Stroke incidence and risk factors in a population - based prospective cohort study

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Stroke is one of the most important causes of ill-health, disability and death in developed countries. Mortality from stroke has been steadily declining over the past three decades and there is a need for other measures of the burden of disease associated with stroke, such as Incidence rates. We used data from the Fourth National Morbidity Survey to estimate the incidence of first ever and recurrent strokes occurring in England and Wales. We also examined the associations between known risk factors and the incidence of first ever and recurrent strokes. Over 80 per cent of strokes occurred in people over 64 years of age. We estimated that in 1999 there were about 87,700 people with a first ever stroke and, 53,700 with a recurrent stroke. Overall 133,700 people experienced a first ever or a recurrent stroke. The strongest associations with first ever strokes were with previous transient ischaemic attack, increasing age, atrial fibrillation, diabetes, heart failure, ischaemic heart disease, hypertension and smoking. For recurrent stroke, the statistically significant associations were with previous stroke, transient ischaemic attack, hypertension, increasing age and diabetes.

Introduction

Stroke (Box 1) is one of the most important causes of ill-health, disability and death in developed countries. About 25 per cent of men and 20 per cent of women can expect to suffer a stroke if they live to be 85 years.[1] The National Service Framework for Older People estimated that over 100,000 people in England and Wales suffer a first stroke every year.[2] Because strokes are common and lead to substantial disability and ill-health, a large proportion of the NHS budget is spent on treating people who have suffered a stroke. In the average general hospital serving a population of 250,000 there will be 25 to 35 patients stroke victims, occupying about 12 per cent of the general medical beds.[3] In the first year after a stroke about 30 per cent of patients will die, most within the first ten days. After one year 65 per cent of the survivors will be living independently, 35 per cent will be significantly disabled and many will need considerable help with daily tasks or visits from a district nurse. Some will be unable to live independently and will be admitted to long-term residential care.[4] Despite the large burden of disease caused by stroke, substantially less is spent on research on stroke than on research on heart disease and cancer.[5]

Many previous studies of stroke have used mortality data to estimate the burden of disease it causes. Although mortality data are useful in doing this, many industrialised countries including England and Wales have seen a steady decline in death rates from cerebrovascular disease over the past three decades. For example the age-adjusted death rates attributed to stroke have declined by about 80 per cent since 1968 in England and Wales.[6] Incidence studies are needed to measure the true burden of disease caused by stroke, particularly if the case-fatality is changing over time. A number of community-based studies of stroke have been carried out in the United Kingdom but these have typically studied people living in one part of the country (for example, Oxford[7]

and South London[8]) and they may not be representative of the whole population. National studies of stroke incidence are rare.

Previous studies have identified possible risk factors for stroke and the evidence has been summarised in a recent scientific statement of the American Heart Association.[9] Other than male sex and increasing age, the important risk factors for stroke include atrial fibrillation, carotid artery stenosis (narrowing), hyperlipidaemia, diabetes mellitus, hypertension, obesity and smoking. Furthermore, because many strokes are ischaemic in origin (due to occlusion of cerebral arteries), we might expect people with ischaemic heart disease also to be at higher risk for stroke. However, unlike some other risk factors, ischaemic heart disease is not on the direct causal pathway for stroke but is a marker for the presence of conditions, such as diabetes and high blood pressure that are. The prevalence of stroke after adjusting for age is about 40 per cent and 70 per cent higher in African-Caribbean and South Asian men than in the general population. The incidence of first ever strokes in African-Caribbean people is about twice that among whites.[8] People in Socio-Economic group V (unskilled manual workers) have a 60 per cent higher stroke risk than those in Socio-Economic group I (professionals), and the mortality rates from stroke are 50 per cent higher in socio-economic group V than in Socio-Economic group I.[10]

The Fourth National Morbidity Survey was a one-year prospective cohort study, carried out in 1991–1992, of 502,482 patients registered with 60 general practices in England and Wales.[11] The main objective of the survey was to examine the workload and pattern of disease in general practice in relation to the age, sex, and socio-economic status of patients. We used data from this survey to estimate the incidence of first ever and recurrent stroke. As the survey required general practitioners to collect information on all reasons for consulting, it also allowed us to estimate the relative aetiological contribution of risk factors for stroke identified in previous studies.

Methods

The study population for the Fourth National Morbidity Survey comprised a 1 per cent sample of the population (502,482 patients) from sixty general practices in England and Wales. The sample was representative of the population of England and Wales for characteristics such as age, sex, social class and housing tenure but because relatively few practices from inner cities participated, there was some under-representation of ethnic minority groups and people living alone.

Box one

What is a stroke?

- A stroke happens when the blood supply to the brain is disrupted. Most strokes occur when a blood clot blocks an artery that is carrying blood to the brain. Some strokes are caused by bleeding within or around the brain from a burst blood vessel. When the blood supply is disrupted, brain cells are deprived of oxygen and nutrients, some are damaged and others die. The site and extent of this damage within the brain determines whether the stroke is fatal or causes permanent or temporary disabilities.

- A transient ischaemic attack (TIA), sometimes called a 'mini' stroke is usually caused by a temporary blockage of a blood vessel. It may be accompanied by disability, which resolves within 24 hours. People who suffer from a TIA are at very high risk of having a stroke.

Recording and validation of data

Before the survey started, doctors and staff from each practice attended three two-day training sessions on the recording of morbidity data. Practices then collected data for two to four weeks before the start of the survey. These data were analysed and any errors or inconsistencies reported to the practices. Once the morbidity survey started in August 1991, general practitioners and nurses recorded information on all face-to-face contacts with patients until the end of July 1992. Each reason for consulting and the place of contact was directly entered into patient records on the practice computer. Every consultation was given a diagnostic Read code and the data were then transferred on disk to the Office of Population Censuses and Surveys where an International Classification of Diseases Ninth Revision (ICD-9) code was assigned.

After the end of the survey, manual practice records were used to identify all patients seen either in the surgery or elsewhere by the 60 practices on four different days. Of the 28,000 patients seen on these days, 96 per cent of contacts with doctors in the surgery and 95 per cent at home had been recorded in the data submitted by the practices. Finally, for a random sample of 999 patients, diagnostic data from paper records was compared with the electronic data submitted by the practices. This showed that 93 per cent of diagnoses had been recorded correctly.

Identification of strokes

We identified all individuals consulting for stroke (ICD-9 codes 430-434 and 436-438) during the study year. The protocol for the morbidity survey specified that each consultation was recorded as either 'first ever' (the first ever episode of a diagnosis), 'new' (a new episode of a diagnosis) or 'ongoing' (a follow-up consultation for a diagnosis). This allowed us to categorise strokes as 'first ever', 'recurrent' or 'previous'. By doing this, we were able to analyse risk factors for first and recurrent strokes separately, and also examine the relative contribution of a previous stroke to the risk of suffering a recurrent stroke.

Risk factors for stroke

The main risk factors used in this study were age, sex, hypertension, atrial fibrillation, diabetes, smoking, ischaemic heart disease, and heart failure. These had been identified as significant risk factors for stroke in previous studies. Risk factors were categorised as 'absent' or 'present', and we did not try to stratify each risk factor by the severity of the condition in the patient. Because the morbidity survey collected information on socio-economic status, we also examined the association between risk of stroke and the social class of the individual. Social class was categorised as 'non-manual', 'manual', 'other' or 'unknown'.

Statistical Analysis

Incidence rates of first ever and recurrent strokes were calculated by age group in males and females. Age-standardised overall incidence rates in males and females with 95 per cent confidence intervals were calculated using the European standard population. The association between stroke and the risk factors included in this study was examined by calculating relative risks with 95 per cent confidence intervals. We first examined the univariate associations between stroke and the risk factors, followed by an analysis after adjusting for age. We then examined the association between the risk factors and stroke in a multivariate analysis. For first ever stroke, we did this with and without

including a history of transient ischaemic attack in the multivariate model to see what effect this would have on the association with the other risk factors. For recurrent stroke, we did this by including and then excluding a history of a transient ischaemic attack or previous stroke in the multivariate model. All statistical analyses were adjusted for clustering within general practices and were carried out using Stata version six.[12]

Results

Incidence of stroke

During the one year period of the survey, 747 people consulted for a first ever stroke and 456 people for a recurrent stroke; in total, 1,138 people suffered a either a first ever or recurrent stroke. The incidence of both stroke types increased substantially with age and was higher in most age groups in men than in women (Table 1). Hence, although the all-ages crude incidence of stroke was higher in females (0.25 per cent in females, 0.20 per cent in males), the age-standardised rate was higher in males (0.20 per cent in males, 0.16 per cent in females). Overall 81 per cent (926/1,138) of the individuals who suffered a first ever or recurrent stroke were over 64 years of age.

Risk factors for stroke

As there were only 25 people aged less than 45 years who suffered a first ever or recurrent stroke, we excluded this age group from the analysis of risk factors.

Univariate associations with no age adjustment

Increasing age was a strong risk factor for stroke (Table 2). People aged 75 years and older had a nine-fold increase in the risk of a first ever stroke and a 14-fold increase in the risk of a recurrent stroke, compared to people aged 45 to 64 years. For first ever stroke, a history of a transient ischaemic attack was associated with a nearly 15-fold increase and atrial fibrillation a six-fold increase in the risk of stroke. For recurrent stroke, a previous history of stroke was associated with a nearly 40-fold increase and a history of a transient ischaemic attack with a more than 20-fold increase in the risk of stroke. However, because of the strong association between stroke and age, all the relative risks in Table 2 should be interpreted cautiously.

Univariate associations with age adjustment

For first ever stroke, a history of a transient ischaemic attack remained the strongest risk factor (seven-fold increase in risk) after age adjustment (Table 3). Atrial fibrillation also remained an important risk factor for first ever stroke (more then three-fold increase in risk) but less strongly than without age adjustment. High blood pressure, congestive cardiac failure, ischaemic heart disease, diabetes and smoking were also significant risk factors for first ever stroke. There was no significant association with manual social class.

For recurrent stroke, a previous history of a stroke (22-fold increase) or a transient ischaemic attack (11-fold increase) were the strongest risk factors (Table 3). Male sex, high blood pressure, congestive cardiac failure, ischaemic heart disease, diabetes, and atrial fibrillation were also associated with statistically significant increases in the risk of recurrent stroke, after age adjustment. Smoking and manual social class were not associated with statistically significant increases in risk.

Multivariate associations, previous history of stroke and TIA included

For first ever stroke, increasing age remained an important risk factor, with a seven-fold increase among people aged 75 years and over, compared with people aged 45 to 64 years (Table 4). A previous history of a transient ischaemic attack was associated with a more than six-fold increase in the risk of a first ever stroke. Atrial fibrillation also remained an important risk factor for first ever stroke (more than two-fold increase in risk). High blood pressure, congestive cardiac failure, ischaemic heart disease, and smoking also remained statistically significant risk factors for first ever stroke. Male sex and manual social class were associated with non-significant increases in risk.

For recurrent stroke, a history of a previous stroke (14-fold increase) or transient ischaemic attack (seven-fold increase) were both associated with large increases in risk after multivariate adjustment (Table 4). The risk of a recurrent stroke was also increased nine-fold in people aged 75 years and over, compared to people aged 45 to 64 years. Male sex, high blood pressure and diabetes also remained associated with a statistically significant increase in the risk of a recurrent stroke. Atrial fibrillation, ischaemic heart disease, congestive cardiac failure, and smoking were all associated with non-statistically significant increases in risk.

Table 1 **Proportion of population by age and sex who consulted with a first ever or recurrent stroke during the year**

Sex	Age Group	Population	First stroke	Incidence % (95% Confidence Interval)	Recurrent Stroke *	Incidence % (95% Confidence Interval)	All new Strokes**	Incidence % (95% Confidence Interval)
Female	0–44	163,305	8	*0.00*	4	*0.00*	11	*0.01*
	45–64	50,647	56	*0.11*	26	*0.05*	76	*0.15*
	65–74	21,785	91	*0.42*	47	*0.22*	134	*0.62*
	75 and over	21,145	270	*1.28*	168	*0.79*	418	*1.98*
	All ages (crude)	256,882	425	*0.17*	245	*0.10*	639	*0.25*
	All ages (age adjusted)			*0.11* *(0.10, 0.12)*		*0.06* *(0.05, 0.07)*		*0.16* *(0.15, 0.17)*
Male	0–44	164,867	10	*0.01*	4	*0.00*	14	*0.01*
	45–64	51,679	84	*0.16*	33	*0.06*	111	*0.21*
	65–74	17,801	98	*0.55*	80	*0.45*	164	*0.92*
	75 and over	11,253	130	*1.16*	94	*0.84*	210	*1.87*
	All ages (crude)	245,600	322	*0.13*	211	*0.09*	499	*0.20*
	All ages (age adjusted)			*0.13* *(0.12, 0.14)*		*0.08* *(0.07, 0.09)*		*0.20* *(0.18, 0.22)*

Age adjusted rates calculated by direct standardisation using European standard population.
* Number of individuals with recurrent strokes.
** Total number of individuals who consulted with a first ever or recurrent stroke during the survey period.

Multivariate associations, previous history of stroke and TIA excluded

Because a previous history of a stroke or transient ischaemic attack was such a strong predictor of stroke, it may mask the strength of association of stroke with some of the other risk factors. Hence, we carried out a second multivariate analysis in which these two variables were excluded.

For first stroke, increased age remained a strong risk factor, with an eight-fold increase in people aged 75 years and over, compared to people aged 45 to 64 years (Table 5). Atrial fibrillation was the second strongest risk factor (nearly three-fold increase in risk). High blood pressure, congestive cardiac failure, ischaemic heart disease, diabetes and smoking were also associated with a statistically significant increased risk of first stroke but male sex and manual social class were not.

For recurrent stroke, age again was the strongest predictor, with a more than 12-fold increase in risk in people age 75 years and over, compared to people aged 45 to 64 years (Table 5). Male sex, high blood pressure, congestive cardiac failure, ischaemic heart disease, diabetes, and atrial fibrillation were also associated with a statistically significant increased of risk of recurrent stroke. The association with smoking did not quite reach statistical significance and there was no association with non-manual social class.

Annual number of strokes in England and Wales

The age-specific rates found in this study were applied to the 1999 mid-year population estimates for England and Wales to calculate the estimated number of strokes occurring annually in the population (Table 6). We estimated that in 1999 about 87,700 people suffered a first ever stroke, 53,700 suffered a recurrent stroke and that overall about 133,800 people suffered a first ever or a recurrent stroke (assuming incidence rates did not change between 1991–92 and 1999).

Table 2 **Associations with first ever and recurrent strokes. Univariate analysis adjusted for clustering within general practices**

	First ever stroke		Recurrent stroke	
Risk factors	OR	95% Confidence Interval	OR	95% Confidence Interval
Gender				
Female	1.00		1.00	
Male	0.87	0.76, 0.99	0.99	0.81, 1.21
Age Group				
45–64	1.00		1.00	
65–74	3.50	2.89, 4.24	5.57	3.84, 8.10
75 and over	9.12	7.44, 11.19	14.13	9.50, 21.00
Hypertension				
No	1.00		1.00	
Yes	1.83	1.45, 2.29	2.11	1.68, 2.66
Heart failure				
No	1.00		1.00	
Yes	4.85	3.99, 5.89	4.51	3.10, 6.56
Ischaemic heart disease				
No	1.00		1.00	
Yes	2.98	1.80, 2.92	2.35	1.77, 3.13
Diabetes mellitus				
No	1.00		1.00	
Yes	2.66	1.98, 3.60	3.58	2.67, 4.83
Current smoker				
No	1.00		1.00	
Yes	0.91	0.75, 1.11	0.75	0.56, 10.00
Unknown	1.11	0.87, 1.43	1.23	0.92, 1.65
Atrial fibrillation				
No	1.00		1.00	
Yes	6.30	4.69, 8.45	4.57	2.89, 7.19
Social Class				
Prof/Skil/Non Man	1.00		1.00	
Man/Unskilled	1.31	1.07, 1.62	1.16	0.90, 1.49
Other	2.07	1.46, 2.94	1.22	0.71, 2.08
Unknown	1.87	1.46, 2.39	2.29	1.75, 2.99
Transient ischaemic attach				
No	1.00		1.00	
Yes	14.50	11.44, 18.35	23.19	18.10, 29.72
History of stroke				
No	..	..	1.00	
Yes			37.87	27.79, 51.62

Discussion

The risk of first ever and recurrent strokes was strongly associated with age; stroke was rare below 65 years of age. Overall, about 60 per cent of new strokes were first ever events. Although crude stroke rates were higher in women, after adjusting for age, rates for both first ever and recurrent strokes were about 25 per cent higher in men. The risk factors most strongly associated with first ever strokes were increasing age, previous transient ischaemic attacks and atrial fibrillation. Other risk factors with statistically significant associations with first ever stroke were hypertension, heart failure, diabetes, current smoking and ischaemic heart disease. For recurrent stroke the strongest associations were with previous stroke, age and transient ischaemic attacks. Other risk factors with statistically significant associations with recurrent stroke were hypertension and diabetes.

Strengths and weaknesses of study

The strengths of this study are that it was population based, the patients were followed up for one year, and there was good recording of morbidity data. The morbidity survey involved 60 practices with a total list size of over 500,000 patients drawn throughout England and Wales. The population is therefore unselected and large enough from which to draw clinically and policy relevant findings. The data collection and validation procedures employed during the morbidity survey were rigorous, and a review of a sample of patient records found an accuracy of over 90 per cent in diagnostic coding.[11] Furthermore, as this was a general morbidity survey, the general practitioners who took part were not focusing on identifying risk factors for any one particular condition, thus reducing the potential for bias.

One potential weakness of the study is that there is no information available on the criteria upon which general practitioners based their diagnoses. Some diagnoses may have been made on clinical grounds alone. Given the size of the population studied and the number of general practitioners involved, the effects of these potential misclassifications is likely to be random rather than systematic and the validity of the results should not be affected greatly. A second limitation is that the morbidity survey relied on diagnoses recorded at the time of a contact between the patient and either the general practitioner or other member of the primary care team. Hence, patients with the disorders examined in this study, such as atrial fibrillation or high blood pressure, who did not consult during the survey period for these conditions, would not have been identified. During the period of the survey (1991–92), the use of anticoagulation in the treatment of atrial fibrillation was not widespread.[13,14] and atrial fibrillation was probably particularly

Table 3 **Associations with first ever and recurrent strokes adjusted for age and clustering within general practices**

	First ever stroke		Recurrent stroke	
Risk factors	OR	95% Confidence Interval	OR	95% Confidence Interval
Gender				
Female	1.00		1.00	
Male	1.10	0.97, 1.27	1.31	1.07, 1.61
Hypertension				
No	1.00		1.00	
Yes	1.56	1.24, 1.95	1.75	1.37, 2.23
Heart failure				
No	1.00		1.00	
Yes	2.16	1.72, 2.69	1.86	1.27, 2.73
Ischaemic heart disease				
No	1.00		1.00	
Yes	1.66	1.31, 2.10	1.63	1.23, 2.14
Diabetes mellitus				
No	1.00		1.00	
Yes	2.10	1.54, 2.84	2.73	2.00, 3.71
Current smoker				
No	1.00		1.00	
Yes	1.37	1.13, 1.67	1.19	0.90, 1.58
Unknown	1.11	0.87, 1.41	1.23	0.93, 1.63
Atrial fibrillation				
No	1.00		1.00	
Yes	3.30	2.42, 4.44	2.23	1.37, 3.63
Social Class				
Prof/Skil/Non Man	1.00		1.00	
Man/Unskilled	1.11	0.89, 1.38	0.95	0.74, 1.23
Other	1.44	0.99, 2.07	0.80	0.47, 1.37
Unknown	1.18	0.93, 1.49	1.38	1.05, 1.81
Transient ischaemic attach				
No	1.00		1.00	
Yes	7.40	5.82, 9.43	11.30	8.64, 14.72
History of stroke				
No	..	..	1.00	
Yes			22.17	16.07, 30.57

Table 4 **Associations with first ever and recurrent strokes. Multivariate analysisadjusted for clustering within general practices**

	First ever stroke		Recurrent stroke	
Risk factors	OR	95% Confidence Interval	OR	95% Confidence Interval
Gender				
Female	1.00		1.00	
Male	1.07	0.93, 1.23	1.30	1.05, 1.61
Age Group				
45–64	1.00		1.00	
65–74	3.08	2.52, 3.75	4.56	3.09, 6.74
75 and over	7.31	5.88, 9.09	9.74	6.42, 14.78
Hypertension				
No	1.00		1.00	
Yes	1.55	1.24, 1.94	1.75	1.38, 2.22
Heart failure				
No	1.00		1.00	
Yes	1.74	1.39, 2.19	1.48	0.99, 2.22
Ischaemic heart disease				
No	1.00		1.00	
Yes	1.37	1.07, 1.74	1.26	0.93, 1.71
Diabetes mellitus				
No	1.00		1.00	
Yes	1.86	1.36, 2.56	2.30	1.66, 3.21
Current smoker				
No	1.00		1.00	
Yes	1.41	1.16, 1.73	1.25	0.92, 1.68
Unknown	1.11	0.79, 1.57	0.83	0.56, 1.25
Atrial fibrillation				
No	1.00		1.00	
Yes	2.47	1.82, 3.36	1.33	0.73, 2.41
Social Class				
Prof/Skil/Non Man	1.00		1.00	
Man/Unskilled	1.07	0.86, 1.32	0.92	0.70, 1.19
Other	1.41	0.97, 2.04	0.83	0.46, 1.49
Unknown	1.25	0.95, 1.65	1.80	1.23, 2.63
Transient ischaemic attach				
No	1.00		1.00	
Yes	6.65	5.13, 8.61	7.62	5.78, 10.04
History of stroke				
No	..	..	1.00	
Yes			14.38	9.88, 20.92

under-diagnosed. Finally, some people who suffered a stroke may not have consulted a general practitioner. This is most likely to have occurred in people who died in hospital and who did not see a general practitioner before admission. Finally, it was not possible to classify strokes on the basis of pathological or clinical subtype.

Comparison with previous studies

Incidence rates

The incidence rates of stroke found in our study are comparable to rates reported from other investigations. The crude all ages incidence rate of a first ever stroke was 0.13 per cent in men and 0.17 per cent in women, and age adjusted rates were 0.13 per cent and 0.11 per cent respectively. These rates are very similar to those found in a study from South London[8] which identified cases during the period 1995–96 from a community stroke register (age-adjusted incidence 0.14 per cent in men and 0.11 per cent in women). The Oxford community stroke project[7] reported a mean annual incidence rate of 0.16 per cent for the period 1981–86. Our study found that age adjusted rates for first ever or recurrent strokes were 0.20 per cent in males and 0.16 per cent in females. A study using the UK General Practice Research Database[15] (GPRD) reported age adjusted incidence rates for 1994 of 0.22 per cent in men and 0.17 per cent in women. The GPRD study reported all new strokes during the study period, including both recurrent as well as first ever strokes.

Risk factors

The relative risk of stroke associated with age and sex found in our study is similar to previously published estimates.[16,17] Hypertension is a well-recognised risk factor for stroke.[9] In our study, it was associated with a relative risk of 1.6 for first ever stroke, which is lower than reported from the Framingham study.[18] However, the population in the Framingham Study included first ever and recurrent strokes, and the relative risk associated with hypertension was adjusted for fewer other risk factors.

Table 5 **Associations with first ever and recurrent strokes. Multivariate analysis adjusted for clustering within general practices**

	First ever stroke		Recurrent stroke	
Risk factors	OR	95% Confidence Interval	OR	95% Confidence Interval
Gender				
Female	1.00		1.00	
Male	1.09	0.95, 1.26	1.40	1.13, 1.73
Age Group				
45–64	1.00		1.00	
65–74	3.19	2.62, 3.89	5.03	3.43, 7.38
75 and over	8.05	6.48, 10.01	12.18	8.07, 18.39
Hypertension				
No	1.00		1.00	
Yes	1.59	1.27, 2.00	1.86	1.46, 2.37
Heart failure				
No	1.00		1.00	
Yes	1.83	1.46, 2.28	1.61	1.09, 2.38
Ischaemic heart disease				
No	1.00		1.00	
Yes	1.42	1.12, 18.1	1.41	1.06, 1.88
Diabetes mellitus				
No	1.00		1.00	
Yes	1.90	1.39, 2.58	2.54	1.86, 3.47
Current smoker				
No	1.00		1.00	
Yes	1.41	1.15, 1.72	1.24	0.92, 1.66
Unknown	1.05	0.75, 1.48	0.77	0.52, 1.14
Atrial fibrillation				
No	1.00		1.00	
Yes	2.70	2.02, 3.62	1.84	1.10, 3.09
Social Class				
Prof/Skil/Non Man	1.00		1.00	
Man/Unskilled	1.07	0.86, 1.33	0.93	0.72, 1.19
Other	1.40	0.97, 2.03	0.83	0.47, 1.45
Unknown	1.28	0.97, 1.69	1.89	1.33, 2.70

Table 6 **Estimates of annual incidence of first ever and recurrent strokes in England and Wales. Age and sex specific rates applied to mid year population estimates for 1999**

Sex	Age group	Population	First stroke	Recurrent stroke	All new strokes
Female	0–44	14,767,224	723	362	995
	45–64	6,162,241	6,814	3,163	9,247
	65–74	2,333,755	9,749	5,035	14,355
	75 and over	2,513,314	32,092	19,969	49,684
	Total	25,776,534	49,378	28,529	74,280
Male	0–44	16,393,366	994	398	1,392
	45–64	6,096,949	9,910	3,893	13,095
	65–74	2,033,506	11,195	9,139	18,735
	75 and over	1,407,637	16,262	11,758	26,269
	Total	25,931,438	38,361	25,188	59,491
Total	0–44	31,160,590	1,718	759	2,387
	45–64	12,259,190	16,724	7,057	22,342
	65–74	4,367,261	20,944	14,174	33,090
	75 and over	3,920,951	48,354	31,727	75,953
	Total	51,707,992	87,739	53,717	133,772

Diabetes has been shown to be an independent risk factor for stroke.[19,20] In our study diabetes was associated with an almost two fold increase in the relative risk of a first ever stroke. Atrial fibrillation is a significant risk factor and from published reports increases the relative risk of stroke by 3–7 times.[21,22] In our study atrial fibrillation, was associated with a 2.5 times increase in the relative risk of first ever stroke. It is likely that the risk associated with atrial fibrillation is under estimated in our study because the prevalence of atrial fibrillation was lower than has been reported elsewhere. Prevalence rates of 3–6 per cent have been reported in over 65-year-olds in other studies from North American and Europe.[23,24,25,26] In our study the prevalence in this age group was 1.7 per cent. The lower prevalence of atrial fibrillation in our study may, in part, be a consequence of the failure to detect asymptomatic cases. Atrial fibrillation was associated with a lower relative risk of recurrent stroke, half that for first ever stroke. This may be because atrial fibrillation is associated with more fatal and severe strokes,[27,28] and thus less prevalent in the survivors of first strokes.

We estimated that smoking was associated with a 1.4 times increase in the relative risk of first ever stroke. An early meta-analysis estimated that smoking was associated with a doubling in the risk of cerebral infarction.[29] Amongst members of the Framingham cohort.[30] smoking was associated with a 1.8 times increase in the relative risk of stroke. Pre-existing coronary heart disease is associated with increased stroke incidence[31,32,33] and mortality.[34] In our study ischaemic heart disease was associated with a 1.4 times increase in the relative risk of first stroke. A history of transient ischaemic attacks and previous stroke are very strong predictors of subsequent stroke (relative risks of 7 and 14 respectively) in our study. We did not find that social class was associated with first ever or recurrent stroke. Most other studies have demonstrated an association between social class and prevalence or mortality from stroke.

Implications for clinicians and policy makers

The decline in mortality attributed to stroke seen in all developed countries over the past 30 years suggests that modifiable factors are important determinants of stroke occurrence. The estimates of age-and sex-specific stroke incidence derived from the national morbidity survey enabled us to estimate that in England and Wales in 1999 there were probably about 87,725 people with a first ever stroke and 53,545 with a recurrent stroke. Overall 133,800 people experienced a first ever or a recurrent stroke. After one year 40,000 will have died and about 33,000 will be significantly disabled and unable to live without support from informal carers or social and community health services. In making this estimation we have assumed that the incidence rate of stroke has remained relatively constant. There is no data from the United Kingdom on secular trends in stroke incidence. However data from the Framingham study[17] showed that over a 30 year period there was no overall reduction in the incidence of stroke or transient ischaemic attacks but the case fatality rates declined and the strokes were less severe during the later years. Information on incidence and disability will be required to monitor the progress towards addressing standard 5 in the NSF for older people;[2] which aims to achieve a reduction in the incidence of stroke through aggressively managing modifiable risk factors and ensuring prompt access to integrated stroke services to improve survival and reduce disability.

The most important modifiable risk factors confirmed by our own and previous studies are hypertension, atrial fibrillation, diabetes, coronary heart disease and smoking.

Conclusions

This study confirms that stroke is an important cause of morbidity in the population and in the elderly in particular. We have also confirmed that the risk factors identified from other investigations were strongly associated with first ever and recurrent strokes in this study population and, we quantified the strength of these associations. There is a need for secular trend data on the incidence of stroke in the United Kingdom to enable modelling to be carried out on the likely need for stroke services. This is important because mortality, the usual proxy for the burden of disease, is no longer suitable for measuring the burden of disease associated with stroke.

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Key points

- Mortality rates for stroke have fallen substantially over the past 30 years in developed countries and are no longer an adequate measure of the disease burden attributed to stroke.
- Using data from the Fourth National Morbidity Survey from General Practice 1991–92 we were able to estimate that the annual age standardised incidence rates for first ever stroke were 0.11 per cent in women and 0.13 per cent in men. The overall age standardised annual incidence of all individuals experiencing a first ever or recurrent stroke was 0.16 per cent of women and 0.20 per cent of men. 81 per cent of strokes were in people more than 64 years of age.
- We estimate that in 1999 in England and Wales there were about 87,700 people with a first ever stroke and, 53,700 with a recurrent stroke. Overall 133,700 people experienced a first ever or a recurrent stroke.
- The most important modifiable risk factors identified by our study are hypertension, atrial fibrillation, diabetes, coronary heart disease and smoking. Previous transient ischaemic attack and stroke, increasing age and male gender were important unmodifiable risk factors.
- Information on incidence and disability, particularly secular trends, is required to monitor the progress towards addressing standard 5 in the NSF for older people; which aims to achieve a reduction in the incidence of stroke.

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