Influence of Socioeconomic Status on Mortality After Stroke
Retrospective Cohort Study

Jasmin Arrich, MD; Wolfgang Lalouschek, MD; Marcus Müllner, MD, MSc

Background and Purpose—Low socioeconomic status is associated with increased morbidity and mortality from stroke.

The purpose of this study was to investigate the association between 4 independent measures of socioeconomic status and mortality of patients with acute ischemic stroke and transient ischemic attack.

Methods—Socioeconomic status was assessed by taking into account levels of education, occupation, occupational status, and income. The end point was overall mortality. We used Cox proportional hazard models to adjust for age, sex, and severity of stroke on admission.

Results—A total of 2606 stroke patients were followed up for a median of 2.5 years. Unskilled workers had a hazard ratio of 1.87 for death after stroke (95% CI, 1.37 to 2.55) and skilled workers had a hazard ratio of 1.61 (95% CI, 1.23 to 2.11) compared with white-collar workers. Of 4 income groups, patients with the second lowest level of income had a hazard ratio of 1.60 (95% CI, 1.10 to 2.33) compared with patients with the highest income. The hazard ratio for death after stroke for early retired patients was 1.75 (95% CI, 1.01 to 3.04) compared with stroke patients in the active workforce at the time of the event.

Conclusions—Socioeconomic status is associated with survival of patients with acute stroke after adjustment for age, sex, and severity of stroke. The influence of socioeconomic status seems to continue to affect the outcome largely independent of stroke severity. (Stroke. 2005;36:000-000.)

Key Words: ischemic attack, transient ■ mortality ■ socioeconomic factors ■ stroke

In developing and developed countries, low socioeconomic status (SES) is associated with poor health. This is true especially for cardiovascular diseases, with stroke as one of the world’s largest health problems. Studies have found an up to 3-fold higher stroke incidence, stroke mortality, and all-cause mortality for stroke patients with lower SES than for patients with higher SES. The manner in which SES acts on health is complex and not well understood. If SES affects the severity of the insult, then this will translate into increased mortality. However, only 1 of the previous studies examining mortality of stroke patients took into account the association between the severity of the initial stroke and mortality. We assessed the associations between SES, severity of stroke, and long-term mortality.

Subjects and Methods

Database
This cohort study was based on a prospective, hospital-based, stroke registry of patients from an urban population admitted to neurology departments in Vienna, Austria, which serve a community of 1.9 million people. Austria is a country with an equitable healthcare system and a low level of income inequality. We prospectively documented on the basis of informed consent all patients with ischemic stroke or transient ischemic attack (TIA) who were admitted to a neurology department within 72 hours of symptom onset between October 1998 and March 2003. We used a structured interview to assess clinical and neurological variables (such as the score on the National Institutes of Health Stroke Scale [NIHSS]), demographic factors, SES, cardiovascular risk factors, and comorbidities. The study was approved by the local ethics committees.

Inclusion and Exclusion Criteria
We included all patients with a diagnosis of ischemic stroke or TIA. The diagnosis of ischemic stroke or TIA was made by 1 of the treating neurologists and confirmed by a subsequent CT or MRI scan. Our definition of stroke relied primarily on the clinical presentation, which complied with the definition of the World Health Organization. We later quantified the severity of each event by using stroke scales such as the NIHSS and the Scandinavian Stroke Scale and classified it by subtypes according to the Bamford classification. We excluded patients in whom a nonischemic cerebrovascular event (eg, cerebral hemorrhage) was confirmed on admission or at a later stage.

Socioeconomic Status
SES was measured on the basis of education, occupation, occupational status at the time of the event, and income. We divided each individual measure into 4 to 7 categories. The categories for education were as follows: (1) no basic school education, (2)
TABLE 1. Baseline Characteristics of Stroke Patients According to Levels of Education and Occupation

<table>
<thead>
<tr>
<th>Education</th>
<th>Patients, No.</th>
<th>Age, y, Mean (SD)</th>
<th>Sex, Female/Total</th>
<th>NIHSS Score, Median (IQR)</th>
<th>Previous TIA/Stroke, No./Total</th>
<th>Ischemic Heart Disease, No./Total</th>
<th>Hypertension, No./Total</th>
<th>Elevated Plasma Lipids, No./Total</th>
<th>Diabetes, No./Total</th>
<th>PVD, No./Total</th>
<th>Currently Smoking, No./Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No basic education</td>
<td>110</td>
<td>68.1 (12.3)</td>
<td>72/110 (66)</td>
<td>4 (2–7)</td>
<td>52/110 (47)</td>
<td>26/94 (28)</td>
<td>68/108 (64)</td>
<td>45/99 (46)</td>
<td>30/105 (29)</td>
<td>15/102 (15)</td>
<td>20/93 (22)</td>
</tr>
<tr>
<td>Secondary school graduation</td>
<td>488</td>
<td>68.9 (13.4)</td>
<td>328/488 (67)</td>
<td>5 (2–8)</td>
<td>214/488 (44)</td>
<td>128/457 (28)</td>
<td>322/467 (70)</td>
<td>182/462 (40)</td>
<td>120/463 (26)</td>
<td>51/461 (11)</td>
<td>105/463 (23)</td>
</tr>
<tr>
<td>Technical training/apprenticed</td>
<td>1155</td>
<td>66.1 (13.7)</td>
<td>468/1155 (41)</td>
<td>4 (2–7)</td>
<td>504/1155 (44)</td>
<td>257/1079 (24)</td>
<td>74/1105 (67)</td>
<td>46/1080 (42)</td>
<td>290/1109 (26)</td>
<td>135/1108 (12)</td>
<td>308/1048 (29)</td>
</tr>
<tr>
<td>Higher secondary school degree</td>
<td>265</td>
<td>65.3 (14.8)</td>
<td>105/265 (40)</td>
<td>4 (1–7)</td>
<td>103/265 (39)</td>
<td>50/256 (20)</td>
<td>168/256 (66)</td>
<td>106/250 (42)</td>
<td>54/253 (21)</td>
<td>19/256 (7)</td>
<td>73/239 (31)</td>
</tr>
<tr>
<td>University graduate</td>
<td>215</td>
<td>66.0 (14.6)</td>
<td>48/215 (22)</td>
<td>3 (1–8)</td>
<td>47/215 (22)</td>
<td>44/204 (22)</td>
<td>132/207 (64)</td>
<td>102/204 (50)</td>
<td>46/207 (22)</td>
<td>10/205 (5)</td>
<td>32/189 (17)</td>
</tr>
</tbody>
</table>

P values are based on nonparametric test for trend unless indicated otherwise.

End Point

The end point was death from any cause. We obtained this information and the date of death from Statistic Austria, a population-based national database on mortality. The latest data update on mortality was December 31, 2002.

Statistical Analysis

We used χ² tests, ANOVA, Kruskal-Wallis tests, or nonparametric trend tests to perform univariate comparisons of groups. We used the Mann-Whitney U test to compare patients with missing values in SES with patients with known values for differences in NIHSS score and age. We calculated Spearman correlation coefficients to examine the strength of associations between measures of SES. We used univariate and multivariate Cox proportional hazards models to assess the association between mortality and each measure of SES. We adjusted for age (years), sex, and stroke severity at admission according to NIHSS (ordinal). We also built a second model, in which we controlled for variables that are known to be at least partly associated with SES (history of stroke and ischemic heart disease, history of hypertension, hyperlipidemia, diabetes, peripheral vascular disease, and current smoking status). We used SPSS (version 10.0) and Stata (version 8) for all analyses.

Results

Baseline Characteristics

Between October 1998 and December 2001, 3607 patients with suspected ischemic stroke or TIA were registered (for simplicity, referred to as ischemic stroke). Of these, we excluded 679 because the final diagnosis was a nonvascular cause of the symptoms, 252 because they had an intracerebral hemorrhage, and 30 because the underlying cause was another cerebrovascular event, such as a subarachnoid hemorrhage or a cerebral sinus thrombosis. Of the remaining patients, we excluded 40 whose duration of stroke symptoms was either not reliably <72 hours or was unknown. A total of 2606 patients were available for analysis. Of these, 47% were women, their mean age was 67 years (SD 14, median 70, interquartile range [IQR] 58 to 77), and the median NIHSS score was 4 (IQR 2 to 8). The median observation time was 2.5 years (IQR 1.5 to 3.3). At the end of the observation period (December 31, 2002), 499 patients (19.1%) had died; the cumulative mortality was 112 (4.3%) within the first month, 171 (6.6%) within the first 3 months, and 309 (11.9%) within the first year.

Baseline characteristics varied across levels of the different measures of SES (Table 1, Table 2). Patients with lower SES were more often women than men. Heterogeneity for age was considerable, with the biggest differences between groups of different occupational situations. Patients with lower income had more severe strokes, defined by a higher NIHSS score on admission, than patients with a higher income. Patients in early retirement or “ordinary” retirement, not surprisingly,
Occupational situation showed no relevant association (r = 0.001) for unskilled workers and 1.6 for skilled workers (P = 0.001) (Table 3). Because of the large number of patients, the probability values for all correlations were >0.05 (P = 0.001). Occupation and educational situations showed no relevant association (P = 0.001) for unskilled workers and 1.6 for skilled workers (P = 0.001). Patients in the group with the second lowest income had a hazard ratio of 1.9 (P < 0.001) compared with patients in the group with the highest income. These results remained largely unaltered after adjustment, except for the group with the lowest income (Table 3).

Exploratory Analyses
When we controlled for variables that are known to be associated with SES, the effects were often slightly reduced in socioeconomically disadvantaged groups and slightly increased in some socioeconomically more advantaged groups. The effect of SES in people in early retirement was no longer significant, but skilled and unskilled workers still had a significantly higher risk of death than white-collar workers. The effect for the second highest income group also remained statistically significant compared with patients with the highest income.

Socioeconomic Status and Survival
Education
We found no significant association between level of education and survival (Table 3).

Income
Patients in the group with the second lowest income had a hazard ratio of 1.6 (P = 0.01) and patients in the group with the third lowest income had a hazard ratio of 1.9 (P < 0.001) compared with patients in the group with the highest income. These results remained largely unaltered after adjustment, except for the group with the lowest income (Table 3).

Occupation
In the univariate analysis, patients who had taken early retirement had a hazard ratio of 4.7 (P < 0.001) and retired patients had a hazard ratio of 6.7 for death (P < 0.001) compared with patients still in employment. After adjustment for age, sex, and stroke severity, patients in early retirement still had a hazard ratio of 1.8 (P = 0.047) compared with patients still in employment (Table 3).

Discussion
Level of occupation, occupational status, and income are related to mortality of stroke patients in Austria. This is attributable in part to lifestyle factors before the initial event. According to our data, an ongoing effect of SES after the event is also present.

Our Findings in Context
We are aware of 3 other studies that have investigated the influence of income and education on all-cause mortality of stroke patients. Jakovljevic et al. found an increased risk for death at 28 days for patients in the lowest income group.
compared with the highest income group and a higher risk for death at 28 days and 1 year for women with a lower educational level compared with patients with the highest educational level. Kapral et al5 found that higher income was associated with a reduction of death at 30 days and 1 year. Aslanyan et al2 found that a higher level of deprivation resulted in a higher relative risk for death. Generally, these results are in agreement with our findings, but there are differences in the adjustment for confounders and measures of SES. Jakovljevic et al stratified their results for age and sex but did not adjust for other confounders, Kapral et al adjusted for comorbidities, and Aslanyan et al adjusted for blood pressure, stroke subtypes, and stroke severity.

We controlled for the confounding variables age, sex, and stroke severity and accounted for clustering of patients treated in the same department. In an exploratory analysis, we also adjusted for cardiovascular comorbidities and risk factors. This analysis was not preplanned because we feared “overmatching,” ie, that controlling for these risk factors might cancel out the association between SES and mortality as SES works through them. The associations between our measures of SES and these risk factors were all very weak (all \( r^2 < 3\% \); data not shown). The results of this exploratory analysis are generally with the use of the simpler and preplanned model. We adjusted for stroke severity, which has also been found to be in the line of causal action of low SES but allows assessment of the strength of the continuing effect of low SES.

Only Jakovljevic et al4 took SES at the level of the patients into account, as we did in our study. Whether individual or aggregate SES is the more relevant risk factor for health is unknown. SES probably acts on both individual and aggregate levels in different ways. A recent Danish study, for example, confirmed the well-established inverse relation

<table>
<thead>
<tr>
<th>Education</th>
<th>No. of Events</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Sex, and Stroke Severity</th>
<th>Adjusted for Multiple Stroke Risk Factors, Exploratory Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No basic education</td>
<td>13</td>
<td>0.71 (0.38–1.34)</td>
<td>0.77 (0.40–1.48)</td>
<td>0.53 (0.23–1.25)</td>
</tr>
<tr>
<td>Secondary school graduation</td>
<td>91</td>
<td>1.16 (0.79–1.71)</td>
<td>1.11 (0.75–1.65)</td>
<td>1.02 (0.62–1.67)</td>
</tr>
<tr>
<td>Technical training/apprenticed</td>
<td>196</td>
<td>0.99 (0.70–1.42)</td>
<td>1.07 (0.75–1.52)</td>
<td>0.99 (0.64–1.53)</td>
</tr>
<tr>
<td>Higher secondary school degree</td>
<td>33</td>
<td>0.71(0.44–1.14)</td>
<td>0.75 (0.47–1.19)</td>
<td>0.65 (0.37–1.14)</td>
</tr>
<tr>
<td>University graduate</td>
<td>36</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation situation</th>
<th>No. of Events</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Sex, and Stroke Severity</th>
<th>Adjusted for Multiple Stroke Risk Factors, Exploratory Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never employed before</td>
<td>4</td>
<td>2.25 (0.84–6.06)</td>
<td>2.49 (0.83–7.50)</td>
<td>0.86(0.11–7.03)</td>
</tr>
<tr>
<td>Household</td>
<td>31</td>
<td>1.36 (0.93–1.98)</td>
<td>1.02(0.68–1.53)</td>
<td>0.87(0.53–1.45)</td>
</tr>
<tr>
<td>Unskilled worker</td>
<td>58</td>
<td>1.51 (1.13–2.03)</td>
<td>1.87 (1.37–2.55)</td>
<td>1.61 (1.08–2.41)</td>
</tr>
<tr>
<td>Skilled worker</td>
<td>76</td>
<td>1.46 (1.12–1.90)</td>
<td>1.61 (1.23–2.11)</td>
<td>1.66 (1.22–2.26)</td>
</tr>
<tr>
<td>Self-employed</td>
<td>44</td>
<td>0.98 (0.71–1.37)</td>
<td>0.92 (0.66–1.28)</td>
<td>1.14(0.79–1.65)</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>1.03 (0.42–2.51)</td>
<td>1.01 (0.43–2.36)</td>
<td>1.15 (0.43–3.06)</td>
</tr>
<tr>
<td>White-collar worker</td>
<td>194</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income</th>
<th>No. of Events</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Sex, and Stroke Severity</th>
<th>Adjusted for Multiple Stroke Risk Factors, Exploratory Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;363€</td>
<td>5</td>
<td>0.96 (0.38–2.39)</td>
<td>1.44 (0.51–4.08)</td>
<td>1.07 (0.26–4.39)</td>
</tr>
<tr>
<td>364–729€</td>
<td>63</td>
<td>1.61 (1.12–2.32)</td>
<td>1.60 (1.10–2.33)</td>
<td>1.39 (0.89–2.19)</td>
</tr>
<tr>
<td>730–1459€</td>
<td>217</td>
<td>1.88 (1.39–2.53)</td>
<td>1.71(1.25–2.32)</td>
<td>1.82(1.26–2.61)</td>
</tr>
<tr>
<td>≥1460€</td>
<td>54</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Hazard ratios (HRs) (95% CIs) for mortality after stroke include groups of SES, age, sex, and stroke severity as independent variables. The exploratory analysis further controls for history of stroke, ischemic heart disease, hypertension, elevated plasma lipids, diabetes, peripheral vascular disease, and smoking status as independent variables. Robust CIs account for correlation among patients treated at the same department. For each variable, the last category serves as reference category.

* \( P = 0.051–0.066 \)
† \( P = 0.011–0.05 \)
‡ \( P = 0.0011–0.01 \)
§ \( P < 0.001 \)
between individual income and mortality but could not find associations between area income inequality and all-cause mortality. Apart from this, it is difficult to control for confounding variables when an aggregate risk factor is used.

**Limitations**

**Bias**
Information on SES was missing for some patients. We lacked information on occupation for 7.6% of our patients, on education for 14.2%, on occupational situation for 6.2%, and on income for 20.5%. Patients with missing data on SES were significantly older, had a more serious stroke outcome in terms of NIHSS score, and had a higher mortality. We think that the information is lacking mainly because patients were too severely ill to be interviewed. It is likely that those patients also had a lower SES, which would lead to an underestimation of the effect. Furthermore, questions on the SES, particularly on income, may be considered threatening. Accordingly, it is not surprising that most missing data were within this category. We do not know how this might influence the observed effects.

Information on NIHSS score was missing for 4.8% of their patients. They did not differ significantly in terms of age, sex, or SES from the rest of our patients.

**Confounding**
The association between SES and death almost disappeared in retired patients and those in early retirement. This shows that our adjustments were successful. It is possible, however, that residual confounding is still operant. The adverse effect of SES in early retired persons is most likely explained to a large degree by comorbidities. Early retirement is often because of ill health, and early retired patients had a higher proportion of all surveyed comorbidities. However, a recent study found that occupational mobility out of the labor market (early retirement, unemployment, housewife return) widens health inequalities. In our exploratory analysis, the effect of early retirement was no longer statistically significant, but the effect size remained largely unchanged. This indicates a lack of power rather than a proof of absence of effect.

**Conclusions**
Socioeconomic inequalities increase mortality in stroke patients. It seems that the influence of SES continues to affect the outcome largely independent of stroke severity. A detailed investigation of this effect may help to target these vulnerable subpopulations.

**Acknowledgments**
The Vienna Stroke Registry is supported by research grants of the Medizinisch-Wissenschaftlicher Fonds des Bürgermeisters der Bundeshauptstadt Wien (projects 1540 and 1829), the Jubiläumsfonds der Österreichischen Nationalbank (projects 6866 and 8281), and the Austrian Research Society (P13902-MED). The Vienna Stroke Registry is sponsored by an unrestricted educational grant of Sanofi-Synthelabo and Bristol-Myers Squibb. The Vienna Stroke Registry is supported by the Wirtschaftskammer Österreich and the Bundesheerant (L. Kaspar, MD). We are indebted to Dr Birte Twisselman for turning our error-riddled language into proper English.

**References**

Influence of Socioeconomic Status on Mortality After Stroke. Retrospective Cohort Study
Jasmin Arrich, Wolfgang Lalouschek and Marcus Müllner

Stroke. published online December 29, 2004;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2004 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/early/2004/12/29/01.STR.0000152962.92621.b5.citation

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/