Incidence of aetiological subtypes in a multi-ethnic population based study:the South London Stroke Register

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Incidence of Aetiological Subtypes of Stroke in a Multi-Ethnic population based study: the South London Stroke Register

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Summary

Background: Stroke risk is higher in black ethnic groups compared to white. Although risk factors for stroke are known to differ between these populations, few population studies have reported on the risk of aetiological stroke subtypes in Black ethnic populations.

Methods: Ethnic group differences in incidence of first ever ischaemic stroke by aetiological subtype were investigated with the South London Stroke Register (SLSR). The SLSR is a population-based stroke register covering a multiethnic inner-city population of 271,871 inhabitants comprising 63% White, 28% Black and 9% other ethnic group. A modified pathophysiological Trial of Org 10172 (TOAST) classification of stroke was used to estimate patterns of aetiological subtype and stroke was subtyped into large artery atherosclerosis (LAA), cardioembolism (CE), small vessel occlusion (SVO), other aetiology (OTH), undetermined (UND) and multiple possible or concurrent aetiologies (CONC).

Findings: Between September 1999 and August 2006, 1181 patients with first ever ischaemic stroke were included in the study. Mean age was 71.4yrs, 51% were female, and 71% of White, 20% of Black, 6% of Other and 3% of unknown ethnic group.
The distribution of the aetiological subtypes was as follows: LAA, 109 (9.3%); CE, 325 (27.8%); SVO, 316 (27.0%); OTH, 40 (3.4%); UND, 283 (24.2%); CONC, 96 (8.2%).
The annual age adjusted incidence rate per 100,000 was for total ischemic stroke 101.2 (95% CI 82.4-122.9) in men and 75.1 (95% CI 59.1-94.1) in women; for LAA 10.4 (95% CI 5.1-18.9) in men and 6.8 (95% CI 2.7-14.2) in women; for CE 23.0 (95% CI 14.6-34.5) in men and 21.5 (95% CI 13.4-32.8) in women; for SVO 30.3 (95% CI 20.5-43.2) in men and 20.3 (95% CI12.5-31.3) in women.

The overall incidence rate ratio (IRR) for Black patients was 1.25 (1.07-1.46), for black Caribbean (BC) patients 1.31 (1.09-1.58), for black African (BA) patients 1.22 (0.93-1.61) and for other ethnic groups 1.24 (0.96-1.61). IRRs for Black ethnic groups as well as for BA and BC were significantly higher for SVO in both sexes, for OTH in Black for females and in BA for males and females compared to White ethnic group; IRRs for other ethnic groups compared to Whites were higher for SVO in females and for UND in males.

Interpretation: Independent, important differences in risk of stroke between different ethnic populations strengthen the evidence-base for studying genetic susceptibility and environmental influences in ethnic groups separately.

Introduction

The risk of stroke varies significantly internationally and although estimating overall stroke risk is relevant to planning stroke care, more detailed assessment of the underlying risk factor profile in stroke populations is relevant to understanding the aetiology and how preventive strategies may need to be tailored in different sociodemographic groups.[1] Population-based studies following key methodological criteria are able to deliver this information but registers that have investigated aetiological stroke subtypes using a mechanism based classification system, [2] such as the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification system, [3] are few and include studies in Germany, [4] the US, [5-8] New Zealand, [9] and Chile [10] but none estimating risk in European multi-ethnic populations or in different groups in the Black population.

Overall there are higher incidence rates of ischemic stroke among Black, Hispanics, Maori/Pacific Islanders and Asian/other groups in the previously reported studies. The most common subtypes are CE, SVO, LAA in the White populations; SVO, CE, LAA in Black/ Hispanics; and CE, SVO, LAA in Maori/Pacific & Asian/Other groups in New Zealand. [5-10]

In recent years, a number of epidemiological studies have also revealed substantial differences in overall stroke risk between different ethnic groups, e.g. in Black populations in the UK or in Black or Hispanic populations in the US. [5, 7, 8,11] The aim of this paper is therefore to estimate the incidence of aetiology of first ever ischemic stroke in different ethnic groups within a multi-ethnic inner city population of South London to determine whether patterns of population risk vary with ethnicity.

Methods

Study population

Patients with first ever ischemic stroke were register within the South London Stroke Register (SLSR). The SLSR is a prospective, ongoing population-based stroke register recording since

January 1995 all hospitalised and non-hospitalised first-ever strokes in patients of all age groups within in 22 electoral wards in Lambeth and Southwark.[11] Data on aetiological subtype commenced in 1999. The source population of the SLSR is 271,871 inhabitants (based on UK population census data and projections) comprising 63% White, 28% Black (9% black Caribbean (BA), 15% black African (BA) and 4% black other/mixed (BO)) and 9% other ethnic groups. The methods of case ascertainment and data collection have been previously described. [11] In brief, all patients with a suspected diagnosis of stroke or transient ischaemic attack documented in different hospital and community based information sources were investigated for study eligibility. Multiple sources of notification were used and capture-recapture models were developed to estimate completeness of case ascertainment. Case ascertainment was estimated to be 84% complete in 1995/1996 and 81% in 2003/2004.[12]

Stroke classification

Stroke was defined according to WHO criteria. [13] Pathological stroke subtypes were classified using neuro-radiology or necropsy results into ischemic stroke, primary intra-cerebral haemorrhage (PICH) or subarachnoid haemorrhage (SAH). Ischaemic strokes were further investigated according to an investigation algorithm and categorised by a study clinician into aetiological subtypes according to the TOAST classification with local modifications to improve investigation rates in different ethnic groups. [14.] This modified classification has excellent inter and intra operator agreement and has been adapted to enable conditions such as sickle cell disease to be classified specifically in 'Other'. Ischemic stroke subtypes included large artery atherosclerosis (LAA) (including extra-cranial large artery atherosclerosis and intra-cranial large artery atherosclerosis), cardioembolism (CE), small vessel occlusion (SVO), other aetiology (OTH) (including other vascular aetiology, other haemoglobinopathy aetiology, other hypercoaguable aetiology, migrainous stroke, other

aetiology not previously mentioned), no aetiology identified (UND) and multiple or concurrent aetiology (CONC).

Data collection

Special trained study nurses and field workers collected all data prospectively. A study clinician verified stroke diagnosis. The following information on sociodemographic characteristics and prior-to-stroke risk factors was collected at initial assessment: self-defined ethnic origin (UK 1991 Census question), classified into White, Black (black-Caribbean, black African, and black Other), other ethnic group; socio-economic status (SES) (based on the Registrar General's codes of occupation), categorised into non-manual (I, II and III non-manual) and manual (III manual, IV and V); hypertension (general practice or hospital records of high blood pressure >140 mm Hg systolic or >90 mm Hg diastolic)[12]; diabetes mellitus (self-reported); smoking; previous transient ischaemic attack (TIA).

Statistical Analyses

The t-test was used to test differences in continuous variables, and the chi–square test for differences in proportions. The denominators for incidence calculations were based on the 1991 and 2001 Office of National Statistic's Census data for the study area by assuming a linear trend (REF 11). In January 2004 the register area was extended after the revision of electoral ward boundaries by about 15%. The population estimates for 2004 onwards for the enlarged study area were estimated in a similar way. Crude incidence rates of ischemic stroke were calculated for age group, gender, ethnic groups, and stroke aetiology; specific incidence rates for gender, ethnic group and aetiological subtype were age adjusted to the standard European population.[15] 95% confidence intervals (CI) for the age-specific rates and age-adjusted rates were calculated using the Poisson distribution. Incidence rate ratios (IRRs)

were calculated for each aetiological subtype to compare stroke incidence between different ethnic groups with the White group being the reference group; 95% CI for the direct standardized IRRs were calculated by the delta method.[16] Differences in proportions of prior-to-stroke risk factors among aetiological stroke subtypes were explored by running separate logistic regression models for each risk factor, adjusted for age, sex, ethnicity and SES as appropriate. Two-tailed probability values are reported and a p-value <0.05 was considered statistically significant in all analyses. Statistical analyses were performed with SAS software version 9.1 (SAS Institute Inc).

Ethics

Patients and/or their relatives gave written informed consent to participate in the study. The design of the study was approved by the ethics committees of Guy's and St Thomas' Hospital Trust, King's College Hospital, St George's Hospital, Queens Square, and Westminster Hospital (London).

Results

Between 1st September 1999 and 31st August 2005, 1181 patients with first ever ischemic stroke were registered in the SLSR and were assessed for aetiological subtype of stroke. In 12 of these patients, TOAST classification was not possible mainly because of missing or incomplete diagnostic information. No differences were found for age, sex and ethnic group between classified and unclassified patients. Unclassified patients were excluded from further analyses. Among the remaining 1169 patients included in subsequent analyses, mean age was 71.4 years, 50.6% were female; 71.3% were of White, 19.9% of Black (12.8% black Caribbean, 6.7% black African, 0.5% black Other), 5.7% of Other and 3.1% of unknown ethnic origin; 86.6% of the patients had an ECG, 59.5% underwent a transthoracic or

transesophageal echocardiography and 66.9% underwent vascular imaging (carotid doppler and/or transcranial colour duplex).

The distribution of the aetiological subtypes was as follows: LAA, 109 (9.3%); CE, 325 (27.8%); SVO, 316 (27.0%); OTH, 40 (3.4%); UND, 283 (24.2%); CONC, 96 (8.2%).

Sociodemographic characteristics and risk factors by aetiological subtype are detailed in Table 1. There were significant differences between aetiological subtypes for age, ethnicity, socioeconomic status, a history or transient ischemic attacks and smoking.

The distribution of aetiological subtypes in Whites was: LAA, 91 (9.7%); CE, 257 (30.8%); SVO, 187 (22.4%); 21 (2.5%); UND, 205 (24.6%). CONC 83 (10.0%); in Blacks: LAA, 20 (8.6%); CE, 40 (17.2%); SVO, 98 (42.1%); OTH, 18 (7.7); UND, 49 (21.0%); CONC, 8 (3.4%); and in other ethnic groups: LAA, 7 (10.6%); CE, 11 (16.7%); SVO, 23 (34.9%); OTH, 1 (1.5%); UND, 20 (30.3%); CON, 4 (6.1%). Table 2 contrasts the SES, demographic and risk factor between White, Black and Other ethnic groups. There are significant differences in age in White, Black and Other ethnic groups across aetiological subtypes and in Whites for SES. There were no significant differences across subtypes for risk factor prevalence in the Black and Other ethnic group but a significantly increased prevalence of smoking in White groups with LAA and SVO (P=0.0002).

The annual age adjusted incidence rate per 100,000 was for total ischemic stroke 101.2 (95% CI 82.4-122.9) in men and 75.1 (95% CI 59.1-94.1) in women; for LAA 10.4 (95% CI 5.1-18.9) in men and 6.8 (95% CI 2.7-14.2) in women; for CE 23.0 (95% CI 14.6-34.5) in men and 21.5 (95% CI 13.4-32.8) in women; for SVO 30.3 (95% CI 20.5-43.2) in men and 20.3

(95% CI 12.5-31.3) in women; for OTH 3.7 (95% CI 1.0-9.9) in men and 2.7 (95% CI 0.5-8.2) in women; for UND 24.8 (95% CI 16.0-36.7) in men and 18.8 (95% CI 11.2-29.4) in women; and for CONC 9.0 (95% CI 4.1-17.1) in men and 5.0 (1.6-11.7) in women. Table 3 reports on the annual, age adjusted incidence rates of the aetiological subtypes by ethnic group and sex.

The overall incidence rate ratio (IRR) for black patients was 1.25 (95% CI 1.07-1.46), for BC patients 1.31 (95% CI 1.09-1.58), for BA patients 1.22 (95% CI 0.93-1.61) and for other 1.24 (95% CI 0.96-1.61). Table 4 details the IRR and corresponding 95% CIs for Black, BC, BA and other ethnic groups for individual aetiological subtypes, using the White group as the reference. IRRs for Black ethnic groups as well as for BA and BC were significantly higher for SVO in both sexes and for OTH in females, for OTH in black females and in BA for males and females compared to white ethnic group. Figure 1 compares the incidence rates and IRRs reported in the studies involving Black ethnic groups (African, African Caribbean). [5,8]

Discussion

This study represents the first European data on the incidence of aetiological stroke subtypes in different ethnic groups, including White, Black and Other ethnic groups, using a modified TOAST classification. It has demonstrated stark differences between the White, Black and Other ethnic groups such as the age at stroke onset and patterns of prior to stroke risk factors and aetiological subtypes in different ethnic groups. In this study, the risk of small vessel occlusion was increased for black African, black Caribbean and other ethnic groups in both sexes, and for Other aetiologies the risk was increased in black females and in black African compared to White ethnic groups.

Age standardised incidence rates varied significantly between groups in SLSR, with cardioembolic stroke being more common in the White group and small vessel occlusion and Other aetiologies in the Black group. Variation between studies may potentially be explained by such factors as for diagnostic precision and the proportion classified as of undetermined aetiology. The proportion of ischemic stroke patients with undetermined aetiology was low in the SLSR (24%) compared with that reported in previous studies (24-54%), which is mainly explained by the fact, that in the present study ischemic stroke of undefined and of multiple aetiology (Concurrent) were reported separately whereas previous studies reported them combined. [4, 5, 9, 10, 17] The distribution of subtypes in the SLSR is similar to a non population based study in South London that included data from the register.[18] Two previous studies comparing the incidence and distributions of aetiological subtypes of stroke amongst non Black groups have reported in detail the differences in risk of the aetiological subtypes across studies to date. [9,10] Their Tables and Figures illustrate the difficulty in comparisons as rates are not always standardised to World or European populations or reported in ways that are readily comparable. Additionally, the studies span 13 years and comparisons are compromised by potential changes in risk over the time period and differences in diagnostic procedures. Figure 1 compares, as far as is feasible given the ways risk and incidence rate ratios have been calculated, the incidence rate ratios for the different aetiological subtypes of stroke in the US and UK studies using Black groups over a 13 year time frame. Figure 1 summarises the main findings that in the studies to date there are consistently increased risks of small vessel occlusion in Black groups, with inconsistent differences for other groups.

There is evidence of diversity within different Black ethnic groups.[19] Previous studies in the US have included significant numbers of Black ethnic minority individuals in stroke incidence studies but have not reported separately on these disparate groups. [5,6,8,20,21,22] The

SLSR has looked separately at Black ethnic groups by black African and black Caribbean ancestry although the power to assess risk across subtypes is limited due to the small number of patients particularly in the Black African group. Overall, risk patterns between these distinct ethnic groups are similar, except a higher rate of other aetiologies among black Africans, which in this study was associated with higher rates of sickle cell disease.

Comparing aetiological subtypes between ethnic groups, we have demonstrated much higher rates of small vessel occlusion in the Black population both in the black Caribbean and black African groups compared with the White ethnic group confirming previous reports (Figure 1). [5, 7, 8] Previous studies have also reported higher rates of large artery atherosclerosis overall, and for both intracranial large artery atherosclerosis and extra cranial large artery atherosclerosis but the confidence intervals are wide in the study reporting intra cranial and extra cranial incidence rate ratios.[5,7,8] In the current study, although incidence rate ratios for individual subtypes corroborated the pattern expected from previous literature on large artery atherosclerosis subtype, the findings did not reach statistical significance. This may have been due to small numbers in the groups. It may also reflect a true difference between the US and UK Black populations due to differences in risk factors such as smoking, which has a great impact on the development of atherosclerosis. [23]

Differences in risk of stroke between different ethnic groups might be caused by differences in underlying risk factors. Age at onset of stroke is significantly lower in all ethnic groups compared to whites in our population and in other previously reported literature.[11] We have previously identified that there are significant variations in underlying risk factor patterns in the SLSR: The African Caribbean/African group have higher rates of prior-to-stroke hypertension and diabetes but reduced rates of smoking, history of transient ischaemic attack

and obesity,[23] and these finding mirror the results from another, non-population based, South London study assessing differences in stroke subtypes between ethnic groups.[18] Comparing results with international studies contrasting ethnic groups, similar differences have been observed in the US with regard to increased hypertension and diabetes in Black Americans and Hispanics in Northern Manhattan and in Blacks in Greater Cincinnati. [5,17] The increased rates of hypertension are linked to small vessel occlusion but in a parallel study in London, using the population of SLSR, even after adjustment for hypertension there was an excess of small vessel occlusion in the Black group.[17] This study reported a relative excess of small vessel disease and intracranial atherosclerosis in Black patients compared with an excess of extracranial atherosclerosis and cardioembolic stroke in White patients, independent of conventional risk factors and social class.[18] Large artery atherosclerosis incidence rate ratios did not differ between ethnic groups unlike the study by Markus, and population-based studies in US. [5, 17,18]

We also observed higher incidence rate ratios for small vessel occlusion in females and for undetermined aetiology in males in other ethnic group compared to Whites. Thus, the increased risk of stroke in different ethnic groups compared to Whites might represent a non ethnic group specific “migration effect”. This effect might be caused by variations in socioeconomic status, differences in access to health care services or different attitudes towards preventive measures between native and migrant populations.

There are strengths and limitations of our study. One limitation to the use of the TOAST classification is the proportion of cases classified as Undetermined. Several studies have estimated the risk and distribution of both the Bamford and TOAST classifications of stroke and identified variations in syndromes between ethnic groups and differences between the

incidence rate ratios estimated using each classification. [9, 18] The advantage of the Bamford classification is that it is less protocol driven yet its prime aim is not to classify aetiology and it does not phenotype the stroke in terms of underlying risk.

Selection bias resulting from differential uptake of diagnostic tests is a possibility. In the SLSR an investigation algorithm was devised as it was thought that the systematic selection of patients for investigation would increase the overall investigation rate. The investigation rates attained with this study are similar to those of other European and US studies. [4,5] We cannot confirm whether investigation rates have been improved upon by the use of this algorithm due to a lack of prior data. However, it seems that the limiting step in achieving high levels of investigation in acute stroke patients is the acutely debilitating nature of the condition itself rather than the availability of scanning facilities. There is also the possibility of information bias. No inter-rater reliability in diagnosis was formally assessed. However a small inter-rater analysis was undertaken on the first 45 consecutive patients recruited into this study. [13] In addition, all diagnoses were made by trained study clinicians and reviewed on a regular basis by an expert stroke physician (AR). No information on genetic and certain lifestyle factors, such as physical activity and body mass index were collected. The use of self-defined ethnicity is necessitated by the use of this for the denominator population (population Census question) but it is known to have problems with accuracy and fluidity over time. One way that this may be overcome for future studies is to record the place of birth and origin in order to further delineate ethnic groups and in order to glean information on genetic versus environmental influence on the risk of stroke. Although the SLSR population contains amongst the highest proportion of black Africans in the UK and probably Europe, numbers in this ethnic group are still small for the purposes of sub-group analyses resulting in lower estimate precisions compared with the other, larger ethnic groups. Some of the tools

used in defining aspects of risk have been designed for use in the West European white population and are not validated or may not be meaningful in these particular ethnic groups, an example of which is the Registrar General Classification for socioeconomic status.[11]

Conclusion

Important differences in patterns of risk of subtypes of ischaemic stroke have been demonstrated between different ethnic groups which strengthen the case for assessing stroke risk strategies separately in these populations. Furthermore, the pattern of aetiological subtypes seen in these ethnic groups demonstrates the importance of studying individual subtypes in multi-ethnic populations. Reasons for the significant increased risk in Blacks and Other ethnic groups of small vessel occlusion and in black Africans of other aetiologies have to be explored in more detail. Further characteristics of populations with regard to genetic risk and other environmental and life course factors is required to develop tailor-made prevention programmes adapted to the needs of specific ethnic groups.

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Conflict of Interest Disclosures

None declared.

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Table 1. Sociodemographic characteristic and risk factors of patients with first ischaemic stroke by aetiological subtype, Sept 1999-2005

	Total	LAA	CE	SVO	OTH	UND	CONC	p-value#
N	1169	109 (9.3)	325 (27.8)	316 (27.0)	40 (3.4)	283 (24.2)	96 (8.2)	
Age, y, mean (SD)	71.35 (13.51)	72.15 (10.52)	74.47 (13.63)	68.77 (12.71)	54.18 (16.24)	71.80 (13.04)	74.30 (12.08)	
Age group, y, n (%)								<.0001
<65	327 (27.97)	30 (27.52)	59 (18.15)	107 (33.86)	30 (75.00)	80 (28.27)	21 (21.88)	
65-74	311 (26.60)	31 (28.44)	76 (23.38)	99 (31.33)	5 (12.50)	79 (27.92)	21 (21.88)	
75-84	340 (29.08)	33 (30.28)	117 (36.00)	80 (25.32)	5 (12.50)	70 (24.73)	35 (36.46)	
85+	191 (16.34)	15 (13.76)	73 (22.46)	30 (9.49)	0	54 (19.08)	19 (19.79)	
Female, n (%)	591 (50.56)	51 (46.79)	190 (58.46)	143 (45.25)	18 (45.00)	145 (51.24)	44 (45.83)	0.12
Ethnic group, n (%)								<.0001
White	834 (71.34)	81 (74.31)	257 (79.08)	187 (59.18)	21 (52.50)	205 (72.44)	83 (86.46)	
Black	233 (19.93)	20 (18.34)	40 (12.31)	98 (31.01)	18 (45.00)	49 (17.31)	8 (8.33)	
Other	66 (5.65)	7 (6.42)	11 (3.38)	23 (7.28)	1 (2.50)	20 (7.07)	4 (4.17)	
Unknown	36 (3.08)	1 (0.92)	17 (5.23)	8 (2.53)	0	9 (3.18)	1 (1.04)	
Socioeconomic status, n (%)								
Non-manual	306 (26.18)	26 (23.85)	88 (27.08)	74 (23.42)	17 (42.50)	76 (26.86)	25 (26.04)	0.0016
Manual	664 (56.80)	64 (58.72)	176 (54.15)	211 (66.77)	19 (47.50)	144 (50.88)	50 (52.08)	
Unknown	199 (17.02)	19 (17.43)	61 (18.77)	31 (9.81)	4 (10.00)	63 (22.26)	21 (21.88)	
Risk factors pre stroke, n (%)*								
Hypertension	729 (63.67)	74 (69.16)	209 (65.52)	203 (64.86)	15 (39.47)	165 (60.00)	63 (67.74)	0.09
Diabetes	236 (20.67)	23 (22.12)	60 (18.52)	65 (21.17)	6 (15.38)	58 (21.17)	24 (25.53)	0.50
Previous TIA	149 (12.93)	24 (22.43)	45 (14.02)	32 (10.19)	3 (7.69)	30 (10.83)	15 (15.96)	0.07
Current smoking	330 (30.44)	39 (37.86)	61 (20.68)	116 (37.79)	10 (27.78)	82 (32.16)	22 (25.00)	0.0001

*restricted to patients without missing values; #p-value for differences between aetiological stroke subtypes; adjusted for age, sex, ethnicity, social class as appropriate

Table 2. Sociodemographic characteristic and risk factors of patients with first ischaemic stroke by aetiological subtype stratified for White (W) and Black (B) ethnic group

	Total			LAA			CE			SVO			OTH			UND			CONC			p-value#		
	W	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**	**W**	**B**	**O**
N	834	233	66	81	20	7	257	40	11	187	98	23	21	18	1	205	49	20	83	8	4			
Age, y, mean (SD)	73.69	64.85	65.02	73.25	66.85	74.71	76.09	65.73	67.73	71.65	64.74	62.83	56.76	51.50	48	74.05	67.12	62.55	74.72	73.13	69.75			
	(12.74)	(13.46)	(13.07)	(10.50)	(10.72)	(6.18)	(12.32)	(16.20)	(13.64)	(12.84)	(10.81)	(14.25)	(14.62)	(18.30)		2.41)	(12.54)	(12.89)	(12.47)	(11.44)	(4.11)			
Age group, y, n (%)																						0.0022	0.0258	0.05
<65	192	94	32	20	10	0	38	13	5	53	40	12	15	14	1	47	15	14	19	2	0			
	(23.02)	(40.34)	(48.48)	(24.69)	(50.00)		(14.79)	(32.50)	(45.45)	(28.34)	(40.82)	(52.17)	(71.43)	(77.78)	(100)	(22.93)	(30.61)	(70.00)	(22.89)	(25.00)				
65-74	192	90	17	23	4	3	57	14	2	46	41	7	2	3	0	50	25	2	14	3	3			
	(23.02)	(38.63)	(25.76)	(28.40)	(20.00)	(42.86)	(22.18)	(35.00)	(18.18)	(24.60)	(41.84)	(30.43)	(9.52)	(16.67)		(24.39)	(51.02)	(10.00)	(16.87)	(37.50)	(75.00)			
75-84	282	38	13	25	5	3	97	11	4	61	15	3	4	1 (5.56)	0	62	5	2	33	1	1			
	(33.81)	(16.31	(19.70)	(30.86)	(25.00)	(42.86)	(37.74)	(27.50)	(36.36)	(32.62)	(15.31)	(13.04)	(19.05)			(30.24)	(10.20)	(10.00)	(39.76)	(12.50)	(25.00)			
85+	168	11	4	13	1	1	65	2	0	27	2	1	0	0	0	46	4	2	17	2	0			
	(20.14)	(4.72)	(6.06)	(16.05)	(5.00)	(14.29)	(25.29)	(5.00)		(14.44)	(2.04)	(4.35)				(22.44)	(8.16)	(10.00)	(20.48)	(25.00)				
Female, n (%)	435	115	22	40	10	1	155	18	6	80	49	10	8	10	0	111	25	5	41	3	0	0.24	0.95	0.44
	(52.16)	(49.36)	(33.33)	(49.38)	(50.00)	(14.29)	(60.31)	(45.00)	(54.55)	(42.78)	(50.00)	(43.48)	(38.10)	(55.56)		(54.15)	(51.02)	(25.00)	(49.40)	(37.50)				
Socioeconomic status, n (%)																						0.0015	0.47	0.39
Non-manual	231	49	16	21	3	1	73	5	5	47	21	3	9	8	0	58	12	5	23	0	2			
	(27.70)	(21.03)	(24.24)	(25.93)	(15.00)	(14.29)	(28.40)	(12.50)	(45.45)	(25.13)	(21.43)	(13.04)	(42.86)	(44.44)		(28.29)	(24.49)	(25.00)	(27.71)		(50.00)			
Manual	459	153	37	50	12	2	135	27	5	124	70	15	11	7	1	98	31	12	41	6	2			
	(55.04)	(65.67)	(56.06)	(61.73)	(60.00)	(28.57)	(52.53)	(67.50)	(45.45)	(66.31)	(71.43)	(65.22)	(52.38)	(38.89)	(100)	(47.80)	(63.27)	(60.00)	(49.40)	(75.00)	(50.00)			
Unknown	144	31	13	10	5	4	49	8	1	16	7	5	1	3	0	49	6	3	19	2	0			
	(17.27)	(13.30)	(19.70)	(12.35)	(25.00)	(57.14)	(19.07)	(20.00)	(9.09)	(8.56)	(7.14)	(21.74)	(4.76)	(16.67)		(23.90)	(12.24)	(15.00)	(22.89)	(25.00)				
Risk factors pre stroke, n (%)*																								
Hypertension	511	160	43	52	16	5	170	27	7	117	70	13	9	6	0	111	34	14	52	7	4	0.20	0.24	0.87
	(62.32)	(70.48)	(67.19)	(65.00)	(84.21)	(71.43)	(66.93)	(69.23)	(63.64)	(62.90)	(72.16)	(59.09)	(42.86)	(37.50)		(55.78)	(70.83)	(73.68)	(65.00)	(87.50)	(100)			
Diabetes	34	73	23	15	5	3	39	16	2	27	28	9	3	3	0	33	19	5	17	2	4	0.83	0.68	0.70
	(16.42)	(32.44)	(35.38)	(18.99)	(27.78)	(50.00)	(15.23)	(40.00)	(18.18)	(14.84)	(29.79)	(39.13)	(14.29)	(17.65)		(16.75)	(39.58)	(25.00)	(20.99)	(25.00)	(100)			
Previous TIA	123	15	6	20	3	0	39	4	1	24	5	2	3	0	0	23	3	2	14	0	1	0.11	0.80	0.84
	(14.95)	(6.52)	(9.23)	(25.00)	(15.79)		(15.23)	(10.26)	(9.09)	(12.97)	(5.10)	(8.70)	(14.29)			(11.50)	(6.12)	(10.53)	(17.28)		(25.00)			
Current smoking	243	57	17	34	4	0	48	7	1	75	28	9	7	2	1	60	14	5	19	2	1	0.0002	0.39	0.81
	(31.52)	(25.45)	(27.42)	(44.74)	(20.00)		(20.08)	(18.92)	(11.11)	(41.44)	(29.17)	(39.13)	(38.89)	(11.76)	(100)	(32.97)	(30.43)	(26.32)	(25.33)	(25.00)	(25.00)			

*restricted to patients without missing values; # p-value for differences between aetiological stroke subtypes; adjusted for age, sex, social class as appropriate

Table 3. Annual incidence rates per 100,000 and corresponding 95% confidence intervals by stroke subtype and ethnic group, categorised as white, black (stratified into black Caribbean (BC) and black African (BA)) and Other ethnic group; incidence rates age adjusted to the Standard European population

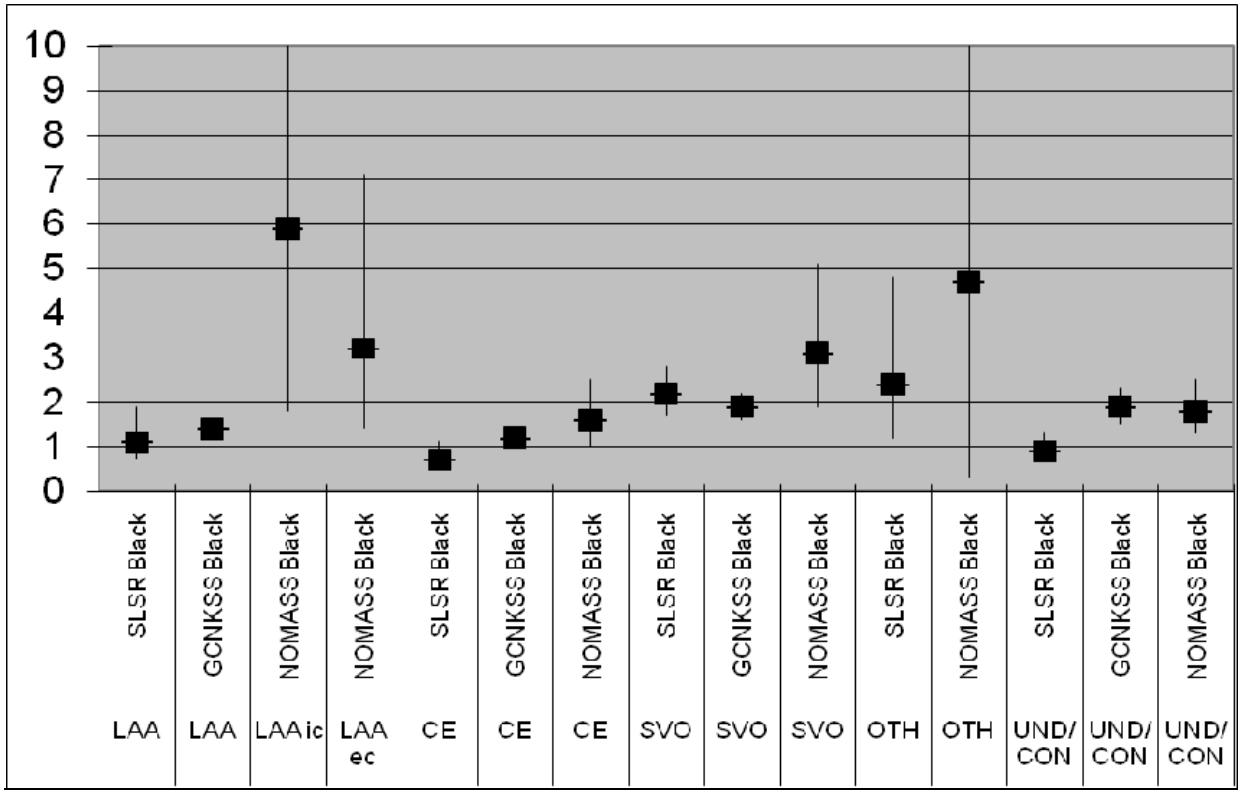
	White		Black		BC		BA		Oth	
	M	F	M	F	M	F	M	F	M	F
Total	92.6	65.5	107.1	92.2	117.0	95.5	102.9	90.1	132.5	64.7
	(74.7-113.5)	(50.6-83.4)	(87.8-129.4)	(74.4-113.1)	(96.8-140.2)	(77.3-116.7)	(84.0-124.8)	(72.5-110.7)	(110.9-157.1)	(49.9-82.5)
LAA	9.9	6.7	9.8	9.1	9.8	10.4	7.0	12.1	21.5	3.6
	(4.7-18.2)	(2.6-14.0)	(4.6-18.1)	(4.2-17.2)	(4.7-18.1)	(5.1-18.9)	(2.8-14.5)	(6.3-21.1)	(13.4-32.7)	(0.9-9.7)
CE	22.9	21.3	18.0	16.0	21.7	17.1	17.3	16.1	14.8	18.0
	(14.5-34.4)	(13.3-32.5)	(10.6-28.4)	(9.2-26.0)	(13.6-33.0)	(10.0-27.3)	(10.2-27.6)	(9.3-26.2)	(8.3-24.5)	(10.7-28.5)
SVO	24.8	13.2	45.1	37.3	49.1	39.5	53.0	31.4	34.3	29.4
	(16.1-36.7)	(7.1-22.5)	(32.9-60.3)	(26.3-51.3)	(36.3-64.8)	(28.2-53.9)	(39.7-69.3)	(21.4-44.5)	(23.8-47.9)	(19.8-42.1)
OTH	3.0	1.7	6.5	5.1	2.1	4.0	13.5	6.9	2.6	0
	(0.6-8.8)	(0.2-6.8)	(2.5-13.7)	(1.7-11.8)	(0.3-7.5)	(1.1-10.2)	(7.3-22.8)	(2.7-14.3)	(0.5-8.2)	
UND	22.3	16.9	21.7	21.6	25.7	21.2	12.1	21.6	47.1	13.6
	(14.1-33.7)	(9.8-27.1)	(13.6-33.0)	(13.5-32.9)	(16.8-37.8)	(13.2-32.3)	(6.3-21.1)	(13.5-32.8)	(34.6-62.6)	(7.4 -23.0)
CONC	9.6	9.6	6.1	6.1	8.5	3.4	0	2.0	12.1	0
	(4.5-17.8)	(4.5-17.8)	(2.3-13.2)	(2.3-13.2)	(3.8-16.5)	(0.8-9.3)		(0.2-7.2)	(6.3-21.1)	

Table 4. Incidence Rate Ratios and corresponding 95% confidence intervals of ischaemic stroke subtype by ethnic groups (White as reference)*

	Black		BC		BA		**Oth**	
	M	F	M	F	M	F	M	F
Total	1.16	**1.41**	1.26	**1.46**	1.11	1.38	**1.43**	0.99
	(0.93-1.44)	**(1.13-1.75)**	(0.97-1.64)	**(1.12-1.89)**	(0.76-1.63)	(0.93-2.04)	**(1.04-1.98)**	(0.63-1.54)
LAA	0.99	1.36	0.99	1.55	0.71	1.81	2.17	0.54
	(0.49-1.99)	(0.66-2.79)	(0.40-2.46)	(0.67-3.58)	(0.21-2.38)	(0.50-6.54)	(0.89-5.29)	(0.07-3.98)
CE	0.79	0.75	0.95	0.80	0.76	0.76	0.65	0.85
	(0.49-1.27)	(0.45-1.26)	(0.53-1.69)	(0.44-1.46)	(0.28-2.01)	(0.24-2.40)	(0.25-1.66)	(0.37-1.95)
SVO	**1.82**	**2.83**	**1.98**	**2.99**	**2.14**	**2.38**	1.38	**2.23**
	(1.28-2.58)	**(1.94-4.12)**	**(1.29-3.04)**	**(1.94-4.61)**	**(1.24-3.69)**	**(1.29-4.38)**	(0.76-2.53)	**(1.13-4.40)**
OTH	2.17	**3.00**	0.70	2.35	**4.50**	**4.06**	0.87	NR
	(0.85-5.53)	**(1.08-8.31)**	(0.15-3.23)	(0.58-9.59)	**(1.24-16.29)**	**(1.04-15.82)**	(0.11-6.78)	
UND	0.97	1.28	1.15	1.25	0.54	1.28	**2.11**	0.80
	(0.59-1.62)	(0.81-2.01)	(0.67-1.99)	(0.73-2.18)	(0.21-1.42)	(0.62-2.65)	**(1.21-3.70)**	(0.31-2.08)
CONC	0.64	0.57	0.89	0.61	NR	0.36	1.26	NR
	(0.22-1.80)	(0.17-1.97)	(0.32-2.43)	(0.14-2.70)		(0.05-2.58)	(0.44-3.58)	

*NR – not reported as no observation in the respective field

Figure 1. Comparison of Incidence Rate Ratios with 95% confidence intervals in Black ethnic groups in SLSR, Northern Manhatten (NOMASS) and Greater Cincinnati (GCNKSS) studies (White as Reference). [5,7]



Large artery atherosclerosis (LAA), cardioembolism (CE), small vessel occlusion (SVO), other aetiology (OTH), undetermined (UND) and multiple possible or concurrent aetiologies (CON)