A Prospective Community-Based Study of Stroke in Kolkata, India

Shyamal K. Das, DM; Tapas K. Banerjee, FRCP; Atanu Biswas, DM; Trishit Roy, DM; Deepak K. Raut, MD; Chandra S. Mukherjee, MRCPSych; Arijit Chaudhuri, PhD; Avijit Hazra, MD; Jayanta Roy, DM

Background and Purpose—Information on essential stroke parameters are lacking in India. This population-based study on stroke disorder was undertaken in the city of Kolkata, India, to determine the subtypes, prevalence, incidence, and case fatality rates of stroke.

Methods—This was a longitudinal descriptive study comprising 2-stage door-to-door survey of a stratified randomly selected sample of the city population, conducted twice per year for 2 successive years from March 2003 to February 2005.

Results—Out of the screened population of 52,377 (27,626 men, 24,751 women), the age standardized prevalence rate of stroke to world standard population is 545.10 (95% CI, 479.86 to 617.05) per 100,000 persons. The age standardized average annual incidence rate to world standard population of first-ever-in-a-lifetime stroke is 145.30 (95% CI, 120.39 to 174.74) per 100,000 persons per year. Thirty-day case fatality rate is 41.08% (95% CI, 30.66 to 53.80). Women have higher incidence and case fatality rates. Despite divergence on socioeconomic status between the slum and non-slum dwellers, stroke parameters were not significantly different.

Conclusion—The age standardized prevalence and incidence rates of stroke in this study are similar to or higher than many Western nations. The overall case fatality rate is among the highest category of stroke fatality in the world. The women have higher incidence and case fatality rates compared with men. (Stroke. 2007;38:906-910.)

Key Words: case fatality ■ epidemiology ■ incidence ■ prevalence ■ stroke

Studies on stroke epidemiology about incidence, prevalence, and case fatality have mostly been conducted among the developed nations. However, the future burden of stroke is likely to increase in the developing countries because of increasing prevalence of hypertension, fast-changing lifestyles, and population restructuring.

In India, during the past decade, the crude prevalence rates of stroke were between 136 and 220 per 100,000. In some studies, the age-standardized prevalence rates varied between 250 and 350 per 100,000, except one study from the Parsi population whose demographic profile was distinct from that of the national mainstream. Low prevalence rate of the stroke survivors as compared with whites and Asians could be caused by either low incidence rate or high case fatality rate.

Over the past few decades, demographic shift caused by increasing life expectancy resulted in a burgeoning aging population in India. The previous urban community-based studies had documented an age adjusted incidence rate of stroke from 13 in 1970 to 105 per 100,000 persons per year in 2001. A recent study has shown increasing prevalence of hypertension particularly among the urban subjects. Thus an increasing incidence of stroke caused by the combined challenges of demographic shift and increasing exposure to risk factor is expected. The previous community-based surveys from India were cross-sectional studies and deficient on information about important stroke parameters.

Hence, in the present study, we planned to determine the subtypes, prevalence, incidence, and case fatality rates of stroke in the city of Kolkata. This is intended to be the most comprehensive population-based survey of stroke in the country to date.

Materials and Methods

This was a longitudinal population-based descriptive study on stroke. Kolkata (erstwhile Calcutta) is the largest city in eastern India, with an area of 185 km² and 4.85 million inhabitants. It is under the jurisdiction of Kolkata Municipal Corporation, our survey area. We utilized the method of stratified random sampling. The area is divided into 5200 blocks, demarcated by the National Sample Survey Organization. Therefore, complete data for each block including geographical locations, boundaries, types of housing, and slum areas therein are available. Based on this...
information, the city was divided into six strata (strata I, slum area; strata II to VI, nonslum areas). From each stratum, nearly equal numbers of blocks were selected using the table of statistical random numbers. From each block, 50% of the households were surveyed by visiting the alternate houses. Thus a total of 166 blocks were covered which enabled screening of 52,377 subjects.

The survey team was composed of four field workers headed by a neurologist. This study was conducted twice every year for 2 consecutive years from March 1, 2003 through February 28, 2005, for a total of 4 assessments over the study period with the same screening questionnaire. In the first stage, field workers performed door-to-door survey with the help of a general screening questionnaire published earlier, which consisted of 3 parts: part I, the demographic details; part II, the screening questionnaires; and part III, detail about onset, number of attack, side affected, associated systemic disease and risk factors, past, family and personal history, with a schema of examination and recording of the investigative findings such as CT scan, if available. In the second stage, neurologists clinically examined the screened positive cases at their residences and recorded the clinical details. Barthel index was applied to evaluate their disability status. The index cases and their next of kin were sources of information and the old medical reports including cerebral CT plates under their personal possession, if available, were carefully reviewed. Customarily, patients had to pay for the CT scan. The cases with diagnostic dilemma (<1% of total) were personally examined by senior neurologists (S.K.D., T.K.B.) in the field.

The field workers also collected information on death caused by stroke: dates of stroke onset and that of death were noted. Later the neurologist visited each of those families and obtained eyewitness accounts of the clinical events and reviewed the relevant clinical records including the death certificates if available. Death certificates were available in less than one-tenth of the cases either because of lack of preservation and misplacement by the family members or deficient in information on the type of stroke. Neurologist also kept a note of the false-negative cases from randomly chosen 10% of the screened negative subjects in all the blocks and these cases were used in the calculation of the weighted prevalence rate of stroke on the whole sample population (vide “statistical analysis”).

Quality Control
Initially, a pilot survey of stroke was conducted on 3041 community subjects. All the screened positive and negative participants were reevaluated by the neurologist, and specificity and sensitivity of the screening instrument was determined as described earlier. The screening instrument was found to have a sensitivity of 83.3% and specificity of 99.9%. The institute’s ethics committee approved the project.

Operational Definitions
Stroke was defined as rapidly developing clinical sign of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or more or leading to death, with no apparent cause other than vascular origin. Cases of transient ischemic attacks were excluded.

Prevalence rate (PR) computed in this study was the period prevalence rate of stroke survivors in the first 12 month period of the survey. It included the old cases before March, 2003 and the new surviving cases between March 2003 and February 2004.

First-ever strokes were defined as clinical strokes that occurred in patients without any prior stroke event.

Average annual incidence rate (AIR) indicated the rate of occurrence of first-ever-in-a-lifetime stroke per 100,000 persons per year. It included the new cases between March 2003 and February 2005.

To assess 30-day case fatality rate, death that occurred within 30 days from onset of incident stroke within the study period was noted.

Cerebral infarction was defined as an area of low attenuation or a normal appearance in the vascular territory on CT scan that corresponded to the recent symptoms and signs when performed within 1 month.

Intracerebral hemorrhage (ICH) was defined as an area of hyperdensity within the brain parenchyma on CT scan with or without extension into ventricles or subarachnoid space or, for scans performed beyond 1 week, an area of attenuation with ring enhancement after contrast injection.

Statistical Analysis
To compare the data of the prevalence and incidence rates with that of other nations, direct age standardization was undertaken to world standard population, European population, and USA 2000 population (US Census Bureau). The 95% CI of the prevalence, incidence, and case fatality rates of stroke were calculated assuming a Poisson distribution for the observed cases. Prevalence was expressed as cases per 100,000 persons. Annual incidence rate was expressed as cases per 100,000 persons per year. Weighted prevalence was derived from the formula: N/(n+10 n)/X, where N=number of cases in primary survey, n=number of false-negative cases detected on resurvey of 10% of the negative samples, and X represents number of sample population. The x² test was applied to find out any difference about various demographic parameters of the slum and nonslum dwellers.

Results
A total of 52,377 subjects (27,626 men, 24,751 women) living in 11,734 households was screened. However, 1.61% households could not be interviewed because of either refusal or unavailability, despite repeated attempts. The overall literacy rate was 81%. The average family size was 4.46 persons. The age and gender distribution of the sample population matched with that of Kolkata population (census India, 2001).

Table 1 shows proportionally higher education and income group in the nonslum population than slum population, but the slum dwellers have higher prevalence, and incidence rates of stroke with lower case fatality rates, although not statistically significant. The age and sex distribution of screened population along with the age and sex specific prevalence and the average annual incidence rates are shown in Table 2.

PR
A total of 247 persons (men 137, women 110) were found to have had stroke on primary survey. Overall crude and sex specific PR (per 100,000 with 95% CI) are 471.58 (414.99 to 533.83), 495.91 (415.06 to 586.15) among men, and 444.43 (364.43 to 535.98) among women. When age standardized to world standard population, overall PR is 545.10 (479.68 to 617.05). The age-specific PR for both the genders are tabulated based on their age during survey and showed progressive increase in prevalence with advancement of age up to the eighth decade followed by decline (Table 2). An additional 8 cases of stroke were found during re-screening process of 10% of the negative sample from all blocks; based on that data, weighted PR is estimated as 624.32 (n=129; 95% CI, 555.64 to 699.24). Evidence of hypertension (≥140/90 mm Hg) is present in 79% of affected subjects. Out of the total cases, 15% persons had recurrent stroke. Twenty cases (8.8%) had their first ever stroke onset before age 40 years. One hundred forty-five (57%) stroke survivors are living independently in the community, whereas 40 (15.7%) are fully dependant on their caregivers for existence.

AIR
The AIR (per 100,000 persons per year with 95% CI) over a 2-year period is 123.15 (102.46 to 232.50), and is higher
TABLE 1. Basic Demographic Features, Prevalence, Incidence, and Case Fatality Rates in Slum and Nonslum Areas

<table>
<thead>
<tr>
<th>Features</th>
<th>Slum Areas (Strata I)</th>
<th>Non-slum Areas (Strata II to VI)</th>
<th>$\chi^2$ P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>11 005 (21%)</td>
<td>41 372 (79%)</td>
<td>NS</td>
</tr>
<tr>
<td>Men</td>
<td>5839 (53.05%)</td>
<td>21 787 (52.66%)</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>5166 (46.94%)</td>
<td>19 585 (47.34%)</td>
<td></td>
</tr>
<tr>
<td>Total families</td>
<td>2321</td>
<td>9413</td>
<td>NS</td>
</tr>
<tr>
<td>Age range (≥60 years)</td>
<td>1223 (11.11%)</td>
<td>7032 (17%)</td>
<td>$P&lt;0.001^*$</td>
</tr>
<tr>
<td>Occupation of earning members</td>
<td></td>
<td></td>
<td>$P&lt;0.001^*$</td>
</tr>
<tr>
<td>Manual</td>
<td>2798 (25.42%)</td>
<td>22 153 (53.5%)</td>
<td></td>
</tr>
<tr>
<td>Nonmanual</td>
<td>1651 (15%)</td>
<td>7032 (17%)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>$P&lt;0.001^*$</td>
</tr>
<tr>
<td>Primary (standard I to X)</td>
<td>7268 (66%)</td>
<td>4207 (10.17%)</td>
<td></td>
</tr>
<tr>
<td>Higher (standard XI and higher)</td>
<td>1651 (15%)</td>
<td>22 135 (53.5%)</td>
<td></td>
</tr>
<tr>
<td>Income (per family per month)</td>
<td></td>
<td></td>
<td>$P&lt;0.001^*$</td>
</tr>
<tr>
<td>&lt; Rs 2500 ($US 56)</td>
<td>252 (10.86%)</td>
<td>1232 (13.08%)</td>
<td></td>
</tr>
<tr>
<td>Rs 2500–5000 ($US 56–111)</td>
<td>1850 (79.70%)</td>
<td>5729 (60.86%)</td>
<td></td>
</tr>
<tr>
<td>&gt; Rs 5000 ($US 111)</td>
<td>219 (9.44%)</td>
<td>2537 (26.95%)</td>
<td></td>
</tr>
<tr>
<td>No. of NSSO blocks selected for study</td>
<td>31/727 (4.26%)</td>
<td>135/4493 (3.00%)</td>
<td>NS</td>
</tr>
<tr>
<td>Prevalent cases of stroke and prevalence rate per 100 000 persons</td>
<td>57 and 517.95 (395.19–667.12)</td>
<td>190 and 459.24 (396.32–530.72)</td>
<td>NS</td>
</tr>
<tr>
<td>Incident cases and average annual incidence rates per 100 000 persons per year (95% CI)</td>
<td>29 and 131.76 (88.94–188.15)</td>
<td>100 and 120.85 (98.37–146.95)</td>
<td>NS</td>
</tr>
<tr>
<td>Case fatality rate (%) 95% CI</td>
<td>9 and 31.03% (14.25–58.89)</td>
<td>44 and 44% (31.77–59.18)</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS indicates not significant; NSSO, National Sample Survey Organization, India (the municipal area of Kolkata comprises a total of 5200 NSSO blocks).

In the education category, primary education included all individuals starting from those who could sign and read, up to those who studied until 10th grade standard. Higher education encompassed those who studied until 11th grade standard or beyond. For nonmanual occupation, children, housewives, and retired person have been excluded.

among women (149.49; 117.49 to 167.60) than men (99.54; 74.85 to 129.70). When age is standardized to world standard population, AIR (95% CI) becomes 145.30 (120.39 to 174.74) and age and sex standardized rates show 117.08 (87.81 to 152.56) among men and 178.01 (102.40 to 223.22) among women. When standardized to European population and US 2000 population, AIRs (95% CI) become 190.49 (157.54 to 228.06) and 215.53 (177.06 to 257.00), respectively. Overall age- and sex-specific average AIR shows progressive increment from seventh decade onward (Table 2).

**Case Fatality Rate**

A total of 53 subjects (men, 21; women, 32) died within 30 days. Thus, the 30-day case fatality rate was 41.08% (95% CI, 31.03% to 51.03%).

TABLE 2. Showing the Demography of the Sample Population, Prevalence, and Average Annual Incidence Rates

<table>
<thead>
<tr>
<th>Age Range, years</th>
<th>Population</th>
<th>PR*</th>
<th>AIR†</th>
<th>Population</th>
<th>PR*</th>
<th>AIR†</th>
<th>Population</th>
<th>PR*</th>
<th>AIR†</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>18 570</td>
<td>26.92</td>
<td>8.07</td>
<td>16 908</td>
<td>17.74</td>
<td>0</td>
<td>35 478</td>
<td>22.54</td>
<td>8.07</td>
</tr>
<tr>
<td>40–44</td>
<td>1965</td>
<td>203.56</td>
<td>25.44</td>
<td>1689</td>
<td>118.41</td>
<td>59.21</td>
<td>3654</td>
<td>164.20</td>
<td>9.05</td>
</tr>
<tr>
<td>45–49</td>
<td>2042</td>
<td>342.80</td>
<td>122.43</td>
<td>1601</td>
<td>437.23</td>
<td>62.46</td>
<td>3643</td>
<td>384.30</td>
<td>14.07</td>
</tr>
<tr>
<td>50–54</td>
<td>2148</td>
<td>961.54</td>
<td>160.26</td>
<td>1042</td>
<td>959.69</td>
<td>527.83</td>
<td>2290</td>
<td>960.70</td>
<td>21.57</td>
</tr>
<tr>
<td>55–59</td>
<td>1029</td>
<td>1166.18</td>
<td>97.18</td>
<td>853</td>
<td>1289.57</td>
<td>462.93</td>
<td>1882</td>
<td>1221.10</td>
<td>23.56</td>
</tr>
<tr>
<td>60–64</td>
<td>920</td>
<td>2173.91</td>
<td>271.73</td>
<td>891</td>
<td>1571.27</td>
<td>392.82</td>
<td>1811</td>
<td>1877.42</td>
<td>30.30</td>
</tr>
<tr>
<td>65–69</td>
<td>662</td>
<td>2416.92</td>
<td>604.23</td>
<td>664</td>
<td>2259.04</td>
<td>677.71</td>
<td>1326</td>
<td>2337.86</td>
<td>30.13</td>
</tr>
<tr>
<td>70–74</td>
<td>579</td>
<td>5872.19</td>
<td>690.85</td>
<td>538</td>
<td>3717.47</td>
<td>1022.30</td>
<td>1117</td>
<td>4834.38</td>
<td>52.00</td>
</tr>
<tr>
<td>75–79</td>
<td>302</td>
<td>4304.64</td>
<td>1158.94</td>
<td>236</td>
<td>7203.39</td>
<td>1906.78</td>
<td>518</td>
<td>5576.21</td>
<td>32.00</td>
</tr>
<tr>
<td>80 and older</td>
<td>309</td>
<td>5825.24</td>
<td>1941.75</td>
<td>329</td>
<td>4559.27</td>
<td>2279.63</td>
<td>638</td>
<td>5172.41</td>
<td>31.00</td>
</tr>
<tr>
<td>Total</td>
<td>27 626</td>
<td>495.90</td>
<td>99.54</td>
<td>24 751</td>
<td>149.49</td>
<td>74.85</td>
<td>52 377</td>
<td>415.06</td>
<td>53.83</td>
</tr>
</tbody>
</table>

95% CI 141.06–586.15 74.85–129.70 364.04–535.98 117.49–167.60 414.99–533.83 102.46–232.50

AIR indicates average annual incidence rate per 100 000 persons per year; PR, prevalence rate per 100 000 persons.

*N in parentheses represents the prevalent cases.

†Numbers in parentheses represent the incident cases over 2 years.
30.66 to 53.80) and greater for women (43.24%; 95% CI, 29.55 to 61.04) than men (38.18%; 95% CI, 23.61 to 58.48). Most deaths (86%) occurred after 50 years of age.

**Stroke Subtypes**

Because several cases had >1 stroke event, total number of stroke events among sampled stroke survivors was 323 (217 patients had a single attack and 38 cases had ≥2 attacks). A total of 69% subjects had CT scan report and only 51.4% had performed it within 1 month. Based on CT scan, cerebral infarction was present in 108 and ICH was present in 58 episodes. Ratio of infarction: hemorrhage was 1.86. In ICH, basal ganglia–thalamic region was the most common site (75%), followed by lobar (12.5%), cerebellar (5%), brain stem (5%), and primary intraventricular region (2.5%). In infarction, the most common lesions (75.6%) were subcortical11 followed by cortex (19.8%), brain stem (2.3%), and cerebellum (2.3%).

**Discussion**

The ideal criteria for conducting a good epidemiological stroke study were followed.12

Compared with the earlier population-based studies on stroke from India,2–6 the present study shows a much higher prevalence rate of stroke, except that of Parsi population, which documented a very high rate (crude prevalence rate, 842.3/100 000), although the US standardized rate declined to 424/100 000 because of the predominantly aged subjects6.

The weighted PR calculated in this study shows higher value than crude PR because of inclusion of the false-negative cases from resurvey of 10% of the negative sample. If the screened negative cases are not assessed (wrongly assuming screen to be perfectly sensitive), prevalence would have been an underestimate. Considering the high specificity of screening instrument, difference in the rates could be caused by failure of reporting the stroke cases to the nonprofessional interviewers by the family members because of either unawareness about manifestation of stroke or concealment of information for privacy, and they might feel comfortable in divulging information only to the visiting doctor.

The prevalence and average annual incidence rates are age-standardized to world standard population to compare with the data of different countries. The age-standardized rates become higher because composition of our population has greater proportion of younger subjects. Age-standardized PR in this study is similar to or higher than those observed in many Western countries,1 even a developed nation in Asia.13

The standardized AIR (per 100 000 persons per year) to world standard population in this study is higher than that observed in USA (107.14 European countries (61 to 111),15–18 and Australia (99),19 although the designs of these studies are not all uniform. The average annual incidence rate in this study is similar to those reported from one of the cities of China (150),20 a developing country. Higher age-specific incidence of stroke, with disproportionately more among women, matches with the higher prevalence of hypertension among women in advanced ages.8

The overall 30-day case fatality rate in our survey is 41.08% (95% CI, 30.66 to 53.80), which is much higher than that observed in the developed nations (17% to 33%).14–17,19 Blacks in the Manhattan stroke study (38%)21 and the inhabitants of Tbilisi in Georgia (35.7%)18 reported similarly high stroke case fatality. Such high case fatality in our study might be related to the lack of the proper medical care. Higher 30-day case fatality rate of stroke among the women may be related to the poor attention paid to the women's health and delay in initiating treatment.22

The reason for stratum-based differences in stroke prevalence, incidence, and case fatality rates is difficult to explain, considering the small sample size (Table 1). Although the slum dwellers have lower educational and income status, differences in various stroke parameters are not statistically significant, indicating exposure to common risk factors such as hypertension.8

The small proportion of young stroke in this study is similar to the non-Indian studies.23 Previous hospital-based studies from India documenting a high proportion of young strokes, ranging between 15% and 30%, were biased because of a preferential admission policy.22

Availability of the reports of cerebral CT scan was useful in 51.4% of the stroke events, because it was performed within 4 weeks. Although the subtyping of the stroke cases based on available imaging showed a higher proportion of ICH, the definite conclusion could not be drawn because the number of cases with neuroimaging were inadequate; however, a report from the same city4 and a Chinese study had documented a high proportion of ICH.20

The present study shows higher prevalence rate of stroke compared with the previous Indian studies. This may be because of a combined effect of greater proportion of elderly population and increasing prevalence of hypertension.4,8,24 The majority of the stroke patients in our community were either ignorant of their hypertension or poorly compliant to antihypertensive medications.8 There were only a few studies in India that determined stroke incidence rate.4,7,24 However, those data of AIR were underestimates because incident cases that died of stroke before assessment were not considered. Therefore, it is difficult to comment on the trend of stroke disorder in India. To our knowledge, this is the first study that determined comprehensively the incidence and case fatality rates of stroke disorder in India, a fast-developing country.

This study, however, has certain limitations. The accuracy of data about age of the elderly population is questionable because there was no way to verify from birth certificates. Screening by nonprofessional workers has limitation because of missed cases. This is partly overcome by estimating the weighted prevalence rate as explained in the analysis section. Data on stroke death before assessment were entirely taken from the caregivers or family members, and because the imaging reports were not available in the majority, accurate subtyping of the death cases could not be performed. Lower case fatality rates among the slum dwellers indicate possible lack of proper reporting of the death cases.

**Conclusion**

This present study has shown that the prevalence and incidence rates of stroke disorder in India are similar to or higher than many other countries. There is probably a high propor-
tion of ICH and 30-day case fatality rate is substantial. Previous experience showed that the effective treatment of hypertension and the improvement of socioeconomic parameters had decreased the incidence of stroke and its mortality.\(^2\) Higher case fatality rate also indicates urgent need of updating of existing acute stroke care facility in India as well as public awareness about the availability of existing resources for optimum therapeutic benefit. Our study also emphasizes the need for the analysis of risk factors and undertaking necessary measures to meet future challenge of the stroke disorder in this country.

### Acknowledgments
The authors thank members of task force on neurology for useful suggestions, Nibedita Roy for secretarial assistance, and Surma Das for editorial assistance.

### Sources of Funding
We deeply thank Indian council of Medical Research, New Delhi (grant ICMR/SWG/NEUROLOGY/9/2001-NCD-I (2001-04360) for funding this project.

### Disclosures
A.B. and J.R. received salary as research associates from the research grant.

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Stroke. 2007;38:906-910; originally published online February 1, 2007;
doi: 10.1161/01.STR.0000258111.00319.58
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2007 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/38/3/906