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Background and Purpose—Some studies suggest that the incidence of stroke may continue to change. We examined recent temporal trends in a defined geographical area of southern Sweden.

Methods—Medical records at the University Hospital of Lund (hospital district population 224 126 in 1993) were retrospectively screened for possible first-ever strokes during 1993 to 1995. Included patients were classified into pathological subtypes (cerebral infarction, intracerebral hemorrhage, subarachnoid hemorrhage, and undetermined pathological type) and according to the Oxfordshire Community Stroke Project (OCSP) classification system. Stroke patients from a previous study from 1983 to 1985 in the same area were reevaluated with the same criteria. Epidemiological data for the 2 time periods were compared.

Results—There were 998 patients with first-ever stroke in 1983 to 1985 and 1318 in 1993 to 1995. The total incidence rate per 100 000 person-years (age-adjusted to the European population) increased from 134 (95% confidence limits [CL] 126 to 143) to 158 (95% CL 149 to 168). The incidence rate for patients <75 years of age increased from 94 (95% CL 85 to 103) in 1983 to 1985 to 117 (95% CL 108 to 127) in 1993 to 1995, whereas the incidence rate for patients ≥75 years was stable. The age-adjusted incidence rates for the OCSP subtypes lacunar and posterior circulation syndromes increased significantly, by 30% and 55%, respectively.

Conclusions—A marked increase in the incidence of first-ever stroke was observed, surprisingly mainly confined to people <75 years of age. The underlying causes of this increase must be explored in future studies. (Stroke. 2000;31:481-486.)

Key Words: epidemiology ■ stroke incidence ■ Sweden
1985, including some possible stroke patients not detected during the earlier study, were reevaluated. The same criteria as for 1993 to 1995 were used. Out of 1120 patients, 122 were excluded. Those excluded were patients with prior stroke (n=89), nonstroke event (n=4), residency outside the present study area (n=18), other causes (TIA, subdural hematoma, trauma, tumor, iatrogenic stroke, stroke onset outside study period; n=10), and patients for whom the medical records not could be found (n=1).

The register was approved by the local Data Inspection Board.

**Stroke Classification**

Patients with clinical first-ever stroke (according to the WHO criteria; see above) were divided into the following main types of stroke: cerebral infarction (CI), intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), and undetermined pathological type (UND).

Stroke patients were considered to have CI when CT, MRI, or autopsy showed signs of infarction in an appropriate area or no signs of intracerebral infarction or hemorrhage. ICH was diagnosed when CT, MRI, or autopsy showed intraparenchymal blood in the brain. SAH was diagnosed when CT, lumbar puncture (LP), or autopsy showed subarachnoid blood. If neither CT, MRI, nor autopsy were undertaken, the cause of stroke was classified as undetermined (UND) unless LP showed SAH.

All patients with CI, ICH, or UND were classified into subtypes of stroke according to the Oxfordshire Community Stroke Project (OCSP) classification system: total anterior circulation syndrome (TACS; large anterior circulation infarct with both cortical and subcortical involvement), partial anterior circulation syndrome (PACS; more restricted and predominantly cortical infarcts), lacunar syndrome (LACS; infarcts confined to the territory of the deep perforating arteries), and posterior circulation syndrome (POCS; infarcts clearly associated with the vertebrobasilar arterial territory). In cases where records were incomplete to determine the OCSP subtype, the patients were classified as unspecified subtype.

**Statistical Methods**

To calculate the population at risk, we used the following scheme for both time periods. Because each study period was 3 years, each person living within the catchment area contributed with 3 person-years (998 in 1983 to 1985 and 1318 in 1993 to 1995) had their first-ever stroke. The median age was 76.3 years (range 18 to 100) in 1983 to 1985 and 75.7 years (range 18 to 100; \( P=0.23 \)) in 1993 to 1995. For men, the median age decreased from 74.2 years in 1983 to 1985 to 72.6 years in 1993 to 1995 (\( P<0.05 \)) and for women the median age was 78.0 years in 1983 to 1985 and 78.9 years in 1993 to 1995 (\( P=0.56 \)).

**Results**

During the 2 periods of the study, a total number of 2316 persons (998 in 1983 to 1985 and 1318 in 1993 to 1995) had their first-ever stroke. The median age was 76.3 years (range 18 to 100) in 1983 to 1985 and 75.7 years (range 18 to 100; \( P=0.23 \)) in 1993 to 1995. For men, the median age decreased from 74.2 years in 1983 to 1985 to 72.6 years in 1993 to 1995 (\( P<0.05 \)) and for women the median age was 78.0 years in 1983 to 1985 and 78.9 years in 1993 to 1995 (\( P=0.56 \)).

**Incidence**

The total age- and sex-adjusted (to the Swedish population December 31, 1993) incidence rate increased from 207 per 100 000 person-years (95% CL 193 to 220) in 1983 to 1985 to 235 (95% CL 222 to 249) in 1993 to 1995. For men, the corresponding rates were 214 (95% CL 196 to 234) in 1983 to 1985 and 246 (95% CL 227 to 265) in 1993 to 1995 and for women 199 (95% CL 181 to 218) in 1983 to 1985 and 225 (95% CL 207 to 243) in 1993 to 1995. The total incidence rate (age-adjusted to the European population) was 134 (95% CL 126 to 143) in 1983 to 1985 and 158 (95% CL 149 to 168) in 1993 to 1995.

In Table 1, age-specific and age- and sex-adjusted incidence rates are shown. Women had significantly lower incidence rates than men in the age groups 55 to 84 years during both study periods. For patients <75 years of age, the incidence rate (age- and sex-adjusted to the Swedish population December 31, 1993) increased from 94 per 100 000 person-years (95% CL 85 to 103) in 1983 to 1985 to 117 (95% CL 108 to 127) in 1993 to 1995. The corresponding figures for patients \( \geq 75 \) years were 1477 (95% CL 1356 to 1606) in 1983 to 1985 and 1560 (95% CL 1446 to 1682) in 1993 to 1995.

**Main Types of Stroke**

Among the 998 stroke patients in 1983 to 1985, 448 (44.9%) had CI, 85 (8.5%) had ICH, 33 (3.3%) had SAH, and 432 (43.3%) had UND. Among the 1318 patients in 1993 to 1995, 973 patients (73.8%) had CI, 152 (11.5%) had ICH, 59 (4.5%) had SAH, and 134 (10.2%) had UND.

**OCSP Subtypes of Stroke**

The number and percentage of patients in each OCSP subtype of stroke (CI, ICH, and UND included) for both periods are shown in Table 2. The proportions of patients with LACS and POCS decreased, whereas the proportion of patients with PACS decreased. There were 30 patients in 1983 to 1985 and 10 patients in 1993 to 1995 with unspecified OCSP subtype. Those patients were excluded from further subtype analysis.

The age- and sex-adjusted (to the Lund-Orup population 1993 to 1995) incidence rates for each OCSP subtype were analyzed. The incidence rate of LACS increased from 38.6 per 100 000 person-years (95% CL 33.7 to 44.0) in 1983 to 1985 to 50.2 (95% CL 45.0 to 55.9) in 1993 to 1995. POCS increased from 18.2 (95% CL 14.9 to 22.0) in 1983 to 1985 to 28.3 (95% CL 24.4 to 32.6) in 1993 to 1995, whereas the incidence rates of TACS and PACS were quite stable. For men, the incidence rate for LACS increased significantly by 44%, from 41.5 per 100 000 person-years (95% CL 34.5 to 49.6) in 1983 to 1985 to 59.6 (95% CL 51.6 to 68.5) in 1993 to 1995. The incidence rate of POCS for men was 20.5 (95% CL 15.6 to 26.3) in 1983 to 1985 and 30.0 (95% CL 24.4 to 36.5) in 1993 to 1995. Among women, there was a marked increase of the incidence rate for POCS by 66%, from 16.0 (95% CL 11.7 to 21.2) in 1983 to 1985 to 26.6 (95% CL 21.4 to 32.7) in 1993 to 1995. The increase in the incidence rate of LACS was only 15% for women (nonsignificant).
**Discussion**

We found that the absolute number of first-ever stroke increased by no less than 32% over a 10-year period and that the total incidence rate (age-adjusted to the European population) increased by 18%. Notably, the incidence rate for patients $\geq 75$ years increased by 25%. Such major changes in the incidence of stroke have not been reported elsewhere for this time period.

**Methodological Aspects**

Some methodological aspects of the present study need to be considered. Being retrospective and hospital-based, this study might have underestimated the true incidence rate. However, the hospitalization rate of stroke in Sweden is known to be very high. Only 3% to 5% of all stroke survivors are treated out-of-hospital (for review see Reference 17). The policy during both periods was that all first-ever stroke patients seeking medical care were treated in-hospital, and there was no increase in the number of hospital beds available for stroke patients during the 2 study periods. Therefore, although it cannot be completely ruled out, we consider it unlikely that an increase in hospitalization rate of stroke patients has occurred. The methods for collection of data to central medical databases at the hospital were similar during both study periods.

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(1) Age-standardized rates (ASR) adjusted to the Swedish population (0 years and older).
(2) Age-standardized rates (ASR) adjusted to the European Population (0 years and older).
*95% CL do not overlap compared with 1983 to 1985.
seek medical care for milder neurological symptoms during the latter study period. Other studies have reported stroke to become a less severe disease during the last decades. However, the design of the present study did not permit analysis on the frequency of seeking medical care for stroke symptoms. The increased incidence rate for the OCSP subtype LACS may reflect an increased hospitalization rate for less severe strokes. However, it has been reported that a large proportion of patients with LACS are substantially handicapped. For patients with rapidly reversible symptoms, we also considered the possibility of a change in the diagnostic coding practices regarding TIA (not included in the WHO definition of stroke) and CI/stroke. To prevent this possible source of error, we evaluated the medical records of all patients with the diagnosis of TIA during both study periods, focusing on the duration of the symptoms.

In other time-trend incidence studies, the possible role of different CT rates over time has been discussed. However, in our study the definition of stroke relies only on clinical presentation and it is therefore unlikely that the more extensive use of CT during the latter period would influence the incidence of stroke. In another study, the use of CT influenced the number of incident strokes by <2% only. Diagnosis and case ascertainment of stroke in people within higher age groups may be more difficult because evaluation of stroke symptoms may be complicated by comorbidity (eg, dementia and osteoarthrosis). However, in our study the increase of the incidence rate of stroke was mainly confined to people <75 years of age.

### Comparison With Other Recent Studies

The total age-adjusted incidence rate (age-adjusted to the European population) observed during 1993 to 1995 in Lund-Orup is well in line with most of the comparable studies in different geographical areas covering parts of the 1990s (shown in the Figure). However, marked higher incidence rates have been reported in Tartu (Estonia) during 1991 to 1993 and in Novosibirsk (Russia) during 1990 to 1992. Somewhat lower incidence rates have been observed in East Lancashire (England) during 1994 to 1995, in Erlangen (Germany) during 1994 to 1996, and in Saudi Arabia during 1989 to 1993. This shows that the results from various stroke studies differ. In a world health perspective, because the elderly part of the population is growing in most countries, even a stable incidence rate will lead to an increased absolute number of stroke patients.

### Possible Explanations for Increasing Stroke Incidence

Some potential factors behind the increased stroke incidence in the present study need consideration. First, the risk factor profile in the population might have changed in an adverse direction. A recent study from Göteborg, Sweden, investigated the trends of cardiovascular risk factors during 1985 to 1995 in people 25 to 64 years of age. The prevalence of smoking declined. By contrast, body mass index and systolic and diastolic blood pressures increased in the population. A significant decrease in both HDL and LDL cholesterol levels was observed, whereas serum triglyceride levels increased. Whether this is a general trend in Sweden is not known. In a recent Dutch study, a considerable proportion of incident strokes among hypertensives was due to undertreatment of hyperten-
sion. Second, overall survival in patients with ischemic heart disease might have improved as the result of better medical treatment, which secondarily could have led to increased stroke incidence. In Rochester, data indicate that persons surviving ischemic heart disease are the primary contributors to the increased incidence rates observed in the 1980 to 1984 time period. Third, during the 1980s and 1990s, the immigration to Sweden increased rapidly, and foreign-born residents now constitute ~11% of the Swedish population. As ethical differences in the incidence of stroke have been reported, this might have influenced the incidence rate of stroke in Lund-Orup.

**Stroke Subtypes**

The possibility to compare the proportions of the main types of stroke in Lund-Orup is limited by the quite low CT rate in 1983 to 1985. However, the proportions of patients with ICH and SAH appear to be quite stable during the study periods and are similar to other studies. The proportions of patients in each OCSP subtype are well in line with other studies. No other study has investigated the temporal trends of the separate OCSP subtypes. Although the present study was retrospective and the OCSP classification was based only on medical records, the observed rapidly increasing incidence rates of LACS and POCS is noteworthy. During the 10-year period the clinical features of cerebellar infarctions have become more well-defined. It is now known that isolated vertigo might be caused by cerebellar lesions in up to 25% of the cases. Because this fact was not fully understood during 1983 to 1985, this might have contributed to an increasing incidence rate of POCS but is unlikely to have affected the total incidence rate of stroke much. The increasing incidence rate of LACS could be a result of changes in the risk factor profile of the population.

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