Stroke Incidence and Mortality in Rural and Urban Shanghai From 1984 Through 1991
Findings From a Community-Based Registry

Yuling Hong, MD, MSc; Michiel L. Bots, MD, PhD; Xinwei Pan, MD; Albert Hofman, MD, PhD; Haozhu Chen, MD

Background  Mortality from stroke has declined in many countries. This decline may result from a fall in incidence of stroke or a decrease in case fatality from stroke. The present study was conducted to investigate the temporal trends of incidence rate, mortality rate, and case fatality of stroke in an urban and rural Chinese population.

Methods  A community-based registry study was established in 1983 in defined rural and urban areas of Shanghai with a population aged 35 to 74 years of approximately 86,000 subjects, adhering to the methods and definitions of the World Health Organization MONICA protocol. All stroke events occurring in the population aged 35 to 74 years in these areas were registered by a special three-level case-registration system.

Results  From 1984 through 1991, 1391 stroke cases were identified. No significant change in the incidence rate of stroke was observed from 1984 through 1991 in men and women living in rural and urban areas. Age-standardized mortality rates (per 100,000 person years) of stroke declined significantly during this period, except for rural women. The annual changes and 95% confidence intervals of age-standardized mortality rates were: for rural men -4.6% (-5.4, -3.9), for rural women -0.6% (-1.6, 0.5), for urban men -2.5% (-3.5, -1.6), and for urban women -4.7% (-5.2, -4.2). A significant decrease in case fatality from stroke from 1984 through 1991 was found among men living in rural areas (from 62.4% to 46.0%) and among women living in urban areas (from 48.4% to 33.3%). Overall case fatality, however, showed a nonsignificant decline over time.

Conclusions  We observed a decline in stroke mortality rate in a rural and urban Chinese population. No significant changes in stroke incidence were found in this study, whereas case fatality appeared to have decreased, in particular among men living in rural areas and women living in urban areas.

Key Words  cerebrovascular disorders • China • epidemiology • incidence • mortality

Cerebrovascular disease is one of the leading causes of chronic morbidity and impairment. Furthermore, stroke is an important cause of death in many countries. In China, stroke constitutes the second most important cause of death in urban areas and the third cause of death in rural areas. In several countries a substantial decrease in the mortality rate of stroke has occurred over the past decades. The precise mechanisms underlying this marked decline are not yet fully understood. It may be a consequence of a decrease in incidence of stroke. Supportive evidence comes from studies that have reported a decline in incidence of stroke. However, in other studies this finding could not be confirmed. Improvement in medical care or a change in the natural history of stroke may have resulted in a diminishing case fatality rate and subsequently may have contributed to the observed decrease in the mortality rate of stroke. The degree to which both phenomena may have contributed to a decrease in mortality rate cannot be ascertained at present.

This study reports on secular trends of incidence and mortality rates of stroke and of case fatality obtained from a population-based study in rural and urban Shanghai, China, in the period 1984 through 1991.

Subjects and Methods

Study Population
The present study is a part of the Sino-Shanghai Cardiovascular Disease Registry Project. The study population, aged 35 to 74 years, consisted of approximately 86,000 subjects living in rural and urban Shanghai, China. Approximately half of these subjects lived in rural areas (Table 1). The size of the population of each year equaled the population size of the last year plus the number of natural increase and net migration in these defined areas. The Sino-Shanghai Cardiovascular Disease Registry Project, which adhered to the World Health Organization (WHO) MONICA definitions and methods, formally started in the beginning of 1983.

Definition of Stroke
In the Sino-Shanghai Cardiovascular Registry, a stroke was defined according to the WHO MONICA criteria: a sudden onset of clinical signs of focal or global disturbance of cerebral function that lasted more than 24 hours, with no apparent cause other than a vascular origin. Global disturbances refer to patients with coma or subarachnoid hemorrhage. Transient ischemic attack and chronic cerebrovascular disease were not included. In the Sino-Shanghai Cardiovascular Registry, no
The stroke incidence rate was calculated as the number of all acute stroke events divided by the number of person years of the study population in whom these stroke events occurred. Mortality rate from stroke was calculated as the number of fatal strokes (death within 28 days after occurrence of the stroke) divided by the number of person years of the study population in whom these fatal events occurred. Case fatality (%) was defined as the number of fatal strokes (death within 28 days after occurrence of the stroke) divided by the total number of stroke events.

**Case Finding**

Information on subjects was derived from three sources: (1) from hospital admissions, discharge records, and emergency rooms; (2) from death certificates obtained from the local public security bureau that is responsible for registering all deaths in the community; and (3) from the residence committees or Red Cross health stations. The staff in the residence committees and Red Cross health stations are socially familiar with every household in their own areas.

Since 1983, a three-level case-registration system with six hospitals and over 60 Red Cross health stations has been established by the Shanghai Institute of Cardiovascular Diseases. When an event occurred, members of the residence committees or Red Cross health stations were first informed, and they then reported to the collaborating hospital concerned. Next, the physician or neurologist in the collaborating hospital was sent to interview the patient or relatives of the patient at home. If the patient was admitted to the hospital, the physician or neurologist visited the hospital to which the patient was admitted, to review the medical records and fill out a registration form at the hospital, or visited the patient's home. Participating physicians in collaborating hospitals obtained all death certificates and selected those with cardiovascular causes and stroke for further record review. All events that occurred out-of-hospital were primarily based on history of symptoms, provided by either the relatives (fatal) or the patients (nonfatal). The information was obtained through the local public security bureau in case of a fatal event or through the Red Cross station in case of a nonfatal event.

Hospital records, medical history, and information from relatives were used to assess the diagnosis of stroke. This was performed by a qualified physician from the Sino-Shanghai Cardiovascular Registry according to the 9th International Classification of Diseases and the MONICA diagnostic criteria. The causes of an out-of-hospital event were coded by a trained physician in collaboration with either the local security bureau or the Red Cross station. All events due to stroke were reviewed and validated by another trained physician. In case of any doubt, the event was reviewed by a second observer, and a final diagnosis was made after agreement.

**Quality of Data**

In the Sino-Shanghai Cardiovascular Disease Registry Project, the standardized procedure for registration of strokes issued by the WHO MONICA Quality Control Center for event registration was closely followed. The proportion of unreported stroke cases was estimated annually from data obtained by a door-to-door survey in a random sample of 10% of the population. This took place by the end of February each year. A special team of field workers was sent to visit the subject of the sample. Each family member (or a neighbor if the subjects were absent) was asked if he or she had had stroke or stroke-related diseases last year and if he or she had been treated at the hospital. The estimated proportion of stroke cases not registered varied from 1% to 6%, without any evidence of a time trend in quality of reporting over the years.

**Data Analysis**

The incidence and mortality rates were obtained over the periods 1984 through 1986, 1987 through 1989, and 1990 through 1991 by calculating the number of events over that period divided by the number of person years over that period. The estimates of stroke incidence rate and of stroke mortality rate for each of the three periods are presented separately for men and women, for rural and urban areas. When appropriate, presented results were adjusted for age, using the direct adjustment for age. Analyses for trends were performed using linear regression analysis. Results are presented with a 95% confidence interval (CI). A χ² test was used to examine the secular trends of case fatality. When appropriate, analyses were performed with adjustment for age.

**Results**

During the period of 1984 through 1991, 1391 strokes were identified, 697 in rural areas and 694 in urban areas, yielding an age-adjusted stroke incidence for men of 218 per 100 000 person years (95% CI 202, 234) and for women of 169 per 100 000 person years (95% CI 156, 182). Of these strokes 672 were fatal, of which 363

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### Table 1. Demographic Characteristics of Study Population in Rural and Urban Shanghai in 1984

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Rural Men</th>
<th>Rural Women</th>
<th>Urban Men</th>
<th>Urban Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-44</td>
<td>6 631</td>
<td>7 872</td>
<td>5 964</td>
<td>5 385</td>
</tr>
<tr>
<td>45-54</td>
<td>5 956</td>
<td>6 507</td>
<td>8 301</td>
<td>7 335</td>
</tr>
<tr>
<td>55-64</td>
<td>5 011</td>
<td>5 430</td>
<td>5 066</td>
<td>5 225</td>
</tr>
<tr>
<td>65-74</td>
<td>2 395</td>
<td>3 215</td>
<td>2 605</td>
<td>3 185</td>
</tr>
<tr>
<td>Total</td>
<td>19 993</td>
<td>23 024</td>
<td>21 956</td>
<td>21 130</td>
</tr>
</tbody>
</table>

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### Table 2. Incidence Rates of Stroke (95% Confidence Interval) in Shanghai per 100 000 Person Years by Age, Sex, and Area*

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Rural Men</th>
<th>Rural Women</th>
<th>Urban Men</th>
<th>Urban Women</th>
<th>Rural and Urban Men</th>
<th>Rural and Urban Women</th>
<th>Rural and Urban All</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-44</td>
<td>14 (5, 23)</td>
<td>16 (7, 26)</td>
<td>5 (0, 11)</td>
<td>6 (0, 13)</td>
<td>10 (4, 15)</td>
<td>12 (6, 18)</td>
<td>11 (8, 15)</td>
</tr>
<tr>
<td>45-54</td>
<td>66 (40, 92)</td>
<td>75 (50, 92)</td>
<td>39 (23, 55)</td>
<td>48 (29, 67)</td>
<td>50 (36, 64)</td>
<td>61 (46, 77)</td>
<td>56 (45, 66)</td>
</tr>
<tr>
<td>55-64</td>
<td>348 (289, 408)</td>
<td>178 (139, 217)</td>
<td>317 (264, 370)</td>
<td>251 (204, 297)</td>
<td>332 (292, 371)</td>
<td>215 (184, 245)</td>
<td>271 (246, 295)</td>
</tr>
<tr>
<td>65-74</td>
<td>936 (805, 1067)</td>
<td>687 (592, 781)</td>
<td>862 (741, 983)</td>
<td>734 (632, 826)</td>
<td>898 (810, 967)</td>
<td>709 (540, 779)</td>
<td>792 (737, 847)</td>
</tr>
</tbody>
</table>

*Incidence rate is the ratio of number of stroke cases to number of person years over the period 1984 through 1991. Incidence rates refer to total stroke incidence (ie, first-ever and recurrent combined).
The present study shows a decrease in the mortality rate of stroke in rural and urban Shanghai from 1984 through 1991. The decline in mortality rate was most pronounced in subjects aged 65 to 74 years. The incidence of stroke remained virtually unchanged. The case fatality from stroke was on average higher in rural areas than in urban areas, and higher in men than in women (Table 5). From 1984 through 1991, case fatality decreased significantly among rural men and urban women. A nonsignificant decrease of case fatality was found for rural women and urban men (Table 5). Annual overall case fatality decreased; however, the estimate did not reach the level of statistical significance (Table 4).

Discussion

Some aspects of the present study need to be addressed. Completeness of case ascertainment is a prerequisite for reliable analyses of disease registry data and for valid estimation of disease incidence. In the present study, the mortality rate of stroke was on average higher in rural areas than in urban areas, and higher in men than in women (Table 5). From 1984 through 1991, case fatality decreased significantly among rural men and urban women. A nonsignificant decrease of case fatality was found for rural women and urban men (Table 5). Annual overall case fatality decreased; however, the estimate did not reach the level of statistical significance (Table 4).

Table 3. Mortality Rates From Stroke (95% Confidence Interval) in Shanghai per 100 000 Person Years, by Age, Sex, and Area*

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Rural Men</th>
<th>Rural Women</th>
<th>Urban Men</th>
<th>Urban Women</th>
<th>Rural and Urban Men</th>
<th>Rural and Urban Women</th>
<th>Rural and Urban All</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-44</td>
<td>6 (0.12)</td>
<td>10 (2.17)</td>
<td>5 (0.11)</td>
<td>4 (0.9)</td>
<td>6 (2.10)</td>
<td>7 (3.12)</td>
<td>7 (3.10)</td>
</tr>
<tr>
<td>45-54</td>
<td>34 (16.53)</td>
<td>17 (5.28)</td>
<td>18 (7.29)</td>
<td>28 (13.43)</td>
<td>24 (14.34)</td>
<td>22 (13.31)</td>
<td>23 (16.30)</td>
</tr>
<tr>
<td>55-64</td>
<td>186 (142, 229)</td>
<td>99 (70, 128)</td>
<td>163 (125, 200)</td>
<td>99 (69, 127)</td>
<td>174 (145, 202)</td>
<td>99 (78, 120)</td>
<td>135 (117, 152)</td>
</tr>
<tr>
<td>65-74</td>
<td>516 (420, 613)</td>
<td>356 (288, 424)</td>
<td>369 (289, 448)</td>
<td>304 (238, 370)</td>
<td>441 (379, 503)</td>
<td>332 (284, 379)</td>
<td>379 (341, 417)</td>
</tr>
</tbody>
</table>

*Mortality rate is the ratio of number of fatal stroke cases to number of person years over the period 1984 through 1991. Mortality rates refer to total stroke mortality rate.
TABLE 4. Sex-Specific Estimates of Annual Change in Incidence and Mortality Rates of Stroke and in Case Fatality From 1984 Through 1991 in Shanghai per 100 000 Person Years

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Incidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>−1.3</td>
<td>8.1, 5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.7</td>
<td>−11.4, 12.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>−3.6</td>
<td>−4.6, −2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>−2.7</td>
<td>−3.7, −1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case fatality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>−2.6</td>
<td>−9.2, 3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>−2.9</td>
<td>−15.6, 9.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In some studies, increased use of CT scan and related case-finding methods has resulted in the ascertaining of more stroke cases, thereby possibly masking a downward trend in stroke incidence over time. In the present study from 1984 through 1991, CT scans were gradually, more frequently made in patients with a suspected stroke in Shanghai. In the Sino-Shanghai Cardiovascular Registry the presence or absence of a CT scan was not used in the final judgment of stroke diagnosis (conforming to WHO MONICA criteria). However, a performed CT scan may have led to a recall bias in some subjects. This may account to some extent for the findings on stroke incidence as observed in this study. In addition, the possibility of a small decline in incidence rate that has been offset by a better case ascertainment cannot be ruled out.

Table 5: Case Fatality (Percentage) of Stroke in Rural and Urban Shanghai From 1984 Through 1991 by Age and Sex

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td>50.0</td>
<td>61.5</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td>65.9</td>
<td>48.2</td>
<td>45.4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>62.4</td>
<td>50.4</td>
<td>46.0*</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Case Fatality (Percentage) of Stroke in Rural and Urban Shanghai From 1984 Through 1991 by Age and Sex

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td>45.5</td>
<td>37.5</td>
<td>83.3</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td>47.3</td>
<td>53.1</td>
<td>55.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>48.5</td>
<td>45.1</td>
<td>46.7†</td>
<td></td>
</tr>
</tbody>
</table>

Test for trends: *χ²=6.25, P=.012; †χ²=0.04, P=.837; ‡χ²=0.07, P=.797; §χ²=4.80, P=.028.

In some studies, increased use of CT scan and related case-finding methods has resulted in the ascertaining of more stroke cases, thereby possibly masking a downward trend in stroke incidence over time. In the present study from 1984 through 1991, CT scans were gradually, more frequently made in patients with a suspected stroke in Shanghai. In the Sino-Shanghai Cardiovascular Registry the presence or absence of a CT scan was not used in the final judgment of stroke diagnosis (conforming to WHO MONICA criteria). However, a performed CT scan may have led to a recall bias in some subjects. This may account to some extent for the findings on stroke incidence as observed in this study. In addition, the possibility of a small decline in incidence rate that has been offset by a better case ascertainment cannot be ruled out.

Our finding of a decline of stroke mortality rate is in accordance with most other reports. Possible explanations of the decrease in stroke mortality rate may be a decline in incidence, a decrease in the case fatality, or both. In the present study, however, incidence of stroke remained virtually unchanged from 1984 through 1991, whereas the case fatality of stroke appeared to have strongly declined in this period. In the Sino-MONICA-Beijing study, in which similar definitions and methods were used as in the present study, a lower case fatality was observed compared with our finding of 35% and 50%, respectively. Differences in age groups (25 to 74 years in Beijing and 35 to 74 years in Shanghai), in completeness of case finding across studies, and in composition of the study groups (proportion of rural and urban subjects) may partly explain this observed difference. A diminished case fatality may be due to improved medical care. In addition, favorable changes over time in risk factors for stroke may have led to the occurrence of milder types of stroke.

The role of change over time in risk factors for stroke should be addressed. Hypertension is considered to play a very important role in the occurrence of stroke, although whether increase in treatment of hypertension has had a beneficial effect on the decline in stroke mortality rate remains an unsettled issue. China has a high stroke-incidence rate and a relatively lower preva-
lence of hypertension compared with Western countries. 31,32 This suggests that other factors may be important in the occurrence of stroke incidence. The impact of environmental smoke, 33,34 diabetes mellitus, 35-36 psychosocial stress, 37 increased use of contraceptives, 38,39 salt intake, 40,41 and serum lipids 42,43 on stroke incidence rate and stroke mortality rate in China should be studied further. Data on temporal changes in risk factors, however, are not available.

In conclusion, we observed a decline in stroke mortality rate in a rural and urban Chinese population. No changes in stroke incidence were found in the present study, whereas case fatality appeared to have decreased, in particular among men living in rural areas and women living in urban areas. Stroke remains a major cause of death and disability in the Chinese population. More attention should be paid to control of risk factors apart from hypertension to reduce stroke incidence.

Acknowledgments

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References

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