

Review Article

Epidemiology of stroke in India

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Stroke is the 2nd commonest cause of mortality worldwide with India currently entering into so called double burden of infection as well as cardiovascular disease a majority of which consist of strokes also called cerebrovascular accident. Even though India harbours around 1/6th of the world population, stroke epidemiology studies across the country are inadequate and mainly limited to major urban and few rural areas. The current article aims to make a review of the major work done in this field of stroke epidemiology and portray its current status across the country. For writing this review, papers were searched in the search engine PUBMED. 'Stroke in India', 'Stroke epidemiology', 'Stroke burden', 'Stroke and India', "risk factors for stroke in India" etc were used as search terms. Stroke studied in various parts of India reflects an ongoing increase of its incidence. Few risk factors are common in all regions and also few others vary among different zones depending on the local social factors. Two most important risk factors are hypertension and smoking. Thus more stringent actions need to be taken for tackling this so called epidemic in this country.

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Key words : Stroke, Haemorrhagic ischaemic, SAH.

Stroke is the second most common cause of mortality and the third most common cause of disability¹. Globally, the subtype of stroke due to ischemia is 68 percent, while that of hemorrhagic stroke (intracerebral haemorrhage and subarachnoid haemorrhage combined) is 32 percent, with a higher occurrence of hemorrhagic stroke in low- and middle-income countries². While the incidence of stroke is decreasing in high-income countries, including United States^{3,4}, the incidence is increasing in low-income countries^{3,2}. The overall rate of stroke-related mortality is decreasing in high income countries, but the absolute number of people with stroke, stroke survivors, stroke-related deaths, and the global burden of stroke-related disability is high and increasing in low income countries⁵.

Stroke Epidemiology in India :

As per the gross domestic product (GDP) study (2010) the burden of stroke is increasing in developing countries including India and it is expected that by 2050, 80% of strokes will occur in these countries. India is said to harbour about 1/6th of the global population although epidemiological data from this country is not enough and is mainly from the urban centres.

Methods : For writing this review, papers were

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searched in the search engine PUBMED. 'Stroke in India', 'Stroke epidemiology', 'Stroke burden', 'Stroke and India', "risk factors for stroke in India" etc. were used as search terms. Total number of papers listed was 1620. Out of this around fifty papers were short listed base on the impact factors of the journals,

more recent datas were preferred, efficacy and large sample sized based studies were given importance and reviewed by the authors.

Prevalence :

The above chart is indicative of the various studies done on stroke epidemiology and as is evident there is a gradually rising trend of prevalence to last decade cause of which could be the increasing occurrence of risk factors like hypertension, demographic change characterised by higher ageing population due to greater life expectancy, change of lifestyle with greater increases in sedentary lifestyle and comforts due to influence of urbanisation and globalisation along with methodological differences.

A stroke study conducted in Kolkata from 1998 to 1999 showed a crude prevalence rate of 147/100,000 and an annual incidence rate of 36/100,000.¹³ When adjusted to

Editorial Comments :

- Stroke 2nd commonest cause of mortality worldwide
- Mean age of stroke 15 years younger compare to developed countries.
- Ratio of cerebral infraction to haemorrhage ranges 1.86 : 1 to 2.21 : 1.
- Proportion of haemorrhagic stroke more in eastern states due to high salt intake.
- Hypertension commonest risk factor.
- Case fatality rate ranges from 29 to 42%.

Table 1 — Prevalence rates of stroke from the major epidemiological studies in India

Place	Rural(R) or Urban(U)	Year	Population(n)	Pr * Per 100,000	Aa -pr ** Per 100,000
North :					
Rohtak,Haryana ⁷	U	1971-1974	79046	44.28	
	R	Same	51165	44.95	
Kuthar Valley, Kashmir ⁸	R	1986	63645	143	244†
West :					
Mumbai (Parsis) ⁹	U	1985	14010	842	424†
Mumbai ¹⁰	U	1997	145456	220	
Gadchiroli ¹⁷ (Maharashtra)	R	2015	45053	388.43	533.58
East :					
Malda, WB ¹¹	R	1989-1990	37286	126	
Baruipur , WB ¹²	R	1992-1993	20842	147	
Kolkata ¹³	U	1998-1999	50231	147	334 ‡
Kolkata ¹⁴	U	2003-2004	52377	472	545§
South					
Vellore ⁶	R	1968-69	258576	57	
Gowribidanore, Karnataka ¹⁵	R	1982-84	57660	52	
Bangalore ¹⁶	R	1993-95	51055	165	262
Bangalore ¹⁶	U	1993-95	51502	136	

AA-PR indicates age-adjusted PR; WB, West Bengal.
 *Crude PR., †US population in 1960., ‡US population in 1996., §World standard population., ?Not mentioned.

the 1996 US population, the age-adjusted prevalence rate was 334/100,000 and the age-adjusted annual incidence rate was 105/100,000. Among risk factors for stroke assessed by case-control study, hypertension was the most important risk factor: odds ratio (OR) for hypertension was 5.04 (95% confidence interval [CI] 4.16-5.92) for women and 21.87 (95% CI 18.69-25.05) for men. Smoking in men had the OR 2.91 (95% CI 1.57-4.25). However, the OR (95% CI) for diabetes was not significant for both women (0.99 [0.28-2.26]) and men (1.61 [0.17-3.05]). Since the smoking prevalence in women was very low, the authors suggested that hypertension being less managed in women than in men might account for the higher incidence and prevalence in women.¹³

According to the India stroke factsheet updated in 2012, the estimated age-adjusted prevalence rate for stroke ranges between 84/100,000 and 262/100,000 in rural and between 334/100,000 and 424/100,000 in urban areas.

Incidence : Incidence rate is a valuable epidemiological index and shows the true trend of a disease. The one study from eastern India did show progressive rise of incidence rate with advancement of age.¹⁴ The age adjusted incidence rates are quite similar in the various parts of India thereby showing less influence of ethnic factors in incidence of stroke in the country however it is higher compared to west where



Fig 1 — Map of India showing the different places where stroke incidence study has been done

they have been successful to reduce it because of greater controlling of risk factor like hypertension and increasing awareness.

Age: The mean age of stroke is about 15 years younger when compared to developed countries. In the various studies shown the mean age of stroke varies from 54.5 years to 67 years which were quite earlier to that in the developed world where the mean age was around 73 years. In Trivandrum, stroke occurred at rate of 7.1 per 1000 per year in people aged ≥ 55 years, and the rate escalated to 13.3 per 1000 in people aged ≥ 75 years (age-adjusted).¹⁹ The stroke in the young age group defined as 40 years or less comprised 3.8%. In this study, the mean age of stroke onset did not differ between the urban and rural populations.²⁰

Gender : In the Mumbai registry, men had a higher stroke incidence rate than did women (crude incidence rate, 149/100,000 person-years for men versus 141/100,000 person-years for women; age-standardized incidence rate, 162/100,000 person-years for men versus 141/100,000 person-years for women).¹⁰ Women were older (68.9 years) compared to men (63.4 years).¹⁰ In the Trivandrum registry, the crude incidence rate was higher in women than in men (115/100,000 person-years for men and 119/100,000 person-years for women), but the age-standardized incidence rate was higher in men than in women (143/100,000 person-years for men and 128/100,000 person-years for women).¹⁹ The Bangalore study also showed a greater preponderance among men (67%) with a male to female ratio of 2:1.²⁰ The observed difference between age and gender and occurrence of stroke was statistically significant ($P < 0.01$).²⁰

In the study done by Pandian et al from the Ludhiana stroke registry out of 3,441 stroke patients the annual incidence rate was 140/

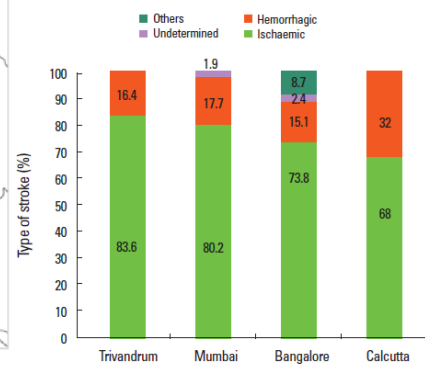


Fig 2 — Distribution of stroke subtypes in the various incidence studies

100,000 (95% confidence interval [CI] 133–147) and age-adjusted incidence rate was 130/100,000 (95% CI 123–137).²² The annual incidence rate for stroke in the young (18–49 years) was 46/100,000 (95% CI 41–51). The case fatality at 28 days was 22%. Patients above 60 years of age and patients who were managed in public hospitals had poor survival. Hot spots for cumulative incidence were seen in central and southern parts of the city, and hot spots for poor outcome were seen in the outskirts of the city.

In the study by Das *et al.* Women have higher incidence and case fatality rates.¹⁴ The age standardized prevalence and incidence rates of stroke in this study are similar to or higher than many western nations. The ideal criteria for conducting a good epidemiological stroke study were followed.²³

Stroke subtypes :

Of patients with first-ever stroke captured in the Mumbai registry, CT imaging was done in 89.2%, and 80.2% of cases were ischemic strokes and 17.7% hemorrhagic strokes (Fig 2).¹⁰ In the Trivandrum registry, 69.7% of patients underwent imaging. Of those, 83.6% were ischemic strokes, 11.6% intracerebral hemorrhages, and 4.8% subarachnoid haemorrhages, respectively.²⁰ There were more strokes of undetermined type in patients enrolled from the rural communities because of a lack of neuroimaging facility (31.2%).²⁰ In the Kolkata study, 32% of the patients had hemorrhagic stroke, which is the highest figure reported so far from India. Based on neuroimaging findings, recent studies have determined the stroke subtypes and the ratio of cerebral infarct to hemorrhage range as 1.86:1 to 2.21:1.¹³⁻¹⁴ Hence, cerebral hemorrhage is proportionately much higher in the Eastern Indian community than Western countries, where the ratio of infarct to haemorrhage is 5:1. In fact higher proportion of hemorrhagic stroke in eastern and north eastern states may be due to high salt intake and uncontrolled hypertension.²⁵ In fact the dietary habit of these regions

of India consume salt even outside meals for example in along with tea as seen in the dietary pattern of labourers of tea garden.²⁵ The overall prevalence of hypertension was 60.8% in labourers of tea garden. Increasing age, consumption of locally prepared alcohol, intake of extra salt in food and beverages and the habit of taking khaini were found to increase the risk of hypertension²⁷⁻²⁸.

Suitable neuroimaging data were available only in 50-60% of cases in these surveys. The Kolkata study¹⁰ demonstrated that the basal ganglia-thalamic region was, by far, the commonest site (75%) of hemorrhage. In contrast, the subcortical region was the commonest site of infarction (75.6%). This predilection for subcortical infarct also is common in other Asian races. A study based on noninvasive tests to determine subtypes of ischemic stroke from a hospital-based registry of Southern India has attributed 41% of strokes to large artery atherosclerosis, 18% to lacunar causes, 10% to cardioembolic causes, and 4% to causes such as Takayasu syndrome, Moya Moya disease, carotid dissection, hyperhomocysteinemia, anticardiolipin antibody, and protein S deficiency. The rest 27% of the cases of ischemic stroke were of undetermined origin.³⁰ Among cardioembolic stroke, rheumatic heart disease (29%) and ischemic heart disease (27%) are predominant causes³¹. In a clinicoradiological study among young strokes,¹⁹ the common site of arterial occlusion was the supraclinoid internal carotid artery, whereas, narrowing or occlusion of major neck vessels occurred in only 10.8% cases.³² Few other Indian studies trying to detect underlying vascular pathology have shown variable findings. The Indian Collaborative Acute Stroke Study (ICASS); a multicentric study conducted among 2,162 admitted stroke patients across southern, northern, and western India observed ischemic stroke in 77%, hemorrhagic stroke in 22%, and unspecified stroke in 1% cases based on cerebral computed tomography (CT).

In India, the pooled data incorporating all the studies reveal that ischemic stroke occurs in 68-80% and hemorrhagic stroke in 20-32%. Ischemic stroke comprise large vessel (41%), lacunar (18%), cardioembolic (10%), other determined (10%), and undetermined (20%) subtypes. The extracranial carotid disease is the etiological factor in 25-26% and intracranial carotid disease in 30% of ischemic stroke cases.³⁴

Risk factors: Various studies have found out that hypertension, smoking (both smoking and chewing), diabetes, alcohol, dyslipidemia, family history of stroke, ischemic heart disease and atrial fibrillation seem to be the key risk factors involved in

Table 2 — Incidence and case fatality rates in studies from different regions in India

Place of survey	Type of Survey	Period	Incidence/100,000/Year (Age adjusted rates)	Case - fatality rate	Mean age of stroke subjects (years)
Kolkata ¹⁴	HH S (U)	2002-5	145.33	41.3% ¹	M-61.6±13.25 F-64.5±13.38 L
Kolkata ¹³	HH S	81998-9	105	NA	
Mumbai ¹⁰	WSC	2005-6	1528	29.8%	66I
Trivandrum ¹⁹	WSC	2005	135 (U-135;R-138)	U-24.5%, R-37.1%	67
Bangalore ²⁰	WSC	2005	NA	19.8%	54.5±17R
Rural Bengal ²³	HH S (R)	1992-8	262	18%	61(M-64;F-57)D
Ludhiana (Pandian) ²¹	WSC	2010-13	130	22%	59 ± 15

Abbrev : WSC- Who Steps Care Approach; HHS- house to house survey; U –urban; R-rural

the stroke epidemic with hypertension being the most important and preventable one.

Urban vs Rural : Of the 541 validated first-ever strokes in Trivandrum, 431 occurred in the urban community and 110 occurred in the rural community. The annual stroke incidence rate was slightly higher in the rural population than in the urban population (crude incidence rate, 116/100,000 person-years for the urban population versus 119/100,000 person-years for the rural population; age-standardized incidence rate, 135/100,000 person-years for the urban population versus 138/100,000 person-years for the rural population) (Table 2).²⁰ It also showed that the number of smokers (men) and presence of multiple risk factors (more than 3) were significantly more in rural population than in urban population. Also the distribution of conventional stroke risk factors was remarkably similar among the urban and rural communities. However number of stroke patients who had imaging was significantly low in rural population.²⁰ Studies from India on cardiovascular risk factors have shown a 2 to 3 times high prevalence of hypertension, hyperlipidemia, obesity, diabetes mellitus, and smoking (in men) in urban compared to rural communities.³⁴⁻³⁵

Case fatality rate: In the Mumbai study, the 28-day case fatality rate was 29.8% (Figure 3).¹⁰ The case fatality rate was 24.5% for urban and 37.1% for rural population (overall 27.2%) in Trivandrum.²⁰ Significantly more rural patients compared to urban patients died within 1 month, which probably reflects the disparity in the quality of acute stroke care between the rural and urban areas.¹⁸ The case fatality rate was 42% in the Kolkata study which included the death of stroke victims before reaching hospital.¹⁴

In a study done by Kalkonde et al 2015³⁶, stroke is the leading cause of death in the rural population in one of the most backward districts of India (Gadchiroli, Maharashtra). To our knowledge, this is the first study of its kind to systematically study stroke mortality in a rural population in India. The mortality rate (crude 121.6 per 100,000 ;age adjusted 191.9) was higher than a study conducted in a rural region of southern state of Andhra Pradesh (crude stroke mortality rate was 94.3 per 100 000 person-years,) whereas in Kolkata study, the crude mortality rate was calculated to about 101.18 per 100,000 population).^{37,14} In this study from rural Maharashtra, it was about 25% higher and indicates possible lack of adequate care for stroke victims in rural areas similar to finding of Trivandrum study.²⁰

	Kolkata (2007) ¹⁰	Kolkata (2001) ⁹	Mumbai (2008) ¹³	Bangalore (2009) ¹⁵	Trivandrum (2009) ¹⁴
Total Cases	247	74	456	1174	541
Proportion of Imaging Performed					
Within 4 Weeks	51.4%	59.5%	89.2%	92%	69.7%
Ischemic Stroke	108	65%	80.2%	73.8%	83.6%
Hemorrhagic Stroke	58	32%	17.7%	23.8%	16.4%
Ischemic/Hemorrhagic stroke	1.86:1	2:1	4.53:1	3.1:1	5.09:1

Yusuf *et al*³⁴ have proposed 5 stages of epidemiological transition based on various stages of economic and social development. In the second phase of the transition, which the authors have termed age of receding pandemics, deaths caused by infectious diseases decrease and hypertension-related deaths (eg, stroke and hypertensive heart disease) increases.

Recently a study has been shown that the trend of cardiovascular disease from India has shown to affect more among economically poor people, people of lower social status and lower education.³⁸ Kolkata study has also shown that those who are living in slum or without slums have no statistical differences in stroke occurrence.¹⁴ So in future economic and social disparity will possibly increase the number of stroke in economically deprived population.

Large swathes of rural India are likely to be going through the second stage of epidemiological transition, where deaths related to uncontrolled hypertension would predominate. A significant number of these deaths can be potentially prevented by controlling hypertension. Also the use of tobacco mainly in the form of cigarettes in urban and bidis in the rural including chewing of tobacco seems to be a major risk factor both in rural and urban settings involving males as well as females. Even smokeless tobacco consumption were high in India with betel leaves being used most commonly in 38.9% patients with an av-

Risk Factors	Kolkata (Eastern India) ¹⁰	Mumbai (Western India) ¹³	Trivandrum (Southern India) ¹⁴	Bangalore (Southern India) ¹⁵	Kolkata (eastern India) ⁹	Rural Bengal (Eastern India) ³⁶
	In Terms of Percentage			Based on Odds Ratio		
Hypertension	65.15%	82.80%	83.20%	48%	Hypertension M-21.87,W-5.04	Hypertension-2.79
Tobacco	33.15%	NA	26.80%	32.60%	Diabetes Mellitus M-1.61,W-0.99	Heart Disease-6.20
DM	25.42%	NA	50%	32.60%	Smoking or-2.91	Smoking -3.92
Alcohol	5.10%	NA	NA	32.60%		DM -1.73
Dyslipidemia	NA	NA	26%	NA		
Family H/O stroke	NA	NA	NA	7.30%		
IHD	4.70%	NA	NA			
AF	NA	NA	NA	9.70%		

erage of 14.6(\pm 3.27) years of addiction.²⁷⁻²⁸

Disability: In the Trivandrum study, the functional outcome was available in 86.8% among stroke survivors.¹⁹ The distributions of functional outcomes at 28 days among stroke survivors were mild disability (Rankin score 2 or less) in 42.4%, moderate disability (Rankin score 3 or 4) in 43%, and bedridden (Rankin score 5) in 14.6%, respectively (Fig 4). Among stroke survivors, there was no significant difference in the functional outcome between men and women ($P=0.17$), between urban and rural patients ($P=0.51$), or across different age groups ($P=0.52$).¹⁹ Recent community study have documented a prevalence of 19.93%³⁹ of post stroke cognitive dysfunction and post stroke depression of 36.98% amongst the stroke survivors.⁴⁰

Stroke in young : Previous hospital-based data from India observed a high proportion of young stroke (first-ever stroke onset below 40 years of age), ranging between 15 and 30%.⁴³ In a recent study at All India Institute of Medical Sciences (AIIMS), out of the 2,634 patients admitted for ischemic stroke, 440 (16.7%) were in the age range of 18-45 years and majority (83.4%) were male.⁴⁴ However, this figure was biased because of preferential admission policy. In the well-designed population-based study,¹⁴ 8.8% of stroke subjects were young, which is similar to that seen in Western countries.⁴⁵ In the late 1960s, however, a population-based study found that 25% of stroke patients were less than 40 years of age, and this included young women with cerebral venous thrombosis (CVT) occurring in the postpartum stage.⁴⁶ CVT was found to be 12 times more common in India than in Western countries. An angiographically proven study reported that 50% of the total cases of stroke in young women were related to pregnancy and puerperium, 95% of which were due to CVT. MoyaMoya disease, common among the Orientals, is also reported from India, but there is no epidemiological data or a large clinical series on it.⁴⁷ Takayasu's arteritis is also often noted among Indians where the genders were almost equally affected.⁴⁸ Stroke occurs in 40% of children and adolescents (4-15 years of age) with Takayasu's arteritis. The subclavian arteries are occluded more often than the carotids, leading to posterior circulation stroke. Although tuberculosis is endemic in India, the disease in a prospective study of young stroke affected only 8% of subjects.⁴⁹

In a hospital-based study of pediatric age group (1 month-18 years) from a tertiary center in northern India,

majority cases were of acute ischemic stroke followed by intracerebral hemorrhage (12.7%) and CVT (8.9%).⁵⁰ The commonest etiology in cases with ischemic stroke were neuroinfections (40%), prothrombotic state (8%), arteriopathy (6.5%), arterial dissection (5%), miscellaneous (4.83%), and cryptogenic (21%). Only about 9% of subjects died.

In another study of younger subjects (18-50 years; mean age, 41.6 years) with hemorrhagic stroke from the same center has been studied.⁵¹ The subjects were predominantly male. The important risk factors were hypertension (57%), hypocholesterolemia (34%), alcohol (15.5%), and anticoagulants (3.5%). Underlying causes were hypertension (79%), vascular malformation (4%), coagulopathy (4%), CVT (2%), thrombocytopenia (0.7%),

vasculitis (0.5%), and cryptogenic stroke (9%). About 2.5% of the subjects died and only 35% had good outcomes. Overall outcome was related to volume of intracerebral hemorrhage, Glasgow Coma Scale, and leukocyte count on admission.

Stroke in pregnancy: Even though pregnancy has stroke as a major comorbidity in this country yet no major epidemiological study in this regards has come up yet. However CVT, Infarcts, hemorrhage and SAH are quite commonly found in Indian settings.

Conclusion :

India seems to be in the middle of a stroke epidemic. Even though measures like the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS) have been taken by the government of India, much needs to be done to decentralise the care of stroke patients from urban based tertiary institutions to rural peripheral hospitals so that earlier and better care can be provided to rural patients as well as the huge burden on urban hospitals become reduced. Not only the government sector but also the private sector needs to come up with joint actions to meet the demand of stroke management. Preventive measures especially control of blood pressure and smoking should be taken strictly and more methods should be improvised for self measurement of BP by ambulatory blood pressure monitoring.

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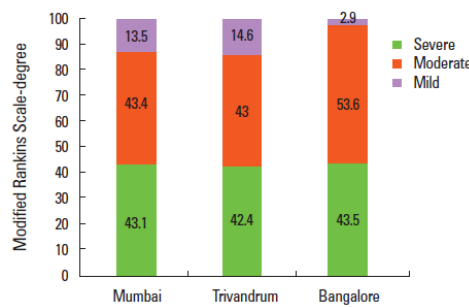


Fig 4 — Distribution of post-stroke disability at 28 days from the onset of stroke among stroke survivors

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