

# Increasing Stroke Incidence in Sweden Between 1989 and 2000 Among Persons Aged 30 to 65 Years: Evidence From the Swedish Hospital Discharge Register

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**Background and Purpose**—Stroke mortality is decreasing in Sweden, as is the case in other Western European countries. However, both decreases and increases have been reported in Sweden for persons younger than age 65 years. The aim of this study was to compare the incidence of stroke in Sweden between the periods 1989 and 1991 and 1998 and 2000 in persons aged 30 to 65 years.

**Methods**—All first-ever stroke patients aged 30 to 65 years in the Swedish Hospital Discharge Register between 1989 and 2000 were included.

**Results**—The age-standardized, 3-year average incidence increased by 19%, from 98.9 to 118.0 per 100 000 among men, and by 33%, from 48.4 to 64.4 among women, between 1989 and 1991 and 1998 and 2000. The largest increase was seen among those younger than 60 years. On a county level, the change in age-standardized stroke incidence varied from small decreases (−3%) to large increases (82%).

**Conclusion**—Stroke incidence increased in Sweden for both men and women between 1989 and 2000. The increase was larger among women. This calls for action when it comes to studying risk factors and planning for prevention and health promotion and indicates the need for gender-specific studies. (*Stroke*. 2004;35:1047-1051.)

**Key Words:** incidence ■ stroke ■ epidemiology

Stroke is a major cause of serious disability and death.<sup>1,2</sup> Approximately 30 000 people have a stroke in Sweden each year.<sup>3</sup> Although stroke mortality appears to be declining,<sup>4–6</sup> the picture is less clear regarding the incidence. Studies from the World Health Organization Monitoring of Trends and Determinants in Cardiovascular Disease (WHO MONICA) project show lower incidence rates in the southern part of Scandinavia and high-incidence areas in the north.<sup>4</sup> Data on stroke trends for Sweden as a whole have not previously been reported, but regional studies have indicated increasing<sup>7–9</sup> and decreasing<sup>4</sup> trends for stroke incidence in younger age groups during the past 20 years. If the incidence of stroke among younger persons of working age is increasing in Sweden, the consequences for the health care system, as well as for other support systems, will be considerable. Reliable information concerning stroke trends may increase our understanding of the causes of the disease and improve priority setting in the health care system.

The aim of this study was to estimate the trend in Sweden between 1989 and 2000 for first-ever stroke incidence among persons aged 30 to 65 years using routinely collected health statistics.

## Subjects and Methods

The study is based on data from the Swedish Hospital Discharge Register (SHDR). We included all patients aged 30 to 65 years who

were discharged with a first-ever stroke from public hospitals in Sweden between 1989 and 2000. Additional data for the county of Östergötland for the period 1997 to 2000 were collected from the National Stroke Register (NSR).

The SHDR is maintained by the National Swedish Board of Health and Welfare and covers all public inpatient care from 1987 onward. Both patient-specific and administrative data are available.

A comparison of SHDR data and data from the Swedish Cause of Death Register (CDR) for the period 1987 to 1996 showed correspondence for 92% of the discharges.<sup>10</sup> In the SHDR, the principal diagnosis or personal identification number were missing in <2% of cases.<sup>10</sup> The coverage of the SHDR was reported to be at least 98% for somatic short-term care in an evaluation using statistics on hospital stays from the Federation of County Councils (FCC) in Sweden.<sup>10</sup>

The NSR is a Swedish register for quality assessment of acute stroke events that was established in 1994. Although reporting is not compulsory, almost all hospitals in Sweden that treat acute stroke patients participated in 1997. In this study, first-ever events from the NSR are presented only for the county of Östergötland.

Stroke was defined according to the WHO criteria as rapidly developing signs of focal or global disturbance of cerebral function lasting >24 hours (unless interrupted by surgery or death), with no apparent nonvascular cause.<sup>4</sup> All strokes were classified according to the international classification of diseases ninth (ICD-9) and tenth revisions (ICD-10).

Patients were classified as having stroke cases if their discharge diagnosis was intracerebral hemorrhage (ICH: ICD-9-431; ICD-10-161), cerebral infarction (CI: ICD-9-434; ICD-10-163), or undetermined pathological type (UND: ICD-9-436; ICD-10-164). Transient

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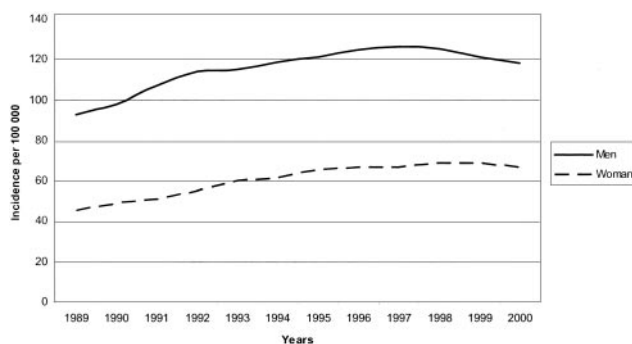
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**Figure 1.** Age-standardized incidence rates of first-ever stroke per 100 000 among men and women in Sweden aged 30 to 65 years reported to the SHDR between 1989 and 2000.

ischemic attack (TIA: ICD-9-435; ICD-10-G45) and subarachnoid hemorrhage (SAH: ICD-9-430; ICD-10-160) were excluded.

Use of personal identification numbers made it possible to exclude patients in the register with stroke diagnoses on >1 occasion from 1987 onward. In such instances, the first occurrence involving a stroke diagnosis was counted.

Annual case-fatality ratios were defined as the proportion of stroke events that were fatal within 28 days of onset of first-ever stroke. Information on date of death was collected from the CDR.

### Statistical Methods

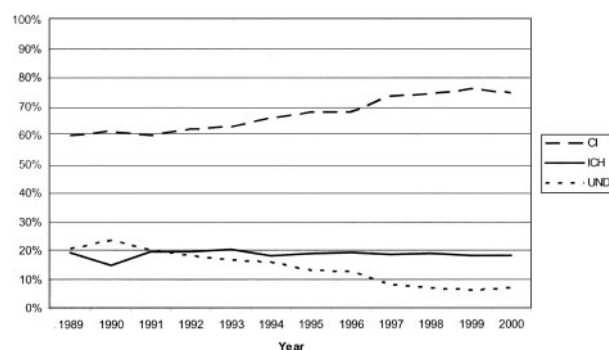
For each year from 1989 through 2000, the annual incidence rate was calculated using population data from Sweden's statistics database.<sup>11</sup> Incidence rates were directly standardized to age using the European standard population<sup>12</sup> as adapted by Appelros.<sup>13</sup> Hospital discharge data were obtained for the age groups 30 to 39, 40 to 49, 50 to 59, and 60 to 65 years, and age-standardization was based on these age groups.

To reduce fluctuations in yearly stroke incidence figure, over-time comparisons of stroke incidence were based on 3-year average incidence rates (eg, 1989 to 1991 through 1998 to 2000). Confidence intervals (95% CI) were calculated using a Poisson distribution.<sup>14</sup>

Because discharge with a stroke diagnosis is the basis for case ascertainment in this study, using the term "stroke incidence" may be somewhat misleading, because the procedure captures the discharge of "old" strokes rather than the occurrence of new strokes. However, because most stroke cases are discharged rather rapidly or die soon after their stroke,<sup>15</sup> it is our view that the discharge data serve as a reasonable approximation of "real" incidence data.

### Results

From January 1, 1989, until December 31, 2000, 43 389 first-ever stroke cases were identified in the SHDR among



**Figure 2.** The variation in reported subtypes of stroke (cerebral infarction=CI, intracerebral hemorrhage=ICH, undetermined pathological type=UND) in the SHDR between 1989 and 2000 among men and women in Sweden aged 30 to 65 years (crude numbers %).

persons aged 30 to 65 years. Sixty-five percent (28 319) were male and 35% (15 070) were female. The crude total incidence rate between 1989 and 2000 was 117.1 and 63.8 per 100 000 for men and women, respectively. Age-standardized incidence rates of first-ever stroke per 100 000 increased until 1998 and then leveled off among both men and women (Figure 1).

The age-standardized, 3-year average incidence rate for those aged 30 to 65 years increased by 19%, from 98.9 to 118.0 per 100 000 for men, and by 33%, from 48.4 to 64.4 per 100 000 for women, between 1989 to 1991 and 1998 to 2000 (Table 1).

The distribution of different subtypes of stroke was similar among men and women and, as seen in Figure 2, CI accounted for the majority of cases. The proportion of reported CI increased from 60% in 1989 to 75% in 2000. The percentage of reported ICH was stable and the proportion of reported UND decreased between 1989 and 2000, from 21% in 1989 to 7% in 2000.

The case fatality for all strokes decreased between 1989 to 1991 and 1998 to 2000 among men (from 21% to 12%) and women (from 19% to 14%).

In those aged 30 to 65 years, the age-standardized stroke incidence increased in all 21 counties between 1989 to 1991 and 1998 to 2000 for men, and in all but 2 counties for

**TABLE 1. Crude and Age-Standardized Incidence Rates of First-Ever Stroke for Men and for Women in Sweden Between 1989 to 1991 and 1998 to 2000**

	1989–1991			1998–2000		
	Incidence (95% CI)	N of Cases	Population	Incidence (95% CI)	N of Cases	Population
<b>Men</b>						
All*	98.9 (96.3–101.5)	5761	5 793 403	118.0 (115.4–120.7)	7989	6 312 747
30–49†	27.0 (25.3–28.7)	1005	3 720 047	32.4 (30.6–34.2)	1205	3 720 233
50–59†	147.9 (141.4–154.5)	1968	1 331 165	186.8 (180.5–193.0)	3431	1 838 554
60–65†	376.4 (362.4–390.3)	2788	742 191	445.7 (430.6–460.8)	3353	753 960
<b>Women</b>						
All*	48.4 (46.6–50.1)	2916	3 559 161	64.4 (62.4–66.4)	4441	6 142 242
30–49†	14.8 (13.5–16.0)	526	1 329 322	21.7 (20.1–23.2)	774	3 572 317
50–59†	67.8 (63.4–72.2)	901	798 490	99.2 (94.6–103.8)	1780	1 794 951
60–65†	186.7 (177.2–196.1)	1489	5 686 973	243.8 (232.8–254.8)	1887	774 974

\*Age-standardized rates. †Crude rate.

**TABLE 2. Age-Standardized Incidence Rates (All Strokes) per 100 000 Among Men and Women Between 1985 and 2000 Reported in Different Swedish Studies**

	1990		1994		1999		2000	
	Men	Women	Men	Women	Men	Women	Men	Women
Sweden (SHDR)	98	49	119	62	121	68	118	66
County of Västra Götaland (SHDR)*	88	38	112	59				
WHO MONICA Gothenburg <sup>4*</sup>	137¶	69¶						
County of Västerbotten and Norrbotten (SHDR)†	91	54	158	76				
WHO MONICA Northern Sweden <sup>4</sup>	207	111						
WHO MONICA Northern Sweden <sup>6</sup>			303	157				
County of Skåne (SHDR)‡			114**	61**				
Lund–Orup <sup>7‡</sup>			106**	52**				
Örebro (SHDR)§					128	63		
Örebro <sup>16</sup>					147	87		
County of Östergötland (SHDR)					114	65	114	74
National Stroke Register Östergötland					79	36	71	43

\*Gothenburg, studied in WHO MONICA, is situated in Västra Götaland (SHDR).

†In WHO MONICA, referred to as Northern Sweden.

‡Lund–Orup is situated in the county of Skåne.

§Örebro is situated in the county of Örebro.

¶1986–1990.

||1985–1990.

\*\*1993–1995.

women. The age-standardized stroke incidence among men ranged from an increase of 3% to 62%, and from a 3% decrease to an increase of 82% among women.

In Table 2 we compare SHDR data with data on stroke trends for the age group 25 to 79 years from studies conducted in Sweden between 1985 and 2000. The stroke incidence estimated from SHDR data are lower than the incidence presented in the WHO MONICA studies<sup>4,6</sup> and in the study conducted in Örebro, by Appelros.<sup>16</sup>

## Discussion

Between 1989 and 2000, the stroke incidence among persons aged 30 to 65 years increased in both men and women in Sweden, but particularly in women. Previous regional studies of stroke incidence among younger age groups in Sweden have shown increases<sup>7–9</sup> as well as decreases.<sup>4</sup> This was reflected in the variation in observed change in stroke incidence in different counties in this study. The SHDR-based incidences are lower compared with earlier studies in Sweden. But the previously observed pattern of high-incidence areas in northern Scandinavia and lower rates in southern Scandinavia was replicated.<sup>4,7,9,17–19</sup> The smallest increase in incidence in the SHDR was found in counties where the stroke incidence between 1989 and 1991 was already high compared with the national average. The greatest increase in stroke incidence was seen in counties with a low stroke incidence in the period 1989 to 1991. The differences in stroke incidence trends between different counties in Sweden indicate that it is difficult to generalize incidence trends to a national level from 1 region.

Several factors may contribute to the increase in stroke in Sweden. These include an increase in well-documented lifestyle-associated risk factors such as obesity, sedentary

lifestyle, smoking, and heavy drinking.<sup>20–24</sup> Migraine and oral contraceptive use are 2 other risk factors among young women.<sup>25</sup> The prevalences of overweight and heavy alcohol consumption (among people younger than age 65 years) have increased in Sweden in recent decades.<sup>26</sup> Although the prevalence of smoking has decreased since the 1960s in men and since the 1970s in women, the generations of women studied here experienced the highest smoking prevalence rates in Sweden.<sup>27</sup>

The data from the SHDR were available on a county level, thereby allowing comparison with regional Swedish studies (Table 2). Rather large differences in estimated incidence were seen. Among the reasons for the differences observed are geographical coverage discrepancies. The SHDR covers the county of Västra Götaland, whereas the WHO MONICA study was confined to the city of Gothenburg, which is situated in this county.<sup>4</sup> Similarly, whole-county SHDR data were compared with city-specific data for Örebro<sup>16</sup> and Lund–Orup.<sup>7</sup> The county-specific data of the SHDR therefore cover wider and more rural areas. Other reasons are differences in time period (Table 2), inclusion of recurrent strokes,<sup>4,6</sup> and inclusion of diagnoses other than CI, ICH, and UND (eg, subarachnoid hemorrhage).<sup>4,7,8,16</sup> Finally, many of the regional studies with procedures for excluding cases not belonging to the region undergoing study probably make more precise estimations of the underlying population than in the present study, which relies on official population statistics.<sup>11</sup>

Compared with the NSR, the SHDR the incidence figures are higher for men and women (Table 2). According to Appelros,<sup>28</sup> the NSR appears to miss >30% of the strokes, because lack of beds in the special stroke units implies

treatment on general wards, where there is less awareness about reporting strokes to the NSR.

## Methodological Aspects

### Case Ascertainment

According to the ideal criteria for stroke incidence studies presented by Sudlow and Warlow,<sup>29</sup> the lack of community-based case ascertainment is a limitation of the present study. The incidence in this study is based on hospitalized cases only. The county councils in Sweden are responsible for reporting all discharge diagnoses to the SHDR on an annual basis. A stroke hospitalization rate >90% has been reported from different parts of Sweden,<sup>7,9,17,28,30</sup> and according to Johansson,<sup>7</sup> the hospitalization rate is unlikely to have increased during the period from 1983 to 1995. Furthermore, Appelros<sup>16</sup> concluded in his study that most nonhospitalized cases came from nursing homes. We therefore do not believe that the observed increases in stroke incidence can be explained by improved coverage of the SHDR, or by an increase in the hospitalization rate for stroke in Sweden between 1989 and 2000.

Regarding stroke sequelae, we included patients, according to their unique personal identification number, the first time they appeared in the register. Nevertheless, we still do not know if they had their first-ever stroke before 1987. However, because the studied population is young, and because stroke is a rare disease in younger persons, recurrent strokes are thus uncommon.

### Misclassification

Lindblad et al<sup>31</sup> validated inpatient discharge diagnoses from 3 hospitals in 1 Swedish county and the diagnosis of stroke was confirmed in 94% of first-ever strokes. However, Stegmayr<sup>30</sup> compared data from 1985 to 1989 obtained in the WHO MONICA northern Sweden study with inpatient data from the SHDR. Among those discharged alive, 32% of stroke diagnoses were false-positives and 6% of nonstroke diagnoses were false-negatives. The most common reasons for false-positive stroke diagnoses were that stroke sequelae, TIA, or patients with diffuse symptoms had been coded as acute stroke.

Other validation studies in the Nordic countries report a high validity for the diagnosis of acute stroke in their national hospital discharge registers.<sup>32,33</sup> A Finnish study reported that during the period 1985 to 1993, there was an agreement on diagnosis in 90%.<sup>33</sup> A Norwegian study conducted between 1994 and 1996 showed that 4.6% of the discharge diagnoses were classified as nonstroke diagnoses after validation.<sup>32</sup> This study<sup>32</sup> also contended that hospital discharge data may overestimate stroke incidence if the diagnoses are not restricted to ICD-9 codes 430, 431, 434, and 436, which are the same diagnoses that are studied here. According to Leppälä<sup>33</sup> and Ellekjaer,<sup>32</sup> hospital discharge diagnoses are valuable sources of information when it comes to epidemiological studies, health planning, and research.

As was seen in Figure 2, the classification of stroke as UND has decreased in favor of specific stroke diagnoses. The increased use of computerized tomography (CT) since the 1980s probably reduced the high false-positive rate,<sup>8,31</sup> espe-

cially in younger age groups in which, according to Johansson,<sup>7</sup> it is easier to diagnose stroke, because symptoms are not complicated by comorbidity such as dementia and osteoarthritis. The trend for TIAs observed between 1985 and 1994 in a French register was stable over time, and the observed increase in incidence of ischemic stroke in that register appeared to be disease-specific.<sup>34</sup> Furthermore, an increase in incident stroke cases caused by improvements in diagnostic techniques alone is likely to affect men and women similarly within the same county. In this study, the incidence trend in several counties was rather different among men and women, with a much larger increase for women in most counties.

Given the high false-positive rate in relation to the false-negative rate, improved classification is not likely to have caused a spurious increase in stroke incidence.

The increased use of CT may have increased the detection of less severe strokes.<sup>8,31</sup> Case fatality (28-day mortality) is a marker of disease severity. Denmark, Sweden, and Finland have low case-fatality rates.<sup>35</sup> The decrease in case fatality observed in this study is in line with other Swedish studies.<sup>8</sup> The increase that is reported in the SHDR therefore may be partly because of an increase in detection of less severe strokes. Indeed, previous studies show that in the western world, stroke has become a disease of less severity.<sup>36,37</sup>

## Conclusions

Data from the SHDR suggest that the stroke incidence in Sweden increased among both men and women between 1989 and 2000. The increase was larger in women than in men. During the same period, the stroke case-fatality rate decreased, and it is possible that part of the increase may be caused by an increased detection of less severe strokes. Further, on the regional level, large differences in incidence trends indicate that caution is warranted when drawing inferences from stroke trend data based only on regional data. An increase in stroke among people of working age is of great consequence for the health care system and other social support systems. This, in combination with the human suffering involved, calls for action when it comes to studying risk factors and planning for prevention and health promotion on individual and governmental levels.

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