square of the height in inches) and the results were stratified into those with lowest, intermediate and highest weight by height indices. The risk of developing stroke or ischemic heart disease was increased in severely overweight white men and to some extent in Negro men as well (fig. 4). White women with the highest indices also seemed to be more susceptible to stroke, but surprisingly this relationship was not evident in Negro women. An analysis of the possible association of Quetelet Index to ischemic heart disease in white and Negro females was not computed because of insufficient information.

RISK OF STROKE OR ISCHEMIC HEART DISEASE ACCORDING TO HEMATOCRIT

As shown in figure 5, white men and women with very high hematocrit levels had an increased risk of developing stroke or ischemic heart disease. Although a similar trend was present among Negro women with very high hematocrit levels, the number of cases of heart disease or stroke in this group was very small and the findings are not considered significant. It is apparent from these analyses that the clinical and laboratory characteristics favoring the development of stroke are not always the same as those associated with the development of ischemic heart disease.

Discussion

The results of this study indicate that the incidence of cerebrovascular disease in this rural population of Southeastern Georgia is considerably higher than that in other sections of the country. Similar high stroke morbidity rates have been reported by Kuller and his associates in the white population of the nearby urban community of Savannah. These workers also noted a high ratio of the incidence of stroke in men to that in women in this area of Georgia as well as in North Carolina. The
HEMOCRIT

Stroke Risk of stroke or ischemic heart disease according to level of hematocrit—age adjusted.

- Men
  - ≤ 40
  - 41–49
  - ≥ 50
- Women
  - ≤ 35
  - 36–47
  - ≥ 48

Our observations on the association of hypercholesterolemia with vascular disease have also been confirmed in other studies. Although high serum cholesterol levels are recognized as a risk factor in coronary artery disease, particularly in the younger age groups, its relationship to the development of cerebrovascular disease is less well established. Chapman reported little or no increase in the risk of stroke associated with high serum cholesterol levels except in those without hypertension. In the Framingham population there was an increase in the incidence of stroke associated with elevated serum cholesterol levels only in subjects under the age of 50. In older age groups, elevated lipid levels are not reliable indicators of susceptibility to either stroke or heart disease. Although the Hiroshima population generally had low cholesterol levels, hypercholesterolemia (values exceeding 220 mg %) was found to be associated with added risk of stroke in both men and women, particularly the latter.

Our observations on the relationship of stroke to antecedent electrocardiographical abnormalities were also noted in the Framingham study. The presence of left ventricular hypertrophy, intraventricular block and nonspecific electrocardiographical abnormalities were associated with a very high risk of cerebral infarction in the Framingham population. Similarly, in Japanese men and women, electrocardiographical evidence of left ventricular hypertrophy (as well as cardiac enlargement by radiographical examination) increased the risk of stroke almost three to five times.

Extreme obesity was found to be associated with an increase in the risk of stroke in men and in white women in the Evans County population. Similar findings were obtained in both the Framingham and Japanese populations. The results of the Los Angeles study also suggested an increased risk of cerebral thrombosis with increasing weight.
CEREBROVASCULAR DISEASE IN EVANS COUNTY, GA.

Only a very few studies have been reported on the relationship of high hematocrit levels to subsequent development of stroke. It is noteworthy that Japanese women with elevated hemoglobin or hematocrit levels seemed to have an increased risk of developing a stroke, but no significant association was found in Japanese men. In the present study, there was some evidence to indicate that high hematocrit levels were associated with increased susceptibility of stroke in white and Negro men. The incidence of ischemic heart disease may also be higher in the white men and women with elevated hematocrit levels on entry into the study.

Many of the factors which were found in this study to increase the susceptibility to stroke have also been reported in other studies of cerebrovascular disease. Our observations on the incidence of stroke, however, differ from those noted in other areas of the country. In the Northeastern and Mid-Western sections of the U.S., for example, the incidence of stroke in white men is similar to (or perhaps only slightly higher than) that in women, whereas the rates for ischemic heart disease in men is usually several times that found in white women. In our sample population, the incidence of stroke in white men was almost four times that of white women, a ratio even greater than that noted for ischemic heart disease in this community. Despite this similarity in the incidence of stroke and heart disease, the risk factors predisposing to stroke were not necessarily applicable to heart disease. It is noteworthy in this regard that relatively few of our cases of ischemic heart disease developed cerebrovascular disease, a phenomenon emphasized particularly in the Framingham study and frequently observed in clinical practice. The type of stroke most commonly associated with ischemic heart disease is that caused by atherosclerotic occlusive disease of the extracranial portion of the carotid or vertebral arteries, or by cerebral embolism associated with cardiac arrhythmias, valvular disease or mural thrombus due to recent myocardial infarction.

The usual manifestations of extracranial carotid disease such as a history of transient cerebral ischemia and the presence of carotid bruits were noted in only very few cases. The possibility that a specific type of stroke accounts for the race, sex and area differences within the United States has been offered by Kuller and his associates. They suggested that populations characterized by a high prevalence of hypertension and low lipid levels should have a higher ratio of intracranial to extracranial vascular disease. This particular combination of risk factors was a common pattern in our stroke cases and tends to support the hypothesis suggested by these workers.

References
14. Chapman JM, et al: Epidemiology of vascular...
Cerebrovascular Disease in the Bi-Racial Population of Evans County, Georgia
CORNONI, C. G. HAMES and W. STUART

Stroke. 1971;2:509-518
doi: 10.1161/01.STR.2.6.509

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/2/6/509