

Stroke Is the Leading Cause of Death in Rural Gadchiroli, India

A Prospective Community-Based Study

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Background and Purpose—Stroke is an important cause of death and disability worldwide. However, information on stroke deaths in rural India is scarce. To measure the mortality burden of stroke, we conducted a community-based study in a rural area of Gadchiroli, one of the most backward districts of India.

Methods—We prospectively collected information on all deaths from April 2011 to March 2013 and assigned causes of death using a well-validated verbal autopsy tool in a rural population of 94 154 individuals residing in 86 villages. Two trained physicians independently assigned the cause of death, and the disagreements were resolved by a third physician.

Results—Of 1599 deaths during the study period, 229 (14.3%) deaths were caused by stroke. Stroke was the most frequent cause of death. For those who died because of stroke, the mean age was 67.47 ± 11.8 years and 48.47% were women. Crude stroke mortality rate was 121.6 (95% confidence interval, 106.4–138.4), and age-standardized stroke mortality rate was 191.9 (95% confidence interval, 165.8–221.1) per 100 000 population. Of total stroke deaths, 87.3% stroke deaths occurred at home and 46.3% occurred within the first month from the onset of symptoms.

Conclusions—Stroke is the leading cause of death and accounted for 1 in 7 deaths in this rural community in Gadchiroli. There was high early mortality, and the mortality rate because of stroke was higher than that reported from previous studies from India. Stroke is emerging as a public health priority in rural India. (*Stroke*. 2015;46:1764-1768. DOI: 10.1161/STROKEAHA.115.008918.)

Key Words: India ■ mortality ■ rural population ■ stroke

The epidemiological transition from higher mortality caused by infectious diseases to that caused by chronic noncommunicable diseases has occurred in India, and chronic noncommunicable diseases have become the leading causes of death.¹ Among chronic noncommunicable diseases, stroke is the second leading cause of death and third leading cause of disability worldwide.^{2,3} In 2011, an estimated 6.2 million people had died because of stroke worldwide.⁴ The Global Burden of Disease Study conducted in 2010 found that the burden of stroke has increased in low- and in middle-income countries, and it is projected that by 2050, 80% of strokes will occur in these countries.^{5,6} About one sixth of the population of the world lives in India. However, the information on stroke burden from population-based studies in India is scarce and when available, it is predominantly from large urban centers.⁷ A majority ($\approx 70\%$) of population of India lives in rural areas and is at high risk of morbidity and mortality from stroke because of lack of knowledge about the risk factors and access to preventive and curative care. Hence, there is a need to evaluate the burden of stroke in rural areas

of India to design appropriate interventions to reduce the burden and then monitor their effect. Measuring cause-specific mortality caused by stroke is one of the important ways to monitor stroke burden. However, collecting reliable population level information on stroke mortality in rural communities remains challenging. Because of poor access to formal healthcare and reliance on complementary and alternative therapies for stroke,⁸ such information cannot be obtained from formal healthcare facilities such as the healthcare centers of the government healthcare system. Furthermore, a majority of deaths in rural India occur outside medical facilities.⁹ To address such challenges in developing countries, verbal autopsy tools have been developed to ascertain causes of death at the population level. In verbal autopsies, the cause of death is determined by trained physicians based on the description of symptoms and circumstances leading to death. The verbal autopsy-derived cause of death has been shown to be reliable for broader cause of death categories,¹⁰ and verbal autopsies have been used to determine stroke mortality in developing countries.^{11,12}

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In this community-based study, we measured mortality caused by stroke using a well-validated verbal autopsy tool in rural areas of Gadchiroli, one of the most backward districts of India. We also ascertained time to death from the onset of symptoms among those who succumbed to stroke.

Methods

Study Area

This study was conducted in Gadchiroli district of India (Figure 1), which is one of the most backward districts of India. It has a total population of 1072942.¹³ A majority (93%) of the population lives in 1679 villages of the district, and about one third (38.3%) of the population of the district is tribal.¹³ The per capita annual income is Rs 33504 (≈550 US dollars).¹⁴

Society for Education, Action and Research in Community Health (SEARCH) is a nongovernmental organization working in Gadchiroli district since 1986. It has a field practice area of 86 villages distributed in 3 administrative blocks (Gadchiroli, Armori, and Chamorshi) of the district (Figure 1), where trained community health workers of SEARCH regularly collect population-based information and provide healthcare for selected ailments to the villagers. SEARCH maintains a population register, and all the births and deaths are recorded.

Sample Size Calculation

We estimated the sample size for this study using the formula $n = \frac{DEFF \cdot Np(1-p)}{[(d^2/Z^2_{1-\alpha/2})(N-1) + p(1-p)]}$, where n is the sample size, $DEFF$ is the design effect, N is the population, p is the expected prevalence, d is the precision of the estimate, and Z is the statistic for a level of confidence. The maximum sample size needed to estimate the true mortality rate of stroke with a precision of $\pm 5\%$ at 95% confidence, considering a design effect of 1.5 was 576. In this study, we analyzed 1599 deaths that occurred between 2011 and 2013.

Data Collection

SEARCH has a mortality surveillance system in 86 villages, which records all deaths in the population by way of regular reporting by the community health workers who are the resident of the village. In addition, periodic house to house cross-surveys are conducted to account for any missing deaths. The information on the causes of all the deaths was collected prospectively using verbal autopsies between April 1, 2011, and March 31, 2013. The trained field supervisors of SEARCH visited the household, where a death has occurred within 2 weeks of death if the death has occurred in the field practice area

of SEARCH and within 4 weeks of death if the death has occurred outside the field area. Information on the circumstances that lead to death was collected using a verbal autopsy tool, which uses an open-ended narrative and a series of close-ended questions. This verbal autopsy tool has been validated in the Registrar General of India's Sample Registration System.¹⁵ The family members were asked to describe the symptoms and circumstances surrounding the death. The field supervisors also used a symptom checklist to obtain additional information on a given symptom.

Assigning Cause of Death

Trained physician coders read the verbal autopsies and assigned the underlying cause of death using the method developed by the Registrar General of India's Sample Registration System.¹⁶ A code was assigned to the cause of death using the World Health Organization's *International Classification of Diseases-Tenth Revision*. Each verbal autopsy was independently coded by 2 physician coders. If there was a disagreement between the coders about the *International Classification of Diseases-Tenth Revision* code assigned to the cause of death, the coders were provided the code assigned to the death by the other physician and were asked to reconcile the cause of death. If the 2 coders continued to disagree, a third senior coder adjudicated the cause of death. Stroke was defined according to the World Health Organization clinical definition as a focal (or at times global) neurological impairment of sudden onset, and lasting >24 hours (or leading to death), and of presumed vascular origin.¹⁷ In the *International Classification of Diseases-Tenth Revision*, stroke deaths can be coded using codes between I61–I69. Because of lack of access to imaging data, we used 2 broad categories: stroke (I-64; $n=107$) and sequelae of cerebrovascular disease (I-69; $n=122$) to code stroke deaths. The diagnosis of sequelae of cerebrovascular disease was made when the death has occurred >1 month after the onset of symptoms of stroke, and stroke was thought to be the underlying cause of death. The 2 coders agreed on the diagnostic code for the stroke deaths in 92% deaths and 8% verbal autopsies needed adjudication.

To obtain information on the time to death from the onset of symptoms of stroke, a physician (V.S.) read all the verbal autopsies of patients who died because of stroke and extracted this information from the verbal autopsies using a standardized data extraction tool.

Ethical Approval

The study was approved by the institutional ethical committee of SEARCH. Verbal consent was obtained from the relatives of the deceased patient, and this consent procedure was approved by the institutional ethical committee of SEARCH. The procedures followed were in accordance with the Helsinki Declaration of 1975, as revised in 2000.

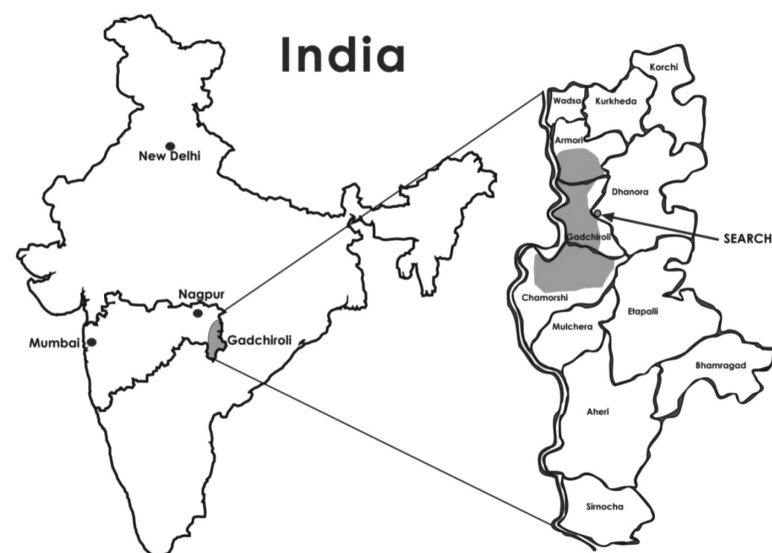


Figure 1. Study site.

Table 1. Total and Stroke Deaths

	Females	Males	Total
Total deaths, n (%)	730 (45.65)	869 (54.35)	1599 (100)
2 y population (person-years)	93 363	94 945	188 308
Crude mortality rate per 1000 population	7.8	9.2	8.5
Stroke deaths, n (%)	111 (48.47)	118 (51.53)	229 (100)
Cause-specific mortality fraction because of stroke, % (95% CI)	15.2 (12.8–18)	13.6 (11.5–16)	14.3 (12.7–16.1)
Mean age of those who died because of stroke (SD)	67.89 (11.26)	67.07 (12.26)	67.47 (11.8)
Crude stroke mortality rate per 100 000 population (95% CI)	118.9 (97.8–143.7)	124.3 (102.9–148.8)	121.6 (106.4–138.4)

CI indicates confidence interval.

Statistical Analysis

We calculated overall, sex-, and age-specific death rates by dividing the number of deaths by the population under surveillance between April 1, 2011, and March 31, 2013, and calculated yearly rates. Age-standardized rates were calculated using world standard population.¹⁸ The de jure method was used whereby only the deaths of the individuals who were resident of the 86 villages were used to calculate death rates. The cause-specific mortality fraction was calculated by dividing the numbers of deaths caused by stroke by the total number of deaths. Data were analyzed using statistical software Stata version 10 (College Station, TX).

Results

There were 1599 deaths between April 1, 2011, and March 31, 2013, over 188 308 person-years of observation. The crude death rate was 8.6 per 1000 population (Table 1).

There were 229 stroke deaths during the study period, which were almost equally distributed between women (48.5%) and men (51.5%). Stroke was the leading cause of deaths in this population and accounted for 14.1% of all deaths (Table 1). The crude stroke mortality rate was 121.6 (95% confidence interval, 106.4–138.4) per 100 000 person-years (Table 1). The age-standardized stroke mortality rate calculated using the world standard population was 191.9 (95% confidence interval, 165.8–221.1) per 100 000 person-years. The age-wise crude stroke mortality rates for women and men are shown in Table 2. The crude mortality rate because of stroke did not differ significantly between women and men. Of all stroke deaths, 55.4% occurred in those aged <70 years. The cause-specific mortality fraction because of stroke in various age groups is shown in Figure 2 and showed an increase after the age of 40 years.

Among those who died because of stroke, 106 (46.3%) died within 30 days of onset of symptoms (Table 3). The proportions of stroke deaths occurring within 30 days were comparable between women and men. Almost one third (31.4%) of the patients who died because of stroke died within the first week from the onset of symptoms of stroke (Table 3).

Among those who died because of stroke, 200 (87.3%) died at home, 24 (10.5%) died in hospitals, 4 (1.8%) died in transit while information on the place of death was not available on 1 (0.4%) death. The cause-specific mortality fraction because of stroke was significantly higher among nonhospital deaths than among hospital deaths (15.4% versus 9.1%; $P<0.01$). More women died at home than men (92.8% versus 82.2%; $P<0.05$), whereas more men died at hospital than

women (15.3% versus 5.4%; $P<0.05$). The distribution of various risk factors as reported by the family members of the deceased patients with stroke and the sensitivity analysis to determine the differences in the reporting of risk factors in hospital and nonhospital deaths are shown in Table 4.

Discussion

Stroke is the leading cause of death in this rural population in one of the most backward districts of India. 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 because of stroke in our study is higher than that from a study conducted in a rural region of Andhra Pradesh state of India in 2003 where the crude stroke mortality rate was 94.3 per 100 000 person-years, whereas in our study, it was $\approx 25\%$ higher and was 121.6 per 100 000 person-years.¹⁹ As expected, the crude stroke mortality rate in our study is also higher than those reported from urban areas of India. For example, in a study conducted in Chennai between 1995 to 1997,²⁰ the crude stroke mortality rates in the age group of 35 to 69 years in women and men were 62 and 89.1 per 100 000 person-years,

Table 2. Age-Wise Crude Stroke Mortality Rates

Age Group, y	Crude Stroke Mortality Rate/100 000 Person-Years		
	Women	Men	Total
<25	0.0	0.0	0.0
25–29	0.0	12.7	6.6
30–34	27.7	0.0	14.2
35–39	12.3	13.0	12.7
40–44	0.0	63.5	31.1
45–49	91.6	67.1	78.8
50–54	190.4	221.9	206.9
55–59	151.8	308.3	233.2
60–64	345.3	329.5	338.1
65–69	803.2	1023.8	905.0
70–74	1298.3	1162.0	1233.4
75–79	3075.5	2835.6	2965.8
80–84	1706.7	4410.4	2884.6
≥ 85	2678.6	3517.6	3073.3
Total	118.9	124.3	121.6

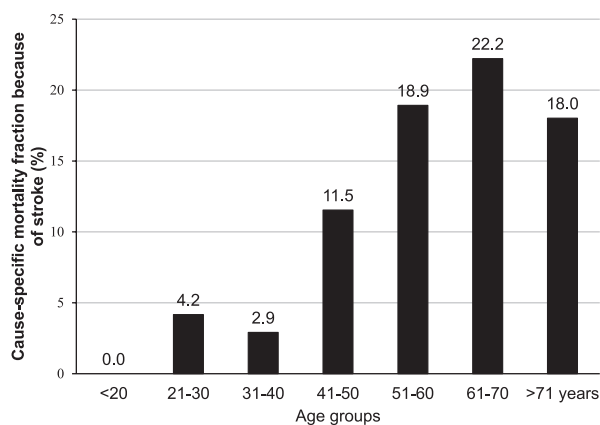


Figure 2. Age-wise cause-specific mortality fraction because of stroke.

respectively, whereas for the same age group, the mortality rates for women and men in our study were 153 and 189 per 100000 person-years, respectively. Similarly, in a study conducted in Bangalore in 2005,²¹ the crude stroke mortality rate was 32.6 per 100000 population and stroke accounted for 6% of all deaths. It is important to note that these studies were conducted 6 to 16 years before the current study, and it is possible that the stroke mortality rates have changed over time in these areas. The high age-standardized stroke mortality rate of 191.9 per 100000 population in our study is comparable with that seen in the countries with high-stroke mortality rates, such as China, Russia, and several countries in the African continent.²²

Of total deaths caused by stroke, about one third of deaths occurred within the first week and almost half of them occurred within the first month after the onset of symptoms of stroke, indicating high early mortality. Several studies from India have reported high early case fatality after stroke.²³⁻²⁵ As we did not follow up patients with stroke prospectively, we could not calculate the case fatality rate caused by stroke in this study, but our findings do indicate high early mortality. The high-stroke mortality rate and the early deaths caused by stroke in rural Gadchiroli could be because of lack of awareness about risk factors of stroke, local belief systems about care seeking, lack of access to preventive and timely as well as adequate curative care. It could be also because of higher occurrence of hemorrhagic stroke caused by uncontrolled hypertension, which is associated with high early mortality.

In India >75% deaths occur at home.⁹ In this study, we found that ≈90% of individuals who died because of stroke died at home, and the cause-specific mortality fraction because of stroke was significantly higher among nonhospital deaths (15.4%) than

Table 3. Time to Death From the Onset of Symptoms of Stroke

Time to Death From the Onset of Symptoms, n (%)	Total (n=229)		
	Women (n=111)	Men (n=118)	
≤30 d	45 (40.5)	61 (51.7)	106 (46.3)
<7 d	29 (26.1)	43 (36.4)	72 (31.4)
>30 d	65 (58.6)	57 (48.3)	122 (53.3)
Unclear from the narrative in the verbal autopsy	1 (0.9)	0 (0)	1 (0.4)

among hospital deaths (9.1%). This could be because of lack of healthcare facilities for stroke available in the district, higher expenses associated with hospital care, or low priority given to the healthcare of patients who have significant disability because of stroke. Furthermore, more women died at home compared with men and more men died in the hospital. Additional studies would be needed to determine the reasons for such differences in healthcare seeking, but 1 potential reason could be the higher priority given to the care of male patients.

Yusuf et al²⁶ 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) predominate. Our data suggest that rural Gadchiroli could be in this second stage of epidemiological transition. 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. Community-based interventions to treat hypertension have resulted in reduced stroke burden.^{27,28} Hypertension often remains undiagnosed, untreated, and uncontrolled in India.²⁹ In our study, only 40% of patients were diagnosed with hypertension before death. The prevalence of other reported risk factors, such as heart disease and diabetes mellitus was also low. This could be because of underdiagnosis from lack of access to formal healthcare. This is evident from the sensitivity analysis (Table 4), where the prevalence of these risk factors was higher among patients with stroke who died in hospital than those who died at other places. In addition, Gadchiroli being an economically underdeveloped district could be in the early phase of epidemiological transition, where the prevalence of these diseases is low.²⁶

The study has several strengths. This is a comprehensive study with collection of population-level data over 188308 person-years of follow-up from a well-defined population living in 86 villages. The death recording was near complete and was ensured through regular reporting and periodic cross-surveys. The data were collected prospectively using a well-validated verbal autopsy tool. Furthermore, the study was conducted in one of the most backward districts of India. However, there are also some limitations. The diagnosis of stroke was based on the verbal autopsy and not on hospital data. Also, as imaging is

Table 4. Prevalence of the Reported Risk Factors for Stroke and the Sensitivity Analysis for the Prevalence of Risk Factors in Stroke Deaths Inside and Outside Hospital

	Women	Men	Total		
	All Deaths (n=111)	All Deaths (n=118)	Hospital Deaths (n=23)	Nonhospital Deaths (n=206)	All Deaths (n=229)
Hypertension	42 (37.8)	51 (43.2)	13 (56.5)	80 (38.8)	93 (40.6)
Diabetes mellitus	2 (1.8)	4 (3.4)	2 (8.7)	4 (1.9)	6 (2.6)
Heart disease	1 (0.9)	0 (0.0)	1 (4.3)	0 (0)	1 (0.4)
Tobacco use	10 (9.0)	80 (67.8)	14 (60.9)	76 (36.9)	90 (39.3)
Alcohol use	3 (2.7)	29 (24.6)	5 (21.7)	27 (13.1)	32 (14.0)

sparsely done in patients with stroke in this district because of lack of imaging facilities, we could not gather the information on stroke subtypes. However, for resource-limited settings, the World Health Organization's stepwise approach to stroke surveillance program has recommended the use of verbal autopsies to identify nonhospitalized fatal strokes.¹⁷ As the information was collected from family members, there is a possibility of recall bias. We contacted family members of the deceased patients within 2 to 4 weeks of death, which is likely to reduce the recall bias. Also, although we used a well-validated verbal autopsy tool, it was not specifically validated for stroke diagnosis in rural Gadchiroli. However, previous studies have shown that the sensitivity and specificity of diagnosing stroke based on VAs remain high across various countries and settings.^{30,31}

Conclusions

Stroke is the leading cause of death and accounted for 1 in 7 deaths in the rural areas of Gadchiroli, one of the most backward districts of India. The mortality rate because of stroke was higher than that reported previously from India. These results indicate that stroke is emerging as a major public health problem in rural India. As hypertension is one of the most important risk factors for stroke, findings from our study highlight an urgent need to screen and treat patients with hypertension in rural areas of India to reduce stroke mortality.

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Disclosures

None.

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