Epidemiology of Subarachnoid Hemorrhage in Finland From 1983 to 1985

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The age-standardized incidence of subarachnoid hemorrhage was 33/100,000/yr among Finnish men and 25/100,000/yr among Finnish women. Subarachnoid hemorrhage represented 11% of all strokes detected during 1983–1985 in the community-based stroke register in three areas of Finland. Age-standardized mortality from subarachnoid hemorrhage was 18/100,000/yr among men and 12/100,000/yr among women aged 25–74 years, representing in men 22% and in women 23% of all deaths from stroke in the register. The case-fatality rate of subarachnoid hemorrhage was high: 35% among men and 33% among women within 2 days after the onset of the stroke attack and 48% in men and 46% in women at 1 month. Our findings suggest that the incidence and mortality of subarachnoid hemorrhage in Finland are among the highest worldwide, although differences in criteria, study methods, and classification procedures reduce the comparability of studies from different countries. The occurrence of subarachnoid hemorrhage in our present study is also higher than that previously reported in this country. We believe that this is more likely due to changes in diagnostic classification and improvements in detection of the disease than to a real increase in the morbidity and mortality of subarachnoid hemorrhage. (Stroke 1991;22:848–853)

In most populations subarachnoid hemorrhage (SAH) represents only about 10% of all strokes but is an important cause of morbidity and mortality, especially among young adults. Despite continuous improvements in the detection and surgical treatment of the disease, its short-term case-fatality rate is still around 40% or over, and a substantial number of survivors are faced with permanent disability.

There are large differences in the incidence of SAH among countries, with the lowest incidence reported in New Zealand.1,2 The highest incidence has been found in Japan,3,4 the United States,5 and Finland,6–11 but among studies in these three countries the within-country variation ranged from 13 to 24/100,000 population/yr. The type of study, the age structure and size of the population studied, the methods employed for the collection of data, and the criteria adopted to define SAH can all influence the rates estimated. The purpose of our study was to assess the incidence, mortality, and case-fatality rate of SAH in three Finnish populations during the early 1980s. Data from the present study were also compared with results from studies carried out in Finland and elsewhere during the previous decades to assess the trend in the incidence of SAH.

Subjects and Methods

Stroke and myocardial infarction registers have been established in eastern and southwestern Finland as part of the World Health Organization Project on Monitoring Trends and Determinants of Cardiovascular Diseases (MONICA Project).12,13 The main objectives of this multinational prospective study are the assessment of trends in morbidity and mortality in coronary heart disease and cerebrovascular disease and the extent to which these trends are related to changes in the levels of risk factors.12–16

In two Finnish parts of the MONICA Project (FINMONICA) monitoring areas, the province of North Karelia in eastern Finland and the rural area around the town of Loimaa plus the city of Turku in southwestern Finland, the registration of stroke was started in the beginning of 1982. In the third area, the
province of Kuopio in eastern Finland, stroke has been registered since the beginning of 1983. Altogether, this registration covers a population of 385,000 persons whose age and sex structure is given in Table 1.

A detailed description of the populations and methodology of registration is given elsewhere (J. Tuomilehto, unpublished observations). In brief, every case of acute cerebrovascular attack or symptoms suggesting a stroke occurring in persons aged 25–74 years who were permanently residing in the monitoring areas was registered. The majority of cases of stroke, especially SAH, are treated in Finnish hospitals. Main sources of registration were hospital admission diagnoses and death certificate diagnoses; hospital discharge diagnoses and cases registered at outpatient departments of the hospitals were also routinely checked. Data were collected in every center by specifically trained nurses, during the stroke attack period whenever possible. More than 28 days after the onset of the attack, the record form was completed for follow-up information. A neurologist was responsible for assigning the diagnostic category and type of stroke, coded according to the international MONICA classification criteria.14

The main information contained in the FINMONICA stroke register used in this report is demographic data, information concerning the onset and duration of symptoms, diagnostic examinations performed, diagnostic category and type of stroke, eventual information about the death of the patient within 28 days, and eventual information about necropsy performed.

According to the international MONICA classification criteria, the diagnosis of stroke is based on the abrupt onset of clinical signs of focal (or global) neurological disturbance that last >24 hours except in cases of sudden death or if the development of symptoms is interrupted by surgical intervention.13,14 MONICA protocol recommends that the codes for specific subcategories of stroke be based on typical symptoms and confirmed, if possible, by examinations or necropsy.13 For SAH, typical symptoms are the abrupt onset of severe headache or unconsciousness or both and signs of meningeal irritation with or without focal neurological deficits. In addition to typical symptoms, the diagnosis of SAH should be supported by one of the following: 1) a recent SAH and an aneurysm or arteriovenous malformation as a necropsy finding, 2) evidence of blood in the sylvian fissures between the frontal lobes or in the cerebral ventricles found on computed tomography (CT scan), 3) bloody cerebrospinal fluid (>2,000 erythrocytes/ml) and an aneurysm or arteriovenous malformation found on angiography, or 4) bloody and xanthochromic cerebrospinal fluid and the possibility of intracerebral hemorrhage excluded by CT scan or necropsy.

The attack rate includes all episodes of SAH occurring during the study period. An attack was classified as a first event if no previous SAH could be traced in the medical history of the patient. Incidence refers to the rate of first events/100,000 population aged 25–74 years/yr. If the patient suffered an attack ≤27 days after the onset of the first acute symptoms, the attack was considered as belonging to the same event. If a previous stroke attack had occurred ≥28 days before the present attack, it was defined as a recurrent event. A fatal event occurred when the person died ≤27 days after the onset of the attack. This was calculated using calendar days according to the practice of the MONICA Project. Mortality was therefore used in the present analysis to indicate the rate of fatal events at 27 days after the onset of symptoms. Cumulative mortality was calculated on the second and 27th days after the onset of symptoms. From these values we calculated the case-fatality rate at 2 and 27 days after the onset of the attack of SAH.

The age distribution of the world population in 5-year age groups was used for the calculation of age-standardized rates, following the practice of the MONICA Project.16 For each rate the 95% confidence interval was calculated; rates differing at the p<0.05 level, using a two-tailed test, are reported as significant. Rate ratios of SAH to all stroke events were calculated for first events, both by age group and

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### Table 1. Mean Population Size and Number of First Events and Incidence of Subarachnoid Hemorrhage by Sex and Age Group for Three FINMONICA Areas and Years 1983–1985 Pooled

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Population size (no.)</th>
<th>Events (no.)</th>
<th>Incidence (no./100,000/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25–34</td>
<td>54,745</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>35–44</td>
<td>45,837</td>
<td>51</td>
<td>37</td>
</tr>
<tr>
<td>45–54</td>
<td>35,381</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>55–64</td>
<td>31,335</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>65–74</td>
<td>18,895</td>
<td>28</td>
<td>49</td>
</tr>
<tr>
<td>Age-standardized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–74</td>
<td>186,193</td>
<td>184</td>
<td>33</td>
</tr>
</tbody>
</table>

FINMONICA, Finnish part of World Health Organization Project on Monitoring Trends and Determinants of Cardiovascular Diseases.
for all ages. For the main analyses, data from the three geographic areas were pooled since the number of cases of SAH per area was small. Differences in rates between the areas are also briefly discussed.

Results

During 1983-1985, 3,576 stroke cases were detected (1,977 in men and 1,599 in women). Of these, 386 were SAH (211 in men and 175 in women). The cases represented in men 11% and in women 13% of the age-standardized rate of strokes detected during the study period. The age-standardized attack rate (first and recurrent events together) of SAH was significantly higher ($p<0.05$) in men aged 25-74 years (38/100,000/yr) than in women (26/100,000/yr).

There were 184 first events of SAH among men (12% of all first strokes registered among men) and 160 among women (13%) (Table 1). The incidence of SAH in men was lowest in the group aged 25-34 years, but otherwise it varied only little by age group. Among women, the incidence increased slightly with age and followed the level in men with a time lag of about 10 years (Table 1). Recurrent events of SAH were rare, only 27 in men and 15 in women. The age-standardized incidence of SAH in FINMONICA was 33/100,000/yr in men and 25/100,000/yr in women (Table 2). When the FINMONICA areas were studied separately, the age-standardized incidence of SAH was lower in Turku/Loimaa than in the other areas.

The rate ratio of SAH as a proportion of the total stroke incidence is shown in Table 3. Although the overall age-standardized rate ratios were quite similar in men and women, the proportion was higher in men than in women below the age of 35 years. The age-standardized sex ratio in the incidence of SAH showed a male excess of about 35% (Table 4). The male excess was highest in the group aged 25-44 years and decreased with age. In mortality from SAH the male excess was 51%.

Altogether, 181 events of SAH were fatal, 101 (48% of all SAH events) among men and 81 (46% of all SAH events) among women. During the 28-day event period, all deaths occurred $\leq 21$ days after the onset of the attack. Mortality from SAH increased with age in both sexes, and there was a 10-year time lag in mortality in women compared with men (Figure 1). Age-standardized mortality from SAH was 18/100,000/yr among men and 12/100,000/yr among women, which represented 22% and 23%, respectively, of the overall stroke mortality. Age-standardized mortality from SAH was significantly higher ($p<0.05$) among men than among women. For mortality from first events only, no significant difference between the sexes was found.

**Table 3. Rate Ratio (SAH/Total Stroke) and 95% CI for First Events by Sex and Age Group for Years 1983-1985 and Three FINMONICA Areas Pooled**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total stroke (no.)</th>
<th>Rate ratio (SAH/total stroke)</th>
<th>95% CI</th>
<th>Total stroke (no.)</th>
<th>Rate ratio (SAH/total stroke)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-34</td>
<td>43</td>
<td>0.58</td>
<td>0.43-0.73</td>
<td>21</td>
<td>0.43</td>
<td>0.21-0.64</td>
</tr>
<tr>
<td>35-44</td>
<td>126</td>
<td>0.40</td>
<td>0.29-0.48</td>
<td>60</td>
<td>0.40</td>
<td>0.28-0.52</td>
</tr>
<tr>
<td>45-54</td>
<td>235</td>
<td>0.19</td>
<td>0.14-0.24</td>
<td>105</td>
<td>0.33</td>
<td>0.24-0.42</td>
</tr>
<tr>
<td>55-64</td>
<td>492</td>
<td>0.07</td>
<td>0.05-0.10</td>
<td>306</td>
<td>0.16</td>
<td>0.12-0.20</td>
</tr>
<tr>
<td>65-74</td>
<td>631</td>
<td>0.04</td>
<td>0.03-0.06</td>
<td>763</td>
<td>0.06</td>
<td>0.04-0.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age-standardized</th>
<th>Total stroke (no.)</th>
<th>Rate ratio (SAH/total stroke)</th>
<th>95% CI</th>
<th>Total stroke (no.)</th>
<th>Rate ratio (SAH/total stroke)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-74</td>
<td>1,527</td>
<td>0.12</td>
<td>0.10-0.14</td>
<td>1,255</td>
<td>0.13</td>
<td>0.11-0.15</td>
</tr>
</tbody>
</table>

SAH, subarachnoid hemorrhage; CI, confidence interval; FINMONICA, Finnish part of World Health Organization Project on Monitoring Trends and Determinants of Cardiovascular Diseases.
Table 4. Sex Ratio in Incidence and Mortality of SAH by Age for Years 1983–1985 and Three FINMONICA Areas Pooled

<table>
<thead>
<tr>
<th>Age group</th>
<th>Incidence</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAH (no.)</td>
<td>Sex ratio</td>
</tr>
<tr>
<td>25–44</td>
<td>110</td>
<td>2.04</td>
</tr>
<tr>
<td>45–64</td>
<td>164</td>
<td>1.07</td>
</tr>
<tr>
<td>65–74</td>
<td>70</td>
<td>1.15</td>
</tr>
<tr>
<td>Age-standardized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–74</td>
<td>344</td>
<td>1.35</td>
</tr>
</tbody>
</table>

SAH, subarachnoid hemorrhage.

The attack was fatal ≤2 days after the onset of symptoms in 74 men (73% of all fatal cases among men) and 58 women (72% of all fatal cases in women). The age-standardized case-fatality rate among men was 35% at 2 days and 48% at 27 days after the onset of symptoms. Among women, the age-standardized case-fatality rate was 33% and 46% at 2 and 27 days, respectively (Figure 2).

Among the 181 fatal cases, the diagnosis was confirmed by necropsy findings in 62% (112 deaths). An additional 9% (16) were diagnosed on the basis of CT findings, and in a further 2% (three) a lumbar puncture together with angiography was used to confirm the diagnosis. Among the 205 nonfatal cases, a CT scan was done in 61% (125) and a lumbar puncture together with angiography in a further 25% (50). The only basis for the diagnosis was typical symptoms together with lumbar puncture in 27% (49) of fatal cases and in 14% (29) of nonfatal cases.

Discussion

Of all stroke events in the FINMONICA areas, 12% were SAH. This proportion of SAH agrees with earlier studies carried out in Finland7,10–12 and abroad.17 According to the previous population-based studies of SAH in Finland, the incidence varied from 10 to 24/100,000. In our present study, the incidence of SAH was higher than previously reported in Finland7–10 and higher than observed in most other countries.1–2,13–20 Almost half of the SAH events were fatal, accounting for 24% of all cases of fatal stroke. The age-adjusted sex ratio for incidence of SAH was 1.35 and for mortality 1.51; that is, the male excess in incidence was 35% and in mortality 51%. The case-fatality rate in our present study was slightly higher than previously reported in Finland,7,10 but similar to that reported in studies from other countries.25

Local neurologists assigned the diagnostic category and defined the type of stroke. About 20% of cases were classified as SAH without benefit of the examinations recommended in the WHO MONICA protocol. In most of these cases, examination consisted of assessment for typical clinical symptoms and lumbar puncture. However, the symptoms and signs of the onset of SAH, together with bloody cerebrospinal fluid, are usually quite reliable for the diagnosis of SAH. Thus, although only the University Hospital of Kuopio provided a CT scan throughout the whole study period, it is not likely that the findings are substantially biased by the lack of technological capacity. Furthermore, we carried out a classification exercise in which we estimated whether a sample of 300 registered cases had been classified correctly according to the standard MONICA classification. Among these cases there were 20 SAHs. The classification exercise showed that all cases of SAH were correctly coded as definite strokes by the local neurologists.

The incidence of SAH was lower in Turku/Loimaa than in Kuopio Province or North Karelia. The same trend has been found for all strokes.17 Mortality rates were also lower, although not significantly, in Turku/Loimaa than in the other areas. It has been established that blood pressure levels are lower in southwestern than in eastern Finland.21 Ad hoc studies on risk factors for SAH in Finland must be carried out to determine whether there is a link between the lower
blood pressure levels and the lower incidence and mortality of SAH in Turku/Loimaa compared with the other two areas.

Comparison between studies is hampered by the lack of agreed-upon criteria for the classification of SAH and by the different age structures of the populations studied. Incidence and the case–fatality rate of SAH have been previously investigated in different areas of Finland. All but one retrospective study were based on prospective registration of stroke cases. Size of the population, age range, and the number of cases detected varied considerably among the studies. The previous studies take into account a wider age range than our present study. Also, the classification criteria adopted in each study are somewhat different. The criteria can, however, be assimilated to ours, with the exception of one study,8 which excluded all patients aged >50 years and hypertensive patients <50 years old who died from the initial hemorrhage. The age-standardization and age range of the population studied may influence the final result. Our age-standardized rates are higher than unstandardized data6,8 or those in studies adjusted to the Finnish population.9,11 Fogelholm9 estimated that if his exclusion criteria had not been so strict, the incidence of SAH would have reached 22–24/100,000/yr.

We recalculated from Aho's study1 the incidence of SAH for people aged 25–74 years using the world population for age standardization. Age-standardized incidence of stroke in Espoo-Kauniainen during the years 1972–1973 was 27/100,000/yr in men and 43/10,000/yr in women. From the study carried out by Sivenius et al9 it was possible to recalculate the incidence for all strokes only, which was similar to that reported in our register. The proportion of SAH (8% of all strokes) was smaller than in other studies, but in the study of Sivenius et al9 the number of SAHs detected was small because the registration period was brief. Overall, we conclude that in our present study the incidence of SAH was slightly higher than previously reported in Finland, except among women in the Espoo-Kauniainen study.7 We believe that this increase is largely explained by methodological differences and more complete case finding and not by a real increase in the incidence of SAH.

The incidence of SAH in our study increased with age only among women. This sex difference is mainly due to the high incidence of SAH in men aged <45 years, where the sex ratio was 2.0.4. After the age of 45 years the incidence was similar in men and women. In the recalculated data from the Espoo-Kauniainen study, the age-adjusted sex ratio was 0.6. In that study, the incidence of SAH in women was similar to that in men aged <45 years and increased in the older age groups. Some other previous Finnish studies have also observed an increase in the incidence of SAH with age in both men and women. Sivenius et al10 reported a sex ratio of 1.3, while other Finnish studies found a higher or equal incidence of SAH in men and women. Compared with all strokes (for which the age-adjusted sex ratio is 1.8), SAH was relatively more frequent among women.

The case–fatality rate in earlier Finnish studies was 41–42% at 3 weeks,6,9 while Aho7 and Kotila10 report rates of 50% and 45%, respectively, at 3 months. The case–fatality rates of our present study were not substantially different from those of previous studies. This suggests that, despite all efforts to improve the treatment of SAH, the short-term prognosis of the patient has not improved during the last decade.

The incidence of SAH in Finland is among the highest in the world. Lower incidences of SAH have been reported from Sweden,19 Australia,20 and New Zealand.1,2 Findings from the United States5–18 and Japan3,4 present rates either lower than or similar to ours. It is difficult to quantify these differences since discrepancies may be related to the different criteria applied for the classification of SAH and to the different age structures of the populations studied. For example, the Auckland study1 adopted more restricted criteria than ours, requiring that the cases be diagnosed on the basis of lumbar puncture only, both uniformly blood stained and xanthochromic cerebrospinal fluid as the necessary findings to qualify. We can divide the SAH events in the FINMONICA stroke register into two groups, probable SAH and definite SAH, where definite SAH comprises only the cases in which the objective investigations were performed. Our definite SAH category would roughly correspond to SAH as classified in the Auckland study.1 This would lower our incidence estimate by about 20%, but it would still be approximately twice the incidence in the Auckland study.

In conclusion, no decline in either incidence or mortality of SAH has taken place in Finland during the last 30 years, in spite of improvements in the detection and medical care of the disease. The major risk factors for SAH, in addition to vascular anomalies, are hypertension and cigarette smoking.5,17,22 Since these risk factors have been declining during the past years,21,22 other factors may increasingly contribute to the etiology of SAH in Finland. It is possible that the increase in alcohol consumption in Finland during the past decades has contributed to the risk of SAH.24 Epidemiological studies on these and other potential risk factors for SAH need to be carried out in Finland since it is clear that primary prevention is the principal strategy to fight a disease with such a high case–fatality rate.

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References


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