Comparison of Probability of Stroke Between the Copenhagen City Heart Study and the Framingham Study

Thomas Truelsen, MB; Ewa Lindenstrøm, MD; Gudrun Boysen, DMSc

Background and Purpose  We wished to test the validity of a stroke probability point system from the Framingham Study for a sample of the population of Copenhagen, Denmark. In the Framingham cohort, the regression model of Cox established the effect on stroke of the following factors: age, systolic blood pressure, the use of antihypertensive therapy, diabetes mellitus, cigarette smoking, prior cardiovascular disease, atrial fibrillation, and left ventricular hypertrophy. Derived from this model, stroke probabilities were computed for each sex based on a point system. The authors claimed that a physician can use this system for individual stroke prediction.

Methods  The Copenhagen City Heart Study is a prospective survey of 19,698 women and men aged 20 years or older invited to two cardiovascular examinations at 5-year intervals. The baseline examination included 3015 men and 3501 women aged 55 to 84 years; 474 stroke events occurred during 10 years of follow-up. In both cohorts initial cases of stroke and transient ischemic attack recorded during 10 years of follow-up were used. We used the statistical model from the Framingham Study to establish a corresponding stroke probability point system using data from the Copenhagen City Heart Study population. We then compared the effects of the relevant risk factors, their combinations, and the corresponding stroke probabilities. We also assessed stroke events during 10 years of follow-up in several subgroups of the Copenhagen population with different combinations of risk factors.

Results  For the Copenhagen City Heart Study population some of the risk factors (diabetes mellitus, cigarette smoking, atrial fibrillation, and left ventricular hypertrophy) had regression coefficients different from those of the Framingham Study population. Consequently, the probability of stroke for persons presenting these risk factors and their combinations varied between the two studies. For some other risk factors (age, blood pressure, and cardiovascular disease), no major differences were found. The recorded frequency of stroke events in subgroups of the Copenhagen population was compatible with the estimated probability intervals of stroke from the Copenhagen City Heart Study and with those from the Framingham Study, but these intervals were very large.

Conclusions  The majority of risk factors for stroke identified by the Framingham Study also had a significant effect in the Copenhagen City Heart Study population. The differences found could be due partly to different definitions of these factors used by the two studies. Although estimated stroke probabilities based on point systems from the Copenhagen City Heart Study and the Framingham Study were similar, the points scored in the two systems did not always correspond to the same combination of risk factors. Such systems can be used for estimating stroke probability in a given population, provided that the statistical confidence limits are known and the definitions of risk factors are compatible. However, because of the large statistical uncertainty, a prognostic index should not be applied for individual prediction unless it is used as an indicator of high relative risk associated with the simultaneous presence of several risk factors.

Key Words  •  clinical trials  •  Denmark  •  epidemiology  •  prognosis  •  risk factors

In Denmark, as well as in the United States, stroke is the third leading cause of death. Its incidence has shown no decreasing trend in the last decades.1 The Copenhagen City Heart Study (CCHS), initiated in 1976, is one of the major prospective cardiovascular surveys in our country permitting studies of incidence and risk factors of cerebrovascular disease.2–6 The effects of risk factors for stroke in our studies were often discussed with reference to the Framingham Study (FS), which is considered by us to be a pioneer cardiovascular survey and is based on a population that is comparable to ours from racial, demographic, and socioeconomic perspectives. Recently an article on
hernorrhage. We used the statistical model from the FS to develop a corresponding stroke probability point system using the data from the CCHS population, based on identical selection of risk factors, ie, age, systolic blood pressure (SBP), the use of antihypertensive therapy, diabetes mellitus, cigarette smoking, prior cardiovascular disease, atrial fibrillation, and left ventricular hypertrophy. The risk factors in our population were defined in the following way: SBP was determined by using a London School of Hygiene sphygmomanometer, with the person in sitting position after 5 minutes of rest. The blood pressure was determined once. The interobservation variation was tested and found not significant. Current antihypertensive therapy, current cigarette smoking, and known diabetes mellitus were included as yes/no variables and recorded from the questionnaire. Atrial fibrillation and left ventricular hypertrophy were determined from the electrocardiogram (ECG) using the Minnesota code. Cardiovascular disease included either earlier myocardial infarction or present angina pectoris or intermittent claudication recorded from the questionnaire and, for myocardial infarction, also from the ECG. The stroke subtypes recorded in the CCHS population were the same as in the FS, except subarachnoid hemorrhage. Then we compared the effects of these risk factors and their combinations and the corresponding stroke probabilities between the two studies. We also calculated the stroke events during 10 years of follow-up in several subgroups of the Copenhagen population with different combinations of risk factors.

The CCHS is a prospective survey of 19,698 women and men aged 20 years or older invited to two cardiovascular examinations at 5-year intervals, in 1976 to 1978 and 1981 to 1983. The study population, sampling procedures, and classification of cerebrovascular events were described earlier.1,2 Cerebrovascular events were recorded until December 31, 1988. For the present analysis we considered 10-year follow-up from examination 1. The events were recorded at the second examination and from hospital records and death certificates. At baseline 3015 men and 3501 women aged 55 to 84 years were eligible for risk factor analysis.

### Results

During the 10-year period 474 initial stroke events occurred in CCHS: 286 in 3015 men and 188 in 3501 women. The mean values for the selected risk factors from the CCHS and the FS populations are shown in Table 1. The corresponding regression coefficients are shown in Table 2. In this subset of the CCHS population the effects of atrial fibrillation (P<.93) or cigarette smoking (P<.17) in men and the effect of left ventricular hypertrophy (P<.99) in women were not statistically significant. In the FS these three risk factors had significant effects, and a significant interaction between SBP and antihypertensive therapy was found in women, whereas in the CCHS there was no significant interaction in either sex.

Based on the regression coefficients shown in Table 2, we created a point system and calculated the corresponding probabilities for developing stroke or transient ischemic attack during a 10-year period. The function S(t) for t=10 years was 0.946 for women and 0.905 for men. The M function (sum of products of regression coefficients and frequencies of risk factors in the CCHS population; Tables 1 and 2) was 5.7046 for women and 6.8122 for men. Stroke probability for men and women and corresponding relative risks (RR) are shown in Tables 3 and 4, respectively.

It can be seen that the regression coefficients varied between the two systems, particularly for diabetes, smoking, left ventricular hypertrophy, and atrial fibrillation. Consequently, the corresponding points and probabilities of developing stroke varied for combinations including these risk factors,7 which can also be seen from the four following examples. For each of these examples, only the chosen risk factors were present; all the other factors were absent.

**Example 1:** A 65-year-old man with an SBP of 165 mm Hg who has diabetes, left ventricular hypertrophy, cardiovascular disease, and atrial fibrillation receives antihypertensive therapy. According to the CCHS he scores 28 points, and his 10-year probability of developing stroke is 68.3% (95% confidence interval [CI], 0% to 86%). According to the FS he scores 26 points, and his 10-year probability of developing stroke is 68.4%.

**Example 2:** A 65-year-old man with an SBP of 165 mm Hg who has atrial fibrillation and left ventricular hypertrophy. According to the CCHS he scores 14 points, and his 10-year probability of developing stroke is 15.9% (95% CI, 0% to 27%). According to the FS he scores 19 points, and his 10-year probability of developing stroke is 32.9%.

**Example 3:** A 71-year-old woman with an SBP of 145 mm Hg who smokes and has cardiovascular disease. According to the CCHS she scores 15 points, and her
TABLE 2. Cox Regression Coefficients for Stroke Risk Factors in the Framingham Study and the Copenhagen City Heart Study

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>FS</th>
<th>CCHS (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Age</td>
<td>.0505</td>
<td>.0557</td>
</tr>
<tr>
<td>SBP</td>
<td>.0140</td>
<td>.0197</td>
</tr>
<tr>
<td>HTN Rx</td>
<td>.3263</td>
<td>2.5432</td>
</tr>
<tr>
<td>SBP * HTN Rx</td>
<td>.0</td>
<td>-.0134</td>
</tr>
<tr>
<td>Diabetes</td>
<td>.3384</td>
<td>.5442</td>
</tr>
<tr>
<td>Smoking</td>
<td>.5147</td>
<td>.5294</td>
</tr>
<tr>
<td>CVD</td>
<td>.5195</td>
<td>.4326</td>
</tr>
<tr>
<td>AF</td>
<td>.6061</td>
<td>1.1497</td>
</tr>
<tr>
<td>LVH</td>
<td>.8415</td>
<td>.8488</td>
</tr>
</tbody>
</table>

FS indicates Framingham Study; CCHS, Copenhagen City Heart Study; SBP, systolic blood pressure; HTN Rx, antihypertensive therapy; SBP * HTN Rx, interaction between SBP and HTN Rx; CVD, cardiovascular disease; AF, atrial fibrillation; and LVH, left ventricular hypertrophy.

10-year probability of developing stroke is 11.8% (95% CI, 6.3% to 16.4%). According to the FS she scores 15 points, and her 10-year probability of developing stroke is 16.0%.

Example 4: A 71-year-old woman with an SBP of 145 mm Hg who has atrial fibrillation and cardiovascular disease. According to the CCHS she scores 27 points, and her 10-year probability of developing stroke is 51.9% (95% CI, 19.6% to 70.3%). According to the FS she scores 18 points, and her 10-year probability of developing stroke is 27.0%.

The examples above show how the values of the prognostic index varied between the two studies, depending on the risk factors included. To control the validity of the prognostic indexes from the two studies, we selected four subgroups of the CCHS population with different combinations of risk factors and assessed the stroke events that occurred during a 10-year follow-up. Then we compared the true stroke frequencies with corresponding estimated probabilities based on the point systems from the two studies. In the following four groups only the chosen factors were present.

Group A comprised men aged 63 to 68 years with SBP between 140 and 160 mm Hg who were smokers. In the CCHS cohort 135 men complied with these criteria; 14 (10.4%) developed stroke or transient ischemic attack during the 10-year period. The corresponding estimated probabilities of stroke would be 7.8% to 13.2% (9 to 13 points) according to the CCHS and 9.7% to 12.9% (10 to 12 points) according to the FS.

Group B comprised men aged 63 to 70 years with SBP between 140 and 170 mm Hg who were smokers and had left ventricular hypertrophy. In the CCHS cohort, 4 of 46 eligible men (8.7%) developed stroke in 10 years. The corresponding estimated probabilities of stroke would be 10.2% to 21.9% (11 to 17 points) according to the CCHS and 14.8% to 25.5% (13 to 17 points) according to the FS.

Group C comprised women aged 55 to 74 years with SBP between 95 and 200 mm Hg who were smokers and had left ventricular hypertrophy. In the CCHS cohort, 6 of 140 eligible women (4.3%) developed stroke in 10 years. The corresponding estimated probabilities of stroke would be 1.8% to 20.2% (2 to 19 points) according to the CCHS and 3.5% to 57.0% (7 to 23 points) according to the FS.

Group D comprised women aged 63 to 70 years with SBP between 140 and 170 mm Hg who were smokers and were receiving antihypertensive therapy. In the CCHS cohort, 3 of 29 eligible women (10.3%) developed stroke in 10 years. The corresponding estimated probabilities of stroke would be 7.8% to 17.7% (12 to 18 points) according to the CCHS and 9.2% to 22.8% (12 to 17 points) according to the FS.

Discussion

Although detailed analysis of the CCHS and FS populations was not the subject of this article, there seemed to be no major differences concerning their composition, and both samples have approximately the same size. However, the regression coefficients for
was a significant risk factor for stroke in the population aged 35 years and older, but its effect decreased with age group. We had previously reported that smoking proportions were also very different in the two studies (Table 2). In the FS population diabetes was nearly three times as frequent as in ours. Moreover, in our study, thereby explaining the relatively important effect of this disease on stroke risk in our population.

Cigarette smoking had a greater effect on stroke risk in the FS population than in ours. Moreover, in our study this effect was not significant in men in the chosen age group. We had previously reported that smoking was a significant risk factor for stroke in the population aged 35 years and older, but its effect decreased with age. The proportions of smokers were also very different: 33.8% and 26.4% in the FS and 67.4% and 51.8% in the CCHS for men and women, respectively (Table 1). Possible differences in smoking habits, such as quantity of cigarettes and inhaling, might also influence the effect of smoking on stroke, but these data were not included in the present analysis.

In both populations atrial fibrillation was associated with elevated stroke risk, and this effect was greater in women than in men. In contrast, the corresponding regression coefficients in our population were nearly three times higher in women and eight times lower (and not significant) in men than in the FS population. The proportions of men and women with atrial fibrillation were two times higher in the FS population. Paroxysmal atrial fibrillation was not likely to be diagnosed during one ECG recording in the CCHS, whereas ECGs from two biennial examinations in the FS might include a greater proportion of this condition. The effect of atrial fibrillation on stroke was also assessed in other prospective studies. The Whitehall Study, based on a cohort of 19,018 men aged 40 to 69 years, found atrial fibrillation in 2.4% of patients, with the RR of stroke associated with this condition being 6.9 (CI, 3.0 to 13.5). In the British Regional Heart Study, based on 7727 men, the frequency of atrial fibrillation was 0.6% and the RR 2.3 (95% CI, 0.1 to 12.7). Both the proportion and effects of atrial fibrillation vary a great deal from one study to another, probably because of the low prevalence of this

### Table 3. Probability of Initial Stroke/TIA for Men Aged 55-84 Years Based on the Copenhagen City Heart Study

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Points</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td>55-56</td>
<td>57-58</td>
<td>59-60</td>
<td>61-62</td>
<td>63-64</td>
<td>65-66</td>
<td>67-68</td>
<td>69-70</td>
<td>71-72</td>
<td>73-74</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td></td>
<td>95-104</td>
<td>105-114</td>
<td>115-124</td>
<td>125-134</td>
<td>135-144</td>
<td>145-154</td>
<td>155-164</td>
<td>165-174</td>
<td>175-184</td>
<td>185-194</td>
</tr>
<tr>
<td>AF</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>LVH</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>HTN Rx</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>CVD</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

SBP indicates systolic blood pressure; AF, atrial fibrillation; LVH, left ventricular hypertrophy; HTN Rx, antihypertensive therapy; CVD, cardiovascular disease; Prob, estimated probability of stroke within 10 years; and RR, relative risk.

In upper table, to calculate total amount of points, the points corresponding to each risk factor present should be added; eg, a man 70 years old who smokes and has diabetes and an SBP of 165 mm Hg scores 7+1+6+7, ie, 21 points.

In lower table, the average RR for men aged 55-84 years in the Copenhagen City Heart Study was 2.7.
condition. In our study four of the 33 men with atrial fibrillation developed subsequent stroke. Statistical analyses based on so few cases often give inconclusive results. Left ventricular hypertrophy was diagnosed from the ECG in both studies. However, in the CCHS its definition was based only on R and S wave potentials, whereas in the FS it required the simultaneous presence of a depressed ST segment or flattened to inverted T waves. Thus, the definition in the FS was more restrictive and selected persons with more severe left ventricular hypertrophy than our definition, which explains why this condition was nearly six times more frequent in the FS population. Thus, despite a lack of apparent social, racial, and demographic differences, both the distribution and the effect of several stroke risk factors varied between these two populations. The majority of these differences might be explained by discrepancies in definitions of risk factors. The prognostic index based on combinations of these risk factors varied correspondingly, so that the point system established in the FS could not be directly applied to our population, which we also have illustrated in some examples of risk factor combinations. In examples 2 and 4 the estimated probability of stroke based on the FS was different from ours, and in example 2 it was outside our 95% CI. However, in examples 1 and 3 the stroke probability was similar.

We found that the real frequencies of stroke events assessed in four subgroups of the CCHS cohort (A through D) were compatible with the corresponding estimated probability intervals based on the CCHS and with those based on the FS. However, these intervals were so large that they would hide even quite large discrepancies between the estimated stroke probabilities and the observed stroke frequencies.

The issue of statistical uncertainty was not discussed by FS authors,7 and the SE corresponding to the difference in proportions of stroke was not presented. Our experience shows that the SE values can be quite large, even for significant risk factors (Table 2). Consequently, the probability of stroke for persons presenting different combinations of risk factors will be subject to great uncertainty, as shown in examples 1 through 4. In example 1 the probability of developing stroke during 10 years was 68.3%, but the 95% CI was 0% to 86%. For example 2 it was outside our 95% CI. In example 3 the stroke probability was much smaller in the CCHS than in the FS population and why its effect on stroke risk was much smaller in the CCHS than in the FS population. Thus, despite a lack of apparent social, racial, and demographic differences, both the distribution and the effect of several stroke risk factors varied between these two populations. The majority of these differences might be explained by discrepancies in definitions of risk factors. The prognostic index based on combinations of these risk factors varied correspondingly, so that the point system established in the FS could not be directly applied to our population, which we also have illustrated in some examples of risk factor combinations. In examples 2 and 4 the estimated probability of stroke based on the FS was different from ours, and in example 2 it was outside our 95% CI. However, in examples 1 and 3 the stroke probability was similar.

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combinations of several risk factors. However, the latter possibility should also be interpreted with caution. Although the information that one's risk is several times higher than average may motivate the patient to attempt reasonable risk factor modification, the risk reduction obtained cannot be derived directly from the stroke probability table. Cessation of smoking might not automatically reduce the stroke risk to the level of nonsmokers, and it is reasonable to suppose that, during a certain time at least, being a previous smoker will be associated with somewhat higher stroke risk than being a nonsmoker. The stroke probability system could, on the other hand, be used for stroke prediction in a given population if the CIs are known and provided that the patient population is representative of the population for which the point system has been established. A practitioner knowing the distribution of risk factors discussed above in his patient population could, according to such a point system, predict how many events will occur in this population during, for example, 10 years. Of course, it is of paramount importance that the risk factor definitions used by a practitioner be compatible with those used to establish the point system.

In summary, the majority of risk factors for stroke identified by the FS also had a significant effect in the CCHS population, with the differences partly due to different definitions. However, the results of this analysis illustrate a basic problem of the epidemiologic method. On the basis of observation in one population it can be possible, to some extent, to predict events in a comparable population but not in a single individual.

Acknowledgments
This study was supported by health insurance funds No. 11/272-90 and No. 11/203-92; the Danish Medical Research Council (No. 12-0807-1); the Foundation of Henry Hansen, member of the Stock Exchange, and his wife Karla Hansen, née Westergaard; and the Danish Heart Foundation. We are indebted to the statistician Jørgen Nyboe, MSc, and to Gorm Jensen, DMS, and Peter Schnohr, MD, who, together with Jørgen Nyboe and Merete Appleyard, RTL, chief secretary of the CCHS, initiated and conducted the CCHS. We also thank Merete Appleyard for her assistance with data processing.

References
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*Stroke*. 1994;25:802-807
doi: 10.1161/01.STR.25.4.802

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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