Increasing Stroke Incidence and Decreasing Case Fatality, 1989–1998
A Study From the Stroke Register in Malmö, Sweden

Hélène Pessah-Rasmussen, MD, PhD; Gunnar Engström, MD, PhD; Ingela Jerntorp, RN; Lars Janzon, MD, PhD

Background and Purpose—Although the incidence of and mortality from myocardial infarction (MI) have declined in most industrialized countries, incidence studies of stroke have shown less consistent trends. This study examines time trends in the incidence of stroke and case fatality rates in relation to socioeconomic circumstances and history of MI.

Methods—Stroke incidence in the city of Malmö, Sweden (250 000 citizens), has been continuously monitored since 1989. All patients 50 to 79 years of age who experienced a first-ever stroke between 1989 and 1998 were included.

Results—We included 3621 patients (1969 men, 1652 women). The age-standardized incidence was 647 per 100 000 persons-years for men and 400 per 100 000 persons-years for women. The annual increase—3.1% in men (P<0.05) and 2.9% in women (P<0.05)—was more pronounced in the younger age groups and was lowest in areas with poor socioeconomic circumstances. We found that 13% of the men and 6% of the women had a history of MI; this proportion was stable over the study period. The average case fatality rates in 1989 to 1998 were 10% for men and 9.3% for women. Rates remained stable for men but declined significantly in women (odds ratio per year, 0.895; 95% confidence interval, 0.84 to 0.95).

Conclusions—In this urban population, stroke incidence increased between 1989 and 1998. The rate of increase tended to be lower in residential areas with least favorable socioeconomic circumstances. The proportion with a history of MI remained unchanged during the study period. There has been significant improvement in the case fatality rate in women but not in men. (Stroke. 2003;34:913-918.)

Key Words: epidemiology ■ incidence ■ myocardial infarction ■ Sweden

Since the development of new strategies for the treatment and prevention of cardiovascular disease, incidence and mortality in ischemic heart disease (IHD) have been declining.1–4 Studies on stroke, however, have yielded less consistent results.5 To what extent this finding may be related to methods of retrieval and validation of cases or strategies for treatment and prevention remains to be evaluated. Whether an increasing population of survivors of myocardial infarction (MI) could explain why stroke incidence has increased in some countries has not been studied.

Malmö, situated in the southernmost province of Sweden, is the country’s third-largest city, with a population of ~250 000 inhabitants. According to official statistics, mortality from IHD has declined annually, with a rate of 3.7% and 4.7% among men and women, respectively, between 1989 and 1998. Three-year survival after MI has continuously increased since 1978.6

The ~800 citizens who annually experience a first stroke are submitted for evaluation and treatment at the University Hospital. Since 1989, these patients have been entered into the Stroke Register of Malmö (STROMA).7 A previous study has shown that between residential areas, defined in terms of their socioeconomic circumstances, there are significant differences in incidence of stroke.8 The objectives of this study from STROMA were to examine time trends in incidence of stroke and case fatality rates in relation to socioeconomic circumstances and to explore possible explanations for the time trends.

Subjects and Methods

STROMA
The inclusion criteria and methods for case finding have been described in detail elsewhere.7,8 Briefly, Malmö residents who suffered a stroke after January 1, 1989, were included in STROMA. Since 1989, a specially trained nurse has actively sought all cases of suspected or diagnosed stroke, both hospitalized and nonhospitalized, at Malmö University Hospital (the only hospital in Malmö): patients attending the Emergency Department, patients suffering a stroke while in hospital for other diagnosis, and patients referred to outpatient consultation at the Department of Neurology and Angiology.

The register nurse, under the supervision of a senior physician, validated the diagnosis through medical records and, when possible,
through patient interview. Stroke was defined as rapidly developing clinical signs of local or global loss of cerebral function lasting >24 hours (or leading to death before then).

The typical clinical picture was required for all cases except for the few cases of sudden death. The stroke subtypes were coded according to International Classification of Diseases (ICD), revision 9. Classification as subarachnoid (ICD 430) or intracerebral hemorrhage (ICD 431) required verification with CT and/or autopsy. Cerebral infarction (ICD 434) was diagnosed when CT and/or autopsy could verify the infarction and/or exclude hemorrhage and nonvascular disease. If neither CT nor autopsy was performed, the stroke was classified as unspecified stroke (ICD 436). Case fatality was defined as death within 28 days after stroke onset.

Patients

The present study is limited to first-ever strokes in patients 50 to 79 years of age. The lower age limit is due to few cases and different stroke pathogeneses below that age. The upper age limit is due to a higher proportion of patients living in nursing homes who thus supplied no information on area of living.

Socioeconomic Circumstances of Residential Areas

The socioeconomic profile of 17 administrative areas in the city of Malmö is based on official statistics from the Malmö City Council and data from Statistics Sweden from 1990 to 91. The socioeconomic score (SES) has been described in detail elsewhere. Briefly, it was calculated from 4 standardized variables (migration rate, percentage of residents with foreign citizenship as a proportion of all citizens with foreign background, dependency on social welfare support, employment rate). The basis for selection of variables was that they should be relevant for socioeconomic deprivation in Sweden in the 1990s, that they should reflect different aspects of socioeconomic deprivation, and that they should be applicable to broad age groups. The urban areas were categorized into low, medium, and high SES.

History of MI

Information on previous MI was retrieved by data linkage with the Malmö Myocardial Infarction Register.

Statistical Analysis

Incidence rates are expressed as number of events per 100 000 person-years. Direct standardization was performed (5-year groups) by use of a standard population with equal numbers in all age groups. Linear regression, ie, modeling of the log incidence as a linear function of year, tested the time trends of stroke incidence. The stroke incidence trends were calculated from the age-standardized rates.

Results

During 1989 to 1998, 3666 persons 50 to 79 years of age (mean, 70.2±7.4 years) with a first-ever stroke were registered in STROMA: 94.5% were treated as inpatients, 0.3% died at the emergency ward (nonhospitalized fatal cases), and 5.2% were treated as outpatients (nonhospitalized, nonfatal). Forty-five persons were excluded because of missing information on area of living.

We included 1969 men and 1652 women in this study. The number of stroke patients in each age category is shown in Table 1.

The average incidence per 100 000 person-years was 647 for men and 400 for women. Among men 50 to 59, 60 to 69, and 70 to 79 years of age, the average incidence per 100 000 person-years was 222, 537, and 1182, respectively; among women, the incidence was 112, 312, and 774, respectively.

CT scans were performed in 89% of the cases, allowing diagnosis of stroke subtype. Forty-eight men (2.4%) and 66 women (4.0%) had subarachnoid hemorrhage; 222 men (11.3%) and 174 women (10.5) had intracerebral hemorrhage; 1524 men (77.4%) and 1248 women (75.5%) had cerebral infarction; and 175 men (8.9%) and 164 women (9.9%) had unspecified stroke.

Trends in Stroke Incidence

The overall age-standardized stroke incidence increased annually by 3.1% (P<0.05) in men and by 2.9% in women...
(P<0.05). Among men who were 50 to 59, 60 to 69, and 70 to 79 years of age, it increased annually by 4.8%, 4.5%, and 2.1%, respectively. Among women, the corresponding values were 7.3%, 1.8%, and 2.8% (Figures 1 and 2).

As the proportion of patients with CT scans increased during the study years, the percentage of patients with unspecified stroke diminished, and both intracerebral hemorrhage and cerebral infarctions increased.

**Trends in Stroke Incidence in Relation to Residential Area (Socioeconomic Circumstances)**
The age-standardized male and female stroke incidences rates per 100 000 person-years were 675 and 410, respectively, in areas with the highest SES. In areas with the lowest SES, the corresponding rates were 602 and 365, respectively. The annual increase in incidence was lowest in areas with the lowest SES. (Table 2)

**Case Fatality**
One hundred ninety-six men (10%) and 153 women (9.3%) died within 28 days. The median ages were 70.4±7.7 and 72.7±6.7 years for men and women, respectively. Among men who were 50 to 59, 60 to 69, and 70 to 79 years of age, case fatality rates were 9.4%, 7.3%, and 11.7%, respectively. Among female patients in corresponding age groups, the rates were 5.3%, 7.2%, and 10.7%.

**Trends in Case Fatality Rate**
The odds of fatal outcome were unchanged in men (odds ratio [OR] per year, 1.0037; 95% CI, 0.95 to 1.06). Among women, the odds of a fatal outcome declined significantly (OR per year, 0.895; 95% CI, 0.84 to 0.95) (Table 1).

**History of MI in Stroke Patients**
Thirteen percent of men and 5.7% of women had had an MI before the stroke event. The odds of having an MI before the stroke was unrelated to year of stroke (men: OR per year, 0.99; 95% CI, 0.95 to 1.04; women: OR per year, 0.98; 95% CI, 0.91 to 1.06) (Figures 3 and 4).

**Discussion**
Although the incidence of and mortality from MI have declined in most industrialized countries, the incidence of stroke has shown less consistent trends. In Malmö, mortality in IHD has similarly decreased, and long-term survival after MI has improved. The present results show that stroke incidence increased between 1989 and 1998. There was no evidence that an increasing population of MI survivors...
contributed to the increased stroke incidence. Case fatality after stroke was stable among men and decreased for women.

**Methodological Aspects**

**Case Retrieval**

Differences over time in case retrieval may cause bias in studies of time trends. However, the methodology (same criteria, same nurse, same senior physician, and same hospital) and routines for referral to hospital were unchanged during the study years. In 2 validation studies, we found that STROMA identified more hospitalized cases than such routine registers as the County and National Patient registers. In Malmö, patients with acute illness traditionally come to the University Hospital directly, even from nursing homes. Primary care is organized by the community and in collaboration with the University Hospital. Patients with transient ischemic attack or very mild strokes who report past symptoms to their general practitioner are routinely referred to the hospital outpatient department for further investigations. Thus, with few exceptions, patients with a diagnosis of stroke in the community are referred to Malmö University Hospital. This is in good agreement with clinical practice in other Nordic countries in which the proportion of nonhospitalized cases is small. In the

**Incidence Trends of First-Ever Stroke: Comparison With Other Studies**

Stoke morbidity and mortality started to decline in the 1950s, with a rapid decrease in the 1970s. In the 1980s, incidence figures tended to increase, coinciding with the introduction of CT, which may have increased the detection of less severe strokes. During the 1980s and early 1990s, very small variations in stroke incidence were seen in New Zealand, western Europe, Russia, and North America; a marked decrease was seen in northern Europe and in Australia; and an increase was seen in middle-aged populations from northern Sweden, in Estonia, and in Lund-Orup, a neighboring county of Malmö. Thus, our figures corroborate the finding that the incidence of first-ever stroke is increasing in south Sweden, especially in the male middle-aged population.

**Possible Explanation for Changing Trends in Stroke Incidence**

Mortality from IHD has continuously declined during the last decades in most industrialized countries, thus theoretically increasing the population at risk from stroke. In Malmö, the incidence of and mortality from MI have declined, and 3-year survival after first MI has continuously improved.

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<td>Annual change, %</td>
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Values are the age-adjusted annual incidence rates of first-ever stroke per 100 000 person-years (number of cases).

*P<0.05.

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**Figure 3. Percent of cases with MI before stroke and time trends in stroke incidence in Malmö, Sweden, 1989 to 1998, in men.**
The proportion of stroke patients who previously had had an MI, however, was stable over the study period, indicating that increased survival after MI could not explain the increasing trends in stroke incidence. These findings suggest that MI prevention may have been more successful than stroke prevention in patients with IHD.

Other reasons for the increasing stroke incidence may be a worsening of the cardiovascular risk factors in the population as indicated in a study from Gothenburg, Sweden. Hypertension increases the risk for all stroke subtypes and is probably the most important stroke risk factor on the basis of degree of risk and prevalence. Despite the efficacy of treatment of hypertension in stroke prevention as seen in trials, the actual control of blood pressure is still a challenge in daily practice, with only a 50% success rate in treated patients in the United States. An excess of stroke incidence can be attributable to undertreatment of hypertension.

Finally, the increasing number of refugees of different ethnic origins, many of whom in poor health, who immigrated to Sweden during the 1980s and 1990s may have contributed to the increase in stroke incidence.

In the present study, we found that, although from a higher level, trends in stroke incidence tended to be better in the low-socioeconomic-level areas. Those findings may indicate a beneficial effect of the egalitarian health care that characterizes Nordic countries.

### Trends in Case Fatality

Trends in case fatality (28-day mortality) have been less studied than incidence and mortality trends. The case fatality rate, however, is an important marker of disease severity and quality of acute care.

In the present study, case fatality decreased significantly in women, while no significant trend was found among men. Our results are partly in agreement with other studies; trends have declined in northern Sweden, Finland, and southeastern New England but are stable in Novosibirsk, Russia. We do not know whether the changes (and lack of changes) are due to changes in disease severity or to changes in stroke care. The same factors that may affect stroke incidence may also affect stroke severity. Whether different trends in case fatality among men and women indicate different trends in disease severity among men and women remains to be evaluated.

A remarkable drop in case fatality was seen in 1997 and especially in 1998 among women and in 1998 among men. No major changes in acute stroke care were undertaken in Malmö until mid 1997, when a stroke care unit was implemented. In other studies, stroke units have shown a decrease in mortality and a better outcome.

### Conclusions

In this urban population, stroke incidence increased between 1989 and 1998. The rate of increase tended to be lower in residential areas with least favorable socioeconomic circumstances. The proportion with a history of MI remained unchanged during the study period. In women but not in men, there has been a significant improvement in case fatality rate.

### Acknowledgments

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### References

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