

Stroke in India: Bio-socioeconomic determinants

Sweta Singla, Rajiv Singla

Kalpavriksh Superspeciality Center, New Delhi, India

ABSTRACT

Worldwide, stroke is one of the leading causes of mortality. Further, it leads to significant morbidity in the form of residual deficits and disability-adjusted life years. India with its culturally diverse environment and economically developing status presents unique challenges in providing stroke care. Various myths, misconceptions, poor knowledge about stroke, and poor availability of health resources afflict the nation and present barriers in stroke management. A multipronged approach to bring various disciplines together with the help of newer technologies such as smartphones and its applications need to be evolved to fight this catastrophic disease.

Key words: Risk factors, social factors, stroke, stroke-care

INTRODUCTION

Worldwide, stroke is one of the leading causes of mortality and morbidity. According to the WHO 2012, of 56 million global deaths, 38 million or 68% were due to noncommunicable diseases (NCDs). The leading causes of NCD deaths were cardiovascular diseases (46% of all NCD deaths), which included an estimated 7.4 million due to coronary heart disease and 6.7 million communicable due to stroke. Nearly, three-quarters of NCD deaths (28 million) occurred in low- and middle-income countries with about 48% of deaths occurring before the age of 70 in these countries.^[1] Stroke is a catastrophic illness. Apart from mortality, it causes significant morbidity. Over the 1990–2013 period, an absolute number of disability-adjusted life years (DALYs) due to Ischemic stroke (IS), and deaths due to all types of stroke has increased significantly. Worldwide, in 2013, there were almost 25.7 million stroke survivors, 113 million DALYs due to stroke, and 10.3 million new strokes. The age-adjusted prevalence of stroke (both ischemic and hemorrhagic) has

increased from 291.2/100,000 in 1990 to 299.2/100,000 in 2013. Separately, the absolute number of cases in whole world for IS was 18,305,491 (17,767,372–18,920,736) and hemorrhagic stroke (HS) was 7,363,457 (7,139,691–7,616,146) in 2013. In 2013, absolute number of new stroke cases for IS were 6,892,857 (6,549,814–7,352,226) and HS were 3,366,175 (3,199,978–3,543,213).^[2] Both developing and developed nations registered increase in the age-specific prevalence rate for stroke though the increase was more in developed nation 577.6/100,000 in 2013 from 472.7/100,000 in 1990 as compared to developing nation 156.0/100,000 people in 2013 from 155.4 (148.6–161.5)/100000 in 1990.

In India, crude prevalence rate of stroke in various studies has been reported as 1.27–2.20/1000 persons with the only exceptions in Parsi community, who showed dramatically high prevalence of 8.42/1000 persons. The difference in the rates given by various studies might be due to either

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Singla S, Singla R. Stroke in India: Bio-socioeconomic determinants. *J Soc Health Diabetes* 2016;4:71-6.

Access this article online

Quick Response Code:



Website:
www.joshd.net

DOI:
10.4103/2321-0656.187993

Corresponding Author: Dr. Sweta Singla, Kalpavriksh Superspeciality Center, Plot No. 66, Sector 12A, Dwarka, New Delhi - 110 075, India.
E-mail: drsweta79@gmail.com

different population composition, different cultures, or different age distribution in various communities. Age standardization according to the US populations revealed a higher prevalence rate as 2.44–4.24/1000 persons.^[3]

In India, various stroke centers maintain stroke registries and have helped in formulating a standard way of collecting more information about stroke patients in recent years. Few of these have reported similar annual incidence rate (AIR) with a Kolkata study suggesting 123.15/100,000 (men, 99.54/100,000; women, 149.49/100,000) persons per year (95% confidence interval [CI], 102.46–232.50; with age-standardized rate to the World standard population as, 145.30; 95% CI, 120.39–174.74). The Mumbai stroke center reported AIR of 148/100,000 persons (95% CI, 120–170; age-standardized to the Segi's 1996 world population, the AIR was 154/100,000). Trivandrum study suggested slightly lower incidence with age-standardized AIRs per 100,000 as 135 (95% CI, 123–146) for total, 135 (95% CI, 122–148) for urban, and 138 (95% CI, 112–164) for rural populations. Indian Incidence rates were more similar figures from Chinese studies as compared to Western studies.^[3] Gender-wise, the crude prevalence, and age-adjusted rates of stroke were higher in men in rural Kashmir (187 and 334/100,000) compared to women (94 and 175/100,000). In Eastern India, a Kolkata study reported age-adjusted prevalence rate to be 3 times higher in women compared to men (men -196 and women - 564/100,000 population), which was implicated to poorly controlled hypertension in women.^[4]

However, despite these figures, other stroke registries need to report their data and collaborate with other centers to find the actual picture of the epidemiology of stroke in more organized manner. Only then would we be able to go local and customize Stroke Care Programs according to the needs of that region.

RISK FACTORS PERTINENT TO INDIAN SCENARIO

Bio-socioeconomics of stroke in India

India with its culturally and economically diverse populations presents a unique scenario where the risk factors in one region might not play an important role in other regions. Indian lifestyle with a carbohydrate-rich predominantly vegetarian diet and a sedentary lifestyle, especially in urban areas might be contributing to high prevalence of metabolic syndrome which further predisposes to atherosclerotic diseases.

Indians as a race have stroke at a younger age. A New Jersey-based study made it more apparent by comparing Indian Americans with white Americans. The mean age in Indian Americans to have a stroke was 64 ± 10 years, whereas it was 71 ± 13 years for white Americans in a scenario that was similar for both the races without any confounding biases caused by environmental factors that are found when different studies are compared. Stroke risk factors were also different in both the groups. Stroke was found to be associated with higher incidence of coexisting diabetes, hypertension, and physical inactivity were more common risk factors in Indian Americans, whereas smoking, atrial fibrillation, and atherosclerosis were more prevalent in White American stroke patients. Indians were found to have more of small vessel disease as compared to large vessel occlusion in whites.^[5] Is the difference in stroke predisposition entirely due to lifestyle or is there a genetic component to this risk is not known completely. A number of studies have tried implicating different genes in the etiology of stroke in Indian population. At present, limited data are available, and genome-wide studies are being planned for further clarity on this subject. Various genes of interest that have a positive association with stroke are the CC genotype of PDE4D (SNP 83T/C), MTHFR C677T, FVL G1691A polymorphism, IL101082 G/A, interferon gamma + 874A/T polymorphism, the ADRB2 Gln27Glu, and ADRB1 Ser49Gly polymorphisms. An exome genotyping study on stroke is presently going on at AIIMS, Delhi, and its results may shed further light on the genetic profiling of the stroke patients.^[6,7]

In affluent India, the pattern of risk factors predisposing to stroke is more or less is similar to Western risk profile. Most of the previous studies done to evaluate what predisposes us to have a stroke have revealed that the established risk factors such as diabetes mellitus, hypertension, and tobacco either as smoking or in the chewable form are no doubt the biggest culprit in stroke causation. Moreover, low hemoglobin was another important risk factors contributing to IS in Indian population. Stroke studies in all age patients (including young stroke) also implicated electrocardiogram abnormality, heart disease of any type, smoking, and alcohol in addition to above factors. In Northern India, low high-density lipoprotein (HDL) and elevated low-density lipoprotein: HDL ratio was observed leading to stroke. Low consumption of fruits and vegetables, sedentary lifestyles, and psychological stress were also found to be contributory factors. Similar results were found in Southern India in young stroke patients with smoking, elevated systolic blood pressure, diabetes, and lower HDL cholesterol as important risk factors.

Three or more metabolic syndrome components were associated strongly with stroke compared with hospital and community controls.^[3] However, how the unique factors in nonaffluent India affect the risk factor profile has not been properly studied. How higher prevalence of infectious diseases such as HIV, Fungal infections, tuberculosis, malaria including cerebral malaria and other infections affects the stroke prevalence rate in India needs to be studied. Furthermore, fetal and early childhood malnutrition leading to the metabolic syndrome and its consequences should be evaluated *per se* from stroke predisposition point of view.^[7] Various other factors such as sedentary lifestyle, smoking with unique smoking habits such as smoking hukka, using nicotine paste, and chewing tobacco need to be evaluated. Tobacco consumption is common in lower socioeconomic strata, and less educated persons are 2.69 times more likely to consume tobacco.^[8]

Studies on the potential triggering factors of stroke have focused on 12 important triggers, namely, alcohol abuse, clinical infection/inflammation, stressful life events, psychological distress, birthday, positive or negative emotions, anger, sudden posture change in response to a startling event, heavy physical exertion, heavy eating, and recreational drug abuse.^[9] In Urban North Indian population, psychological stress (17.6%), acute alcohol abuse (10.7%), and clinical infections (8.3%) were the most common triggers.^[10] In Northwest India, 73% stroke patients reported exposure to at least one potential triggering factor during the 2 h period before onset of stroke symptoms out of which 66% reported at least one of these triggers: Exposure to anger, sudden change in posture, or negative emotions.^[11]

Some studies have shown an association between atherosclerosis or cardiac disease and past infection with *Chlamydia pneumoniae* with few studies showing a rise in *C. pneumoniae* immunoglobulin A (IgA) and (IgG) antibodies in stroke patients, raising the possibility that infection-related immune reaction is the trigger for acute stroke.^[12]

Vegan lifestyle is way of life in India where a large number of people are strictly vegetarians due to religious reasons. This may be leading to folate and cobalamin deficiency and subsequently to high homocysteine levels. A report from AIIMS suggests that even among apparently healthy Asians showed mean homocysteine levels in the range of 18–23.9 $\mu\text{mol/L}$, which is on the higher side.^[13] The higher mean homocysteine level in Indian population has implication in its being a stroke risk factor as has been shown in a study by Modi *et al.*^[14]

India, with its vast population and limited health resources, has been suffering with poverty as one of the important social diseases. With poverty, comes the burden of the prolonged morbidity due to poorly managed illnesses. The prevalence of the infectious diseases is higher, and NCDs take a backtrack because of the lower emphasis given to them. Moreover, stroke is a disease, which not only affects an individual but also affects the family. The younger onset of stroke in India means that many a times the sole earning support of the family gets affected and the rest of the family is also financially affected. Apart from the financial burden and no state support facilities, the caregiver to the patients also has to undergo physical trauma and mental stress while taking care of stroke patients. In an eastern Indian study, increased workload, related anxiety and depression, and sleep disturbance were reported by 70%, 76%, and 43% of caregivers of the stroke patients, respectively. A significant majority (80%) of caregivers also reported financial worry, which was greater among slum dwellers and less educated families.^[15] Apart from bearing the financial burden of the stroke, the whole family struggles to meet with its life goals with a huge drain on physical and emotional energy. Due to dearth of medical manpower, post stroke care training and support are not available to family members. This worsens the outcome of stroke. Expensive therapy of associated comorbidities like diabetes and dyslipidemia add to the financial burden of illness.^[16]

Psychosocial aspects specific for stroke care

Lack of awareness about the symptoms and the possibility that these symptoms can be reversed with early stroke care plays a vital role in preventing these patients to report directly to higher centers. Many of these patients may also report to quacks for evaluation, which are more numerous, ill-equipped to handle these patients, but perhaps are more accessible to general population than organized health care.

Poverty

Nonaffordability of the stroke care and expensive evaluation is also a problem in India where the per capita income is very low, and majority of the patients depend on state- or government-aided facilities for evaluation. Government tertiary care centers are few and overburdened. Very few patients subscribe medical insurances (<10%).^[8] The cost of stroke evaluation including the cost of magnetic resonance imaging brain, magnetic resonance angiography, echo, and carotid Doppler [Table 1] apart from the blood investigations that are needed to take care and evaluate stroke patients is out of reach of those below poverty line and especially when the definition of poverty incorporates

Table 1: Stroke care in India in a nutshell

Stroke care In India	
Indian population (WHO, 2015)*	1.3 billion
Stroke PR ^[3]	1.27-2.20/1000 persons
Age-standardized PR (US population) ^[3]	2.44-4.24/1000 persons
Stroke incidence rate (/100,000) ^[3]	Kolkata: 123.15 Mumbai: 148 Trivandrum: 135 50
Stroke care units ^[16]	50
Cost of stroke evaluation: Varies from 10,000 to 20,000 [†]	
Cost of NCCT head	Approximately Rs. 1500-2500
Cost of MRI brain	Approximately Rs. 5000-6000
Cost of echo	Approximately Rs. 1000-2000
Cost of holter	Approximately Rs. 1000-4000
Cost of carotid Doppler	Approximately Rs. 1800-2500
Approximate cost of blood investigations (CBC, LFT, KFT, lipid profile, HbA 1c, homocysteine)	Varies as per region
Cost of injection actilyse (for thrombolysis) ^[7]	Rs. 55,000
Approximate cost of secondary prevention of stroke (antihypertensive, antiplatelet, statin) ^[7]	Rs. 500/month

*Date accessed from <http://www.who.int/gho/countries/ind.pdf?ua=1>, [†]Cost quoted after searching for cost price in Delhi NCR on online platforms like Mediffee.com. PR: Prevalence rate; MRI: Magnetic resonance imaging; CBC: Complete blood count; KFT: Kidney function test; LFT: Liver function tests; HbA 1c: Hemoglobin A 1c; NCCT: Noncontrast computed tomography; NCR: National capital region

fulfillment of only the basic need of food and does not take into consideration the other basic needs such as shelter, clothes, health, and education.^[7] With limited health facilities, both state-owned and private and poor affordability, struggling literacy rate and poor knowledge about diseases in general, a lot needs to be done to make a comprehensive plan for stroke care.

Myths and misconceptions

There are various myths and misconceptions in the general population, especially in rural regions in India that affect the stroke care. In some parts of India, massaging a patient with pigeon's blood is supposed to heal paralysis.^[17] Whereas 7% of patients thought oil massage would improve stroke and another 3% believed in witchcraft, faith healing, homeopathic, or ayurvedic treatment (Alternative medicine) in Northwest India.^[7] Urban Areas are not totally spared, with people living in prominent cities in North India having similar beliefs. Popular treatment for stroke in Karnal, a prominent city in Haryana, is to visit Mai Devi Temple. Furthermore, with the prominent mindset that alternative medicines do not have any side effects, one of the authors occasionally encounters an educated patient who comes only for stroke workup and refuses management due to apparent side effects of allopathic medicine.

Poor status of women in socioeconomic culture – gender disparity

Gender differences in stroke show conflicting reports, if one tries to dive further into the subject. Various regions have reported different findings. Women have higher age-adjusted prevalence rate (564/100,000 for women versus 196/100,000 for men) and incidence rate (204/100,000 for women versus 36/100,000 for men) in Kolkata.^[18] Whereas in Mumbai registry, men had a higher stroke incidence rate than did women (crude incidence rate, 149/100,000 person-years for men vs. 141/100,000 person-years for women) and women patients were older (68.9 years) compared to men (63.4 years). Trivandrum stroke registry suggested higher crude incidence rate in women than in men (115/100,000 person-years for men and 119/100,000 person-years for women). The Bengaluru study also showed a greater preponderance among men (67%) with a male to female ratio of 2:1. The observed difference between age and gender and occurrence of stroke was statistically significant ($P < 0.01$).^[16] Reasons for gender disparities in stroke care in India could be multifactorial such as variation in culture, religion, and social customs. This could also be related to the greater importance of the society to men's health such as a tendency to preferentially spend resources on men's health care (who are usually the sole source of household income).

AVAILABILITY AND ACCESS TO STROKE CARE

Present scenario of stroke care

For a nation with the population of more than 1.2 billion population, there are only 100 centers that have facilities for intravenous thrombolysis and approximately 50 centers that can perform intra-arterial or mechanical thrombolysis. Most of these centers are in private health-care sector and in urban area, which poses and caters to a limited urban population. Even though stroke centers have been shown to improve the outcome in stroke patients with their multidisciplinary care but due to their expensive settings they push off the limited financial budgets of the hospitals in both private and government sectors and stroke care takes a backseat.^[8,16]

Barriers to stroke care

Various centers have tried evaluating factors that pose barriers to acute stroke care. One of the major factors that cause limitations of the availability of the acute care in stroke patients is lack of awareness of early stroke symptoms. Neither the patient nor the attendants were aware of the earliest symptoms of the stroke in a study done in Northwest India. Seventy-three percent of the

patients and their attendants misinterpreted symptoms and did not look for urgent care.^[19] In India where the two-thirds of population lives in villages do not have ready access to tertiary care health centers leave alone stroke units. First point of contact of these patients is either a local medical practitioner who could be following either allopathic medicine or one of the alternative medicines. The knowledge about stroke in these patients as well as local medical practitioners was very limited. A study done in South India revealed that only 69% were aware of the term stroke and further only 63% were able to list the symptoms. Barely, 58% knew that diabetes, smoking, and hypertension are risk factors for stroke. No participant was aware of the endovascular thrombolysis injection for better recovery from stroke and 23% of the participants did not think stroke is an emergency condition.^[20]

Stroke awareness is better in urban population as is seen in a study done in Eastern India. A population-based survey on knowledge, attitude, and practices was done in Kolkata, which is a major metropolitan and medical center in East India. Two hundred and eighty-two families were grouped as stroke-afflicted family (SAF) or non-SAF (NSAF) according to whether they had a stroke patient within themselves. Knowledge about stroke prevailed in 97% participants and was significantly higher in the SAF group. Both groups had better knowledge about prominent symptoms of stroke (loss of consciousness and paralysis) and admitted it as emergency situation requiring hospitalization and it being potentially preventable. Ironically, SAF group had lesser knowledge of the risk factors such as diabetes ($P < 0.001$), smoking ($P < 0.014$), alcoholism ($P < 0.0001$), family history ($P < 0.0001$), and mild stroke symptoms such as headache, ($P < 0.001$), vomiting ($P < 0.001$), and fits ($P = 0.003$) as compared to the NSAF group.^[21]

Even in regions where thrombolysis is available not all patients are able to benefit from the facility. In a study that was done in tertiary care center with a stroke unit in Bengaluru, 100 consecutive patients who were candidates for thrombolysis but were not thrombolysed for various reasons were evaluated. The biggest hurdle for early hospital presentation is failure of patients to recognize stroke (73%), followed by lack of neuroimaging facility (58%), nonaffordability (56%), failure of patient's relative to recognize stroke (38%), failure of the primary care physician to recognize stroke (21%), and transport problems (13%). Awareness of thrombolysis as a treatment modality for stroke was seen only in 2%. This underlines the fact that a vast number of cases goes unreported and most patients never contact doctors but alternative medical practitioners.^[22]

In India, the rehabilitation is mainly centered on physiotherapists. With 32800 physiotherapists registered in Indian Association of physiotherapists till 2011, 3000 occupational therapists registered in Indian Association of Occupational therapists till 2011, 1700 speech therapists registered in Indian Association of speech therapists, and 500 speech therapists registered in Rehabilitation Council of India, very few centers have organized in-hospital and outpatient rehabilitation facilities in the country. Further, dependence on massage by alternative practitioners hampers the rehabilitation process.^[16]

With limited number of neurologist and even fewer trained stroke specialists, there is a urgent need to train more people in stroke care. Moreover, this training should be imparted to anyone who is the first level of contact with these patients. Tier I cities usually have better facilities, so the focus should now shift to tier II and tier III cities, and all the doctors who work in emergency management should be encouraged to join stroke care workforce and should be encouraged to manage stroke in their respective regions.

Prevention of stroke – a public health responsibility: Campaigns under government initiative

Stroke being a major health-care problem needs urgent attention from the health-care policymakers. With stroke-associated mortality being 22 times that of infectious diseases such as malaria and tuberculosis, it has been suggested earlier too that importance of both primary and secondary prevention of stroke cannot be over emphasized. Moreover, with the present number of neurology services that are available in India with approximately 1300 neurologists throughout India, the only way the epidemic of the stroke can be fought would be with the help of the physicians who are available locally and first contact with these patients. With the training programs directed at physician level and with the help of the political will, basic stroke care programs may be started, which may spread education about this disabling problem apart from giving care to these patients. Programs in strokeology and stroke fellowships may be offered in selected centers and should be open to general physicians and emergency medicine specialists so that centers which do not have neurologists may also start managing stroke with confidence and optimally.^[23]

With the advent of the smartphone, the connectivity of the doctors to the experts has become easier and information can be shared easily and fast. Mobile applications have been developed and can be further bettered to help doctors in the periphery who can take guidance from the stroke

Table 2: Socioeconomic factors affecting stroke care

Cultural factors: Cultural beliefs, myths, and misconceptions
Poor awareness among people about stroke, its risk factors, symptoms, and management strategy
Gender difference in stroke care
Health resources: Suboptimal and not easily accessible
Poor affordability for the available health resources

specialists sitting in urban areas. New health applications such as “Care for Stroke” have been developed as an intervention to help stroke patients in their rehabilitation. Even though the application is presently not available to general population, development of similar applications may lead the way to provide expert stroke care in the remotest of regions.

As the stroke care is time sensitive and there is a window period for thrombolysis, the use of telemedicine to communicate with stroke experts and take appropriate decisions can be a boon for remote areas. Table 2 enumerates, in a nutshell, the barriers in stroke care. What is needed is an effort from multiple disciplines to come together as an organization or a forum to discuss how these barriers might be overcome and “Fight against Stroke” might be planned.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Available from: http://www.who.int/gho/ncd/mortality_morbidity/ [Last assessed on 2016 Jul 09].
- Feigin VL, Krishnamurthi RV, Parmar P, Norrving B, Mensah GA, Bennett DA, *et al.* Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. *Neuroepidemiology* 2015;45:161-76.
- Banerjee TK, Das SK. Fifty years of stroke researches in India. *Ann Indian Acad Neurol* 2016;19:1-8.
- Gourie-Devi M. Epidemiology of neurological disorders in India: Review of background, prevalence and incidence of epilepsy, stroke, Parkinson's disease and tremors. *Neurol India* 2014;62:588-98.
- Biswas M, Sen S, Jennifer Simmons BS. Etiology and risk factors of ischemic stroke in Indian-American patients from a hospital-based registry in New Jersey, USA. *Neurol Asia* 2009;14:81-6.
- Kumar A, Kumar P, Kathuria P, Misra S, Pandit AK, Chakravarty K, *et al.* Genetics of ischemic stroke: An Indian scenario. *Neurol India* 2016;64:29-37.
- Pandian JD, Srikanth V, Read SJ, Thrift AG. Poverty and stroke in India: A time to act. *Stroke* 2007;38:3063-9.
- Wasay M, Khatri IA, Kaul S. Stroke in South Asian countries. *Nat Rev Neurol* 2014;10:135-43.
- Guiraud V, Amor MB, Mas JL, Touzé E. Triggers of ischemic stroke: A systematic review. *Stroke* 2010;41:2669-77.
- Sharma A, Prasad K, Padma MV, Tripathi M, Bhatia R, Singh MB. Prevalence of triggering factors in acute stroke: Hospital based observational cross-sectional study. *J Stroke Cerebrovasc Dis* 2015;24:337-47.
- Razdan S, Pandita KK, Raina SK. Triggering risk factors for stroke: A case crossover study from a tertiary care hospital in Northwest India. *J Neurol Disord* 2013;1:101.
- Rai NK, Choudhary R, Bhatia R, Singh MB, Tripathi M, Prasad K, *et al.* *Chlamydia pneumoniae* seropositivity in adults with acute ischemic stroke: A case-control study. *Ann Indian Acad Neurol* 2011;14:93-7.
- Vikram NK, Pandev RM, Sharma R, Misra A. Hyperhomocysteinemia in healthy Asian Indians. *Am J Hematol* 2003;72:151-2.
- Modi M, Prabhakar S, Majumdar S, Khullar M, Lal V, Das CP. Hyperhomocysteinemia as a risk factor for ischemic stroke: An Indian scenario. *Neurol India* 2005;53:297-301.
- Das S, Hazra A, Ray BK, Ghosal M, Banerjee TK, Roy T, *et al.* Burden among stroke caregivers: Results of a community-based study from Kolkata, India. *Stroke* 2010;41:2965-8.
- Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. *J Stroke* 2013;15:128-34.
- Durai Pandian J, Padma V, Vijaya P, Sylaja PN, Murthy JM. Stroke and thrombolysis in developing countries. *Int J Stroke* 2007;2:17-26.
- Banerjee TK, Mukherjee CS, Sarkhel A. Stroke in the urban population of Calcutta – An epidemiological study. *Neuroepidemiology* 2001;20:201-7.
- Pandian JD, Kalra G, Jaison A, Deepak SS, Shamsher S, Singh Y, *et al.* Knowledge of stroke among stroke patients and their relatives in Northwest India. *Neurol India* 2006;54:152-6.
- Lakshmi K, Viswanath K, Ze CE, Sam Marconi D, David SN, Isaac R. Stroke care challenges in rural India: Awareness of causes, preventive measures and treatment options of stroke among the rural communities. *Ind J Comm Health* 2014;26:349-55.
- Das S, Hazra A, Ray BK, Ghosal M, Chaudhury A, Banerjee TK, *et al.* Knowledge, attitude, and practice in relation to stroke: A community-based study from Kolkata, West Bengal, India. *Ann Indian Acad Neurol* 2016;19:221-7.
- Badachi S, Mathew T, Prabhu A, Nadig R, Sarma GR. Hurdles in stroke thrombolysis: Experience from 100 consecutive ischemic stroke patients. *Ann Indian Acad Neurol* 2015;18:415-8.
- Mishra NK, Khadiolkar SV. Stroke program for India. *Ann Indian Acad Neurol* 2010;13:28-32.