Disparity and Its Time Trends in Stroke Mortality Between Urban and Rural Populations in China 1987 to 2001
Changing Patterns and Their Implications for Public Health Policy

Xin-Hua Zhang, MD, PhD; Tingrui Guan, MD; Jiawen Mao, BSc; Lisheng Liu, MD

Background and Purpose—The purposes of this study were to describe stroke mortality in urban and rural populations in China and to monitor the transition using the best available surveillance data during the past 2 decades.

Methods—Age- and sex-specific mortality data were obtained from the death registration and classification system covering 100 million population in selected urban and rural areas in China. The age-adjusted stroke mortality and its time trends for population at aged 35 years and over were compared between urban and rural populations during the period of 1987 to 2001.

Results—The age-adjusted stroke mortality was higher in urban than in rural populations until the end of 1990s. The urban:rural ratio was 1:16 for men and 1:21 for women in 1987, but this dropped to 0.77 and 0.79, respectively, in 2001 due to a remarkable decrease in stroke mortality in urban areas (~2.0% for men and ~2.5% for women annually, P<0.001), but with little change in rural men (P=0.969) and women (~0.7%, P=0.021) over the period. The decrease is mainly observed in the elderly population. It increased in the population aged 35 to 54 years for all area–gender groups except for urban women.

Conclusions—The heavier burden of stroke shifted from urban to rural areas where a larger population resides and healthcare services are less developed than in urban areas in China. The increasing trend in the younger population will impose a greater burden in the near future. Healthcare policymakers need to focus their attention on this situation and take suitable measures to cope with the challenges it poses. (Stroke. 2007;38:3139-3144.)

Key Words: epidemiology ■ socioeconomic disparity ■ stroke

In 2005 in China, the country with approximately one fifth of the world population, stroke caused approximately 1.5 million deaths (one fourth of total deaths from stroke in the world) and left more with different levels of disability.1,2 Like in most developing countries, it has been widely recognized that stroke mortality was higher in urban than in rural areas in China.3 However, the pattern is the opposite in developed countries or among countries in the world, where the risk of stroke is higher among economically disadvantaged populations than better-off ones.4,5 Socioeconomic status at either an individual or a population level relates to lifetime exposure to the factors related to stroke such as early life development, unhealthy lifestyle, access to healthcare services, and so on. Monitoring the transition of stroke between urban and rural populations in a country experiencing fast economic development would have important implications. The information would help to understand the effect of socioeconomic development on stroke risk and is critical for healthcare policymakers in deciding the priority of healthcare services and strategies in prevention in China. Experiencing of the transition may also help other middle- and lower-income countries to predict the burden of stroke in their populations.

China does not have a complete nationwide death registration and classification system as those in developed countries, although any death is required by law to be reported and recorded in the local police department with a death certificate signed by a physician. The cause-specific mortality and their time trends are monitored by the surveillance systems in selected urban and rural areas. The largest and longest running registration system in China was administered by the Ministry of Health. It involved approximately 10% of the population from selected urban and rural areas since the mid-1980s. The system provides the area (urban, rural), age-, sex-, and cause-specific mortality data from more than 100 million residents in the populous areas with relatively good reporting and classification mechanisms. Large cities and surrounding areas were more likely to meet the criteria to be included in the system than remote areas; thus, the data are not representative of the general population in China, because

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the economically better-off populations are overrepresented, but the most disadvantaged areas were rarely included in the system. In this report, we have used the mortality data from this system to describe the disparity in stroke mortality and the time trends between urban and rural populations within the surveillance areas in a country experiencing fast socioeconomic development. To minimize the influence of changing practice for coding causes of deaths on the time trends, we only used the data coded with the 9th edition of the International Classification of Diseases (ICD-9) from 1987 through 2001 in China.

Results
Throughout the study period, stroke mortality accounted for approximately 20% to 23% of deaths from all causes and for 52% to 58% of deaths from cardiovascular diseases in the population aged 35 years and over in the selected urban and rural areas covered by the surveillance system.

Table 1 displays the age-adjusted mortality averaged over the 3-year periods of 1987 to 1989 and 1999 to 2001 for men and women aged 35 years and over in urban and rural areas. All-cause mortality was higher in rural than in urban populations throughout the period. However, the level of all-cause mortality decreased more in urban than in rural areas (−18% versus −16% for men and −24% versus −14% for women) in the 15-year period. Consequently, the urban: rural ratio of all-cause mortality decreased from 0.87 in 1987 to 1989 to 0.84 in 1999 to 2001 for men and 0.94 to 0.84 for women.

In 1987 to 1989, the age-adjusted mortality from total cardiovascular disease was higher in urban than in rural areas. However, it decreased twice as much in urban than in rural areas during the study period (16% versus 8% for men and 24% versus 13% for women). The urban: rural ratio of total cardiovascular mortality changed from 1.06 in 1987 to 1989 to 0.97 in 1999 to 2001 for men and from 1.12 to 0.97 for women.

Similar to mortality from total cardiovascular diseases, mortality from stroke was higher in urban than in rural areas (380 per 100 000 versus 337 per 100 000 for men and 283 versus 244 for women) in the beginning of the study period. However, the pattern reversed in 1999 to 2001 with 292 per 100 000 versus 331 per 100 000 for men and 204 versus 222 for women as a result of the age-adjusted mortality from stroke decreasing far more in urban than in rural populations (−23% versus −2% for men and −28% versus −9% for women) during the period. The urban: rural ratio of stroke mortality decreased from 1.13 to 0.88 for men and 1.16 to 0.92 for women.

The annual age-adjusted stroke mortality for the age group 35 years and over from 1987 to 2001 is displayed in Table 2.

Statistical Analysis
Stroke mortality for the age group of 35 years and over was adjusted by the age structure of the population in the surveillance areas in 1994. The age-adjusted mortality was averaged over 3 years (1987 to 1989 and 1999 to 2001) and compared between urban and rural settings for men and women separately. We calculated trends from 1989 and 1999 to 2001 and compared between urban and rural settings. To minimize the influence of changing practice for coding causes of deaths on the time trends, we only used the data coded with the 9th edition of the International Classification of Diseases (ICD-9) from 1987 through 2001 in China.

Table 1. Age-Adjusted Mortality (per 100 000 per year, mean of 3 years) in Men From Selected Urban and Rural Areas, 35 Years and Over, China

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cause</td>
<td>1653.5</td>
<td>1902.8</td>
<td>0.87</td>
<td>1350.8</td>
<td>1606.5</td>
<td>0.84</td>
<td>−18.3</td>
<td>−15.6</td>
</tr>
<tr>
<td>Total</td>
<td>658.1</td>
<td>619.9</td>
<td>1.06</td>
<td>549.8</td>
<td>568.3</td>
<td>0.97</td>
<td>−16.5</td>
<td>−8.3</td>
</tr>
<tr>
<td>Stroke</td>
<td>380.4</td>
<td>337.4</td>
<td>1.13</td>
<td>291.7</td>
<td>331.1</td>
<td>0.88</td>
<td>−23.3</td>
<td>−1.9</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cause</td>
<td>1210.5</td>
<td>1282.9</td>
<td>0.94</td>
<td>918.8</td>
<td>1098.8</td>
<td>0.84</td>
<td>−24.1</td>
<td>−14.4</td>
</tr>
<tr>
<td>Total</td>
<td>525.3</td>
<td>471.1</td>
<td>1.12</td>
<td>397.8</td>
<td>410.6</td>
<td>0.97</td>
<td>−24.3</td>
<td>−12.8</td>
</tr>
<tr>
<td>Stroke</td>
<td>283.5</td>
<td>244.1</td>
<td>1.16</td>
<td>204.3</td>
<td>222.4</td>
<td>0.92</td>
<td>−27.9</td>
<td>−8.9</td>
</tr>
</tbody>
</table>

CVD indicates cardiovascular disease.

Materials and Methods
Sources of Data
The age-, sex-, and area-specific mortality data in 5-year age groups for people aged 35 years and over were obtained from the Vital Statistics Annual Report provided by the Center for Health Statistics Information, Ministry of Health, the People’s Republic of China. The report was based on the mortality surveillance program in China, which included more than 100 million residents from 40 middle to large cities (urban) and 100 counties (rural) in 25 provinces. Similar proportions of populations from urban and rural areas were involved. The causes of deaths are based on physicians’ death certificates, which are submitted to police departments and then forwarded to the municipal, provincial, and national departments of health for coding and then reported to the Ministry of Health. The underlying causes of deaths were coded according to ICD-9 from 1987 to 2001 using information provided on the death certificates. Death from stroke included those that were coded as ICD-9 430 to 438; total cardiovascular disease were those coded as ICD-9 390 to 459.
Stroke mortality decreased 2.0% annually for urban men and 2.5% for urban women during the period, but only modestly in rural women (−0.7% annually, P=0.021). There was no significant change observed in rural men (P=0.969 for trend). Consequently, the pattern of high-urban and low-rural in stroke mortality in the population gradually reversed: the urban:rural ratio of mortality from stroke became less than one for men from 1998 and for women from 2000.

Figure 1 illustrates the disparity and time trends of stroke mortality for urban and rural populations by sex- and age-specific subgroups. Age-adjusted stroke mortality was higher in urban than in rural populations for all sex- and age-specific groups until the late 1990s. Because stroke mortality decreased earlier and more in urban than in rural populations, the level of stroke mortality between urban and rural areas crossed over in all 3 age groups for both men and women.

Figure 1 also indicates the different time trends of stroke mortality that occurred between different age groups. Over the period studied, stroke mortality declined almost linearly in the elderly in urban populations (−2.0% annually for men and −2.2% for women, P<0.001) and in rural populations (−0.8% and −1.6%, respectively).

For the age group 55 to 74 years, stroke mortality decreased in urban populations, especially after the mid 1990s (annual change of −2.5% for men and −2.6% for women, P<0.001 for both), but there was virtually no significant change in rural populations (P>0.1 for rural men and women).

For the age group 35 to 54 years, a contrary trend was observed in urban and rural men and rural women; the age-adjusted stroke mortality increased significantly for men in urban (1.8% annually, P=0.002) and rural areas (3.9%, P<0.001) and for women in rural areas (2.2%, P<0.001) during the period. However, stroke mortality decreased remarkably in urban women (−2.5% annually, P<0.001).

**Discussion**

Throughout past 20 years, stroke has remained the leading cause of deaths in the Chinese population. Stroke mortality decreased in the general population during the period, mainly in the elderly population but increased in the younger population. The decrease was greater for women than for men. It happened earlier and faster in economically better-off urban areas than in disadvantaged rural areas. Consequently, stroke mortality was higher in urban than in rural populations, but it has reversed since the end of the 1990s. The burden of stroke is now much higher in rural than in urban populations in China not only because a larger population resides in rural areas, but also because the age-specific mortality of stroke is now higher in rural than in urban populations. The transition is alarming for health education and healthcare services in China.

Stroke mortality observed in the selected urban and rural areas under the surveillance system might be different from that at a national level because the areas chosen were not a representative sample of the country. The socioeconomic situation and healthcare services in the areas selected were better than in those not included. The level of all-cause mortality could be lower, whereas stroke mortality could be higher comparing the areas within the registration system with those outside, at least at the beginning of the studied period. However, the vital statistics of more than 100 million people in 25 provinces/municipal cities in China provided the largest and best available database to monitor age-, sex-, and age-specific mortality.

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**Table 2. Age-Adjusted Stroke Mortality (per 100 000) for People Aged 35 Years and Over in Selected Urban and Rural Areas, 1987 to 2001, China**

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban</th>
<th>Rural</th>
<th>Urban</th>
<th>Rural</th>
<th>Urban:Rural Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>373.9</td>
<td>321.6</td>
<td>302.9</td>
<td>249.7</td>
<td>1:16 1:21</td>
</tr>
<tr>
<td>1988</td>
<td>379.0</td>
<td>337.2</td>
<td>270.3</td>
<td>243.9</td>
<td>1:12 1:11</td>
</tr>
<tr>
<td>1989</td>
<td>388.3</td>
<td>353.3</td>
<td>277.2</td>
<td>238.7</td>
<td>1:10 1:16</td>
</tr>
<tr>
<td>1990</td>
<td>377.1</td>
<td>324.8</td>
<td>264.4</td>
<td>235.0</td>
<td>1:16 1:13</td>
</tr>
<tr>
<td>1991</td>
<td>356.6</td>
<td>314.6</td>
<td>247.1</td>
<td>212.6</td>
<td>1:13 1:16</td>
</tr>
<tr>
<td>1992</td>
<td>366.1</td>
<td>322.1</td>
<td>257.2</td>
<td>219.8</td>
<td>1:14 1:17</td>
</tr>
<tr>
<td>1993</td>
<td>352.3</td>
<td>301.6</td>
<td>250.6</td>
<td>212.7</td>
<td>1:17 1:18</td>
</tr>
<tr>
<td>1994</td>
<td>357.3</td>
<td>315.6</td>
<td>248.0</td>
<td>217.1</td>
<td>1:13 1:14</td>
</tr>
<tr>
<td>1995</td>
<td>349.6</td>
<td>322.9</td>
<td>248.6</td>
<td>216.6</td>
<td>1:08 1:14</td>
</tr>
<tr>
<td>1996</td>
<td>351.7</td>
<td>309.0</td>
<td>242.6</td>
<td>209.0</td>
<td>1:14 1:16</td>
</tr>
<tr>
<td>1997</td>
<td>341.0</td>
<td>313.0</td>
<td>235.7</td>
<td>216.8</td>
<td>1:09 1:09</td>
</tr>
<tr>
<td>1998</td>
<td>335.4</td>
<td>345.7</td>
<td>243.4</td>
<td>216.5</td>
<td>0.97 1:12</td>
</tr>
<tr>
<td>1999</td>
<td>320.5</td>
<td>322.3</td>
<td>224.0</td>
<td>214.9</td>
<td>0.99 1:04</td>
</tr>
<tr>
<td>2000</td>
<td>296.6</td>
<td>334.2</td>
<td>209.2</td>
<td>224.7</td>
<td>0.89 0.93</td>
</tr>
<tr>
<td>2001</td>
<td>258.1</td>
<td>336.8</td>
<td>179.5</td>
<td>227.5</td>
<td>0.77 0.79</td>
</tr>
</tbody>
</table>

Percent change/year (95% CI)  
-2.0 (−2.6 to −1.4) 0.0 (−0.6 to 0.6) −2.5 (−3.0 to −1.9) −0.7 (−1.3 to −0.1)  
P value <0.0001 0.969 <0.0001 0.021  

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cause-specific mortality and the time trends between urban and rural areas. It revealed the direction of the disparity of stroke mortality over the time between urban and rural areas or between areas with different levels of socioeconomic development in the country. The change rate in stroke mortality in the areas outside the system might be different, but the direction of the trends should be similar to that within the system.

The reliability of the mortality rates in the vital registration system depended on the accuracy of the population size and the completeness of reporting all deaths. China has relevant demographic information locally and nationally through the residence registration system, which relates to schooling, housing, employment, and social welfare, and is managed by local police offices. More detailed information on population demographics is obtained by regular census with representative national samples. Although it is compulsory to report deaths to the residence registration unit in local police offices, underreporting of deaths happens, especially in remote areas and for the population under 5 years of age.8 Registration of death in large cities and surrounding areas was reasonably complete. The underreporting of deaths in the population aged 35 years and over in the death registration and classification system should have been minimal. Figure 2 compares the age-specific all-cause mortality for both urban and rural populations in the system with that from household surveys with national representative samples in the same year.2,9

The time trends of stroke mortality could be affected by the accuracy and consistency of diagnosis and classification over the time. To avoid the influence of changing coding practice, we only analyzed the mortality data coded with ICD-9 and the broader classification of cerebrovascular diseases (ICD-9 430 to 438). During the period studied, the accuracy of diagnoses and classification may have improved due to better training of staff and application of advanced techniques. For example, the percentage of CT or MRI used in the diagnoses of stroke increased in China, especially in urban areas. The multicenter collaborative study in China involved 12 urban and rural populations aged 35 years and over revealed that the percentage of using CT scan in diagnosis of stroke increased from 49.4% in 1991 to 91.4% in 2000; the proportion of unclassified stroke decreased from 51.7% to 8.5% during the period.10 The improvement in diagnosis and classification may have contributed partly to better clinical management and reduced misclassification. However, the decrease stroke mortality could not be explained by reduced misclassification because the trend of stroke mortality was in parallel with an even greater reduction in mortality from total cardiovascular diseases and deaths from all causes in rural areas.

The case fatality of acute hemorrhagic stroke is much higher than for ischemic stroke. The decreasing proportion of hemorrhagic stroke over the time could also play an important role in the disparity and time trend of stroke mortality between urban and rural areas. In 2004, the proportion of hemorrhagic stroke among all patients with stroke discharged from hospitals near rural areas was higher than for hospitals in large or middle cities (38% versus 27%).2 Data from the surveillance program for cardiovascular diseases in the Beijing population aged 25 to 74 years showed that the incidence rate of hemorrhagic stroke dropped from 109.5 per 100,000 in 1984 to 59 per 100,000 in 1999.11

Figure 1. Age-adjusted stroke mortality and time trends between urban and rural populations by age and sex subgroup, 1987 to 2001.
There was no evidence that the incidence of stroke decreased during the studied period in China. Data from the surveillance program in Beijing showed that the incidence of stroke increased for the age group of 25 to 74 years between 1984 and 1999 (2.4% annually for men and 2.2% for women), whereas stroke mortality decreased substantially in the same population during the same period (−3.5% annually for men and −4.6% for women). There is no report yet from similar long-term studies in the elderly or in rural populations. An increasing prevalence of stroke in both urban and rural areas observed from 3 National Surveys for Health Care Services in China (9.8 per 1000 residents in 1993, 13.1 in 1998, and 13.0 in 2003 for urban areas versus 2.0, 3.4, and 4.4, respectively, for rural areas) suggested that the decreasing trends of stroke mortality could be attributed partly to the better clinical management.

It has been widely recognized that stroke, like other chronic diseases, would be more common in urban areas than in rural areas in developing countries due to the higher risk profile: high blood pressure, diabetes, and hyperlipidemia related to an unhealthy lifestyle that includes energy-dense food, less physical activity, smoking, alcohol drinking, and so on at an early stage of socioeconomic development. This situation is still true according to the national survey on health status and nutrition conducted in 2002. However, the differences are getting narrower, and the risk of stroke for rural populations became similar to that for urban populations. Furthermore, rural populations were predisposed to a higher risk of stroke and other cardiovascular diseases when infectious diseases were not a leading cause of death as demonstrated by life course epidemiological studies that individuals born or raised in families of low socioeconomic status were more likely to develop stroke or coronary heart diseases in adulthood. Better healthcare services and greater attention to primary prevention in urban than in rural areas also contributed to the changing pattern of stroke mortality in China.

Data from the World Health Organization indicated that stroke mortality was higher in low- or middle-income countries than in high-income countries, and within high-income countries, the risk of stroke was higher in disadvantaged than in better-off populations. The limited information from low- or middle-income countries revealed that the individuals with a high socioeconomic status were at a higher risk than those with a low socioeconomic status. China, as a developing country, is experiencing fast economic development and witnessing the transition of stroke from a “developing” to a “developed” pattern.

It has been observed that mortality from stroke or from total cardiovascular diseases was higher in north than in south areas in China. The geographic differences (it is partly reflected by the socioeconomic development also) would not affect the result from current analysis because the selected urban and rural areas were from same provinces that covered most part of China and each province provided similar urban and rural populations.

The transition of stroke mortality observed in the Chinese urban and rural population has important implications for policymakers to decide the priorities for healthcare programs in China. It is an enormous challenge for the Chinese government and healthcare professionals to meet. Rural populations are still threatened by infectious diseases and chronic disease are rapidly increasing, but healthcare services in these areas are hardly affordable or accessible for them.

Although mortality from stroke has declined significantly in the elderly population, the total number of cases are not expected to reduce because of population grows and improved life expectancy. Moreover, the current trend of stroke mortality in the younger population in both urban and rural areas will add to the burden in the near future.
These findings underline the importance of more aggressive efforts to control the risk factors of stroke and other cardiovascular diseases, especially in rural areas and in young men.

Disclosures

None.

References

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