Influence of Socioeconomic Circumstances in Early and Later Life on Stroke Risk Among Men in a Scottish Cohort Study

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Background and Purpose—The purpose of the study was to investigate stroke risk by socioeconomic measures.

Methods—The analysis was based on a large cohort study of 5765 working men, from 27 workplaces in Scotland, who were screened between 1970 and 1973. Stroke was defined as having a hospital admission with a main diagnosis of stroke or dying of stroke in the 25-year follow-up period.

Results—There were 416 men who had a stroke. Men with manual occupations when screened, on first entering the workforce, men with manual occupations, and men whose fathers had manual occupations had significantly higher rates of stroke than men in the nonmanual categories. Men who left full-time education at age 16 years or under also had significantly higher rates of stroke. Men living in more deprived areas had higher rates of stroke, but the rates were not statistically significant. The most marked difference was in relation to father’s social class, and although adjusting for risk factors for stroke attenuated the relative rates, men whose fathers were in manual social classes had higher relative rates of stroke than men whose fathers were in nonmanual classes (adjusted relative rate for father’s social class III manual was 1.37 [95% CI 1.03 to 1.81] and for father’s social class IV or V was 1.46 [1.09 to 1.96]). Men who were upwardly mobile (father’s social class manual, own social class nonmanual) had a rate of stroke similar to that of stable manual men.

Conclusions—Poorer socioeconomic circumstance was associated with greater stroke risk, with adverse early-life circumstances of particular importance. (Stroke. 2000;31:2093-2097.)

Key Words: cerebrovascular disorders n epidemiology n prospective studies n social class

Stroke is one of the major causes of death in the United Kingdom, but understanding of stroke epidemiology is less complete than that of coronary heart disease (CHD). Although stroke mortality has declined in the West over the past 50 years, it has increased in other parts of the world, particularly eastern Europe.1,2 In Scotland, 11% of deaths in men and 15% of deaths in women aged ≥65 years were caused by stroke in 1997.3 Scotland also had higher stroke mortality rates than the rest of the United Kingdom.4 Stroke morbidity is a leading cause of disability, particularly among the elderly, so reducing the burden of stroke has implications for quality of life as well as for health-service planning.4

Socioeconomic differences in stroke risk have been seen in many countries,5 but it is not clear whether these differences can be accounted for by differences in risk factors. In the present study we present an analysis of stroke risk in a large, prospective cohort study of employed men in Scotland, which recorded several socioeconomic measures. In particular, occupational social class in adulthood and in childhood (as measured by father’s main occupation) were available. Members of the cohort underwent screening in the early 1970s, and a large number of risk factors for stroke were measured. Previous findings from this cohort, using 21 years of mortality, highlighted deaths from stroke and stomach cancer as being particularly related to socioeconomic circumstances during childhood.6 We now report on follow-up data for stroke deaths and hospital admissions for stroke over a 25-year period.

Subjects and Methods
This analysis was based on part of a cohort of employed people from 27 workplaces in Glasgow, Clydebank, and Grangemouth, who were screened between 1970 and 1973. The full sample consisted of 6022 men and 1006 women. Participants completed a questionnaire and attended a physical examination. Women have been excluded from this study because of their small number and their not being representative of the socioeconomic spectrum (most were from only 2 workplaces). Full details have been described elsewhere.7

The physical examination included measurement of blood pressure, height, forced expiratory volume in 1 second (FEV1) and a 6-lead ECG. The questionnaire collected information about smoking, alcohol consumption, angina (from the Rose angina questionnaire),8 age leaving full-time education, home address, and occupation.

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Blood pressure was measured with the subject seated, and diastolic pressure was recorded at the disappearance of the fifth Korotkoff sound. The adjusted FEV1 was defined as the actual FEV1 as a percentage of the expected FEV1 (obtained from a linear regression of age and height from a healthy subset of the study). A 6-lead ECG recording was made with the subject seated. The ECG was coded according to the Minnesota system, with the codes 1.1 to 1.3, 4.1 to 4.4, 5.1 to 5.3, and 7.1 considered evidence of ischemia, encompassing diagnoses of definite myocardial infarction, myocardial ischemia, and left bundle branch block. Angina was considered present if the definite or possible criteria of the Rose angina questionnaire were met. Severe chest pain was defined as a participant’s admitting to ever experiencing a severe pain across the front of the chest lasting half an hour or more. Preexisting CHD was defined as a participant’s having angina, ECG-documented ischemia, or severe chest pain. Units of alcohol consumed per week were calculated from responses to the questionnaire about usual weekly consumption of beer, spirits, and wine.

The home address at the time of screening was retrospectively assigned a postal code, which enabled a deprivation category, as defined by Carstairs and Morris, to be ascertained. This measure is an area-based measure of deprivation, obtained from 4 census variables: male unemployment, overcrowding, car ownership, and the proportion of heads of households in social classes IV and V. A deprivation score for each postal code sector is obtained, which is then converted to 7 categories ranging from 1 (least deprived) to 7 (most deprived).

The questionnaire asked for the main occupation of the participant’s father, the participant’s own first regular occupation (excluding temporary work), and the participant’s occupation at the time of screening. Social class was coded according to the Registrar General’s Classification for each of the 3 occupations. For this analysis, social class was defined as either nonmanual (classes I, II, and III nonmanual) or manual (classes III manual, IV and V) for each of the 3 occupations. Father’s social class was subsequently also defined in 3 groupings (nonmanual, III manual, IV and V). Age leaving full-time education was categorized as >16 years or ≤16 years. Deprivation category was defined as 1 to 4 (high) or 5 to 7 (low). Social mobility from father’s to own social class was analyzed in 4 categories – both nonmanual (stable nonmanual), father nonmanual and own class nonmanual (downwardly mobile), father manual and own class nonmanual (upwardly mobile) and both manual (stable manual).

The analysis was based on 5765 men aged between 35 and 64 years at screening, who had not embarked from Britain during the follow-up period. Data were missing for the following categories: 9 men for social class, 87 men for first social class, 112 men for father’s social class, 8 men for age leaving full-time education, and 9 men for deprivation. Missing data were excluded from the relevant analysis. Study participants were flagged at the National Health Service Central Register in Edinburgh. Dates of death up to the end of 1998 and their causes were provided. In addition, a computerized link with acute hospital discharges in Scotland provided records of all main diagnoses of stroke between 1972 and 1998. Stroke was defined as either having a hospital admission with a main diagnosis of stroke in the 25-year follow-up period after screening or dying of stroke in the 25-year follow-up period. Stroke was defined as International Classification of Diseases (ICD)-8 or ICD-9 codes 430 to 438, and as ICD-10 codes I60 through I69 and G45. Cox’s models were used to calculate proportional hazards regression coefficients for each socioeconomic variable separately (social class, first social class, father’s social class, age leaving full-time education, and deprivation category). The exponentiated proportional hazards regression coefficients are referred to as relative rates. Survival time was taken from the date of screening until either the date of hospital admission for stroke or the date of death from stroke if no hospital admission for stroke was found. Adjustments were made for risk factors related to stroke risk by including them in the models.

Results

In the 25-year follow-up period, 333 men had a hospital admission with the main diagnosis of stroke and 83 men died of stroke without having a hospital admission record in Scotland for stroke. The total number of men defined as having a stroke for this study was, therefore, 416.

Men with manual occupations when screened, men with manual occupations on first entering the workforce, and men whose fathers had manual occupations all had significantly higher relative rates of stroke than men in the nonmanual categories (Table 1). Men who left full-time education at 16 years or under had a significantly higher relative rate of stroke than men who left at older ages. Men living in the most deprived areas had a nonsignificantly raised relative rate of stroke compared with men living in more affluent areas. Exclusion of men with preexisting coronary disease did not affect the results. For own social class, first social class, age leaving full-time education, and deprivation categories, the relative rates were non-significant when adjusting for other risk factors for stroke. For father’s social class, the relative rate for manual compared with nonmanual remained significant when adjustments were made for other risk factors. A more detailed analysis by father’s social class in 3 categories was undertaken. The 3 categories, chosen to be of adequate size, were (1) nonmanual (I, II, and III nonmanual), (2) III manual, and (3) IV and V. Table 2 presents the age-adjusted relative rates of stroke by father’s social class and shows the effect of adjusting for risk factors individually and, finally, together. Men with fathers in the 2 manual social classes had significantly higher rates of stroke than men with fathers in nonmanual classes when adjusted for age only. Men with fathers in social classes IV and V had the highest rate. Adjustment for each risk factor individually attenuated the relative rates, with height and systolic blood pressure being the only ones having a substantial effect. Adjustment for all the risk factors attenuated the relative rates considerably, although both manual categories remained at significantly higher risk than the nonmanual category. The trend across the 3 father’s social class groups also remained significant at statistically conventional levels (P<0.05). The survival curves for the 3 groups are shown in the Figure.

Men whose fathers were in manual social classes and whose own social class was manual (stable manual) had almost double the rate of having a stroke than men in the stable nonmanual group when...
adjusted for age only (Table 3). The fairly large upwardly mobile group also had a significantly increased rate (1.60 [95% CI 1.16 to 2.21]). The rate of the downwardly mobile group was not significantly different from that of the stable nonmanual group, but since the number of events was small, this could have resulted from chance. Adjusting for all the risk factors showed the stable nonmanual and the downwardly mobile groups to have a similar rate of stroke in contrast to the upwardly mobile and the stable manual groups, which had an almost-identical higher rate of stroke. This would suggest that it is father’s social class which has the strongest influence on stroke risk, and this risk is not dependent on social class obtained in adulthood.

**Discussion**

In this study, we have shown that poorer socioeconomic experience, defined in several ways, is associated with greater risk of stroke in 25 years of follow-up in a cohort of working men. The risk was particularly strong in men with fathers in manual social classes, and further analysis showed that conventional risk factors could explain some, but not all, of this elevated risk.

Other studies have found relationships with adulthood social class. In an international overview, Kunst et al 5 found that stroke mortality was higher in manual than nonmanual

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**TABLE 1. Relative Rates of Stroke in 25 Years of Follow-Up by Socioeconomic Measures for Men in the Collaborative Study**

<table>
<thead>
<tr>
<th>Socioeconomic Measure</th>
<th>Men, n</th>
<th>Strokes, n</th>
<th>Age Only</th>
<th>All Risks*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social class</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonmanual</td>
<td>2904</td>
<td>181</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manual</td>
<td>2852</td>
<td>235</td>
<td>1.37 (1.13–1.66)</td>
<td>1.07 (0.87–1.31)</td>
</tr>
<tr>
<td>First</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonmanual</td>
<td>2199</td>
<td>128</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manual</td>
<td>3479</td>
<td>279</td>
<td>1.42 (1.15–1.75)</td>
<td>1.15 (0.92–1.43)</td>
</tr>
<tr>
<td>Father’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonmanual</td>
<td>1370</td>
<td>69</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manual</td>
<td>4283</td>
<td>335</td>
<td>1.70 (1.31–2.20)</td>
<td>1.40 (1.07–1.83)</td>
</tr>
<tr>
<td>Age leaving full-time education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;16 y</td>
<td>1166</td>
<td>59</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>≤16 y</td>
<td>4591</td>
<td>357</td>
<td>1.57 (1.19–2.07)</td>
<td>1.28 (0.96–1.70)</td>
</tr>
<tr>
<td>Deprivation category</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–4</td>
<td>2974</td>
<td>195</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5–7</td>
<td>2782</td>
<td>221</td>
<td>1.17 (0.96–1.42)</td>
<td>0.96 (0.79–1.18)</td>
</tr>
</tbody>
</table>

*Age, smoking, adjusted FEV1, diastolic and systolic blood pressures, height, alcohol consumption, and preexisting CHD.

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**TABLE 2. Relative Rates of Stroke by Father’s Social Class, Adjusted for Risk Factors**

<table>
<thead>
<tr>
<th>Father’s Social Class, Category</th>
<th>I and II and III</th>
<th>Ill Manual</th>
<th>IV and V</th>
<th>Trend (Across Groups)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men, n</td>
<td>1370</td>
<td>2462</td>
<td>1821</td>
<td></td>
</tr>
<tr>
<td>Strokes, n</td>
<td>69</td>
<td>189</td>
<td>146</td>
<td></td>
</tr>
</tbody>
</table>

Relative rate adjusted for

| Age                            | 1.64 (1.24–2.16) | 1.78 (1.34–2.37) | 0.0002   |
| Age and smoking                | 1.59 (1.21–2.09) | 1.74 (1.31–2.32) | 0.0003   |
| Age and adjusted FEV1          | 1.61 (1.22–2.12) | 1.74 (1.30–2.32) | 0.0004   |
| Age and diastolic blood pressure| 1.58 (1.20–2.08) | 1.71 (1.29–2.28) | 0.0004   |
| Age and systolic blood pressure| 1.53 (1.16–2.02) | 1.69 (1.27–2.25) | 0.0006   |
| Age and height                 | 1.52 (1.15–2.01) | 1.62 (1.21–2.16) | 0.003    |
| Age and alcohol consumption    | 1.60 (1.22–2.11) | 1.72 (1.29–2.29) | 0.0004   |
| Age and preexisting CHD        | 1.61 (1.22–2.12) | 1.72 (1.29–2.30) | 0.0004   |

All above risk factors*         | 1.37 (1.03–1.81) | 1.46 (1.09–1.96) | 0.019    |

*Age, smoking, adjusted FEV1, diastolic and systolic blood pressures, height, alcohol consumption, and preexisting CHD.

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men in all countries found that socioeconomic inequalities were substantially larger for stroke than for CHD mortality. The Whitehall study of male civil servants in the London area found an inverse relationship between occupational grade and age-adjusted stroke mortality. Men whose own occupation was manual in the British Regional Heart Study had almost twice the risk of fatal or nonfatal stroke as men in nonmanual social classes, adjusting for age only. Additional adjustment for systolic blood pressure and smoking accounted for half the excess. In an Australian study, men in manual occupations were 60% more likely to die of stroke than men in professional occupations. The Rotterdam study of elderly women found that with socioeconomic status defined as the occupation of the head of the household, professionals had a significantly lower risk of stroke than manual workers. High socioeconomic groups, defined by education and household income, had the lowest stroke risk. Adjustments for risk factors had small effects.

In another study in the West of Scotland (the Renfrew/Paisley study), we found that stroke (again defined as hospital admission for stroke or death from stroke) was strongly related to adulthood social class for men and women. Adjustment for risk factors accounted for most of the difference between social classes.

There have been fewer studies of stroke and deprivation category. Gradients in stroke mortality between the most affluent and the most deprived have been described for Scotland. An ecological study in England found significant positive correlations between deprivation and stroke mortality at ward level. An ecological analysis of the 22 districts of the Scottish Heart Health Study found that hospital admission rates for stroke were significantly associated with deprivation score. In the Renfrew/Paisley study, deprivation category was strongly related to stroke risk in men and women. Adjustment for risk factors explained some, but not all, of the difference between the stroke risk for men and women living in affluent and deprived areas. However in the current study, deprivation category was the weakest of all the socioeconomic factors investigated.

Father’s social class, taken to be an indicator of childhood socioeconomic circumstances, is measured less frequently than adult social class in cohort studies. We previously showed that adverse socioeconomic circumstances in childhood have a specific influence on mortality from stroke and stomach cancer. Other causes of death were influenced by both childhood and adulthood circumstances (CHD and respiratory disease mortality), or predominantly by adulthood circumstances (lung cancer, other cancer, and accidents and violence). With 25 years of mortality follow-up, together with 25 years of information on hospital admissions for stroke, we have shown that father’s social class is the strongest of the socioeconomic indicators for stroke risk. Adjustment for risk factors for stroke explained some of the difference in risk of stroke between nonmanual and manual father’s social classes, but significantly elevated risks remained for men with fathers in manual social classes. We found that men who were upwardly mobile (father’s social class manual, adult social class nonmanual) had risks similar to those of men who remained in manual social classes. Improving one’s social position does not, therefore, appear to greatly improve one’s stroke risk. This emphasizes the strong influence of early-life socioeconomic circumstances on stroke risk.

No association was seen between father’s social class and prevalence of nonfatal stroke in the British Regional Heart Study, but this related only to those who had survived to 1992, so selective survival differences may have influenced the findings. No association was seen between father’s social class and fatal and nonfatal stroke in a large cohort of middle-aged female nurses; however, due to selection into this profession, nurses with manual and nonmanual social class backgrounds will not be representative of the source population in ways that could distort underlying associations. A strong association was seen between father’s social class and stroke mortality in the Boyd Orr cohort, and adjustment for the Townsend deprivation index of area of residence in adulthood did not affect this relationship.

All of the risk factors could explain some variation in stroke risk by father’s social class (Table 2). Adjustment for height produced the greatest decrement in risk, and this suggests the involvement of early-life factors, since poor childhood circumstances (for example, lack of food and childhood illness) can lead to reduced stature in adulthood. Other studies have shown inverse relationships of height with stroke mortality or events. Blood pressure is the most important identified risk factor for stroke, but the differences in blood pressure according to childhood social circumstances are relatively small: <2 mm Hg difference between men with fathers in social classes I and II and those with fathers in social classes IV and V. Even accepting that this adulthood measure is only a proxy for lifetime blood pressure, it is unlikely that residual confounding by blood

| TABLE 3. Relative Rates of Stroke by Mobility From Father’s to Own Social Class, Adjusted for Risk Factors |
|---------------------------------------------------------------|---------------|---------------|---------------|---------------|
| Stable Nonmanual | Downwardly Mobile | Upwardly Mobile | Stable Manual |
| **Men, n** | 1156 | 212 | 1694 | 2582 |
| **Strokes, n** | 54 | 15 | 120 | 215 |
| Relative rate adjusted for | | | | |
| **Age** | 1 | 1.37 (0.77–2.43) | 1.60 (1.16–2.21) | 1.94 (1.44–2.61) |
| **All risk factors** | 1 | 1.09 (0.61–1.94) | 1.44 (1.04–1.99) | 1.42 (1.04–1.95) |

*Age, smoking, adjusted FEV1, diastolic and systolic blood pressures, height, alcohol consumption, and preexisting CHD.
pressure could explain the association between father’s social class and stroke risk. Blood pressure will also proxy for unmeasured nutritional factors (such as salt consumption) that may influence stroke risk through blood pressure. Similarly, adjusting for cholesterol did not affect the association; so, to the degree to which dietary factors are indexed by blood lipids or blood pressure, it is unlikely that such nutritional factors generate the association between early-life deprivation and stroke. Clearly, unmeasured nutritional factors that are not related to blood lipids or blood pressure could be involved, with antioxidants being an example of these. Several other potential mechanisms could relate childhood deprivation to later stroke risk. Low birthweight is strongly socially patterned and also predicts adulthood stroke, which suggests that suboptimal fetal development increases susceptibility. Poor growth in childhood may also predispose to adulthood stroke, as could chronic infections acquired in childhood. Limitations of this study, as in similar prospective cohort studies, are that risk factors and socioeconomic measures were measured at baseline and may have changed during the follow-up period.

To conclude, we have shown that poor socioeconomic experience is associated with increased risk of stroke. Adverse circumstances in early life are particularly important, and adulthood behavioral risk factors such as smoking and alcohol consumption can explain only some of the difference in stroke risk. Improving one’s social position does not remove the effect of adverse social circumstances in childhood on stroke risk. If we want to reduce both overall levels of stroke and socioeconomic differentials in stroke in the future, we must recognize the importance of providing the best environment in which children can grow up.

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References
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http://stroke.ahajournals.org/content/31/9/2093