Symposium

Incidence and Long-Term Prognosis of Initial Stroke and Acute Myocardial Infarction in Okinawa, Japan

Koshiro FUKIYAMA, Yorio KIMURA, Kiyoshi WAKUGAMI, and Hiromi MURATANI

We performed a cross-sectional survey of the incidence of stroke and acute myocardial infarction (AMI) in Okinawa, Japan, with a census population of about 1.2 million. A total of 3,644 cases of first-ever stroke and 898 cases of initial AMI were detected. The age-adjusted annual incidence rate of stroke was 105 per 100,000 of the standard population of Japan based on census population taken in 1985, and that of AMI was 26 per 100,000. The case-fatality rate of stroke within 28 days of onset was 12.8%, and that of AMI was 22.2%. Of the stroke cases, 51.4% were diagnosed as brain infarctions, 38.7% as brain hemorrhages, and 9.3% as subarachnoid hemorrhages. The diagnoses of stroke subtypes were confirmed by computed tomography or magnetic resonance imaging in 98.4% of all stroke cases. The long-term prognosis of patients with stroke and AMI was studied by examining their 10-yr survival rates (follow-up rate 89.8%). The cumulative survival rate was 38.2% in brain infarction cases, 40.4% in brain hemorrhage cases, and 38.2% in AMI cases. The 50% reduction of survival had occurred at 2,880 days after onset in brain infarction cases, at 2,764 days in brain hemorrhage cases, and at 2,658 days in AMI cases. In Okinawa, the incidence rate of AMI was still considerably lower than that in the Western population, and the rate of stroke was similar to that in the Western population. The ten-year survival rates were quite similar in AMI and stroke, and both were unexpectedly high. (Hypertens Res 2000; 23: 127-135)

Key Words: stroke, AMI, incidence, case-fatality, long-term prognosis

Introduction

Over the last two decades there has been a precipitous fall in mortality due to stroke in Japan (1), while the mortality from acute myocardial infarction (AMI) has fallen only slightly (2, 3). There is, however, a question as to whether the trends in mortality have been accompanied by similar trends in morbidity. Since stroke and ischemic heart disease are the leading causes of disability, measurement of community-based incidence of the diseases is important for the development of health care benefits as well as the development of medical issues. A large-scale population study, however, has not been conducted in Japan.

We performed a cross-sectional field study of the incidence of stroke and AMI in Okinawa Prefecture, which consistently has the highest life expectancy in Japan (2), with a census population of about 1.2 million in 1990. We describe here the incidence rate and the long-term prognosis of persons experiencing first-ever stroke and initial AMI.

Study Population

Okinawa Prefecture is a subtropical island chain in the southwest part of Japan with an area of 2,254 km² and with 4 main and about 35 smaller inhabited islands. The study population was comprised of all residents of Okinawa. The census population in 1990 was 1,222,398; more than 96% of all inhabitants were living on 1 of the 3 main islands, and 68% were residing in urban areas. Ten percent

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of the population were 65 yr and older.

**Case Ascertainment**

We organized a study group for the surveillance of cardiovascular diseases in Okinawa (the Co-operative Study Group of Morbidity and Mortality of Cardiovascular Diseases in Okinawa, known as the COSMO Group (4)) in 1988 in cooperation with 9 non-private hospitals, 25 large private hospitals, and all the clinics registered with the Okinawa Medical Association. Seven Public Health Centers, the Environment and Health Department of the Prefectural Government, and the Department of Legal Medicine of the University of the Ryukyus were also engaged in the study.

For this study, physicians of the Third Department of Internal Medicine at the University of the Ryukyus regularly visited the hospitals involved in the study. They investigated the medical records of patients diagnosed as having stroke or AMI, including suspected cases, their electrocardiograms, laboratory data, and computed tomography (CT) or magnetic resonance imaging (MRI) films, and they recorded the findings on registration sheets. Records of autopsies were reported regularly. Public health nurses of the Public Health Centers regularly visited households with aged or disabled persons or households receiving public financial aid. They sent us summary reports of possible patients of stroke or AMI, so that we could search their medical records to confirm the diagnosis.

**Definition of Stroke and Acute Myocardial Infarction**

Stroke was clinically defined as a focal or global disturbance of cerebral function of sudden onset, lasting 24 h or longer or leading to death with no apparent cause other than that of vascular origin (5). Stroke was classified according to the diagnostic guidelines provided by the Ad Hoc Committee of the Ministry of Health and Welfare on Cerebrovascular Diseases (6) and findings on CT or MRI scans. Patients who were found to have stroke focus/foci only through CT or MRI scans but who did not meet the clinical criteria were not included.

Criteria for the identification of AMI were based on those listed by the World Health Organization Monitoring Trends and Determination in Cardiovascular Disease (WHO-MONICA) project (7), and both definite and possible myocardial infarctions were included.

The final decision as to registration was made by two physicians (Y.K. and K.K.). Patients having a past history of stroke or myocardial infarction were not included in the analysis.

**Statistical Analysis**

Crude annual incidence rates were determined using the census population of Okinawa in 1990. Age-adjusted annual incidence rates were calculated by the direct method using the standard population derived from the census population of Japan in 1985, and also using the standard population of the world. Comparison of parameters between subgroups was made using one-way analysis of variance. Multiple logistic analysis was applied to assess the independent associations of age, sex, and clinical findings with occurrence of acute death from stroke. The survival curve and the cumulative survival rate after stroke or AMI were determined using the Kaplan-Meier method. A p-value of less than 0.05 was considered to be statistically significant. Values were expressed as mean ± standard deviation.

**Incidence of First-ever Stroke and Initial Acute Myocardial Infarction**

A total of 4,756 stroke cases (2,573 men and 2,183 women) and 1,059 AMI cases (695 men and 364 women) were registered during the 3-yr study period (4). Excluding the cases of transient ischemic attack (120 men and 89 women) and the cases of patients with previous history of stroke and myocardial infarction, the number of cases of first-ever stroke and initial AMI in the study period was 3,644 (1,960 men and 1,684 women) and 898 (587 men and 311 women), respectively (8). CT or MRI examination within 1 wk of the onset of the stroke was performed in 98.4% of the cases registered. Among the 898 cases of AMI, 783 cases were diagnosed as definite and 115 as possible according to the criteria of the WHO MONICA project (7).

The age-adjusted annual incidence rate of first-ever stroke was 105 per 100,000 standard population of Japan (136 in men and 81 in women), and it was 76 per 100,000 (99 in men and 58 in women) when adjusted to the standard population of the world.

The age-adjusted annual incidence rate of AMI was 26 (41 in men and 14 in women) per 100,000 standard population of Japan, and when adjusted to the standard population of the world, it was 19 (30 in men and 9 in women) per 100,000.

To compare our results directly with those of the WHO MONICA project (9, 10) and with those reported in a previous study (11), we re-analyzed our data according to the age at onset of stroke or AMI. In those aged 35 to 64 yr, the age-adjusted annual incidence rate of stroke was 121 (155 in men and 88 in women) per 100,000 standard population of the world and that of AMI was 31 (53 in men and 11 in women). For those aged 55 yr or more, the age-adjusted annual incidence rate of stroke and AMI was 362 (481 in men and 277 in women) and 94 (144 in
men and 57 in women) per 100,000 standard population of the world, respectively. The ratio of the incidence rate of first-ever stroke for both sexes to that of AMI was approximately 4:1. The crude annual incidence rate of stroke increased with increasing age in both men and women (Fig. 1).

Among the 3,644 cases of first-ever stroke, 1,872 cases (51.4%) were diagnosed as brain infarction BI, 1,412 (38.7%) as brain hemorrhage BH, 339 (9.3%) as subarachnoid hemorrhage SAH, and 21 (0.6%) as undetermined type UND. Age-specific annual incidence rates of each subtype of first-ever stroke are shown in Fig. 2. When the data for men and women were combined, the crude annual incidence rate of BI as well as that of BH increased with increasing age, and overall, the former was 1.3 times higher than the latter. In the age class of 45-54 yr and younger age classes the crude annual incidence rate of BH was higher than that of BI, while the crude
annual incidence rate of BI was significantly higher than that of BH in the age class of 65-74 yr and older classes. The peak incidence of SAH was observed in the age class of 75-84 yr.

The findings showed that BH was the predominant subtype of stroke in the younger age classes, while BI was predominant in the older age classes. Even when the data for men and for women were analyzed separately, the crude annual incidence rates of BH and BI still increased with increasing age, and BI occurred more frequently in older age classes in both men and women. The total annual incidence rates of BI and BH were significantly higher in men than in women, and the age-specific incidence rate of BI was significantly higher in men in the age classes from 45-54 to 75-84 yr. Although the age-specific incidence rate of BH tended to be higher in men than in women in every age class, the differences between men and women were not significant.

The crude annual incidence rate of AMI also increased with increasing age (Fig. 1). AMI was more prominent in the age class of 45-54 yr and older in men, and the incidence peaked in the age class of 85 yr and older. In women, it became prominent in the age class of 65-74 yr and older and peaked in the age class of 75-84 yr. The total crude annual incidence rate of AMI was significantly higher in men than in women, and this sex difference in the age-specific incidence rate was observed in the age classes of 65-74 yr and younger, but not in the age classes of 75-84 and older.

Mean Age at Onset

The mean age at onset of first-ever stroke was 66.1 ± 14.8 yr (63.6 ± 14.2 in men and 68.9 ± 15.0 in women), and that of AMI was 66.3 ± 13.5 yr (62.3 ± 13.0 in men and 74.0 ± 11.0 in women). There was no significant difference between that of stroke and that of AMI. The mean ages at onset for BI, BH, and SAH were 69.8 ± 13.0 yr (67.4 ± 13.0 in men and 72.9 ± 12.4 in women), 62.8 ± 15.5 yr (59.8 ± 14.2 in men and 66.6 ± 16.2 in women), and 58.9 ± 15.1 yr (55.0 ± 14.9 in men and 60.7 ± 14.9 in women), respectively. The difference of mean age at onset between men and women was statistically significant for each subtype of stroke and AMI.

Subtypes of Stroke

CT scanning was the principal method used to classify the subtype of stroke. Examination solely with MRI was performed in less than 5% of all cases. CT or MRI was performed in 1,846 of the 1,872 cases of BI (98.5%), and 74.5% showed pathological findings on the CT scan corresponding to the acute neurological deficit. The locations of lesions on brain imaging were as follows: 92.6% in the cerebrum, 2.9% in the cerebellum, 2.6% in the brainstem, and 1.9% in combined regions. The proportional frequency of lesions in the territory of deep perforating arteries was 36.0% of the total cases (48.8% when excluding cases without low-density areas on CT) and decreased steadily with increasing age.

In the 1,412 cases of BH, 1,393 cases (98.7%) had brain scans that revealed a focus or foci corresponding to the clinical symptoms. Eighty-three percent of the 1,393 cases had hematomas in the supratentorial region. About 70% were putaminal or thalamic hemorrhages, including hemorrhaging involving both regions. Only in the age class of 34 yr and younger was subcortical hemorrhage the most common (55%) subtype.

Prevalence of Known Hypertension and Cigarette Smokers

The prevalence of preexisting hypertension that had been documented before the onset of stroke or AMI was markedly high and ranged between 60.9% and 78.6% (lowest in patients of AMI and highest in patients of BH). Most notably, in the cases of BH of the four age classes from 35 to 74 yr, the prevalence of known hypertension was 80% or more. Of the stroke patients with preexisting hypertension, 47% had received drug therapy, and 38% were untreated, while 15% had received no information about antihypertensive treatment. In the patients of BI, these values were 57%, 18%, and 15%, and in the patients of BH, they were 37%, 49%, and 14%, respectively. In patients of AMI, they were 61%, 23%, and 16%, respectively.

The smoking status was known in 2,700 of the 3,644 stroke patients and in 704 of the 898 AMI patients. In the stroke patients the prevalence of ex-smokers was 9.9% (13.7% for men, and 4.6% for women) and that of current smokers was 39.6% (53.2% for men, and 21.0% for women). In the AMI patients the proportion of ex-smokers was 11.4% (12.0% for men, 10.0% for women) and that of current smokers was 55.4% (67.9% for men, and 28.1% for women). AMI patients were significantly more likely to be current smokers than were stroke patients.

Blood Pressure and Serum Cholesterol Concentration at the First Measurement after the Onset of Stroke or AMI

Average blood pressures at the first measurement after the onset (in most cases within 2 d) of BI, BH, and SAH were 157 ± 30/86 ± 16 mmHg, 177 ± 35/97 ± 20, and 162 ± 35/90 ± 20 mmHg, respectively. Both systolic and diastolic blood pressures were significantly higher in the patients of BH than in the patients of BI and SAH. Serum total cholesterol concentrations were obtained in 1,942 of the 3,644 stroke patients and in 485 of the 898 AMI patients within 1 wk after the onset. Serum cholesterol was
196 ± 48 mg/dl in the patients of stroke, 199 ± 50 mg/dl in cases of BI, 195 ± 44 mg/dl in cases of BH, and 185 ± 47 mg/dl in cases of SAH. In the patients of AMI it was 204 ± 48 mg/dl, significantly higher than in BH and SAH.

**Case Fatality**

Within 28 days after the onset, death occurred in 465 of the 3,644 cases of first-ever stroke and in 199 of the 898 cases of initial AMI. The case fatality rate was 12.8% (men 12.7, women 12.9) in stroke and 22.2% (men 17.5, women 30.5) in AMI.

Fatality was significantly higher in the cases of AMI than in those of stroke. The difference became greater in the older age classes, with the case-fatality rates in those aged 75 yr and older being about 3.3 times higher in AMI than in stroke. In the AMI cases fatality rates were significantly higher among women than among men. In contrast, there were no sex differences in case-fatality rates in total stroke cases or within each subtype of stroke. The case-fatality rate was highest in the cases of SAH and lowest in those of BI.

The mean age of the stroke patients who died within 28 days was 66.3 ± 16.7 yr (62.5 ± 16.7 in men and 70.6 ± 15.7 in women), and that of AMI patients was 73.1 ± 12.3 (68.5 ± 12.6 in men and 78.2 ± 9.8 in women). The stroke patients who died within 28 d were significantly younger than the AMI patients who died within 28 d. This was also true when data for men and for women were analyzed separately. Furthermore, in both stroke and AMI patients, the mean age of those who died within 28 d was significantly higher in women than in men. The mean age of the patients with BI who died within 28 d after the onset was 76.5 ± 11.9 (75.5 ± 11.7 in men and 77.6 ± 12.1 in women), and that of BH was 63.0 ± 17.3 (58.8 ± 16.3 in men and 69.2 ± 16.9 in women), and that of SAH was 63.1 ± 15.5 (56.8 ± 15.2 in men and 66.7 ± 14.6 in women).

The case fatality rate within 28 d after onset by quintiles of blood pressure was also determined. In cases of BI it was highest in the lowest quintile (≤131 mmHg) and in cases of BH it was highest in the highest quintile (≥206 mmHg). Although the case-fatality rate due to BH was slightly higher in the lowest quintile than in the second-lowest quintile, the difference was not significant. In cases of BH the case-fatality rate also differed significantly with diastolic blood pressure at the first measurement after the onset; it was significantly higher in the highest and second-highest quintiles (> 100 mmHg).

Multivariate analysis using a multiple logistic model demonstrated that disturbance of consciousness was a highly significant risk factor for death in the acute period in both BI and BH, whereas sex was not a significant risk factor. In BI, age, low systolic blood pressure, and large lesion size were also each independently associated with the case fatality rate within 28 d. Age was not predictive of death in the acute period in the cases of BH. Low serum total cholesterol concentration was not a significant predictor of death in the acute period of either BI or BH.

**Survival after Stroke and Acute Myocardial Infarction**

A portion of the patients with first-ever stroke and initial AMI were followed up for 10 yr, from April 1, 1988, to December 31, 1998. Their prognosis was confirmed by death certificate and resident card. The subjects followed included 1,651 patients with BI, 1,246 patients with BH, and 794 patients with AMI, and the follow-up rate was 89.8% in total, 89.5% in stroke, and 91.3% in AMI. The follow-up duration and cumulative survival rate by sex are summarized in Table 1.

Although the mean age at onset was different among the patients with BI, BH, and AMI, the survival curves were very similar (Fig. 3). The ten-year survival rates were 38.2%, 40.4% and 38.7%, respectively.

There was no big difference in the survival curve between men and women in both BI and BH. However, survival after AMI was quite different between men and women; the 10-yr survival rate was 47.3% for men and 27.7% for women.

The follow-up duration and cumulative survival rate in every age class are summarized in Table 2. Survival after stroke or AMI was dependent on age, and the survival curve showed a more precipitous fall in the elderly. In BI, the 10-yr cumulative survival rate was the highest, 77.6%, in the age class of 54 yr old and younger, and the lowest, 3.2%, in the age class of 85 yr old and over. Similarly, it was 58.3% and 5.1% in BH, and 74.8% and 0% in AMI, respectively.
Japan was formerly one of the countries with the highest mortality rates due to stroke in the world. Over the last two decades, however, there has been a precipitous fall in the incidence of mortality due to stroke, especially from BH, in Japan (1). However, the trends in the incidence rate have not been well clarified in large-scale studies. When compared with the incidence rates of stroke in other countries, that in Okinawa was no longer high. In the 18 populations involved in the WHO MONICA project (1985-1987), the age-adjusted annual rate of incidence of stroke in the world population aged 35 to 64 ranged from 125 to 361 per 100,000 in men and from 61 to 294 per 100,000 in women (9). Those rates were 155 for men and 88 for women in the present study. Even in older age groups, the incidence rate in Okinawa was not high. The age-adjusted annual rate of incidence as it relates to the world population aged 55 yr and over was 362 per 100,000 in Okinawa, which was relatively lower than that in Rochester, MN, USA (511, 1980-1984), Dijon, France (434, 1985-1986), Umbria, Italy (548, 1986-1989), and Perth, Australia (552, 1989-1990) (11).

The case-fatality rate within 28 d after stroke onset was also low in Okinawa. The rate for those aged 35 to 64 yr was 12% for men and 14% for women. In the WHO MONICA project (1985-1987, aged 35 to 64 yr), the rate ranged from 15% to 49% for men and from 18% to 57% for women (9). The case-fatality rate for those aged 55 yr and over was 12% in Okinawa, whereas it was 24% in Auckland, New Zealand (1991) (12), 23% in Perth (1989-1990) (11), and 17% in Rochester (within 30 days after the onset, 1980-1984) (13).

### Table 1. Survival after Brain Infarction, Brain Hemorrhage and Acute Myocardial Infarction

<table>
<thead>
<tr>
<th></th>
<th>Mean age at onset (y.o.)</th>
<th>Mean follow-up duration (days)</th>
<th>50% Survival (days)</th>
<th>Cumulative survival rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>68.0</td>
<td>3,268</td>
<td>2,926</td>
<td>37.6</td>
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<tr>
<td>Women</td>
<td>73.3</td>
<td>2,340</td>
<td>2,761</td>
<td>39.1</td>
</tr>
<tr>
<td>BH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>60.7</td>
<td>2,269</td>
<td>3,168</td>
<td>40.4</td>
</tr>
<tr>
<td>Women</td>
<td>67.5</td>
<td>2,114</td>
<td>2,325</td>
<td>38.2</td>
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<tr>
<td>AMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>62.5</td>
<td>2,291</td>
<td>3,421</td>
<td>47.3</td>
</tr>
<tr>
<td>Women</td>
<td>74.4</td>
<td>1,642</td>
<td>1,493</td>
<td>27.7</td>
</tr>
</tbody>
</table>

BI, Brain Infarction; BH, Brain Hemorrhage; AMI, Acute Myocardial Infarction.

### Table 2. Survival after Brain Infarction, Brain Hemorrhage and Acute Myocardial Infarction in an Age-Class

<table>
<thead>
<tr>
<th>Age-class</th>
<th>Mean follow-up duration (days)</th>
<th>50% Survival (days)</th>
<th>Cumulative survival rate (%)</th>
</tr>
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<tr>
<td>BI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>~54</td>
<td>3,268</td>
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<td>77.6</td>
</tr>
<tr>
<td>55~64</td>
<td>2,989</td>
<td>—</td>
<td>65.8</td>
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<tr>
<td>65~74</td>
<td>2,651</td>
<td>3,380</td>
<td>41.0</td>
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<td>75~84</td>
<td>1,812</td>
<td>1,620</td>
<td>16.9</td>
</tr>
<tr>
<td>85~</td>
<td>1,004</td>
<td>618</td>
<td>3.2</td>
</tr>
<tr>
<td>BH</td>
<td></td>
<td></td>
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<td>2,522</td>
<td>—</td>
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<td>55~64</td>
<td>2,628</td>
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<td>75~84</td>
<td>1,439</td>
<td>1,018</td>
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<td>85~</td>
<td>915</td>
<td>489</td>
<td>5.1</td>
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<tr>
<td>AMI</td>
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<td></td>
<td></td>
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<tr>
<td>~54</td>
<td>2,710</td>
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<td>739</td>
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</table>

BI, Brain Infarction; BH, Brain Hemorrhage; AMI, Acute Myocardial Infarction.

**Comment**

Japan was formerly one of the countries with the highest mortality rates due to stroke in the world. Over the last two decades, however, there has been a precipitous fall in the incidence of mortality due to stroke, especially from BH, in Japan (1). However, the trends in the incidence rate have not been well clarified in large-scale studies. When compared with the incidence rates of stroke in other countries, that in Okinawa was no longer high. In the 18 populations involved in the WHO MONICA project (1985-1987), the age-adjusted annual rate of incidence of stroke in the world population aged 35 to 64 ranged from 125 to 361 per 100,000 in men and from 61 to 294 per 100,000 in women (9). Those rates were 155 for men and 88 for women in the present study. Even in older age groups, the incidence rate in Okinawa was not high. The age-adjusted annual rate of incidence as it relates to the world population aged 55 yr and over was 362 per 100,000 in Okinawa, which was relatively lower than that in Rochester, MN, USA (511, 1980-1984), Dijon, France (434, 1985-1986), Umbria, Italy (548, 1986-1989), and Perth, Australia (552, 1989-1990) (11).

The case-fatality rate within 28 d after stroke onset was also low in Okinawa. The rate for those aged 35 to 64 yr was 12% for men and 14% for women. In the WHO MONICA project (1985-1987, aged 35 to 64 yr), the rate ranged from 15% to 49% for men and from 18% to 57% for women (9). The case-fatality rate for those aged 55 yr and over was 12% in Okinawa, whereas it was 24% in Auckland, New Zealand (1991) (12), 23% in Perth (1989-1990) (11), and 17% in Rochester (within 30 days after the onset, 1980-1984) (13).
Recently, a Japanese population-based study group reported the preliminary results on the age-adjusted annual incidence rate of first-ever stroke and AMI in eight communities spanning the country from Hokkaido (northern part of Japan) to Okinawa (14). The age-adjusted annual incidence rates of first-ever stroke ranged from 83 (Suita City, an urban area in Osaka Prefecture) to 142 per 100,000 standard population of Japan (Tsushima Islands, a fishery area in Nagasaki Prefecture). The case-fatality rates within 30 d after stroke onset ranged from 11.2% to 19.1%. Thus, low rates of incidence and case fatality are observed not solely in Okinawa, but are common to all of modern Japan. Our results together with previous reports (9, 11, 14) strongly suggest that the incidence rate of stroke has significantly decreased in Japan.

In mainland China there was a clear north-south gradient of stroke incidence (15). This north-south gradient of stroke incidence was mainly due to the regional difference in the prevalence of hypertension. The north-south gradient of stroke was also partly attributable to regional differences in the consumption of alcohol and the prevalence of cigarette smoking (15). However, our results and those of a previous report (14) suggest that there was no north-south gradient of stroke incidence in Japan, where no significant regional difference in the prevalence of hypertension (16) or smoking (17) was observed. With respect to salt intake, the regional difference was rather small in Japan; that is, daily salt intake ranged between 11.1 g/d and 13.2 g/d (17). When the incidence rate of stroke in Taiwan (18), which is located close to Okinawa, was adjusted with the world standard population, it was 320 (with 95% confidence interval of 258-382) per 100,000 persons/yr for those aged 36 yr and older. This value was apparently higher than that in Okinawa. This suggests that climate itself may not be a main determinant of stroke incidence.

The incidence rate of AMI was also low in Okinawa. The age-adjusted annual incidence rate of AMI adjusted to the world standard population for those aged 35 to 64 yr was 53 per 100,000 in men and 11 per 100,000 in women. In the WHO MONICA project 1985-1987, it ranged from 45 to 586 in men and from 7 to 187 in women. The male-to-female ratio of AMI incidence ranged from 1.9 to 10.9 in the populations surveyed in the WHO MONICA project (11). In Okinawa, the male-to-female ratio of AMI incidence was 4.8, which was similar to the ratios reported in Western countries (10). The case-fatality rate within 28 d after onset of AMI was also low in Okinawa, being 12% for men and 13% for women aged 35 to 64 yr. In the WHO MONICA project (1985-1987), it ranged from 9% to 48% among men and from 4% to 66% among women (10).

Several cohort studies suggested that there was no clear time-related trend in AMI incidence in Japan (19). However, when compared with the age-adjusted annual incidence rate of first-ever stroke, that of AMI was much lower in the present study, the ratio being approximately 4:1. The ratio of stroke to AMI in Japan ranged from 3.3 (Suita City) to 7.6 (Akita Prefecture, in the northern part of Honshu, the main island) in a previous population-based study (14). When the data for subjects aged 35 to 64 yr were examined, the ratio of stroke to AMI was 2.9 for men and 8.2 for women in Okinawa. On the other hand, in the communities involved in the WHO MONICA project the ratios of stroke to AMI ranged from 0.4 to 1.0 in men and from 0.9 to 2.6 in women (9, 10). Thus, the low incidence rate of AMI seems to be a common finding in Japan and, in combination with the low case-fatality rate, may contribute to the longevity of Japanese people.

In the present study, in almost all of the cases of first-ever stroke registered, the patients were examined by brain scanning, mainly by CT scanning. There have been few comparable studies in terms of size or the frequency of brain scanning (13, 20, 21). In a hospital-based study in Akita, Japan, 2,168 stroke patients were examined by CT, although recurring attacks were also included in that study (20). In the Perth Community Stroke Study (21) 536 stroke events were examined, and 461, 86% had a definite pathological diagnosis by CT, MRI, or autopsy. In a community-based study performed in Rochester, MN, USA, 731 first-ever strokes were registered, and the proportion of the cases examined by CT increased progressively, reaching more than 85% in the last three years of the period studied (13).

The proportional frequency of SAH in Okinawa is not very different from that in other communities in Japan and in Western countries (13, 20, 21). On the other hand, the proportional frequency of BH in Okinawa is higher than that noted in previous reports (13, 20, 21). In Okinawa BI occurred approximately 1.3 times more frequently than BH. The ratio of BI to BH was 2.0 in Akita (20), 6.3 in Perth (21), and 7.3 in Rochester (13). According to a preliminary result (14), the ratio of BI to BH in eight Japanese communities, not including Okinawa, is approximately 2.5. Thus, a relatively high frequency of BH appears to be one of the unique characteristics of stroke in Okinawa.

We could not clarify whether the high frequency of BH in Okinawa is due to an actual higher incidence of BH or due to the lower incidence of BI, because actual incidence rates of BH and BI were not reported in the previous studies (13, 14, 20, 21). However, we speculate that poor management of hypertension, especially in the younger age groups, might be one of the reasons for the relatively high proportion of BH in Okinawa. The prevalence of known hypertension prior to BH onset was especially high (exceeding 80%) in the age group of 35-64 yr, in which BH occurred more frequently than or as often as BI. Moreover, the frequency of untreated hypertension...
was especially high in the patients of BH.

In the cases of BI, about one-third of the lesions were located in the territory of the deep perforating arteries, as depicted on CT examination, and this was found in about half of the cases with definite lesions on CT. In the Hisayama study (22), in 53% of 105 cases of BI confirmed with autopsy or CT examination the lesions were located in the deep perforator territory. A high proportion of infarction in this region has been found in other communities in Japan (23), whereas in Western countries BI occurs much more frequently in the territories of cortical branches (24). These findings indicate that BI in Japan seems to be frequently of an arteriolosclerotic rather than an atherosclerotic nature. Furthermore, the cases of BI were also frequently associated with a higher prevalence of known hypertension. Since the Hisayama study (25) demonstrated that hypertension is a significant and independent risk factor for BI in the deep perforator territory, improvement in the management of hypertension may reduce the occurrence of BIs in this region.

In addition, the low case-fatality rate during the acute phase of BI may relate to the fact that the lesions are frequently located in the deep perforator territory, because the BI lesions in this territory are generally small, and our results suggest that a large low-density area depicted on the CT scan as well as a disturbed consciousness level are the strongest predictors of case fatality within 28 days of BI.

Long-term survival after BI and BH were both dependent on age and were similar between men and women. However, survival after AMI was greatly shorter in women than in men. The difference is attributable to the mean age at onset, which was 12 yr older in women than in men. Causes of death will be clarified elsewhere in the future.

In conclusion, the age-adjusted annual incidence rate of first-ever stroke in Okinawa, Japan, is no longer higher than the world average. However, it was still four-fold higher than that of AMI, which is still considerably lower than the incidence rates in Western countries. The proportional frequency of BH is high, and among the cases of BI, the lesion is frequently located in the deep perforator territory. The more distinctive characteristics of stroke in the Okinawan population probably relate to poor management of hypertension. Although Okinawa already has the highest life expectancy and the lowest cardiovascular disease death rate in Japan (2), improvement in the management of hypertension may further extend the life expectancy and decrease the cardiovascular disease death rate.

References

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