Stroke is the third leading cause of death in US Blacks and is an important cause of mortality and morbidity worldwide. Mortality rates are higher in Blacks than in Whites in the United States at ages below 70 years. In Blacks, advanced age, elevated blood pressure, diabetes mellitus, and smoking are the only risk factors for stroke whose status has been firmly established by published data. More data are needed to assess other likely risk factors of importance for risk stratification and intervention and to determine the fraction of racial differences in stroke that may be explained by risk factor differences. Higher prevalences of hypertension, diabetes, obesity (in women), elevated lipoprotein(a) level, smoking (in men), and low socioeconomic status may contribute to the higher stroke incidence and mortality in US Blacks as compared with Whites. However, further environmental influences must be studied and candidate genes identified before assuming that racial differences can be attributed to inborn susceptibility linked to inheritance of specific genes. Am J Epidemiol 1999; 150:1266–74.

Stroke is the third leading cause of death in US Blacks (1). It is an important cause of mortality and morbidity in Blacks worldwide (2). Since 1914, US vital statistics have shown higher mortality from stroke in Blacks than in Whites; differentials have persisted as diagnostic technology has developed over the century (3–6). The excess stroke mortality in Blacks is greatest at ages 45–64 years, with little difference in mortality rates above age 70 (4–19). In the 1960s, stroke death rates for US Blacks were among the highest in the world (3); in 1990, they fell between the high rates of Eastern Europe and the low rates of North American Whites (4, 7–9). Stroke is an important contributor to the higher all-cause mortality seen in US Blacks as compared with Whites (1, 10). Despite these facts, many questions remain regarding the etiology of stroke in Blacks and the basis for racial differences in stroke occurrence (4, 11). In this report, data on risk factors from the US National Center for Health Statistics are examined and epidemiologic studies of stroke in Black populations are reviewed in an attempt to critically examine the current state of knowledge and to suggest directions for future research and prevention.

**Blood pressure**

Among Blacks in developed countries, elevated blood pressure is the best established risk factor for stroke in terms of strength and consistency of findings, meeting epidemiologic criteria for a causal relation (4, 6). It is also the most important factor in terms of population attributable risk and potential for modification (4–7, 15, 20–57). Several prospective cohort studies have estimated the relative risk for stroke associated with elevated blood pressure in Blacks. In a national sample, the First National Health and Nutrition Examination Survey (NHANES I) Epidemiologic Follow-up Study, systolic blood pressure was similarly significantly related to stroke risk in Blacks and Whites (25, 26, 53). In Black men screened for the Multiple Risk Factor Intervention Trial, a 10-mmHg increase in diastolic blood pressure increased stroke risk by 86 percent, significantly more than the 45 percent increase seen in White men (22, 37). In a large health maintenance organization cohort, the adjusted relative risk of hospitalization for cerebral thrombosis with a 10-mmHg increase was 1.14 (95 percent confidence interval (CI): 0.97, 1.33) in Blacks and 1.14 (95 percent CI: 1.00, 1.29) in Whites (27). Thus, elevated blood pressure is a powerful risk factor for stroke in
blacks, probably similarly to whites in relative terms but with greater effect in terms of the number of cases explained.

The epidemiology of hypertension in black populations has been well documented elsewhere (1, 7, 8, 12, 20-57). Prevalence, incidence, and blood pressure levels are higher in blacks than in whites. In 1988-1994, the age-adjusted prevalence among US adults aged 20-74 years was 33.8 percent for black women, 19.3 percent for white women, 34.9 percent for black men, and 24.3 percent for white men (1). In the 1985 national health interview survey, 79 percent of blacks and 77 percent of whites correctly identified hypertension as the most significant cause of stroke (45). Data from the 1990 national health interview survey showed no further improvement in the public’s knowledge about the causes of stroke, and possibly a slight decline, with 72 percent of blacks and 73 percent of whites correctly identifying hypertension as the most significant cause of stroke (D. Rose, National Center for Health Statistics, personal communication, 1998). In the third national health and nutrition examination survey, hypertension awareness, treatment, and control rates in 1992-1994 failed to improve beyond rates observed in 1988-1991 (21). Despite the marked improvements in detection and control of hypertension over the past two decades, the still unsatisfactory rates for hypertension among black men, the lack of further improvement in the 1990s, and suboptimal knowledge levels suggest that considerable work is still needed to control hypertension in black communities.

Clinical trials in over 47,000 subjects have provided conclusive evidence that antihypertensive treatment is effective in preventing stroke in blacks and whites (7, 48, 49). Meta-analysis of data from five randomized clinical trials that reported results separately by race revealed no indication of a differential effect in blacks (32 percent reduction in stroke occurrence) versus whites (37 percent reduction) (49). Although the efficacy of hypertension treatment in preventing stroke in the setting of a clinical trial seems established, ecologic studies have been unable to consistently demonstrate an effect at the community level (51). More data on the efficacy of hypertension treatment in black and white stroke survivors are needed (36, 40). In the hypertension detection and follow-up program, results suggested that blood pressure treatment and strict control might largely eliminate racial differences among women, but further analyses on this point are needed (48, 55).

Diabetes mellitus

Several recent studies have found diabetes mellitus to be an important risk factor for stroke in blacks. In the NHANES I epidemiologic follow-up study, a history of diabetes was similarly associated with increased risk of stroke in blacks (relative risk = 2.5 for men and 2.4 for women) and whites (25). In the health maintenance organization cohort, serum glucose level was predictive of cerebral thrombosis in blacks (27). No data were found on the relation between glucose intolerance or diabetes assessed by glucose tolerance testing and stroke in blacks.

The epidemiology of diabetes in blacks has been reviewed elsewhere (58, 59). In the united states, non-insulin-dependent diabetes mellitus is more prevalent in blacks than in whites (1). Recent national data have indicated a higher prevalence of diagnosed and undiagnosed diabetes in blacks than in whites. Furthermore, the relations between the fourfold increase in black americans’ rate of known diabetes between 1963 and 1985 and trends in stroke and ischemic heart disease mortality require study (15).

Prior heart disease and electrocardiographic abnormalities

Prior heart disease is an established risk factor for stroke in populations of European descent; however, few studies have addressed this question in blacks (4, 26, 57, 60). This subject is discussed at length elsewhere (61). Available data suggest different modes of action for this risk factor in blacks and whites, perhaps related to greater prevalence of hypertensive heart disease in blacks and myocardial infarction in whites (26). Atrial fibrillation is a powerful risk factor for stroke among whites; its role in stroke among blacks has not been adequately studied. A study of 4 million medicare recipients followed for 4 years revealed that, compared with those without atrial fibrillation, black men and women with atrial fibrillation had 1.4 and 1.7 times the risk of nonembolic stroke and 4.3 and 7.3 times the risk of embolic stroke, respectively (39). Four-year risks were highest among black women with atrial fibrillation (21.3 percent for nonembolic stroke and 3.28 percent for embolic stroke). The associations were similar in whites. Similarly, little is known about coronary disease and congestive heart failure as stroke risk factors in blacks. In a series of stroke patients, blacks tended to have less atrial fibrillation and coronary disease than whites and a similar frequency of heart failure (60). In one cohort, a history of heart disease was a significant risk factor for stroke in whites but not in blacks (26). The effectiveness of antithrombotic and antiplatelet therapy for atrial fibrillation or other forms of heart disease has not been studied in blacks.

In developed countries, heart disease is the leading cause of death in both blacks and whites; the prevalence of heart disease in these populations may be...
similar in elderly Blacks and Whites. In developing countries, heart disease and stroke are growing problems. The prevalence of hypertensive heart disease and of echocardiographic and electrocardiographic abnormalities has been found to be higher in Blacks than in Whites in the United States (9, 61, 62). Atrial fibrillation may be less prevalent in US Blacks than in US Whites (39, 61).

Transient cerebral Ischemia and large vessel atherosclerosis

Few prospective studies have published data on transient cerebral ischemia or asymptomatic carotid bruises as a precursor of stroke in Blacks (4, 6). Some cohort studies report a lower incidence of transient ischemic attack (TIA) in Blacks than in Whites (4, 57), while cross-sectional studies report a similar or higher prevalence of history of TIA symptoms in Blacks than in Whites (4, 63–65). No useful information has been found on the strength of TIA or carotid atherosclerosis as a risk factor for subsequent stroke in Blacks (4), but several studies currently under way may provide such data (64, 65). Utilization of carotid endarterectomy is much lower in US Blacks than in US Whites (66). Ankle-brachial index, an index of lower extremity arterial disease, is associated with prevalent stroke/TIA and carotid atherosclerosis in Blacks and Whites (56).

Smoking

Tobacco use is the leading external (nongenetic) factor contributing to death in the United States, and it is an important risk factor for all types of stroke in Whites (4, 6, 22, 37, 67–70). However, relatively few data from prospective cohort studies are available for Blacks. In the health maintenance organization cohort, Black cigarette smokers of ≥1 pack/day had four times the risk of stroke as never smokers (27). No interaction of race with smoking was found for stroke mortality among men in the Multiple Risk Factor Intervention Trial (22). Given the importance of smoking as a modifiable risk factor, further studies in large cohorts of Black women as well as men are needed. For example, the large cohorts of the American Cancer Society would be excellent for studies that might examine possible interactions of smoking with other risk factors among Blacks.

In 1994, among US adults over age 18, the prevalence of cigarette smoking was 21.1 percent in Black women, 24.3 percent in White women, 33.5 percent in Black men, and 27.5 percent in White men (1). Thus, cigarette smoking is of great importance, second only to hypertension, as a stroke risk factor because of its high prevalence and high relative risk.

Age, sex, hormone therapy, and genetic markers

Increasing age has been associated with increased stroke mortality and morbidity in essentially all studies of Blacks (1, 3–6, 13, 18, 22). In recent decades, male sex was associated with higher stroke mortality at ages under 75 years but was inconsistently associated with morbidity (4, 57, 63, 71). Among Blacks in the health maintenance organization cohort, males had a higher risk of hospitalization for cerebral thrombosis than females (27). However, prior to 1960, the age-adjusted stroke death rate among Nonwhites in the United States was higher for women than for men (3, 12), and it was reported to be higher for women than for men among "colored" (mixed race) people in South Africa in 1978–1982 (72).

Reproductive history may influence stroke risk in women. Women with six or more pregnancies had a 70 percent increased risk of stroke compared with nulligravid women (73). High dose estrogen oral contraceptives may increase the risk of stroke in women, and postmenopausal estrogens may reduce the risk (74, 75). However, no data on oral contraceptive use or hormone replacement therapy and stroke risk in Blacks were found. In recent years, the prevalence of oral contraceptive use has been slightly lower in Blacks than in Whites, and use of hormone replacement therapy has been much lower (76, 77).

Population-based data on genetic markers and stroke risk in Blacks were not found. In a multicenter study, increased risk of stroke associated with a positive family history of stroke could not be shown to differ in Blacks and Whites; however, the number of stroke events in Blacks was small (n = 14) (78). Further research in larger Black populations is needed.

Conditions affecting blood viscosity and coagulation

Homozygous sickle cell disease, chiefly affecting Blacks, is a risk factor for ischemic stroke because of increased hemolysis and altered rheologic properties of red blood cells which favor cerebral ischemia. Stroke may affect 6–9 percent of children with sickle cell anemia, although recent studies suggest a protective effect of multiple blood transfusions (79). Concomitant alpha thalassemia appears to lower stroke risk in these patients (80). Among Blacks in the Evans County cohort, a positive association between high hematocrit level and stroke was suggested (57). No association was found in a national cohort (81), nor was there an association with serum transferrin saturation, an indicator of body iron stores (82). Data on high blood fibrinogen levels or other coagulation factors and stroke in Blacks are limited. Fibrinogen was posi-
tively associated with history of TIA or stroke in Blacks but not in Whites in the Atherosclerosis Risk in Communities Study (83). Racial differences in the prevalence of abnormal levels of several coagulation factors and indicators of platelet function in normal persons and stroke patients indicate the need for further studies (34, 84).

**Blood lipids**

The relation between blood lipid levels and stroke risk in Blacks has been insufficiently studied (4, 83–87). Serum total cholesterol was not related to stroke incidence in Blacks or Whites in the Evans County cohort (57), but a significant relation was found with hospitalization for cerebral thrombosis in the health maintenance organization cohort (27) and with nonhemorrhagic stroke mortality in the Multiple Risk Factor Intervention Trial cohort (22). An increased risk of hemorrhagic stroke was found in men with low serum cholesterol levels (22). In Atherosclerosis Risk in Communities subjects aged 45–64 years, the prevalence of a self-reported history of stroke/TIA was higher in Blacks than in Whites (3.0 percent vs. 2.0 percent), as were mean lipoprotein(a) levels (160.5 μg/ml vs. 81.6 μg/ml) (83). Lipoprotein(a) levels were statistically significantly higher among persons with a self-reported history of stroke/TIA for both races (in Blacks, 191.3 μg/ml for a stroke/TIA history vs. 159.6 μg/ml for no history). Lipoprotein(a) was also associated with carotid artery wall thickness in Black men and diabetes in Black women (85). Black stroke patients were reported to have elevated levels of apolipoprotein AIC, and the Sac I polymorphism in the AIC lipoprotein gene cluster was more common in Blacks with carotid stenosis than in those without it (11, 86). In the Atherosclerosis Risk in Communities Study, serum total cholesterol and low-density lipoprotein cholesterol were not associated with prevalent TIA or stroke in Blacks, but mean high-density lipoprotein cholesterol was lower and triglyceride levels were higher in Blacks with a stroke history than in those without such a history (83). Serum total cholesterol was not a significant predictor of total stroke in several studies. No data on lipoprotein levels and incidence of stroke subtypes were found.

In 1988–1994, the prevalence of high cholesterol (mean level ≥240 mg/dl) in the United States was 19.4 percent for Black women, 20.2 percent for White women, 15.7 percent for Black men, and 17.8 percent for White men (1); mean serum cholesterol levels were 203, 205, 199, and 202 mg/dl, respectively. Recent clinical trials suggest that β-hydroxy-β-methylglutaryl-coenzyme A reductase inhibitors may lower the risk of stroke as well as of coronary disease events, but data on Blacks are lacking (55). Thus, it seems likely that high lipoprotein(a) and low high-density lipoprotein cholesterol, and perhaps high low-density lipoprotein cholesterol, are risk factors for ischemic stroke in Blacks. However, more cohort studies of the relations of low-density lipoprotein and high-density lipoprotein cholesterol, apolipoproteins, and lipoprotein(a) to each stroke subtype are needed.

**Obesity and dietary factors**

Obesity or overweight has not been shown to be a risk factor for stroke independently of age, blood pressure, and other risk factors for stroke in Blacks (26, 27, 57). In the Evans County cohort, lean Black men had a lower risk of stroke than obese Black men, but no such relation was found in Black women (57). Obesity was associated with increased risk of stroke in Whites. In the United States, the prevalence of overweight is much higher in Black women (53.0 percent) than in White women (33.9 percent) or Black (34.0 percent) or White (34.3 percent) men (1).

Few data on dietary risk factors in Blacks have been published. One striking finding was the strong protective effect of fish intake on stroke incidence and death seen among Blacks in a national cohort (87) (figure 1). Fish-eaters had only half the stroke risk of non-fish-eaters and one fourth the risk of stroke death. This exciting finding, with its important public health implications, deserves further investigation.
implications, should be confirmed by other studies. In this same cohort, Whites with a serum folate concentration ≤9.2 nmol/liter had a relative risk of stroke of 1.18 (95 percent CI: 0.67, 2.08), whereas Blacks had a relative risk of 3.60 (95 percent CI: 1.02, 12.71) (88). Data on the relation of stroke risk to high sodium intake or to low potassium, calcium, antioxidant vitamin, or fruit and vegetable intake in Blacks were lacking. However, the potential importance of nutritional factors in stroke risk among Blacks is great, and expanded research is urgently needed. Adherence to the Dietary Approaches to Stop Hypertension (DASH) diet and weekly intake of baked or broiled fresh ocean fish, canned tuna, or salmon have been suggested as prudent measures for Blacks at increased risk of stroke (55).

Alcohol intake and illegal drug use

Alcohol intake has not been thoroughly studied as a stroke risk factor in Blacks, and existing studies have yielded inconclusive results. In the health maintenance organization cohort, no significant association of usual alcohol consumption with hospitalization for cerebral thrombosis could be demonstrated for Blacks or Whites (27). However, an earlier study from the same group suggested an inverse association with occlusive cerebrovascular disease in both Blacks and Whites (68). A case-control study carried out in a predominantly (71 percent) Black sample indicated that chronic or acute alcohol ingestion was associated with increased odds of ischemic stroke, but after data were controlled for smoking and hypertension the association was no longer significant (adjusted odds ratio = 1.68; 95 percent CI: 0.84, 3.35) (69). At ages 45 years and over, fewer Blacks (24.5 percent of women, 51.3 percent of men) than Whites (44.0 percent of women, 65.5 percent of men) were alcohol drinkers in the United States in 1990 (1). Among drinkers, 7.7 percent of Blacks and 10.4 percent of Whites reported consuming 14 or more drinks per week. Further studies of relations between acute and chronic alcohol intake and the risk of each type of stroke, as well as studies of cocaine and other illegal drugs, are needed (28).

Physical inactivity and heart rate

Limited data suggest that physical inactivity and high heart rate may be independent risk factors for stroke in Blacks (89, 90). Low levels of physical activity were associated with increased risk of stroke in Blacks in a national cohort (89). This pattern was consistent, although conventional levels of statistical significance were not attained. In addition, a significant association of high pulse rate with a twofold increased stroke risk was seen in Blacks (>84 beats/minute vs. <74 beats/minute; risk factor-adjusted relative risk = 2.07 (95 percent CI: 1.25, 3.43)). Further studies are needed to confirm these findings.

Indicators of inflammation and other biochemical variables

New research on indicators of inflammation and other biochemical analytes indicates that some may be risk markers for stroke in Blacks. In a cohort study, no association was found between white blood cell count and stroke risk in Blacks (91). However, a high serum albumin concentration (>4.4 g/dL) was associated with a risk of incident stroke which was one half that seen at low levels and a risk of stroke death which was one fourth that seen at low levels (92) (figure 2). Erythrocyte sedimentation rate was not associated with stroke risk (93). Relations with hyperhomocysteinemia, hyperuricemia, hypokalemia, and hypomagnesemia require additional study in Blacks (26).

Socioeconomic status, region, and urbanization

Low socioeconomic status in the United States has been related to increased hypertension prevalence, blood pressure levels, and stroke mortality in both Blacks and Whites (4, 10, 26, 94–97). In US Black populations, an investigation of the variation in stroke mortality trends from 1968 to 1987 among state economic areas categorized by socioeconomic structure showed an inverse relation between the educational achievement level of communities and stroke mortality (96). The difference in rates between the highest

![Figure 2](https://academic.oup.com/aje/article-abstract/150/12/1266/53087)
and lowest educational achievement levels diminished over time. In Blacks, a strong association between increased stroke incidence and nonmetropolitan residence that was independent of region and other stroke risk factors was demonstrated (98); the adjusted risk was increased 60 percent in the Southeast and 110 percent in other regions. Reports relating season or climate to stroke occurrence in Blacks were not found.

Risk factors in Africa

Although population-based data and analytic studies from Africa are few, the prevalence of putative risk factors among stroke patients, hospital patients, and population samples has been reported (23, 30, 41, 43, 44, 71, 72, 99–101). For example, the MEDUNSA Stroke Data Bank series of cases in South African Blacks (with computed tomography utilized in 82.2 percent of cases) revealed that 71.2 percent had had cerebral infarction (29). The prevalences of hypertension and increased age were similar to those in Western stroke populations. Interestingly, a probable or definite cardiac source for cerebral embolism was present in 46 percent of the patients. However, TIA, peripheral vascular disease, and coronary artery disease occurred far less frequently than is reported in Western patients. In young adults and children in Africa, infectious and other nonatherosclerotic etiologies of stroke syndromes (e.g., syphilis, human immunodeficiency virus, tuberculosis, and neurocysticercosis) remain important. In African populations, hypertension predominates over risk factors related to affluence and westernization, such as diabetes and smoking; however, these factors are assuming increasing importance in some urban areas.

Conclusions

Stroke is the third leading cause of death in US Blacks and is an important cause of mortality and morbidity worldwide. Below the age of 70 years, mortality rates are higher in Blacks than in Whites in the United States. Among Blacks, advanced age, elevated blood pressure, diabetes mellitus, and smoking are the only risk factors for stroke whose status has been firmly established by published data. More data are needed to assess other likely risk factors of importance for risk stratification and intervention and to determine the fraction of racial differences in stroke that may be explained by risk factor differences. A higher prevalence of hypertension, diabetes, obesity (in women), elevated lipoprotein(a) levels, smoking (in men), and low socioeconomic status may contribute to the higher stroke incidence and mortality seen in Blacks as compared with Whites. However, additional environmental influences must be studied and candidate genes identified before we assume that racial differences can be attributed to inborn susceptibility linked to inheritance of specific genes.

Further research should be directed toward studying racial variations in the susceptibility of various vascular beds to hypertension and arteriosclerosis, as well as the relative importance of blood pressure, diabetes, and other putative risk factors (102). Risk factors for each stroke subtype should be examined separately. For example, higher levels of lipoprotein(a) in Blacks than in Whites should be examined as a potential cause of the higher incidence of lacunar stroke in Blacks. Interactions among risk factors should be examined. Large cohort studies of mortality or chronic disease which include Blacks should include analyses of stroke risk whenever possible. Given the cost, amount of time, and logistic effort required for cohort studies, increased use should be made of case-control studies of stroke in Blacks (103). Sufficient numbers of Blacks should be included in clinical trials to make subgroup analyses possible (104, 105). Selected trials in all-Black or predominantly Black samples should be conducted (105). In addition to hypertension and diabetes control and smoking cessation, dietary and lifestyle interventions such as use of the DASH diet and increases in fish intake and physical activity level should be evaluated in prevention studies. Strategies for primary and secondary prevention of stroke appropriate for particular segments of the Black population must be developed and rigorously implemented to reduce the burden of premature mortality and morbidity due to stroke among Blacks (106–109).

REFERENCES


