Increased Common Carotid Intima-Media Thickness in UK African Caribbeans and Its Relation to Chronic Inflammation and Vascular Candidate Gene Polymorphisms

Hugh Markus, FRCP; Zoltan Kapozsta, MD; Ralph Ditrich, MD; Charles Wolfe, MD; Nadira Ali, MSc; John Powell, PhD; Mike Mendell, MD; Marisa Cullinane, PhD

Background and Purpose—Individuals of African Caribbean descent who live in the United Kingdom have an increased risk of stroke. The reasons for this are not fully understood, but differences in genetic predispositions or other novel stroke risk factors could play a role. US blacks have been reported to have increased common carotid artery wall thickness, or intima-media thickness (IMT), measured by ultrasound. We measured carotid IMT in UK African Caribbeans compared with UK whites and determined whether different distributions of polymorphisms in potential candidate vascular genes or differences in measures of chronic inflammation or infection could account for any difference.

Methods—In a population study, common carotid artery IMT was measured in 202 white men and 89 African Caribbean men. The distribution of polymorphisms in ACE, paraoxonase 1, paraoxonase 2, and methylenetetrahydrofolate reductase genes was determined. Serum C-reactive protein and Helicobacter pylori seropositivity were determined.

Results—Carotid IMT was increased in African Caribbeans even after controlling for cardiovascular risk factors, including homocysteine and social class: $\beta=0.113$, 95% CI 0.036 to 0.189, $P=0.004$. There was a significant interaction with smoking and mean IMT ($P=0.022$), and the difference in both measures of IMT between ethnic groups was largely limited to individuals who had never smoked. There were significant ethnic differences in the distributions of 3 of the 4 candidate genes studied (ACE, paraoxonase 1, and methylenetetrahydrofolate reductase). $H$ pylori seropositivity was increased in African Caribbeans (78.7% versus 53% in UK whites). However, neither the genetic polymorphisms nor $H$ pylori seropositivity was related to IMT, and ethnic differences in their distribution did not account for the increased IMT seen in African Caribbeans.

Conclusions—Carotid IMT is increased in UK African Caribbeans even after controlling for conventional risk factors. There are highly significant ethnic differences in the distribution of many potential cerebrovascular candidate genes. Although those we examined did not explain the ethnic differences in IMT, other genetic predispositions or environmental exposures could account for these differences. (Stroke. 2001;32:2465-2471.)

Key Words: blacks ■ carotid artery ■ genetic polymorphism ■ Helicobacter pylori ■ intima media thickness

Individuals of African and African Caribbean descent living in the United Kingdom and the United States have a markedly increased risk of stroke compared with white individuals.1,2 In a recent population stroke registry study in London, UK, African Caribbeans had a doubling of stroke incidence compared with that of whites.1 This increased incidence remained after adjustment for cardiovascular risk factors and socioeconomic status. The reasons for this increase in stroke risk are uncertain, although the increase in risk could be related to differences in the prevalence of cardiovascular risk factors or susceptibility to them, reduced access to or utilization of medical care, uncontrolled for socioeconomic factors (including associated environmental factors), and/or differing genetic predispositions.1,2 Small studies have shown different distributions in candidate gene polymorphisms between white and African Caribbean populations.3,4 Such genetic differences could underlie the differences observed in stroke risk. Chronic inflammation has been implicated in the pathogenesis of cardiovascular disease.5,6 It is possible that an increased prevalence of chronic inflammation and chronic infection might be present in African Caribbean populations secondary to larger families, different cultural practices, and poorer socioeconomic conditions. However, there are few studies investigating whether such novel genetic and other risk factors may account for the increased stroke risk found in African Caribbeans.

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Stroke is available at http://www.strokeaha.org
One method of assessing cerebral arterial damage in a community population is measurement of common carotid artery (CCA) wall thickness. By use of high-resolution duplex ultrasound, it is possible to measure arterial wall intima-media thickness (IMT) and to determine the presence and thickness of any atheromatous plaque. It has been demonstrated that ultrasonic measurements of IMT correlate well with measurements determined histologically. Increased IMT has been shown to be correlated with a wide variety of cardiovascular risk factors and to predict subsequent stroke risk in middle-aged and elderly individuals.

CCA IMT has been reported to be significantly increased in African Americans, but this difference is not fully accounted for by conventional cardiovascular risk factors.

In a community-based study, we determined whether CCA IMT was increased in UK African Caribbeans compared with UK whites. We investigated the relationship between IMT and both chronic inflammation and chronic infection with Helicobacter pylori. We also examined the relationship with polymorphisms in 4 cardiovascular candidate genes: specifically, polymorphisms in the genes encoding ACE, paraoxonase 1 (PON1), paraoxonase 2 (PON2), and methylenetetrahydrofolate reductase (MTHFR). ACE plays a central role in the renin-angiotensin system and has been implicated in a variety of cardiovascular diseases, including stroke. Serum paraoxonase is an HDL-associated esterase, and it has been suggested that it plays a role in atherosclerosis. MTHFR variants are associated with altered levels of serum homocysteine, which is itself a risk factor for cardiovascular disease, including stroke.

Subjects and Methods

Subjects

Male individuals aged 40 to 75 years were randomly selected from 2 general practices in South London. An initial sample size of 300 (200 whites and 100 African Caribbeans) was sought. A brief questionnaire was sent to 1287 individuals; this questionnaire asked about their ethnicity and whether they would participate in the study. Five hundred twenty-seven (41%) replies were received. Fifty-nine letters were returned because the individuals were no longer at that address, and 5 individuals had died. Of the respondents, 378 (72%) agreed to participate, and they were sent an appointment date; 307 of these then attended the study. Seven of these were of neither white nor African Caribbean descent and were excluded. Nine individuals with a past history of stroke or transient ischemic attack were also excluded, leaving 291 individuals who were included in the study. Of these, 202 were white, and 89 were African Caribbean. A cardiovascular interview and examination were carried out. These included any history of arterial hypertension, diabetes mellitus, myocardial infarction, stroke or transient ischemic attack, angina, peripheral vascular disease, and/or smoking. Adult socioeconomic status was coded according to the UK Registrar General’s classification.

Body mass index was calculated. Three blood pressure measurements were obtained with subjects in the supine position and were averaged to obtain a mean systolic and diastolic blood pressure. Blood samples were drawn from each subject, and serum and plasma were centrifuged and frozen at −70°C. Blood was also taken for genotyping.

Imaging Protocol

Carotid artery imaging was performed with a Phillips S800 2-MHz carotid duplex machine by use of a 7-MHz transducer. Each examination cycle included sequential longitudinal and transverse views of the CCA, the carotid bifurcation, and the internal carotid artery bulb. All ultrasonic examinations were stored on a super VHS video system for subsequent offline processing. Settings for depth-gain compensation, preprocessing, persistence, and postprocessing were held constant. Images were recorded at 60-dB log compression, and gain was adjusted so that the arterial wall–internal wall interface was just visible. Video images were captured at a standard point in systole of the cardiac cycle by triggering to the ECG.

The frozen video images were digitized and transferred for further analysis to a PC. Images were analyzed with the researchers blinded to patient identity and ethnicity. CCA IMT was measured on the far wall at the straight portion of the CCA starting 20 mm proximal to the tip of the flow divider. Both maximal and mean CCA IMT were measured. Mean IMT was measured by using a semiautomated computer analysis system that detects the blood/intima borderline and the media/adventitia borderline with the use of a gray value algorithm. Differences between these 2 borderlines were measured along a line orthogonal to the arterial wall. Single IMT values were obtained from pixel-to-pixel measurements on neighboring lines perpendicular to the vertical line and then averaged and expressed as the mean IMT. Maximal IMT was determined visually from the frozen CCA image.

In 29 individuals, reproducibility of measurements was estimated. These subjects returned for a further scan separated by ~1 month. These scans were analyzed in a similar manner, with the researchers blinded to subject identity and whether the scan was a first or repeat scan. The regression coefficient was 0.78 (P<0.0001) between mean CCA IMT measurements and 0.81 (P<0.0001) between maximal CCA IMT measurements. The standard deviation of repeated measurements on the same subject was 0.060 mm for mean IMT measurements and 0.128 mm for maximum IMT measurements.

Laboratory Analysis

Serum total cholesterol was determined on all samples. Homocysteine was measured by using a fluorescence polarization immunoassay. C-reactive protein (CRP) and H pylori serology were measured by ELISA. For H pylori serology, an antibody level of ≥10 U/mL was taken as indicating positive serology.

DNA was extracted by using a commercially available kit (Nucleon, Scotlab Ltd). The ACE insertion/deletion (I/D) polymorphism was amplified by using the polymerase chain reaction (PCR), with previously described primers that generate a 190-bp product in the absence of the insertion and a 490-bp fragment in the presence of the insertion.

The reaction products were analyzed by agarose gel electrophoresis. It has been suggested that the D allele in heterozygous samples can be preferentially amplified, leading to incorrect typing of ID as DD. Therefore, all samples found to have DD genotype were subjected to a second independent PCR amplification as previously described by Lindpaintner et al.

The primer pair that was used yields a 335-bp product in the presence of an I allele and no product in samples homozygous for DD. The MTHFR C677T substitution (m/M) was identified by using restriction enzyme digestion of the PCR amplification products as previously described.

Digestion with HinfI results in 175- and 23-bp fragments. Genotyping of the PON1 codon 192 polymorphism (A/B) was performed by using primers described by Sanghera et al.

Genotyping of the PON2 codon 311 polymorphism (G/C) was performed by PCR to amplify a 262-bp fragment followed by a restriction digestion with DdeI.

All genotyping and biochemical assays were performed with researchers blinded to patient identity and results of the IMT analysis.

Statistical Analysis

Analysis between CCA IMT and cardiovascular variables was performed by using linear regression. The distributions of serum homocysteine and CRP approximated normal distributions only after logarithmic transformation; therefore, this was performed before analysis. Socioeconomic status was entered as a nonlinear variable by use of dummy variables. Socioeconomic groups 1 and 2 were combined because there were only 7 individuals in the former category. Analyses were performed for maximal CCA IMT and for mean CCA IMT.
Results

Cardiovascular risk factor distributions between the 2 populations are shown in Table 1. Compared with UK white individuals, UK African Caribbean individuals had higher systolic and diastolic blood pressure, were more likely to be on antihypertensive therapy, and had lower serum cholesterol levels. Among the African Caribbean group, there was an increased proportion of individuals of lower socioeconomic status. There was no difference in body mass index, smoking history, or serum homocysteine between the 2 ethnic groups.

After entering age, cardiovascular risk factors including homocysteine, and socioeconomic status into the regression model with ethnicity as the dependent variable, only cholesterol (P < 0.0001) and socioeconomic status (P < 0.0001) remained significantly different between the 2 groups.

There was no significant difference in CRP between the 2 ethnic groups. H pylori seropositivity was significantly more common in UK African Caribbean subjects (78.7% versus 53.0% in UK white subjects, P < 0.0001); this difference persisted after controlling for cardiovascular risk factors and socioeconomic status (odds ratio 2.500, 95% CI 1.268 to 4.930, P = 0.008). In contrast, there were highly significant differences in the distribution of polymorphisms in 3 of the 4 candidate genes studied. These are shown in Table 2. The ACE D allele and the PON1 B allele were more common in African Caribbeans, whereas the MTHFR M allele was more common in whites. There was no difference in the distribution of the PON2 polymorphism.

Both left and right CCA and mean CCA age-adjusted mean and maximal IMT measurements were increased in African Caribbean individuals compared with white individuals (Table 3). Maximum IMT remained significantly increased in African Caribbeans after controlling for cardiovascular risk factors, including cholesterol and homocysteine (β = 0.116, 95% CI 0.043 to 0.189, P = 0.002). Controlling also for socioeconomic status reduced the strength of the association slightly (β = 0.113, 95% CI 0.036 to 0.189, P = 0.004). Similar associations were seen with mean IMT. The association between mean IMT and ethnicity (Table 4) remained significant after controlling for cardiovascular risk factors, includ-
ing homocysteine ($\beta=0.040$, 95% CI 0.006 to 0.075, $P=0.022$). The association also remained significant after controlling for socioeconomic status ($\beta=0.037$, 95% CI 0.001 to 0.073, $P=0.046$). Results of regression coefficients after controlling for all cardiovascular risk factors, including socioeconomic class, are shown in Table 4.

Interactions with ethnicity affecting the relationship between risk factors and IMT were sought. There was no interaction between hypertension, socioeconomic class, body mass index, diabetes, or age and ethnicity. There was a significant interaction between ethnicity and smoking for age-adjusted mean IMT ($P=0.022$). Age-adjusted mean and maximum IMT measurements are shown in Table 5. The relationship between ethnicity and mean IMT was present only in nonsmokers compared with exsmokers or current smokers, whereas for maximum IMT, the relationship was much stronger in nonsmokers. After adding all the other cardiovascular risk factors as covariants, a similar picture was found, with the relationship between both mean and maximum IMTs being significant only in nonsmokers.

Log CRP was significantly related to mean IMT with an age-adjusted regression coefficient ($\beta$) of $2.73 \times 10^{-3}$ (95% CI 0.001 to 0.054, $P=0.044$). However, entering log CRP or H pylori seropositivity into the model had no effect on the strength of the association between IMT and ethnicity. There was no association between any of the polymorphisms and either maximum or mean CCA IMT (Table 6). There were no interactions between genotypes in their relationship with either mean or maximum IMT. Entering the polymorphisms into the linear regression had no effect on the strength of the association between ethnicity and CCA IMT.

**Discussion**

The results demonstrate that CCA IMT is significantly increased in UK African Caribbeans after controlling for both conventional cardiovascular risk factors (including homocysteine) and socioeconomic status. Differences were seen in both mean IMT measured over the whole arterial segment and maximum IMT. A significant interaction was found with smoking history, and the increased IMT in African Caribbean individuals was largely limited to individuals who had never smoked. We examined a number of novel infective and genetic potential risk factors for cardiovascular disease, but these failed to explain the differences. Increased IMT is believed to represent early arteriosclerosis. Increased CCA IMT has been associated with conventional cardiovascular risk factors in many studies, including the present study. In addition, prospective studies have demonstrated that increased IMT is an independent risk factor for both stroke and

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**TABLE 4. Relationship Between Cardiovascular Risk Factors, Socioeconomic Status, and Ethnicity With IMT Measurements From Multiple Regression Analysis**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Mean IMT</th>
<th></th>
<th>Maximum IMT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>95% CI</td>
<td>$P$</td>
<td>$\beta$</td>
</tr>
<tr>
<td>Age</td>
<td>$5.06 \times 10^{-3}$</td>
<td>0.003 – 0.007</td>
<td>&lt; 0.0001</td>
<td>$7.54 \times 10^{-3}$</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>$1.82 \times 10^{-3}$</td>
<td>0.001 – 0.003</td>
<td>&lt; 0.0001</td>
<td>$2.25 \times 10^{-3}$</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>$-2.21 \times 10^{-3}$</td>
<td>-0.004 – -0.001</td>
<td>0.006</td>
<td>$-3.83 \times 10^{-3}$</td>
</tr>
<tr>
<td>Diabetes</td>
<td>$7.45 \times 10^{-2}$</td>
<td>0.019 – 0.130</td>
<td>0.008</td>
<td>$0.148$</td>
</tr>
<tr>
<td>Body mass index</td>
<td>$4.30 \times 10^{-3}$</td>
<td>0.001 – 0.007</td>
<td>0.008</td>
<td>$3.71 \times 10^{-3}$</td>
</tr>
<tr>
<td>Years smoked</td>
<td>$6.64 \times 10^{-4}$</td>
<td>0.000 – 0.001</td>
<td>0.114</td>
<td>$3.82 \times 10^{-3}$</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>$-3.24 \times 10^{-4}$</td>
<td>-0.015 – -0.015</td>
<td>0.966</td>
<td>$7.57 \times 10^{-3}$</td>
</tr>
<tr>
<td>Log homocysteine</td>
<td>$-1.77 \times 10^{-2}$</td>
<td>-0.132 – -0.097</td>
<td>0.760</td>
<td>$-7.91 \times 10^{-2}$</td>
</tr>
<tr>
<td>A-C ethnicity</td>
<td>$3.70 \times 10^{-2}$</td>
<td>0.001 – 0.073</td>
<td>0.046</td>
<td>$0.113$</td>
</tr>
<tr>
<td>SE status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3a</td>
<td>$2.30 \times 10^{-2}$</td>
<td>-0.037 – -0.083</td>
<td>0.453</td>
<td>$3.80 \times 10^{-2}$</td>
</tr>
<tr>
<td>Class 3b</td>
<td>$2.52 \times 10^{-2}$</td>
<td>-0.043 – -0.048</td>
<td>0.913</td>
<td>$-1.88 \times 10^{-2}$</td>
</tr>
<tr>
<td>Class 4</td>
<td>$2.92 \times 10^{-2}$</td>
<td>-0.020 – -0.078</td>
<td>0.242</td>
<td>$3.28 \times 10^{-2}$</td>
</tr>
<tr>
<td>Class 5</td>
<td>$2.77 \times 10^{-3}$</td>
<td>-0.041 – -0.061</td>
<td>0.706</td>
<td>$1.24 \times 10^{-2}$</td>
</tr>
</tbody>
</table>

BP indicates blood pressure; A-C, African Caribbean; and SE, socioeconomic. Results are from the semiautomated analysis of an arterial segment giving a value of mean IMT and from the manual measurement of the single maximum value (maximum IMT). For SE status, because of the small numbers in groups 1 and 2, these are amalgamated, and the changes in IMT associated with the other groups, compared with groups 1 and 2, are shown.
ischemic heart disease. Most IMT assessments have been performed in white individuals, and there have been relatively few in African Caribbean individuals. The finding of increased IMT in this ethnic group is consistent with increased cerebral artery damage and the increased stroke risk reported in previous studies.

Stroke itself is very heterogeneous, representing a syndrome rather than a single disease. The pathogenic mechanisms underlying cerebral small-vessel disease may be quite different from those underlying large-vessel disease, cardioembolic stroke, or other stroke subtypes. In addition, even in patients with large-vessel stroke, risk factors may act at a number of stages in the pathogenic process, including early arteriosclerosis, progression of established atheromatous plaques, and conversion of a stable to unstable plaque with secondary thromboembolism. If one assumes that different genetic and other risk factors contribute to particular phases of this process, identifying individual genes that may each have relatively small effects will prove difficult. Studying an early stage of the disease process (or intermediate phenotype) such as IMT is likely to be a more powerful technique for the identification of genetic predispositions. Fewer genes are likely to be involved in this limited part of the disease process, thereby increasing the statistical power of the study. In addition, measuring IMT as a continuous variable, rather than using the dichotomous variable stroke as an end point, increases the power of such a study.

There is increasing evidence that genetic factors are important in cerebrovascular disease. This is supported by twin and family history studies. A recent family study has suggested that the heritability of IMT itself is very high. Differing genetic predispositions could account for at least part of both the increased stroke risk and the increased IMT seen in African Caribbeans. The present study demonstrates that there are highly significant differences in the distribution of candidate gene polymorphisms between African Caribbean and white populations. The ACE D allele, which has been associated with an increased risk of cardiovascular disease in some but not all studies, was more common in African Caribbean individuals. Paraoxonase has been suggested as a

<table>
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<tr>
<th>TABLE 5. Relationship Between Ethnicity and Mean and Maximum IMT in African Caribbean and White Groups Divided Into Smokers and Those Who Never Smoked</th>
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</thead>
<tbody>
<tr>
<td>Mean IMT</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Never Smoked</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>A-C</td>
</tr>
<tr>
<td>P</td>
</tr>
<tr>
<td>Age plus other adjustments*</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>A-C</td>
</tr>
<tr>
<td>P</td>
</tr>
</tbody>
</table>

Values are mean±SD. *Adjusted for age, systolic and diastolic BP, body mass index, cholesterol, socioeconomic class, and log homocysteine.

<table>
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<tr>
<th>TABLE 6. Effect of Entering CRP and H pylori Seropositivity and Results of Genotyping Individually Into the Multiple Regression on the Strength of the Relationship Between Ethnicity and IMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Factor</td>
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<tr>
<td>------------</td>
</tr>
<tr>
<td>CVS risk factors</td>
</tr>
<tr>
<td>+ H pylori</td>
</tr>
<tr>
<td>+ Log CRP</td>
</tr>
<tr>
<td>+ ACE</td>
</tr>
<tr>
<td>+ MTHFR</td>
</tr>
<tr>
<td>+ PON1</td>
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<tr>
<td>+ PON2</td>
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</tbody>
</table>

CVS risk factors indicate results after controlling for the following cardiovascular risk factors: age, systolic BP, diastolic BP, diabetes, years smoked, serum cholesterol, body mass index, and log serum homocysteine. ACE indicates ACE gene enzyme polymorphism; MTHFR, MTHFR gene polymorphism; and PON1 and PON2, PON1 and PON2 polymorphisms, respectively.
potential cardiovascular candidate gene. Mice lacking the PON1 gene develop accelerated atherosclerosis, and both the polymorphisms that we studied in PON1 and PON2 have been associated with ischemic heart disease and stroke, although this association has not been found in all studies. Results of previous studies looking at associations with carotid IMT in white diabetic and hypercholesterolemic subjects have been conflicting. Raised homocysteine levels have been associated with an increased risk of stroke in a number of studies and with increased CCA IMT. The MTHFR polymorphism that we studied has been associated with increased homocysteine levels in white populations and with cardiovascular end points in some studies, although a meta-analysis failed to show an association with cardiovascular disease, despite an association with homocysteine levels. Despite the marked ethnic difference in the distribution of these polymorphisms, they were not related to IMT in the present study, and they did not contribute to the increased IMT seen in African Caribbeans. Nevertheless, the markedly different distribution of candidate gene polymorphisms between the ethnic groups suggests that polymorphisms in other candidate genes may play a role in mediating the increased risk of stroke in African Caribbeans.

There has been considerable interest in the role of inflammation and chronic infection in the pathogenesis of atherosclerosis, ischemic heart disease, and stroke. A number of studies have demonstrated an increased prevalence of seropositivity to H pylori in individuals suffering cardiovascular disease, although the results of recent prospective studies have been less consistent. Increased inflammation as determined by CRP levels has been associated with cardiovascular disease in both cross-sectional prospective studies. We found an increased prevalence of H pylori seropositivity in African Caribbeans even after controlling for cardiovascular risk factors and socioeconomic status. However, we found no association between H pylori seropositivity and IMT, and the H pylori seropositivity difference between the ethnic groups was unable to explain the increase in IMT seen in the African Caribbeans. In addition, we found no difference in levels of inflammation, as assessed by CRP, between the 2 ethnic groups.

A number of different methods have been used to measure IMT, and we determined the mean IMT over a segment of the vessel by using a semiautomated computer analysis system and also the maximum IMT. Our reproducibility studies suggested that mean IMT measurements were more reproducible. However, we found a stronger association between maximum IMT and ethnicity. The 2 measurements may assess slightly different parts of the arteriosclerotic process. Mean IMT measures the response of the whole vessel, whereas maximum IMT may assess a more advanced part of the disease process by measuring an area of focal atherosclerosis. The optimal measure remains uncertain, although one recent prospective study found a stronger association between maximum IMT and risk of future cardiovascular disease.

A strength of the present study is the use of a community population sample. In the inner city population that we studied, estimation of the representativeness was difficult because of the lack of any record of ethnicity on the general practitioner patient registers and the mobility of the population. We received 527 replies, but of these, 64 indicated that the subjects had moved or died. Of the remainder, 66% attended the study. Even with a most conservative estimate, assuming that all these patients were eligible, our recruitment rate would be 25%. However, it is likely to be higher because at least 10% to 20% of the population is neither white nor African Caribbean, and not all questionnaires sent to addresses at which individuals no longer lived are likely to have been returned. Selection bias in recruitment of one ethnic group could result in overrepresentation of certain individuals, particularly of a different socioeconomic status in one ethnic group. However, the risk factor profiles in the present study are similar to those seen in a recent previous community risk factor study in South London. The distribution of socioeconomic class seen in the present study is very similar to that found in a recent risk factor study in the same London borough and similar to that found in the 1991 census. Furthermore, the most recent census data from 1991 reported that 69.7% of the local population were white and that 21.8% were black, whereas a more recent estimate suggests that the proportion of individuals with either African Caribbean or African descent has increased to 25%. Therefore, the proportion of the 2 ethnic groups who responded, with a white to African Caribbean ratio of 2.26, is of the same order as the distribution found in the local community. Our results are directly applicable to the African Caribbean community in London. Although this group shows an increase in stroke risk similar to that seen in black Americans, our results are not necessarily generalizable to African Caribbean populations living in other locations.

In summary, our results demonstrate an increase in CCA IMT in African Caribbeans that is independent of conventional cardiovascular and socioeconomic factors. This difference is predominantly found in nonsmokers. Although we demonstrated marked differences in the distribution of a number of candidate gene polymorphisms between the ethnic groups, these were unable to explain this increase in IMT. However, IMT may offer a useful intermediate phenotype that can be used to explore the role of genetic and other novel risk factors in the increased stroke risk seen in African Caribbeans.

Acknowledgments
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References


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