Trends in the stroke incidence and case fatality from 1999 to 2022: The South London Stroke Register

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Introduction

Global Stroke Statistics (2019):
- Over 12 million people experienced a stroke.
- 6.5 million deaths due to stroke [1].

Post-Stroke Consequences:
- Major contributor to physical disability.
- Leads to cognitive impairment.
- Causes communication difficulties.
- Can result in depression and anxiety.
- Impacts overall quality of life [2].

Future Predictions:
Despite prevention improvements, global stroke burden set to increase.
Rising rates linked to aging global population.

Contributing factors to the fluctuating incidence rates:
- Changes in Stroke Management (Past 30 Years)
- Reduction in hypertension prevalence in high and upper-middle income countries.
- Improved detection, treatment, and control of hypertension [3].
- Rising global rates of obesity and diabetes [4].
- Treatment Innovations such as: (1) introduction of advanced neuroimaging tools (CPT/MRI); (2) Implementation of thrombectomy; (3) Advent of direct oral anticoagulants; (4) Early supported discharge protocols.

Research aim: We analysed trends in incidence and 30-day survival rate of stroke from 1999 to 2022 in a population-based study in a diverse area of South London.

Methods

The South London Stroke Register (SLSR) was initiated in 1995. SLSR is an ongoing longitudinal population-based study [5]. The study covers all people with their first stroke in their lifetime. Participants are from a defined area of South London (27 wards within the boroughs of Lambeth and Southwark). The 2021 Census reports the area has 393,555 inhabitants. Of these inhabitants: 51.1% identified as White, 8.9% as Asian, Asian British, or Asian Welsh, 25.6% as Black, Black British, Black Welsh, Caribbean, or African, 7.5% were from Mixed or Multiple ethnic groups, 6.6% identified as other.

Stroke Classification: Patients diagnosed and then categorised into stroke types: cerebral infarction, primary intracerebral haemorrhage, and subarachnoid haemorrhage. Unconfirmed subtypes left as undefined. IS subtypes determined using TOAST criteria: (1) Large-artery atherosclerosis, (2) Cardio-embolism, (3) Small-vessel occlusion, (4) Other determined aetiology, (5) Unknown aetiology.

Stroke type determined using: (1) Neuroimaging (CT or MRI) within 30 days post-stroke (2), Analysis of cerebrospinal fluid (specifically for SAH where imaging was inconclusive), (3) Post-mortum examination results If inconclusive, labeled as "undetermined".

Risk Factors: Hypercholesterolaemia (from 2001 onwards), Hypertension, Atrial Fibrillation, Myocardial Infarction, Heart failure, Transient Ischaemic Attack (TIAs), Diabetes, and Smoking. Patient functioning capacity was assessed using the Barthel Index (BI) at 3 months and 1 year post-stroke.

Statistical Analysis: Used data on stroke cases from 1999-2022. Diagnosis based on International Classification of Disease (ICD) [6].

Denominator Estimation: Based on ONS census mid-year population estimates. To correct for the changes in electoral ward boundaries from 2018-2022, we used linear extrapolation from 2018-2022 for population changes in Southwark.

Local and Adjusted Incidence Rates: Annual incidence rates of stroke estimated in SLSR core area. Rates were adjusted to standard European population. 95% Confidence intervals (95% Cis) were estimated using bootstrap technique with 100,000 iterations.

30-Day Survival: Kaplan-Meier method and log-rank tests for all-cause mortality. Multivariable Cox proportional hazards models for stroke outcomes. Adjusted for demographic variables, risk factors, clinical indicators, and acute phase care. Analysis was performed using survival R package [7] and survminer R package [8].

Results

Table 1. Participant characteristics stratified by quadrennial cohorts.

	1995-1998	1999-2002	2003-2006	2007-2010	2011-2014	2015-2018	2019-2022
Total N = 7698	n = 1304	n = 1085	n = 1328	n = 1076	n = 858	n = 914	n = 1133
	N/mean (%/SD)	N/mean (%/SD)	N/mean (%/SD)	N/mean (%/SD)	N/mean (%/SD)	N/mean (%/SD)	N/mean (%/SD)
Age (mean/SD)	71.7 (13.82)	69.74 (14.47)	69.15 (15.16)	69.82 (15.66)	67.47 (16.06)	68.14 (16.26)	66.87 (15.78)
Female (n/%)	666 (51.1)	544 (50.1)	622 (46.8)	539 (50.1)	397 (46.3)	415 (45.4)	504 (44.5)
Male (n/%)	638 (48.9)	541 (49.9)	706 (53.2)	537 (49.9)	461 (53.7)	499 (54.6)	627 (55.3)
Ethnicity (n/%)							
White (n/%)	1027 (78.8)	756 (69.7)	882 (66.4)	710 (66.0)	465 (54.2)	473 (51.8)	536 (47.3)
Black (n/%)	216 (16.56)	216 (19.91)	315 (23.72)	277 (25.7)	304 (35.43)	356 (38.95)	450 (39.72)
Unknown (n/%)	9 (0.7)	50 (4.6)	35 (2.6)	21 (2)	20 (2.3)	18 (2)	42 (3.7)
Do not want to share (n/%)	3 (0.2)	7 (0.6)	11 (0.8)	11 (1)	16 (1.9)	15 (1.6)	32 (2.8)
Education (n/%)							
No formal education	NA -	NA -	12 (0.9)	15 (1.4)	16 (1.9)	10 (1.1)	9 (0.8)
Primary	1 (0.1)	1 (0.1)	58 (4.4)	84 (7.8)	40 (4.7)	58 (6.3)	60 (5.3)
Lower secondary	3 (0.2)	15 (1.4)	375 (28.2)	308 (28.6)	164 (19.1)	179 (19.6)	261 (23)
Upper secondary	1 (0.1)	4 (0.4)	126 (9.5)	243 (22.6)	315 (36.7)	225 (24.6)	155 (13.7)
Post-secondary, non-tertiary	NA -	2 (0.2)	50 (3.8)	50 (4.6)	27 (3.1)	84 (9.2)	164 (14.5)
The first stage of tertiary	NA -	2 (0.2)	31 (2.3)	67 (6.2)	73 (8.5)	117 (12.8)	127 (11.2)

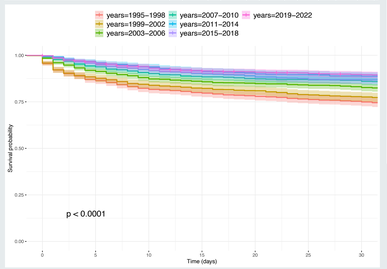

Figure 3. Quadrennial 30-day survival rate.

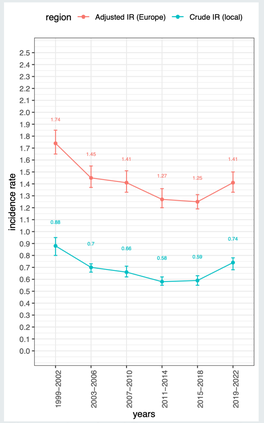

Figure 1. Local and European age and sex-standardised temporal incidence rates (95% Confidence Intervals) per 100,000 cases.

Table 2. Incidence Rates of Stroke with 95% Confidence Intervals between 1999 and 2022

YEARS	CRUDE INCIDENCE RATE PER 100,000 PEOPLE		STANDARISED INCIDENCE RATE (TO EUROPEAN POPULATION)	
	IR	*95 % CI*	*IR*	*95 % CI*
1999-2002	0.88	[0.8 ; 0.95]	1.74	[1.65 ; 1.85]
2003-2006	0.7	[0.66 ; 0.73]	1.45	[1.37 ; 1.55]
2007-2010	0.66	[0.62 ; 0.71]	1.41	[1.33 ; 1.51]
2011-2014	0.58	[0.55 ; 0.62]	1.27	[1.2 ; 1.36]
2015-2018	0.59	[0.55 ; 0.63]	1.25	[1.19 ; 1.31]
2019-2022	0.74	[0.68 ; 0.78]	1.41	[1.33 ; 1.5]

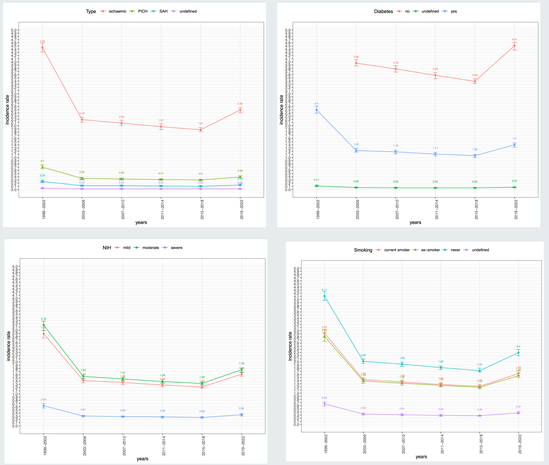

Figure 2. Local temporal incidence rates (95% Confidence Intervals) per 100,000 cases stratified by stroke type (ischemic, SAH, PICH), NIH severity (mild, moderate, severe) diabetes status, smoking status, and Hypercholesterolemia status.

Sample characteristics: 7,698 first stroke cases were identified from 2001 to 2022. Source population increased from 324,825 (2001) to 386,842 (2021).

Incidence rates: Crude stroke incidence decreased from 0.88 (1999-2022) to 0.59 (2015-2018) but increased to 0.74 in 2019-2022. Standardised incidence rates showed a similar pattern (Figure 1). This trend in incidence rate varied across stroke clinical subtypes and other clinical characteristics, such as stroke severity and risk factors including diabetes, hypercholesterolemia and smoking (Figure 2).

30-day survival: Longitudinal analysis showed a decline in 30-day survival hazard over time (Figure 3). Stroke severity (NIHSS score) increased the likelihood of 30-day fatality. Haemorrhagic strokes had a higher 30-day fatality rate than infarct strokes.

Age at first-ever stroke: the trends differed among various ethnic groups. Black African individuals were younger at their first-ever stroke compared to other groups.

Discussion

Stroke incidence appears to have increased in the past few years on a background of two decades of reduction. Quadrennial 30-day fatality HRs reduced remarkably from 0.88 in 1999-2002 to 0.74 in 2019-2022.

Strengths and Limitations

We present population based, ethnically and socioeconomically diverse, rigorous case ascertainment, 27 years of data, detailed data/adjustments for confounding. We did not identify any systematic bias in selection and retainment. However, the study focused on a specific geographical area within London, which may limit the extrapolation of our findings to broader populations and contexts. The explanation for some rapid changes in the trends in the past include changes in case assortment, inclusion of cases with less severe strokes; and potential covariates to consider hospital admission, secondary prevention, rehabilitation received. The notable decline in stroke incidence is encouraging and can be attributed to the advancement in stroke prevention, healthcare policy changes, and targeted interventions [9]. Potential contributing factors to the improved overall survival rate are the introduction of new treatments such as thrombectomy as well as MRI-based diagnosis.

Implications for clinical practice and future research

Information is scarce on what factors influence stroke survival, in various etiological subtypes, including the roles of hyperacute stroke unit services (HASUs), centralised stroke care, and early rehabilitation. Understanding these can inform tailored and targeted interventions and care paths for each stroke subtype. The UK's NHS aims to enhance stroke care, with goals like a tenfold increase in thrombectomy treatments, currently given to only 1% of stroke patients [10]. Expanding such treatments and optimising service models could reduce fatalities. Detailed data on stroke causes can guide better planning and resource allocation.

References:

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