identify a variation in stroke incidence over the days of the week. Second, the physical fitness or bodily strength of younger men is generally superior to older men. Due to this reason, younger men might be more physically able to adapt to an acute change in activity pattern or environment than older men. Thus, the triggers might not affect younger men to the same extent as older men. On the other hand, the older men will be physically more vulnerable to the change in activity pattern or environment. Thus, the triggers might not affect the younger men as strongly as the older ones. In rural areas in Japan, older residents often work outside, especially in farming. Similarly, a report [21] from Takashima estimated that more than 60% of male residents aged 60 or more in the area are involved in some type of work. About one third of them are involved in cultivation, such as growing rice or vegetables and other related activities. Some of the others are engaged in white-collar or professional jobs or in jobs linked to blue-collar work. More than 77% of the older men aged 60 years or more are reported to have a regular lifestyle pattern. Shifts in their activity pattern during the days of the week are likely to have caused the weekday variation of stroke in the older-age group. Shifting from a nonworking weekend into the work week with a change in rest/activity cycle could serve as a trigger for stroke.

Analogous to Wang et al. [5] we also found the weekly distribution of strokes to differ between men and women. We observed the after weekend increase in stroke incidence among men only. This phenomenon may be explained, at least partly, by the very different traditional gender roles in Japanese family life. Generally men have an activity outside the house during the weekdays and rest during the weekends, thus having disparity in their weekly activities. Though women also work outside the home, housekeeping works keep them in a constant working pattern all over the week. The abrupt shift in the day-to-day activity pattern that occurs for men may act as a stroke-triggering factor contributing to an increased stroke incidence after the weekend.

Similar to the results of another study [5], the increased incidence of stroke in the after weekend group in this study was mainly due to an increased occurrence of cerebral infarction. Contrary to our anticipation, a similar variation was not observed in hemorrhagic stroke. We anticipated that the external triggering factors would affect both the infarction and hemorrhagic types of stroke similarly. This dissimilarity between the 2 types of stroke may possibly be attributed to the smaller number of hemorrhagic strokes during the study period.

The present study is based on registry data and thus, it is mainly community-based surveillance data. The characteristics of the data set do not assist primarily in exploring the mechanisms responsible for the weekly variation in stroke incidence. Now identifying the weekly trend, an interesting area for investigation will be the relationship of variations in physical activity and daily routines among days of the week and stroke occurrence, in perspective of demographic characteristics. Changes in the rest/activity cycle with a shift from the nonworking weekend to the work week could serve as a trigger factor for stroke. The physiological processes related to a change in these activities may trigger acute stroke. It would be advantageous to examine these factors using longitudinal data.

Explanations for the after weekend increase in stroke incidence in other studies [1–5] include socioeconomic status [1] and working status [2]. The shift from a relaxing weekend to a working Monday has been reported to be associated with an increased incidence of cardiovascular events [22]. Willich et al. [23] documented an increased risk of myocardial infarction on Monday and hypothesized that external triggering factors may play a role in the acute causation of a cardiovascular event. In addition to the external trigger, Muller et al. [24] considered the rest/activity cycle in shifting from the nonworking weekend to the work week as an important aspect for acute cardiovascular disease. This cycle could serve as a triggering factor for cardiovascular events, which in turn could also apply to stroke.

Kelly-Hayes et al. [2] found an association between drinking, smoking and hypertension with Monday increase in stroke incidences. On the contrary, in our study after weekend increase in stroke incidence was observed both for the presence or absence of history of drinking, smoking, hypertension and diabetes.

It has been suggested that the Monday increase in coronary events might be an artifact of the registration process because the Monday incidence report also contains those occurring on Sunday [25]. However, the date of stroke onset in our registry was defined by the date of first presentation of symptoms, rather than the date of hospital admission. This definition of stroke onset prevents such misclassification of incidence date in our registry.

The comprehensiveness of the registration system for cardio-cerebrovascular diseases such as stroke is essential in determining the incidence and trend in a particular area. A system to capture all patients in the study area, together with accurate diagnosis, is required to ensure the completeness of the registration [26]. Factors that re-

duce the comprehensiveness of a register are missing cases or cases lacking a confirmed diagnosis, patients being admitted to hospitals outside the registration area and nonregistration. The quality of our registration system was assured by its completeness. Our registry system was planned to capture all the cases in the study area by covering all the hospitals in the county. It has been estimated that more than 98% of all hospital admissions of Takashima County are seen in these institutions. To ensure that eligible patients hospitalized outside the county were not omitted, registration procedures were also conducted at 3 high-level medical facilities outside the county.

In Japan almost 100% of the residents are covered by health insurances under the control of the Ministry of Health and Welfare [27]. Therefore, individuals with mild stroke who visited general physicians in the community are almost always referred to secondary- or tertiary-level hospitals for extensive investigations. In addition to that, 24-hour round the clock emergency ambulance service is available for residents without any charge. The usual practice in Japan is to take patients with any acute disease conditions to the emergency facilities. Thus, we believe that extremely few patients would be left out of our registration system.

Most of the stroke cases in Japan are referred to hospitals for admission and CT is performed in more than 90% of the admitted cases, even in rural areas [15, 28]. The strength of this study is the accuracy of the diagnostic investigations, resulting in almost complete categorization of stroke subtype. The 2 major hospitals in Takashima County both have CT facilities. Among the study cases in our registry, 92.9% had CT or MRI performed. Therefore, we believe that identification of stroke cases in our study was almost complete and stroke diagnosis and classification was accurately conducted.

The main limitation of our study is the missing information for a number of registered patients about their history of risk factors: hypertension, diabetes, smoking and drinking. As we could not find any particular pattern for the missing information, we excluded these cases during the analysis of risk factor influence. We also could not reckon the disease duration for hypertension and diabetes or quantify the amount of alcohol or cigarette smoking, both in cases of habitual quantity or just before the stroke onset. Rather, we used only information reported about the presence or absence of a history of risk factors prior to the stroke onset.

Finally, the Takashima Registry covers a rural and semiurban population in Japan which may be different from the urban population. However, in an urban environment the disparity of activity pattern among the days of the week would be more distinct. Therefore, we believe that the peak in stroke incidence after the weekend would also occur in urban settings.

In conclusion, we found that older men showed an increased stroke incidence after the weekend. This trend holds for both the presence and absence of conventional risk factors. Thus, our analysis points towards an influence of internal or external stroke-triggering factors in both the activities of daily living as well as during the time immediately preceding acute onset of stroke. The identity of these triggering factors requires further exploration. An interesting area for further investigation will be the relationship of the variation in daily activities among the days of the week and stroke occurrence using longitudinal data. Our findings also suggest that there are days of increased stroke risk, which may be helpful in designing more effective stroke prevention strategies.

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Surveillance and measuring trends of stroke in Japan: The Takashima Stroke Registry (1988 – present)

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Abstract The Takashima Stroke Registry is a disease registration system for stroke established in Japan in 1988. This stroke registry is a population-based, prospective, observational study whose objective is to monitor trends in the incidence and case-fatality of stroke in Japan. Takashima County is located in the rural area of the Shiga prefecture in central Japan, having a stable population of approximately 54,000. It is a farming community with similar cultural values and standards of living throughout the region. The population has remained fairly stable during the 16-year study period. 1750 stroke cases (men 937 and women 813) were registered during 1988–2002. The average ages of the men and women patients were 69.4 and 74.4 years respectively. Stroke diagnostic criteria are established for the Monitoring System for Cardiovascular Disease commissioned by

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the Ministry of Health and Welfare, Japan. These criteria were based on WHO-MONICA project. Takashima registry system was planned to capture all the cases in the study area by covering all the hospitals of the county. To ensure that eligible patients hospitalized outside the county were not omitted, registration procedures were also conducted at three high-level medical facilities within the Shiga region but outside the county. Due to the high rate of computed tomography use in Japan the identification of stroke cases within the study area is almost complete and stroke diagnosis and classification are accurately recorded.

Stroke surveillance

Disease surveillance provides essential information that can be used for designing effective prevention strategies, appropriate allocation of health resources, assessment of effectiveness of the health programs, etc. Disease registries for chronic diseases, including stroke, are essential in determining the incidence and trends in a particular population.

Takashima Stroke Registry

The Takashima Stroke Registry is an integrated part of the ongoing Takashima Cardio-cerebrovascular Disease Registry, a disease registration system for stroke

and acute myocardial infarction established in Japan in 1988. The registration study is a population-based prospective, observational study whose objective is to measure trends in the incidence and case fatality of stroke and to compare them with other populations within and outside Japan.

Geographical setting

Figure 1 shows Takashima County, Shiga prefecture in the map of Japan. Takashima County is located in the predominantly rural area of Shiga prefecture in a central area of Japan. It is primarily composed of mountainous rural areas. The largest freshwater lake in Japan, Biwako Lake, is located to the east of Takashima County. Weather in the Shiga follows four very distinct seasons: winter, spring, summer, and autumn, with significant seasonal fluctuations.

Population characteristics

Table 1 shows the characteristics of the residents of Takashima County. It is a farming community with inhabitants mainly classified culturally into the same subgroup and has similar standards of living. The population has remained fairly stable during the 16-year study period, with a population of 55 451 (49.2% male and 50.7% female) in the year 2000 (1), with 22.3% of the population aged 65 years or more.
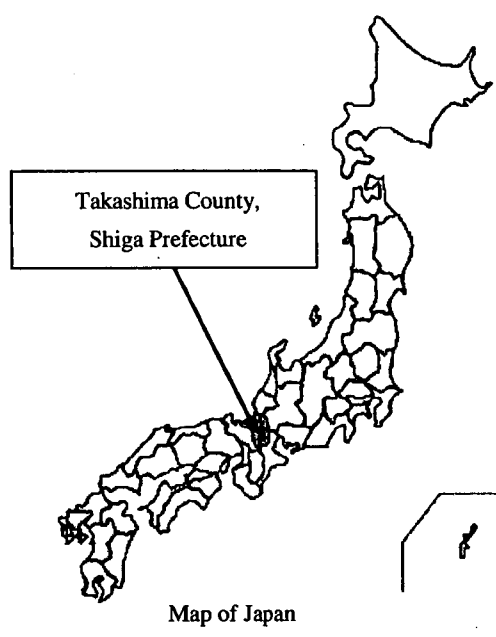
Fig. 1 Location of Takashima County, Shiga prefecture in Japan

Table 1 Population characteristics of the Takashima Stroke Registration area, Takashima County, Shiga, Japan*

Characteristics	Takashima County Number
Population	
Total	55451
Gender	
Men	27323 (49·2%)
Women	28128 (50·7%)
Age group	
Aged up to 14 years	8720 (15·7%)
14–64 years	34360 (62·0%)
Aged 65 years or more	12354 (22·3%)
Sex ratio (males per 100 females)	94·9
Population density	
Total land area	511 km²
No. people per hectare (total land area)	1·08
No. people per hectare (total dwell able area)	4·70
Industrial Population	
Primary[†]	1871 (6·8%)
Secondary[‡]	10470 (38·1%)
Tertiary[§]	15145 (55·1%)

*Data are based on the 2000 population census of Japan (1). (age unknown 16).
[†]Primary: agriculture, fishing, forestry, etc.
[‡]Secondary: industry sector.
[§]Tertiary: service sector.

Case finding and registration process

Takashima County contains two community hospitals: Takashima General Hospital, a public facility with 261 beds located in the south of the county, and Makino Hospital, a private facility with 72 beds located in the north. Additionally, there is also a geriatric hospital, Imazu Hospital, which is the only dedicated facility for elderly people in the county. It has been estimated that approximately 98% of all hospital admissions are seen at these community hospitals (2). The remaining patients are seen at three tertiary care hospitals: Shiga University of Medical Science Hospital and Otsu Red Cross hospital in Otsu City, and Shiga Medical Center for Adults in Moriyama City, which have more sophisticated facilities for advanced treatment. These are located outside the county but within the Shiga prefecture.

Registered patients included all residents of the county who were hospitalized with stroke in the two community hospitals and the geriatric hospital. Also, the patients who are residents of Takashima County but were hospitalized with a stroke at any of the three tertiary hospitals outside the county were also included. Internist and specialist investigative personnel trained by neurologists and epidemiologists carried out both the case finding and registration of patients who met the criteria. Before final decisions on inclusion in the registry, physicians and epidemiologists checked the records for absolute verification for eligibility. Registration procedures were investigated once every 3 months at the six facilities. We registered all cases that met the inclusion criteria (2, 3) on the basis of the medical records from all the relevant hospitals inside and outside the county and the county ambulance records. We used the registration form of the Monitoring System for Cardiovascular Disease commissioned by the Ministry of Health and Welfare, Japan (3). Registered stroke patients were monitored annually by death certificates. Original death certificates were reviewed at the county health center with the approval of the Ministry of Public Management, Home Affairs, Post and Telecommunications, Japan, and the General Affairs Office of Japan in order to establish cause of death. Patients' privacy was protected.

Stroke diagnostic criteria

The stroke diagnostic criteria used in this study are those established for the Monitoring System for Cardiovascular Disease commissioned by the Ministry of Health and Welfare, Japan (3). These criteria are in accord with the World Health

Organization's MONICA (Monitoring of Trends and Determinants in Cardiovascular Disease) (4) projects. These define a stroke as a sudden onset of neurological symptoms, which continue for a minimum of 24 h or result in death. Early case fatality was defined as patients who died within 28 days of the onset of a stroke event. The diagnosis of stroke type was based on clinical symptoms as well as computed tomography (CT) scans. A cerebral infarction was defined as a region of low-density absorption on a CT scan. An intracerebral hemorrhage was defined on the basis of a region of high-density absorption in the causal region due to a hematoma as shown on a CT scan. A subarachnoid hemorrhage was defined on the basis of a region of high-density absorption in the cerebrospinal fluid due to a hemorrhage as shown on a CT scan. Patients who satisfied clinical symptoms of acute stroke but whose type of stroke could not be determined based on clinical signs and/or CT scan results were labeled having as unclassified stroke. Cerebral infarction was classified as either cerebral thrombosis or cerebral embolism.

Items recorded at the registration of a stroke were:

- the date and time of the event,
- the situation and symptoms during the event,
- the extent of neurological symptoms during the event,
- clinical observations during the event (e.g., blood pressure, presence of fibrillation, level of consciousness, impairment of neurological function),
- past medical history,
- family medical history,
- smoking history,
- alcohol use,
- early (within one week) rehabilitation,
- fatality (within 28 days),
- cause of death,
- recurrence in acute stage, and
- CT scan observations.

On admission to hospital, patients were also examined for abnormal lipids and kidney function. Items investigated in the CT scan were the size of regions of low-density absorption in association with cerebral infarction, and the size of regions of high-density adsorption in

Table 2 Stroke cases within the Takashima Stroke Registration System area, Takashima County, Shiga, Japan (1988–2002)

Characteristics	Stroke cases
Registered stroke cases	1750
Total	
Men	937 (53·5%)
Average age of men	69·4 years
Women	813 (46·5%)
Average age of women	74·4 years
Up to 64 years	434 (24·8%)
65 years and older	1316 (75·2%)
Stroke subtype	
Cerebral infarction	1177 (67·3%)
Intracerebral hemorrhage	380 (21·7%)
Subarachnoid hemorrhage	167 (9·5%)
Unclassified	26 (1·5%)

association with cerebral hemorrhage. Cerebral angiography was used to investigate cerebral aneurysms and anomalies in the cerebral venous system, and secondary cerebral infarctions associated with subarachnoid hemorrhage.

Registered events

The Takashima Stroke Registry is an ongoing disease registry that has been compiling stroke cases since 1988. A total of 1750 (53·5% men and 46·5% women) cases have been recorded in the registry as of 2002. The majority of the stroke cases were of infarction type (67·3%), followed by hemorrhagic type (21·7%), of stroke. Table 2 shows the stroke cases of Takashima Stroke Registration System by gender, age, and sub-type.

Comprehensiveness

The comprehensiveness of the registration system for cardio-cerebrovascular diseases such as stroke is essential to determine the incidence and trends in a particular area (4, 5). A system to capture all patients in the study area, together with an accurate diagnosis, is required to ensure the comprehensiveness of the registration (6, 7). Factors that reduce the comprehensiveness of a register include missing cases or cases lacking a confirmed diagnosis, patients being admitted to hospitals outside the registration area,

and non-registration. The quality of our registration system was assured by its completeness. Our registry system was planned to capture all the cases in the study area by covering all the hospitals of the county. It has been estimated that more than 98% of all hospital admissions of Takashima County are seen in these institutions (2). To ensure that eligible patients hospitalized outside the county were not omitted, registration procedures were also conducted at three high-level medical facilities outside the county.

In Japan, almost 100% of residents are covered by health insurance under the control of the Ministry of Health and Welfares (2, 8). Therefore, people with mild stroke who visited general physicians in the community are almost always referred to secondary- or tertiary-level hospitals for extensive investigations. In addition to this, a 24 h, round-the-clock emergency ambulance service is available for all residents without charge. The usual practice in Japan is to take patients with any acute disease conditions to emergency facilities. Thus, we believe that few patients would be left out of our registration system.

Most of the stroke cases in Japan are referred to hospitals for admission and CT scans are performed on more than 90% of the admitted cases, even in rural areas (2, 9). The strength of this study is the accuracy of the diagnostic investigations, which allows almost complete

categorization of stroke sub-type. The two major hospitals in Takashima County both have CT facilities. Therefore, we believe that identification of stroke cases within the study area was almost complete and stroke diagnosis and classification was accurately recorded.

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