Background and Purpose—Stroke is a leading cause of disability and death worldwide. In the absence of published population-based prevalence data, we investigated the prevalence and risk factors of stroke in a population of varying urbanization in Sri Lanka.

Methods—A population-based, cross-sectional study was conducted among 2313 adults aged ≥18 years residing in Colombo, selected using a multistage, probability proportionate-to-size, cluster sampling technique. Data were collected using an interviewer-administered questionnaire. Ever diagnosis of stroke was confirmed by medical doctors based on World Health Organization criteria and corroborated by documental evidence.

Results—Of the total population (52.4% women; mean age, 44.2 years; SD, 16.6), the prevalence of stroke was 10.4 per 1000 (95% confidence interval, 6.3–14.5) with a 2:1 male:female ratio. Beyond the age of 65 years, the prevalence was higher by 6-fold among men and by 2-fold among women. Ninety two percent had developed hemiparesis, 58.3% had dysphasia, and 16.7% had loss of balance. Hypertension was the commonest risk factor (62.5%) followed by smoking (45.8%), excess alcohol (41.7%), diabetes mellitus (33.3%), and transient ischemic attack (29.2%); 79.2%, predominantly men, had ≥2 risk factors. A percentage of 58.3 had brain computed tomographic scans, of whom 85.7% had ischemic strokes. A percentage of 64.3 had to change or give up working because of stroke-related disability.

Conclusions—Age-adjusted stroke prevalence in urban Sri Lanka lies between high-income and low-/middle-income countries. The prevalence of stroke and its risk factors were higher among men. (Stroke. 2015;46:00:00-00. DOI: 10.1161/STROKEAHA.115.010203.)

Key Words: prevalence ■ risk factors ■ Sri Lanka ■ stroke

Stoke has been ranked the second most common cause of death and the third most common cause of disability-adjusted life years lost worldwide. Overall, 71% of these stroke deaths and 78% of disability-adjusted life years lost occur in low- and middle-income countries. The South Asian region makes up >40% of the developing world and is thought to be the highest contributor to the global stroke mortality. However, apart for a few studies conducted in India, well-designed population-based stroke prevalence data from the South Asian region are scarce. Given the differences in population structures, level of education, cultural belief-based practices, and access to and availability of stroke-related health services between countries, data from one country are unlikely to accurately reflect the stroke prevalence in the region or that of another country in the same region. Population-based stroke epidemiology data are essential to develop effective stroke prevention, management, and rehabilitation strategies specific to each country and its population, as well as to plan effective global campaigns against stroke.

The burden of stroke in Sri Lanka is on the increase with the current demographic transition toward an ageing population. However, population-based stroke prevalence data are limited to a single unpublished study done in a suburban community before 2003. We aimed to determine the prevalence of stroke and its risk factors in an urban setting in Sri Lanka, which represents varying degrees of urbanization.

Methods

A population-based cross-sectional study was conducted in the district of Colombo, which is one of the 25 administrative divisions of Sri Lanka comprising 2.3 million inhabitants of diverse socioeconomic, ethnic, and religious backgrounds and has the highest population density of 3300/km². It includes the commercial capital of Sri Lanka that represents the most urban district in the country. Colombo is divided into 566 Grama Niladhari (GN) divisions, which are the smallest administrative units in a district. The GN divisions under the purview of Municipal or Urban Councils comprise the urban sector, whereas all other GN divisions comprise the suburban sector.
The study population included adults aged ≥18 years residing for ≥1 year in the district of Colombo. The sample size was determined as 2387 to detect an expected prevalence of stroke of 0.9% with 0.01 precision, 5% level of significance, design effect of 6 for a cluster size of 51 and ρ of 0.1, and 15% nonresponse. The study sample was selected using a multistage sampling technique from 46 GN divisions to obtain a cluster size of 51. In the first stage, the number of GN divisions to be selected from either the urban or suburban sector was determined proportionate to the population in each sector. Within each sector, the required number of GN divisions was selected using probability proportionate-to-size technique. In subsequent stages, 17 households (assuming 3 adults in each household) were selected as a cluster in each selected GN division. The first household in each cluster was selected randomly, whereas the others were taken consecutively from the first selected household. Data were collected over a period of 11 months.

A pretested, validated questionnaire (online-only Data Supplement) with both open- and close-ended questions in the local vernacular language (Sinhala and Tamil) was administered to the participants by trained preintern medical officers. We used the World Health Organization definition of stroke. Where available, data were corroborated by documental evidence (medical records, brain scan reports, and medication history) in addition to interviewing the participants and their carers.

**Results**

A total of 2313 people of 782 households were recruited for this study, giving a response rate of 96.9%. Of them, 52.4% were women. The mean age of participants was 44.2 years (SD, 16.6 years) with a median age of 42 years. They represented the adult population in Sri Lanka, with the majority in the age group of 18 to 44 years and only 12.8% in the age group of ≥65 years.

Age and sex-specific prevalence of stroke is shown in Figure. In the study population, 24 were identified with an acute stroke (5.63 per 1000 adults; 95% CI, 2.3–11.7). Among men, the highest prevalence was in the age group of 75+ years. The mean age of stroke victims was 64.3 years (SD, 16.6 years) with a median age of 62 years. They represented the adult population in Sri Lanka, with the majority in the age group of 18 to 44 years and only 12.8% in the age group of ≥65 years.

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**Discussion**

In this population-based study conducted in the most populous district in Sri Lanka, the prevalence of stroke was 10.4 per 1000 adults aged ≥18 years (95% CI, 6.3–14.5) with a 2:1 male:female ratio. When age adjusted, the prevalence of stroke in inhabitants aged ≥65 years was higher (37 per 1000 adults; 95% CI, 15.5–58.5) than that reported for rural and urban India and rural China but lower than that reported for urban China.10

Age remains the strongest nonmodifiable risk factor of stroke. All the stroke victims in our study were ≥45 years old, whereas the prevalence of stroke increased 6-fold among men and 2-fold among women aged ≥65 years. The mean age of stroke onset was marginally lower than that of regional countries (59 years in Pakistan; 63 years in India) and markedly lower than that of Western countries (68 years in the United States; 71 years in Italy).2 This disparity between the South Asian countries and Western countries probably reflects the differences in the prevalence of stroke risk factors and the access to healthcare.

One third of stroke victims reported a previous history of transient ischemic attack or stroke, whereas 84.2% had ≥2 risk factors. As expected, the prevalence of vascular risk factors among the stroke victims was higher than that of the general population (Table). Rapid urbanization leading to sedentary lifestyles is likely to increase the prevalence of conventional stroke risk factors. The magnitude of the effect of nonconventional stroke risk factors, such as central nervous system infections, substance abuse, and tobacco chewing, remains unknown because of the lack of relevant studies. Approximately 16% of Sri Lankans are known to use smokeless tobacco products.11

**Figure**. Age- and sex-specific prevalence of stroke among adults aged ≥18 years in the district of Colombo (prevalence of stroke among adults aged 18 to 44 years was zero and is not shown in the figure; 95% confidence intervals are indicated within parentheses).
Ours was a prevalence study, and we did not evaluate stroke-related physical or mental disability and care needs. However, we found that 2 of 3 stroke victims had to change occupation or give up working because of stroke-related disability.

The strengths of this study were many. Colombo being the commercial metropolis of Sri Lanka provided an ideal urban setting that is most vulnerable for accumulating stroke risk factors and unhealthy lifestyles. We further used a robust sampling technique to ensure that the study population represented adults exposed to varying degrees of urbanization. The use of trained preintern medical doctors as interviewers and the use of multiple sources in ascertaining the diagnosis of stroke improved the quality of our data. In Sri Lanka, medical notes (discharge summaries written in diagnosis cards, clinic notes written in clinic books, and prescriptions), investigations, and their reports are routinely given to patients for safe keeping, and therefore, they were accessible to the interviewer. Stroke was only coded if symptoms had persisted for ≥24 hours to exclude transient ischemic attack that is a common source of misclassification.12

The limitation of our study is that there is possibility that we may have missed paroxysmal atrial fibrillation among our stroke victims because longer duration ECG testing is not done routinely in the stroke work-up. Furthermore, we used a time-locked definition of stroke sans magnetic resonance imaging, which may have underestimated subclinical strokes.

Table. Demographic Characteristics, Clinical Presentations, and Stroke Risk Factors of Adults Aged ≥18 y With an Ever Diagnosis of Stroke

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients With Stroke in the Study*</th>
<th>Sri Lankan Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>64.7 (11.9)</td>
<td>61.6 (13.0)</td>
</tr>
<tr>
<td>Sinhalese ethnicity</td>
<td>15 (93.8)</td>
<td>8 (100.0)</td>
</tr>
<tr>
<td>Income &lt;Rs. 10 000 (USD 75)</td>
<td>13 (81.2)</td>
<td>4 (50.0)</td>
</tr>
<tr>
<td>Gave up job after stroke†</td>
<td>8 (66.7)</td>
<td>1 (50.0)</td>
</tr>
<tr>
<td>Stroke symptoms‡</td>
<td>Loss of strength/numbness in the face, arm, or leg on one side</td>
<td>14 (87.5)</td>
</tr>
<tr>
<td></td>
<td>Difficulty speaking or understanding</td>
<td>9 (66.2)</td>
</tr>
<tr>
<td></td>
<td>Blurring of vision, double vision or loss of vision/field</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td></td>
<td>Severe and unusual headache (worst-ever headache)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>Loss of balance</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>No. of symptoms</td>
<td>1</td>
<td>7 (43.8)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6 (37.5)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>Risk factors</td>
<td>TIA/past stroke§</td>
<td>7 (43.8)</td>
</tr>
<tr>
<td></td>
<td>Hypertension</td>
<td>10 (62.5)</td>
</tr>
<tr>
<td></td>
<td>Diabetes mellitus</td>
<td>5 (31.2)</td>
</tr>
<tr>
<td></td>
<td>Atrial fibrillation</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>HD</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td></td>
<td>Smoking§</td>
<td>11 (68.8)</td>
</tr>
<tr>
<td></td>
<td>Excess alcohol§</td>
<td>10 (62.5)</td>
</tr>
<tr>
<td></td>
<td>Family history of stroke</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td></td>
<td>Dyslipidemia</td>
<td>12.6†</td>
</tr>
<tr>
<td></td>
<td>Obesity</td>
<td>20.3 in men and 36.5 in women‡</td>
</tr>
<tr>
<td>≥2 risk factors§</td>
<td>16 (100)</td>
<td>3 (37.5)</td>
</tr>
<tr>
<td>Total</td>
<td>16 (100)</td>
<td>8 (100)</td>
</tr>
</tbody>
</table>

IHD indicates ischemic heart disease; NA, not available; and TIA, transient ischemic attack.

*Summarized in n (%) except age given in mean (SD).
†10 who were not used at the time of stroke were removed.
‡Sudden onset and lasting ≥24 h.
§Significant at P<0.01.
Conclusions
This is the first population-based study on stroke prevalence in an urban community that is highly vulnerable to stroke in Sri Lanka. These data may not represent the country as a whole because of regional differences in socioeconomic status and risk behaviors. Future studies should include participants from urban and rural communities from different parts of the country to improve external validity.

Disclosures
None.

References
Prevalence of Stroke and Its Risk Factors in Urban Sri Lanka: Population-Based Study
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SUPPLEMENTAL MATERIAL
Supplemental methods

**Stroke questionnaire**
There were two components in the interviewer-administered stroke questionnaire: Household identification and individual

**Household identification questionnaire:**
Age and sex of each current household member

**Individual questionnaire (in four parts):**
Diagnosis of stroke and stroke risk factors of participants was made by triangulation of several methods (history obtained using an interviewer-based-questionnaire and confirmed by perusal of documental evidence such as diagnosis cards issued by hospitals and general practitioners, brain scan reports, clinic follow-up records and drug prescription cards. In Sri Lanka, medical notes - discharge summaries written in ‘diagnosis cards’, clinic notes written in ‘clinic books’ and prescriptions; investigations and their reports are routinely given to patients for safe keeping and were therefore accessible to the interviewer).

**Part I: Demographic and socio-economic characteristics of participant**
- Age at last birthday, sex, ethnicity, current and previous occupations, reasons for change in occupation, monthly household income

**Part II: Diagnosis of stroke**
- Whether ‘ever experienced one or more of the following symptoms that was of sudden onset and lasted for more than 24 hours’
  - Loss of strength (weakness) and/or numbness of face, arm and/or leg on one side
  - Difficulty speaking or understanding
  - Blurring of vision, double vision, or loss of vision in one eye or part of the visual field
  - Severe and unusual headache (worst ever)
  - Loss of balance

If the answer is ‘yes’ to one or more symptoms,
- Whether the patient sought any treatment for his/her symptoms; if yes, what type of medical treatment (western, indigenous) was solicited and whether the patient was informed by the health-care personnel that the symptoms were representative of a stroke (corroborated from medical notes)
- Whether the patient had a brain scan; if yes, confirmation of stroke diagnosis and type by perusing the brain scan report

**Part III: Details of the stroke**
- Whether symptoms experienced were the first ever episode
- If not, the number of similar episodes experienced in the past (month and year of each episode) (confirmed by documental evidence)
Part IV: Risk factors of stroke

- Ever being informed/diagnosed by a medical personnel before or at the time of stroke diagnosis of having one or more of the following conditions: transient ischaemic attack, elevated blood pressure, diabetes mellitus, atrial fibrillation, ischaemic heart disease and heart attack/infarct (confirmed by documental evidence)
- Any family history of stroke; if yes, relationship and age of onset of stroke
- Tobacco use: cigarettes/ beedee/ cigars/ pipes/ chewed (smokeless tobacco): quantity and duration
- Alcohol consumption: quantity (units) and duration
- Physical activity: type and duration per day, per week and total duration