

Age and Ethnic Disparities in Incidence of Stroke Over Time

The South London Stroke Register

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Background and Purpose—Data on continuous monitoring of stroke risk among different age and ethnic groups are lacking.

We aimed to investigate age and ethnic disparities in stroke incidence over time from an inner-city population-based stroke register.

Methods—Trends in stroke incidence and before-stroke risk factors were investigated with the South London Stroke Register, a population-based register covering a multiethnic population of 357 308 inhabitants. Age-, ethnicity-, and sex-specific incidence rates with 95% confidence intervals were calculated, assuming a Poisson distribution and their trends over time tested by the Cochran–Armitage test.

Results—Four thousand two hundred forty-five patients with first-ever stroke were registered between 1995 and 2010. Total stroke incidence reduced by 39.5% during the 16-year period from 247 to 149.5 per 100 000 population ($P < 0.0001$). Similar declines in stroke incidence were observed in men, women, white groups, and those aged >45 years, but not in those aged 15 to 44 years (12.6–10.1; $P = 0.2034$) and black groups (310.1–267.5; $P = 0.3633$). The mean age at stroke decreased significantly from 71.7 to 69.6 years ($P = 0.0001$). The reduction in prevalence of before-stroke risk factors was mostly seen in white patients aged >55 years, whereas an increase in diabetes mellitus was observed in younger black patients aged 15 to 54 years.

Conclusions—Total stroke incidence decreased during the 16-year time period. However, this was not seen in younger age groups and black groups. The advances in risk factor reduction observed in white groups aged >55 years failed to be transferred to younger age groups and black groups. (*Stroke*. 2013;44:3298-3304.)

Key Words: epidemiology ■ ethnology ■ incidence ■ risk factors ■ stroke

Stroke is the second leading cause of death worldwide, and the global effect of stroke is considerable based on disability-adjusted life years.¹ Incidence rates of stroke are reported to be declining in developed countries, presumably because of improvements in stroke prevention and increasing awareness of healthy living. However, there are epidemics of obesity and diabetes mellitus, and there are communities at high vascular risk, such as people of African origin, in the United States and United Kingdom.^{2–4} Despite reported declining incidence rates, with an aging population, the number of stroke patients will increase because risk increases exponentially with age.^{3,5}

Higher stroke incidence rates have been reported in the black populations compared with the white populations in the United States and the United Kingdom.^{4,6} Population-based studies in the United States, such as the Framingham Heart Study⁷ and the Greater Cincinnati/Northern Kentucky Stroke study (GCNKSS),⁴ have reported that stroke incidence was decreasing in white groups but not in black groups. Similar trends in incidence were found in population-based studies

in the United Kingdom, such as the Oxford Vascular Study (OXVASC)⁸ in white populations and the South London Stroke Register (SLSR)⁶ in multiethnic populations. Despite the overall incidence declining, stroke in young adults was shown to be increasing in a recent study from GCNKSS by Kissela et al,⁹ in which significant increases in stroke incidence were reported in young adults aged 20 to 54 years in both black and white groups during a 12-year study period. A similar trend for stroke in young adults was also found in ischemic stroke admissions in the United States Nationwide Inpatient Sample.¹⁰ However, most of these studies reported trends in stroke incidence in 2 or 3 different time points.^{4,8,9,11} Data on continuous monitoring of stroke incidence among different ethnic groups in the same populations are lacking.⁶

The SLSR is a prospective population-based register documenting all first-in-a-lifetime strokes since January 1, 1995, in a multiethnic inner-city population.^{6,12} Based on data from SLSR, we aimed to investigate trends and differences in the incidence and vascular risk factors in different age and ethnic groups during the continuous 16-year study period.

Received June 25, 2013; accepted September 9, 2013.

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The online-only Data Supplement is available with this article at <http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.113.002604/-/DC1>.

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Stroke is available at <http://stroke.ahajournals.org>

DOI: 10.1161/STROKEAHA.113.002604

Methods

The methods of the SLSR have been described in detail previously^{13,14} and are summarized here. The SLSR is a prospective population-based stroke register set up in January 1995, recording all first-ever strokes in a defined region of Lambeth and Southwark, with a population of 310 026 according to the 2001 United Kingdom Census, with 63% white, 28% black (9% black Caribbean, 15% black African, and 4% black other), and 9% other ethnic groups. At the time of the 2011 census, the SLSR source population had increased to 357 308, with 56% white, 25% black (7% black Caribbean, 14% black African, 4% black other), and 18% other groups. The largest increase was seen in those aged 45 to 59 years (44%); the number of those aged >65 years fell by 12% from 28 646 to 25 227, and there was almost no change for those <18 years. There were 3%, 2%, 51%, and 232% increases in white, black, Asian, and other ethnic groups, respectively.

Case Ascertainment and Data Collection

Stroke was defined according to World Health Organization criteria.¹⁵ Standardized criteria were applied for ensuring completeness of case ascertainment, including multiple overlapping sources of information.¹⁶ Data were collected prospectively by specially trained study nurses and field workers. Stroke diagnosis was verified by a study doctor. Hospital surveillance for admission of stroke included hospitals serving the study area. Community surveillance for stroke included patients under the care of all general practitioners within the study area, and general practitioners were contacted regularly and asked to notify all patients with stroke. Notification sources included accident and emergency records, hospital wards, requests for brain imaging, death certificates, coroner's records, hospital medical staff, community therapists, bereavement officers, and hospital-based stroke registers. Patients <15 years were excluded in the study because they were more likely to follow different pathogenesis. Capture–recapture models estimated completeness of case ascertainment in this population to be ≈80% (between 75% and 88%) as shown in the previous studies from SLSR.^{6,13,17}

Sociodemographic Characteristics

Ethnic origin¹⁸ (self-definition, census question) was stratified into white, black (black Caribbean, black African, and black other), and other ethnic groups. Socioeconomic status was categorized as non-manual, manual, and others/unknown according to the patient's current or most recent employment using the United Kingdom General Register Office occupational codes.

Stroke Subtype

Classification of the pathological subtype^{12,16} (cerebral infarction, primary intracerebral hemorrhage, and subarachnoid hemorrhage) was based on results from ≥1 of the following: brain imaging, cerebrospinal fluid analysis, or necropsy examination. Cases without pathological confirmation of stroke subtype were unclassified. The proportion of stroke patients receiving computerized tomography increased from 79.8% in 1995–1998 to 95.9% in 2007–2010, and only 11.6% of patients received an MRI in 1995–1998 compared with 67.8% of those who received an MRI in 2007–2010.

Risk Factors Before Stroke

History of hypertension (high blood pressure >140 mmHg systolic or >90 mmHg diastolic), myocardial infarction, atrial fibrillation, and transient ischemic attack was collected from patients' general practitioners and hospital records. Information on diabetes mellitus, smoking history (current, former smoker, never smoked), and alcohol drinking status (yes/no) was self-reported at initial assessment.

Statistical Analysis

Continuous variables were summarized as mean (SD) and categorical data as count (percentage). Student *t* test and Wilcoxon signed-rank

test were used to test differences in continuous variables when appropriate, and the χ^2 test was used for proportions. The source populations of the SLSR from 1995 to 2010 were estimated from the United Kingdom Census data for 1991, 2001, and 2011 by assuming a linear trend between 2 adjacent censuses. Data were reported in 4-year time intervals, 1995–1998, 1999–2002, 2003–2006, and 2007–2010, to increase the sample size in subgroups. The average age-specific incidence rates were calculated for each time period and stratified by ethnicity. We used 2 different cutoffs for age groups, 15 to 44 years/45+ years and 15 to 54 years/55+ years, to present the age-specific incidence rates. Annual incidence rates by sex, ethnicity, and age group were age-adjusted to the 2011 England and Wales population.¹⁹ The 95% confidence intervals for the incidence rates were calculated assuming a Poisson distribution. The Cochran–Armitage test for trend was used to test the changes over time in age-, ethnicity-, sex-, and before-stroke risk factor–specific incidence rates. Statistical analyses were performed with the statistical software R version 2.11.1.

Ethics

Patients or their relatives gave written informed consent to participate in the study. Ethical approval was obtained from the ethics committees of Guy's and St Thomas' Hospital Trust, King's College Hospital, Queens Square, and Westminster Hospital (London).

Results

Between January 1995 and December 2010, 4245 patients with first-ever stroke (age ≥15) were registered in the SLSR. Changes in sociodemographic characteristics over time are shown in Table 1. The mean age of onset of stroke decreased from 71.7 years (1995–1998) to 69.6 years (2007–2010; $P=0.0001$). There were significant increases in the proportion of young patients, from 5.1% in 1995–1998 to 8.4% in 2007–2010 for those aged 15 to 44 years ($P=0.0094$), and from 11.1% to 19.9% for those aged 15 to 54 years ($P<0.0001$). The proportion of black patients also increased from 16.6% to 25.6% ($P<0.0001$) during the study period.

Characteristics of Young Patients With Stroke

Table 2 describes the characteristics of young patients with stroke aged 15 to 54 years ($n=656$) versus those aged >55 years ($n=3589$). The number of young patients increased from 145 in 1995–1998 to 174 in 2007–2010, whereas the number of those aged >55 years fell significantly from 1158 to 702 during the same period. Compared with those aged >55 years, the young patients were more likely to be men (58.5% versus 48.7% for young and old patients, respectively), to be black (38.1% versus 17.2%), to have a nonmanual job (34.5% versus 25.2%), to have an intracerebral hemorrhage (20.1% versus 11.6%) or a subarachnoid hemorrhage (18.6% versus 2.5%), and to have lower prevalence of most vascular risk factors. However, there were more current smokers (41.3% versus 29.4%) and drinkers (59% versus 51%) in the young group compared with those aged >55 years. All comparisons are statistically significant, with $P<0.0001$.

Stroke Incidence

Changes in standardized incidence rates (age-adjusted to the 2011 England and Wales population) stratified by sex, ethnicity, and age group are presented in Table 3 and Figure. Total stroke incidence decreased by 39.5% during this 16-year period, from 247 to 149.5 per 100 000 per year ($P<0.0001$).

Table 1. Sociodemographic Characteristics for First-Ever Strokes (Age ≥15 Years)

	1995–1998 (n=1303)	1999–2002 (n=1072)	2003–2006 (n=994)	2007–2010 (n=876)	P Value
Age at stroke onset	71.7 (13.9)	69.8 (14.5)	69.3 (15.1)	69.6 (15.8)	0.0001
15–44 y old at stroke onset	67 (5.1%)	62 (5.8%)	73 (7.3%)	74 (8.4%)	0.0094
15–54 y old at stroke onset	145 (11.1%)	174 (16.2%)	163 (16.4%)	174 (19.9%)	<0.0001
Male	636 (48.8%)	533 (49.7%)	537 (54%)	427 (48.7%)	0.0536
Ethnic group					
White	1026 (78.7%)	752 (70.1%)	671 (67.5%)	577 (65.9%)	<0.0001
Black	216 (16.6%)	208 (19.4%)	221 (22.2%)	224 (25.6%)	
Other	52 (4%)	62 (5.8%)	73 (7.3%)	56 (6.4%)	
Unknown	9 (0.7%)	50 (4.7%)	29 (2.9%)	19 (2.2%)	
Socioeconomic status					
Nonmanual	320 (24.6%)	285 (26.6%)	264 (26.6%)	263 (30%)	<0.0001
Manual	775 (59.5%)	555 (51.8%)	548 (55.1%)	351 (40.1%)	
Others/unknown	208 (16%)	232 (21.6%)	182 (18.3%)	262 (29.9%)	

Summary statistics are mean (SD) or count (%) as appropriate.

A similar decline in stroke incidence was observed in men from 277.3 to 158 ($P<0.0001$) and in women from 217.3 to 138.6 ($P<0.0001$). However, there were differences in the incidence trends between ethnic groups and between age groups. During the study period, a 41.3% reduction in stroke incidence was observed in the white group from 233.4 to 137.1 ($P<0.0001$), whereas no significant changes in incidence rates were seen in the black group (from 310.1 to 267.5, not significant, with $P=0.3633$), and a constantly higher incidence was observed in the black group compared with the white group. In the same period, a 40% reduction in incidence was observed in those aged >45 years, from 473.6 to 284.2 ($P<0.0001$), whereas no significant changes were found in the younger group aged 15 to 44 years ($P=0.2034$). For those aged 15 to 54 years, however, a significant reduction in incidence was observed from 31.1 to 24 ($P=0.0013$). Table 4 shows trends in age-specific incidence rates by ethnicity. Statistically significant decreases (after correcting for multiple comparisons) in the rates of first-ever stroke were found in the white population aged >45 years ($P<0.0001$ – 0.0051) and in the black population only for those aged 55 to 64 years ($P<0.0001$). There were no significant changes in incidence rates for young white groups aged 15 to 44 years and for most of the black age groups, young and old, except for those aged 55 to 64 years.

Stroke Subtype and Risk Factor Prevalence

There was a trend toward a higher proportion of ischemic stroke and a lower proportion of hemorrhagic stroke during the 16-year study period (Table I in the online-only Data Supplement). Statistically significant changes were found in all age and ethnic groups except the older black group aged >55 years. The trend was most pronounced in the younger black patients aged 15 to 54 years, with an 82% increase in the proportion of ischemic stroke from 36.2% in 1995–1998 to 65.9% in 2007–2010 ($P<0.0001$).

Table 5 shows trends in the vascular risk factors stratified by age and ethnicity. Risk factor reduction was mostly seen in white patients aged >55 years, with statistically significant decreases observed in the prevalence of before-stroke

myocardial infarction, atrial fibrillation, previous transient ischemic attack, smoking, and drinking. However, this was counterbalanced by a significant increase in the prevalence of diabetes mellitus ($P=0.0256$). For black patients aged >55 years, there was only a decline in the prevalence of previous transient ischemic attack ($P=0.0064$) and drinking ($P<0.0001$). For younger patients aged 15 to 54 years, no statistically significant changes were observed in any of these risk factors, except that there was a significant increase in the prevalence of diabetes mellitus among young black patients, rising from 4.3% in 1995–1998 to 21.4% in 2007–2010 ($P=0.0078$), and a marginal decrease in current smokers among young white patients from 63.5% to 47.2% ($P=0.0410$). The use of age 55 years as a cutoff in analyses for stroke subtype and vascular risk factor prevalence was to increase the numbers in subgroups of younger patients so that statistical tests were feasible.

Discussion

In this inner-city population-based study, we have observed strikingly higher stroke incidence rates in black groups compared with white groups. Total stroke incidence was reduced by 39.5% during the 16-year study period, but this was not seen in younger age groups aged 15 to 44 years and black groups. These findings were important both for understanding the effect of stroke and identifying disparities in risks related to age and ethnicity that have relevance to prevention strategies. There have been reports of ethnic disparities in stroke incidence from population-based studies in the United States, United Kingdom, and New Zealand.^{4,6,9,11,12,20–22} However, this study identifies sustained inequalities in risk and demonstrates differential reductions of incidence among different age and ethnic groups. The SLSR is population-based and, hence, less biased, with a well-phenotyped stroke cohort, allowing analyses to control for potential confounding factors and to identify underlying clinical and socioeconomic factors that could be used for better risk factor control.^{6,12,13}

Although the causes of ethnic disparities in stroke risk are not entirely clear, they might be, in part, because of differences in the prevalence of established cardiovascular risk factors.^{6,20}

Table 2. Comparison of Characteristics of First-Ever Strokes: Aged 15 to 54 Versus 55+ Years

	Aged 15–54 y (n=656)	Aged 55+ y (n=3589)	P Value
Age	44.4 (8.7)	75 (9.9)	<0.0001
Year of stroke			
1995–1998	145 (22.1%)	1158 (32.3%)	<0.0001
1999–2002	174 (26.5%)	898 (25%)	
2003–2006	163 (24.8%)	831 (23.2%)	
2007–2010	174 (26.5%)	702 (19.6%)	
Male	384 (58.5%)	1749 (48.7%)	<0.0001
Ethnic group			
White	322 (49.1%)	2704 (75.3%)	<0.0001
Black	250 (38.1%)	619 (17.2%)	
Other	58 (8.8%)	185 (5.2%)	
Unknown	26 (4%)	81 (2.3%)	
Socioeconomic status			
Nonmanual	226 (34.5%)	906 (25.2%)	<0.0001
Manual	302 (46%)	1927 (53.7%)	
Others/unknown	128 (19.5%)	756 (21.1%)	
Stroke subtype			
Infarct	369 (56.2%)	2806 (78.2%)	<0.0001
PICH	132 (20.1%)	418 (11.6%)	
SAH	122 (18.6%)	91 (2.5%)	
Unclassified/unknown	33 (5%)	274 (7.6%)	
Risk factor before stroke			
Hypertension	269 (41%)	2307 (64.3%)	<0.0001
Myocardial infarction	28 (4.3%)	408 (11.4%)	<0.0001
Atrial fibrillation	18 (2.7%)	647 (18%)	<0.0001
Previous TIA	35 (5.3%)	452 (12.6%)	<0.0001
Diabetes mellitus	79 (12%)	683 (19%)	0.0001
Current smoker	271 (41.3%)	1054 (29.4%)	<0.0001
Drinker	387 (59%)	1830 (51%)	<0.0001

Summary statistics are mean (SD) or count (%) as appropriate. Infarct indicates cerebral infarction; PICH, primary intracerebral hemorrhage; SAH, subarachnoid hemorrhage; and TIA, transient ischemic attack.

We observed a higher prevalence of hypertension and diabetes mellitus in black patients compared with white patients in each of the 4 time periods in all age groups. Because hypertension

and diabetes mellitus are well-established and are major risk factors for stroke across all ethnic groups,^{20,23} they may account for a significant proportion of the higher stroke incidence observed in black patients.

Also, it is particularly striking that a range of vascular risk factors seen reduced in the white groups (age >55 years) over time remained unchanged in black groups, except a significant reduction in previous transient ischemic attack and drinking in those aged >55 years and a significant increase in diabetes mellitus in those aged 15 to 54 years (Table 5). Other possible explanations for ethnic disparities include cultural differences in perceptions of health and the health care system, environmental exposures, genetic factors, socioeconomic status, and educational attainment.² Our results seem similar to findings from previous studies of trends in before-stroke risk factors based on either a mainly white population^{8,24} or a multiethnic population,^{4,9} except that we did not find a significant reduction in hypertension in white groups in this inner-city population.

We did not specifically examine genetic factors in our study. There have been reported racial/ethnic differences of genetic polymorphisms: for example, CYP2C19 variant that affects warfarin metabolism may have a higher frequency of occurrence in some racial/ethnic groups,² but these results need to be further validated before actually going to clinical practice.

Many studies have compared ethnic differences in stroke incidence or stroke mortality and have observed that socioeconomic status accounted for a proportion of the observed ethnic differences (eg, 39% in GCNKSS).²⁵ However, many investigators question the validity of typical socioeconomic status indicators when comparing status across ethnic groups.² We did not have income data in our study and we used manual and nonmanual categorization as an indicator for socioeconomic status. Recent studies from SLSR showed that socioeconomic status (manual versus nonmanual) was not associated with provision of short-term care including stroke unit admission¹⁴ or with long-term survival after stroke.²⁶

Kissela et al⁹ reported findings from the GCNKSS that the proportion of total first-ever stroke in those 20 to 54 years of age increased from 12.9% to 18.6% during a 12-year period (using only 3 time points), which are in accordance with the findings in our study. They also reported that incident stroke in this age group increased from 26 to 48 per 100 000 among

Table 3. Annual Stroke Incidence Rate per 100 000 Population (95% CI), Adjusted to the England and Wales Population

	1995–1998	1999–2002	2003–2006	2007–2010	P Value*
Total	247 (233.5–261.2)	211.7 (199–225.1)	175.3 (164.3–186.8)	149.5 (139.4–160.1)	<0.0001
Men	277.3 (254.4–302.2)	235.5 (214.9–258)	207.9 (189.8–227.7)	158 (142.4–175.1)	<0.0001
Women	217.5 (201.2–234.9)	186.6 (171.1–203.3)	145.5 (132.3–159.7)	138.6 (125.8–152.4)	<0.0001
White	233.4 (219.2–248.3)	189.8 (176.3–204)	157.2 (145.4–169.7)	137.1 (126–148.9)	<0.0001
Black	310.1 (256.5–377.1)	230.6 (192.2–278.2)	223.5 (189.6–265.2)	267.5 (223–321.1)	0.3633
Aged 15–44 y	12.6 (9.7–16.2)	11.2 (8.6–14.4)	10.4 (8.1–13.1)	10.1 (7.9–12.8)	0.2034
Aged 45+ y	473.6 (447.2–501.2)	405.5 (380.7–431.7)	334.6 (313.2–357.2)	284.2 (264.6–305)	<0.0001
Aged 15–54 y	31.1 (26–37)	37.6 (32–43.9)	25.8 (21.8–30.3)	24 (20.5–28)	0.0013
Aged 55+ y	662.9 (624.8–702.9)	547.2 (511.7–584.6)	463.1 (432–495.9)	391.3 (362.7–421.6)	<0.0001

CI indicates confidence interval.

*P values were obtained from Cochran–Armitage tests for trend after correcting for multiple comparisons.

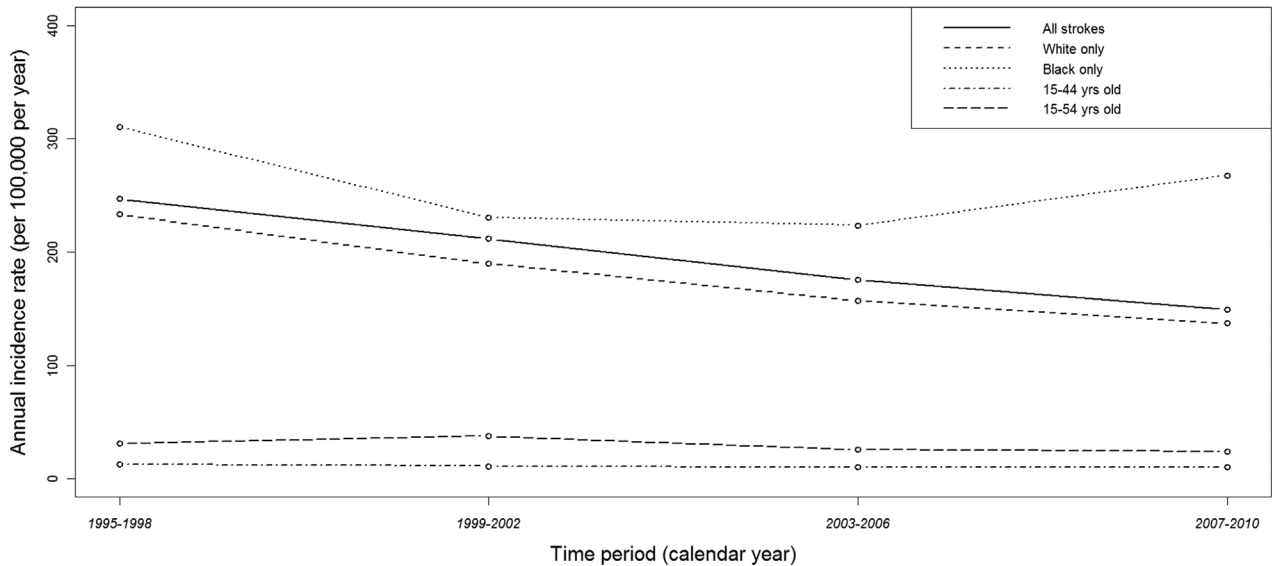


Figure. Trends in stroke incidence by ethnicity and age group (age-adjusted).

white groups and from 83 to 128 among black groups. In our study, overall incidence rates for those aged 15 to 44 years remained unchanged from 12.6 to 10.1 (not significant with $P=0.2034$) during the 16-year period. When stratified by age and ethnicity, no statistically significant changes in incidence were found in young white groups aged 15 to 44 years (8.5–6.7) and in black groups in general, except for those aged 55 to 64 years. Our observed incidence rates for young strokes are similar to those in several other studies, with reported incidence rates ranging from 3 to 23 per 100000.^{9,27,28} George et al¹⁰ have reported that ischemic stroke admissions in the United States Nationwide Inpatient Sample rose steadily from 1995 to 2008 among young adults aged 14 to 44 years, which was associated with an increase in prevalence of major risk factors such as hypertension, diabetes mellitus, and obesity. This is likely to

lead to major future public health concern because stroke in younger people will influence long-term disability and result in handicap that will affect health and social care services.

The reasons for this trend toward increased risk in younger stroke patients are not clear. However, it could be because of a rise in classical cardiovascular risk factors such as diabetes mellitus, obesity, and high cholesterol level. A significant trend toward increase in diabetes mellitus, high cholesterol, and obesity over time was found among young respondents aged 20 to 54 years based on the National Health and Nutrition Examination Survey national survey data in the United States.⁹ The rise in obesity and diabetes mellitus among young adults is more common in black patients compared with white patients.²⁹ A study from the GCNKSS suggested that diabetes mellitus might particularly increase the risk of ischemic

Table 4. Age-Specific Annual Incidence Rates (95% CI) for First-Ever Stroke During the 16-Year Study Period, Stratified by Ethnicity, per 100 000

Age Category	1995–1998	1999–2002	2003–2006	2007–2010	P Value*
White					
15–44	8.5 (5.8–12.1)	6 (3.8–8.9)	8.1 (5.7–11.2)	6.7 (4.6–9.4)	1.0000
45–54	81.1 (60.8–106.1)	86.6 (65.9–111.7)	53.3 (38.9–71.3)	40.4 (28.9–55)	0.0004
55–64	227.7 (189.7–271.1)	239.9 (198.6–287.3)	190.8 (155.8–231.5)	149.8 (120–184.8)	0.0051
65–74	560.8 (496.7–630.9)	437.8 (376.1–506.6)	351.6 (296.7–413.7)	293.4 (242.4–351.9)	<0.0001
75–84	1057.1 (949.4–1173.7)	774 (677.6–880.2)	748.3 (654.1–852.2)	631.3 (542.2–730.8)	<0.0001
85+	1933.7 (1666.4–2231.5)	1453.2 (1221.7–1715.8)	1086.5 (896.3–1305.3)	1185.2 (985–1414.1)	<0.0001
Black					
15–44	23.7 (16.2–33.4)	19.4 (13.2–27.6)	12.8 (8.2–19)	16.8 (11.6–23.7)	0.5156
45–54	78.9 (44.1–130.1)	152.4 (104.9–214.1)	113.1 (76.9–160.6)	160.1 (119.2–210.5)	0.3265
55–64	381.7 (288.3–495.6)	310.7 (227.4–414.4)	244.4 (175.4–331.6)	112.5 (68.7–173.8)	<0.0001
65–74	761.4 (592.4–963.6)	581.2 (447.6–742.1)	691.9 (549.5–860)	566 (431.9–728.5)	1.0000
75–84	1251.5 (866.7–1748.8)	657.3 (421.2–978)	989.2 (700–1357.8)	1302 (946–1747.8)	1.0000
85+	2471.6 (1185.2–4545.3)	1708.2 (819.2–3141.5)	902.9 (331.3–1965.1)	2554.3 (1460–4148)	1.0000

CI indicates confidence interval.

*P values were obtained by using Cochran–Armitage test for trend and corrected within each age stratum for multiple testing.

Table 5. Vascular Risk Factor Prevalence in SLSR

	Age: 15–54 y					Age: 55+ y				
	1995–1998	1999–2002	2003–2006	2007–2010	PValue	1995–1998	1999–2002	2003–2006	2007–2010	PValue
White										
Hypertension	34 (40%)	23 (27.7%)	28 (34.1%)	21 (29.2%)	0.2637	622 (66.1%)	344(51.4%)	382 (64.9%)	322 (63.8%)	0.9329
MI	7 (8.2%)	4 (4.8%)	6 (7.3%)	2 (2.8%)	0.2549	142 (15.1%)	70 (10.5%)	68 (11.5%)	55 (10.9%)	0.0176
AF	1 (1.2%)	2 (2.4%)	6 (7.3%)	3 (4.2%)	0.1261	237 (25.2%)	115 (17.2%)	121 (20.5%)	100 (19.8%)	0.0198
Previous TIA	11 (12.9%)	2 (2.4%)	4 (4.9%)	4 (5.6%)	0.0542	150 (15.9%)	77 (11.5%)	85 (14.4%)	49 (9.7%)	0.0056
Diabetes mellitus	8 (9.4%)	9 (10.8%)	5 (6.1%)	8 (11.1%)	0.9811	110 (11.7%)	92 (13.8%)	93 (15.8%)	76 (15%)	0.0256
Current smoker	54 (63.5%)	44 (53%)	42 (51.2%)	34 (47.2%)	0.0410	327 (34.8%)	205 (30.6%)	167 (28.4%)	145 (28.7%)	0.0052
Drinker	68 (80%)	50 (60.2%)	57 (69.5%)	52 (72.2%)	0.4791	618 (65.7%)	284 (42.5%)	310 (52.6%)	220 (43.6%)	<0.0001
Black										
Hypertension	25 (53.2%)	36 (56.2%)	26 (47.3%)	44 (52.4%)	0.7157	134 (79.3%)	100 (69.4%)	134 (80.7%)	114 (81.4%)	0.2857
MI	1 (2.1%)	0 (0%)	1 (1.8%)	5 (6%)	0.0828	15 (8.9%)	8 (5.6%)	11 (6.6%)	10 (7.1%)	0.6051
AF	1 (2.1%)	1 (1.6%)	2 (3.6%)	1 (1.2%)	0.8340	11 (6.5%)	9 (6.2%)	13 (7.8%)	14 (10%)	0.2228
Previous TIA	2 (4.3%)	3 (4.7%)	2 (3.6%)	6 (7.1%)	0.4692	26 (15.4%)	15 (10.4%)	11 (6.6%)	10 (7.1%)	0.0064
Diabetes mellitus	2 (4.3%)	8 (12.5%)	7 (12.7%)	18 (21.4%)	0.0078	67 (39.6%)	43 (29.9%)	64 (38.6%)	53 (37.9%)	0.9156
Current smoker	20 (42.6%)	13 (20.3%)	17 (30.9%)	18 (21.4%)	0.0593	42 (24.9%)	32 (22.2%)	40 (24.1%)	26 (18.6%)	0.2762
Drinker	32 (68.1%)	26 (40.6%)	27 (49.1%)	41 (48.8%)	0.1866	108 (63.9%)	60 (41.7%)	98 (59%)	45 (32.1%)	<0.0001

AF indicates atrial fibrillation; MI, myocardial infarction; SLSR, South London Stroke Register; and TIA, transient ischemic attack. P values were obtained from the Cochran–Armitage test for trend.

stroke in young patients.^{23,30} We found increases in the prevalence of diabetes mellitus among young stroke patients aged 15 to 54 years, but it was only statistically significant in black patients, with an increase from 4.3% to 21.4%. The significant reduction in major risk factors observed in white patients aged >55 years was not seen in young patients aged 15 to 54 years for both black and white patients. Compared with those aged >55 years, the young patients in our study were more likely to be men, to be black, to have an intracerebral hemorrhage or a subarachnoid hemorrhage, and to currently drink and smoke (Table 2). These features are useful in identifying young stroke patients and designing risk reduction programs for young adults.

The decline in stroke incidence may be partly because of improvements in prevention, combined with an increase in healthy living. A recent study by Marshall et al³¹ showed antiplatelet and cholesterol-lowering treatment for treating before-stroke risk factors had improved significantly from 1995 to 2010 in SLSR, similarly for both white and black patients. We do not have information on the use of these medications among different age groups. However, as Kissela et al⁹ argued, the elderly might get preferential prevention treatments compared with young adults because stroke was not expected to occur in the young. Also, many young adults do not visit a doctor regularly to monitor their health status, especially with regard to vascular risk. These may partially explain the increased risk in young stroke patients, but no formal analysis has been undertaken to confirm a causal relationship. The relatively lower computerized tomography/MRI scan rates in the earlier years of SLSR might affect the diagnosis and subtype of stroke. It is also possible that more strokes in the young are being detected because of greater use of computerized tomography/MRI because younger people may have been more likely to have undergone these scans.⁹ There was no change

in case mix (eg, Glasgow Coma Scale and previous Barthel index) over time among age and ethnic groups in SLSR, and this adds strength to our argument of sustained inequalities in stroke incidence among different age and ethnic groups.¹⁴

A standardized definition of young adults is lacking. We used age groups of 15 to 54 years as young patients with strokes in our study, although we also used those of 15 to 44 years in subgroup analyses where appropriate. Kissela et al⁹ have used a range of 20 to 54 years for young patients with stroke, but they also used a range of 20 to 44 years in their subgroup analyses. We did not specifically subdivide the age group of 15 to 54 years into young and middle-aged because dividing the younger age into young and middle-aged would make numbers too small for analysis and the unusual causes of stroke, for example, arteriovenous malformation, patent foramen ovale, and recreational drugs dissection, continue to present in middle age; therefore, there is probably no clinical justification to subdivide. Nevertheless, it would be interesting to formally assess the difference in risk factors between young and middle-aged groups if numbers allowed.

There are limitations to this study. We do not have data regarding risk factor levels, such as body mass index and cholesterol (incomplete) in the stroke register; therefore, we could not comment on the effect of obesity in our study. Because there are only ≈170 patients aged 15 to 54 years in each time period (Table 1) and even fewer in the 15 to 44 years age group, the power to detect changes in risk factor prevalence in these subgroups is limited. For black groups, we did not have family migration history, and risk factors might vary between first- and second-generation migrants. There was a slight decrease in completeness of case ascertainment from 84% during 1995–1996 to 75% in 2001–2002, followed by increases to 88% in 2005–2006,^{6,13} although the overall trend was not significant. The reason for these changes was unclear

and may need further investigation. Furthermore, these estimates were provided only for total completeness; therefore, we could not exclude that completeness varied in specific sub-groups, which may influence the interpretation of the data.

Conclusions

Overall stroke incidence declined during the 16-year time period. However, this was not seen in younger age groups and black groups. Sustained or increased stroke risk was found in younger age groups and black groups. Advances in risk factor reduction observed in older white groups failed to be transferred to both younger age groups and black groups.

Sources of Funding

The study was funded by the Northern & Yorkshire National Health Service (NHS) R&D Program in Cardiovascular Disease and Stroke, Guy's and St Thomas' Hospital Charity, Stanley Thomas Johnson Foundation, The Stroke Association, Department of Health Healthcare Quality Improvement Partnership grant, National Institute for Health Research (NIHR) Program grant (RP-PG-0407-10184), and the NIHR Biomedical Research Center at Guy's and St Thomas' NHS Foundation Trust and King's College London.

Disclosures

None.

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SUPPLEMENTAL MATERIAL

Supplemental Table I

Supplemental table I: Trends in stroke subtypes between age and ethnic groups

		Aged 15-54 years				Aged 55+			
		1995-1998	1999-2002	2003-2006	2007-2010	1995-1998	1999-2002	2003-2006	2007-2010
White	Cerebral infarct	49(56.3%)	37(44%)	52(63.4%)	54(75%)*	685(72.8%)	533(79.7%)	488(82.9%)	420(83.2%)**
	Intracerebral haemorrhage	13(14.9%)	16(19%)	8(9.8%)	8(11.1%)	109(11.6%)	83(12.4%)	66(11.2%)	41(8.1%)
	Subarachnoid haemorrhage	22(25.3%)	27(32.1%)	18(22%)	6(8.3%)	24(2.6%)	15(2.2%)	13(2.2%)	6(1.2%)
	Unclassified/unknown	3(3.4%)	4(4.8%)	4(4.9%)	4(5.6%)	123(13.1%)	38(5.7%)	22(3.7%)	38(7.5%)
Black	Cerebral infarct	17(36.2%)	26(40%)	33(60%)	56(65.9%)**	128(75.7%)	119(82.6%)	132(79.5%)	113(80.7%)
	Intracerebral haemorrhage	14(29.8%)	26(40%)	12(21.8%)	15(17.6%)	24(14.2%)	16(11.1%)	21(12.7%)	16(11.4%)
	Subarachnoid haemorrhage	15(31.9%)	12(18.5%)	8(14.5%)	5(5.9%)	7(4.1%)	5(3.5%)	7(4.2%)	1(0.7%)
	Unclassified/unknown	1(2.1%)	1(1.5%)	2(3.6%)	9(10.6%)	10(5.9%)	4(2.8%)	6(3.6%)	10(7.1%)

Chi-squared test: ** significance at P-value<0.0001; * significance at P-value=0.0156.

Age and Ethnic Disparities in Incidence of Stroke Over Time: The South London Stroke Register

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Stroke. 2013;44:3298-3304; originally published online October 10, 2013;
doi: 10.1161/STROKEAHA.113.002604

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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