Association Between Socioeconomic Status and Functional Impairment 3 Months After Ischemic Stroke

The Berlin Stroke Register

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Background and Purpose—We aimed to analyze the association between patient socioeconomic status and functional impairment 3 months after ischemic stroke and to identify factors that influence this association.

Methods—Data were obtained from the Berlin Stroke Register, a network of 14 stroke units in Berlin. Ischemic stroke patients consecutively admitted to 1 of the hospitals in the Berlin Stroke Register between June 2010 and September 2011, were followed-up 3 months after the index event by postal or telephone interview. We used multivariable logistic regression to examine the association between highest education as marker of socioeconomic status and functional impairment after stroke defined by Barthel Index categories. We adjusted for age, sex, prestroke dependency, stroke severity, functional deficit after stroke onset, and comorbidities as possible confounding factors.

Results—A total of 1688 ischemic stroke patients who were alive at 3 months and completed the questionnaire were included in the analysis; 40% of the patients were female and 50% of the patients were 70 years or older. Age, prestroke dependency, stroke severity, and the absence of comorbidities were significantly associated with good functional outcome at 3 months. In multivariable analysis, a higher probability of good outcome was observed in patients with college or university degree (odds ratio, 2.18; 95% confidence interval, 1.39–3.42) compared with patients with no completed education.

Conclusion—Patients with lower education have considerably lower rates of good functional outcome after stroke that cannot be fully explained by variations in the patients’ clinical and demographic characteristics. (Stroke. 2012;43:3325-3330.)

Key Words: acute stroke ■ education ■ epidemiology ■ ischemia ■ socioeconomic status ■ stroke recovery

People from lower socioeconomic groups have a higher burden of stroke in terms of both incidence and case fatality rates.1-7 Although the evidence regarding incidence and mortality is by far strongest, previous studies also reported a social gradient in impairment after stroke with patients from lower socioeconomic groups having poorer functional outcome than patients from higher socioeconomic groups.6,8-10 Low socioeconomic status also seems to increase the risk of nursing care dependency and institutionalization after stroke.8,11 Disparities in stroke incidence across socioeconomic groups have been tried to be explained by differences in the prevalence of major risk factors.11,12 However, the social gap in stroke outcome and recovery is not yet fully understood. Possible reasons include differences in stroke severity or in other clinical factors between higher and lower socioeconomic groups. Trends have been reported for stroke patients with lower socioeconomic status to have more severe neurological deficits,3,8,11,13 and lower socioeconomic status consistently has been found to be associated with greater burden of different comorbidities.3,14 However, previous studies investigating the association between socioeconomic status and mortality3,5,6,14 or functional impairment6,8-10 after stroke insufficiently adjusted for these potential confounders. In addition, studies focusing on stroke recovery mainly included rather small sample sizes.

We aimed to analyze the association between patient socioeconomic characteristics and functional impairment 3 months after stroke in a large multicenter study, and to examine whether this association can be explained by differences in severity of symptoms and comorbidities.

Materials and Methods

The Berlin Stroke Register

The Berlin Stroke Register is a network of stroke units in the city of Berlin aiming to improve acute treatment of stroke patients. The
hospitals collect data for all patients treated with stroke or transient ischemic attack to continuously monitor quality of stroke care. Based on these data, hospital performance is regularly evaluated using quality indicators developed by the German Stroke Registers Study Group. The participating stroke units currently document ≈9000 patients per year, covering ≈80% of all stroke patients in Berlin.

Between June 2010 and September 2011, recruitment for a 3-month follow-up of consecutively treated patients took place within 13 hospitals of the Berlin Stroke Register. Duration of patient recruitment varied between the hospitals because of different capacities of the participating facilities (median duration, 14 months; interquartile range, 10–15.5 months).

Patients received standardized postal questionnaires 3 months after the index event. Patients who did not return the questionnaire were reminded by a telephone call and were offered to complete the questions on the telephone. In case the patients could not be contacted by telephone, a next of kin not living with the patient was contacted. If participants were unable to answer the questionnaire or were unable to be interviewed, the questions could also be answered by proxies. Telephone interviews were conducted by trained fieldworkers. Vital status of patients lost to follow-up was verified with the data registration office. Questionnaires used were validated for postal or telephone use and for use with proxies.

Study Population

Data collection during acute treatment in hospital included all patients aged 18 years or older who were admitted to 1 of the participating hospitals after first or recurrent stroke or transient ischemic attack within 7 days after onset of symptoms. Stroke was defined according to World Health Organization criteria. The following analyses were restricted to patients who completed the follow-up. Patients who died before follow-up, patients who withdrew their consent, and patients lost to follow-up were excluded from the analyses. Patients with transient ischemic attack or intracerebral hemorrhage also were excluded.

Socioeconomic Status

Information on patient socioeconomic status was obtained at follow-up 3 months after stroke using education as an indicator of socioeconomic status. Data reflecting highest educational level and vocational training qualification were summarized into the following categories according to recommendations from German epidemiological societies and the Federal Statistical Office: (1) no completed education; (2) basic or secondary education and no vocational training; (3) basic or secondary education and vocational training; (4) high school degree; and (5) college or university degree.

Other Patient Characteristics

Data on clinical characteristics such as comorbidity and data on demographic characteristics such as age group, sex, and prestroke dependency were documented by members of hospital staff during acute treatment. Stroke severity was assessed using the German version of the National Institutes of Health Stroke Scale. The following comorbidities were recorded during stay in hospital: diabetes mellitus (elevated blood glucose level or history of diabetes or medical treatment); atrial fibrillation (documented by standard ECG or long-term ECG or history of atrial fibrillation or medical treatment); previous stroke (evidence for previous stroke lasting >24 hours in patient report or imaging); hypertension (systolic blood pressure of >140 mm Hg or diastolic blood pressure of >90 mm Hg or medical treatment); and hypercholesterolemia (elevated cholesterol level >190 mg/dL or history of hypercholesterolemia or medical treatment). Prestroke dependency was defined as being dependent on professional or informal nursing care at home or living in an institution.

Functional Impairment 3 Months After Stroke

Functional impairment 3 months after stroke was defined by the Barthel Index (BI), which has been validated for the use in postal and telephone follow-up studies. The instrument assesses limitations in activities of daily living with a score from 0 (completely dependent) to 100 (independent). It includes items on bathing and washing, getting dressed, eating, going to the toilet, moving around the house, ascending stairs, and moving from bed to chair, as well as bladder and bowel control. Functional outcome was grouped into 3 categories: poor (BI, 0–70); moderate (BI, 75–95); and good (BI, 100).

Statistical Analysis

Descriptive statistics were used to provide information on the patients’ demographic, socioeconomic, and clinical characteristics. We calculated for each level of education the distribution of possible determinants of functional recovery such as age and sex, stroke severity, prestroke dependency, and comorbidities. For each education category, we also calculated the proportion of patients with good functional outcome 3 months after stroke. To test for statistical significance of differences between education groups, we used the χ² test for categorical variables. To examine associations between possible risk factors and 3-month functional outcome, univariate logistic regression analyses were performed. Associations were expressed as odds ratios with corresponding 95% confidence intervals. In multivariable logistic regression models, we calculated adjusted odds ratios and 95% confidence intervals to examine associations between socioeconomic status and good functional outcome (BI, 100) at 3 months. The initial model was adjusted for age and sex. In a second model, prestroke dependency, stroke severity, and comorbidities (diabetes mellitus, atrial fibrillation, previous stroke, and hypertension) were added as independent factors. We accounted for possible collinearity between the included variables by performing a linear regression using multicollinearity diagnostic statistics, in which we included the independent variables from our final logistic regression model.

All tests were 2-sided, and statistical significance was determined at an alpha level of 0.05. Statistical analyses were performed with the SPSS Statistics 18.0 software package.

Ethics Approval

Patients or their legal representatives provided their written informed consent to participate in the study. The study has been approved by the ethics committee of Charité—Universitätsmedizin Berlin (EA1/061/10). The data management concept was evaluated positively by the data protection officers of the participating institutions.

Results

Study Population

Between June 2010 and September 2011, 3222 patients alive at discharge provided informed consent to participate in the follow-up study, giving a participation rate of 64.9% of patients screened. Of those, information on survival 3 months after stroke was available for a total of 3123 patients (96.9%). Patients with a diagnosis of transient ischemic attack (677 patients) or intracerebral hemorrhage (97 patients) were excluded from the analysis. Of the remaining 2349 patients with ischemic stroke, 477 patients (20.0%) were lost to follow-up. Of the patients with complete follow-up, 184 patients were excluded because of missing information on education level or functional recovery at 3 months. Therefore, a total of 1688 ischemic stroke patients were included in the final analysis (Figure 1).

Patient Characteristics

Forty percent of the patients were female, and 50% of the patients were 70 years or older. Basic characteristics of the patients according to highest education level are presented in Table 1. Patients with lower education levels were older
compared with patients with higher education levels (48% of patients in the lowest compared with 39% of patients in the highest education group were 75 years or older). Female respondents more often reported a lower education level than male patients, which was particularly true for older participants 31% of the elderly male respondents reported a college or university degree, whereas only 10% of the females 75 years or older did. Prestroke dependency was unequally distributed across education groups, with smaller dependency rates in the higher education groups and higher rates in the lower education groups. Stroke severity and functional impairment at stroke onset, however, did not vary significantly depending on education level. Patients with lower education levels had a higher probability of development of diabetes mellitus or hypertension than patients with higher education levels. We did not find differences in the distribution of atrial fibrillation, previous stroke, or hypercholesterolemia. The total number of comorbid conditions that patients experienced did not differ significantly between education groups.

Table 1. Patient Characteristics and Functional Outcome According to Highest Educational Level

<table>
<thead>
<tr>
<th></th>
<th>No Completed Education</th>
<th>Basic/Secondary Education and No Training</th>
<th>Basic/Secondary Education and Training</th>
<th>High School Degree</th>
<th>College/University Degree</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>162</td>
<td>130</td>
<td>941</td>
<td>125</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>Younger than 65 (%)</td>
<td>27</td>
<td>29</td>
<td>33</td>
<td>36</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>65–74 (%)</td>
<td>25</td>
<td>26</td>
<td>34</td>
<td>28</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>75–84 (%)</td>
<td>39</td>
<td>34</td>
<td>23</td>
<td>24</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>85 or older (%)</td>
<td>9</td>
<td>12</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Female (%)</td>
<td>45</td>
<td>72</td>
<td>40</td>
<td>40</td>
<td>27</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Independent before stroke (%)</td>
<td>88</td>
<td>85</td>
<td>91</td>
<td>92</td>
<td>95</td>
<td>0.004</td>
</tr>
<tr>
<td>NIHSS score &lt;5 (%)</td>
<td>70</td>
<td>68</td>
<td>66</td>
<td>68</td>
<td>74</td>
<td>0.188</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>35</td>
<td>30</td>
<td>29</td>
<td>23</td>
<td>18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Atrial fibrillation (%)</td>
<td>26</td>
<td>24</td>
<td>21</td>
<td>22</td>
<td>22</td>
<td>0.725</td>
</tr>
<tr>
<td>Previous stroke (%)</td>
<td>25</td>
<td>18</td>
<td>23</td>
<td>19</td>
<td>20</td>
<td>0.351</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>83</td>
<td>85</td>
<td>85</td>
<td>70</td>
<td>77</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypercholesterolemia (%)</td>
<td>58</td>
<td>59</td>
<td>64</td>
<td>59</td>
<td>61</td>
<td>0.515</td>
</tr>
</tbody>
</table>

NIHSS indicates National Institutes of Health Stroke Scale.
Functional Impairment 3 Months After Stroke

Of the patients included, 13% had a poor outcome (BI, 0–70), 26% had a moderate outcome (BI, 75–95), and 62% had a good functional outcome (BI, 100) 3 months after stroke. In univariate analyses, probability of good functional outcome (BI, 100) increased significantly in line with higher education level (Figure 2). Higher odds of good outcome were further observed for younger age, male sex, independent living before stroke, lower stroke severity, and the absence of diabetes mellitus, atrial fibrillation, previous stroke, and hypertension. In patients younger than 75 years, functional deficit in the follow-up differed only marginally by sex. In patients 75 years or older, the proportion of patients with good functional outcome was significantly higher in men (51%) than in women (36%).

Multivariable Analyses

In a first step, we adjusted the association between education and functional outcome for age and sex, which only marginally attenuated the association (Table 2). Further adjustment for prestroke dependency, stroke severity, and comorbidities considerably contributed to the predictive power of the model (Nagelkerke’s $R^2$ increased from 0.16–0.32). Multicollinearity diagnostic statistics revealed no relevant correlation between the independent factors. The variance inflation factor was only marginally increased in the included variables. The association between education and functional impairment, however, was only slightly affected by the inclusion of clinical variables. The adjusted analyses showed that patients with college or university degrees had >2-fold higher probability of good functional outcome (odds ratio, 2.18; 95% confidence interval, 1.39–3.42) compared with patients with no completed education. Age, prestroke dependency, stroke severity, diabetes mellitus, previous strokes, and hypertension were also significantly associated with functional impairment at 3 months.

Discussion

In this study we analyzed socioeconomic differences in functional impairment among survivors 3 months after stroke and tried to examine whether these differences can be explained by variations in stroke severity and other clinical and demographic patient characteristics. We observed a substantial social gradient in functional impairment, with patients in the lower education groups being significantly less likely to report a good outcome than patients in the higher education groups.

This result is in line with results of other studies that found similar differences in impairment between socioeconomic groups. Results from previous studies suggested inequality in poststroke recovery might be attributable to differences in stroke severity and deficit at stroke onset. Patients with higher socioeconomic status were consistently reported to have less severe strokes, defined by National Institutes of Health Stroke Scale scores, level of consciousness and ability to walk without assistance, and scored higher in functional outcome immediately after stroke onset. Unlike those reports, we did not find a remarkably unequal distribution of stroke severity between education groups. Prestroke dependency was more frequently reported in patients with lower education. These patients also had a higher prevalence of diabetes mellitus and hypertension, which corroborates findings of previous studies.

However, the social gradient in stroke recovery we observed remained nearly unchanged after adjustment for potential confounders. Differences in 3-month functional outcome seem to be insufficiently explained by differences in the distribution of clinical risk factors. This might be attributable to relevant determinants of functional recovery for which we did not collect information. Unmeasured factors might include environmental, behavioral, and psychosocial aspects closely related to socioeconomic living conditions. Our data lack, for example, information on lifestyle factors such as physical activity and smoking. We also did not collect data on psychosocial variables such as social support and resilience or coping abilities, which are most likely to influence recovery.

The study has strengths and limitations. The strengths of this study include its multicenter approach and its large sample size compared with other studies examining poststroke functional impairment. We used not only data from self-report questionnaires but also information extracted from medical records, which gave us the possibility to adjust the analyses for the most relevant clinical confounders.

The study’s limitations include a rather low participation rate of 64.9%, a loss to follow-up rate of 20.0%, and 9.8% of patients with incomplete data for either functional recovery or education who were not included in the analyses. The patients included in the present analyses were significantly younger and had less severe strokes and minor functional impairment than the total population of ischemic stroke patients documented in the Berlin Stroke Register. This selection bias might be attributable to the fact that patients were to give informed consent to participate. Although we tried to obtain consent from legal representatives for incompetent patients, they were not always available. However, even in a sample of less severely affected stroke patients with an assumed higher recovery rate at 3 months, we could still see a strong impact.
of education on functional outcome, which we expect still underestimates the true association.

We cannot rule out that some patients might have been included in the study twice if they had been treated for recurrent events in another of the participating stroke units. Because of data protection regulations, the patients’ personal data had to remain in the treating hospital and we were not able to check whether they had been included for a previous event elsewhere.

A further limitation was that we obtained data on the patients’ socioeconomic characteristics during follow-up because this information was not included in the baseline dataset. Because of this constraint, we do not have information on the education level of patients who did not agree to participate or who were either lost to follow-up or died during the 3 months after stroke.

Different measures can be used to define socioeconomic status. We decided against using an area-based measure as an indicator for socioeconomic status. These measures assume a certain socioeconomic homogeneity within neighborhoods and stability over time, which we found unlikely to be true, especially in an urban and fast-changing area like Berlin. To define socioeconomic status on the individual level, aggregated indices comprising different dimensions like education, income, and occupational position are certainly the method of choice. Income can be a sensitive issue for respondents and thus is difficult to obtain, which is why education is frequently used as a proxy for socioeconomic status in self-report surveys. This has certain disadvantages. For example, education is usually completed in young adulthood and thus does not reflect informal training and social advancement later in life. However, despite many shortcomings of the single measures commonly used as indicators for socioeconomic status, education frequently has been reported to be the closest proxy to aggregate measures of socioeconomic status. It remains relatively stable over time, is more comparable across genders than occupation, and is less likely to be reversed by ill health than income or occupation. Asking solely for education level and neglecting other dimensions of socioeconomic status thus might bias the

| Table 2. Crude and Adjusted Odds Ratios for Good Functional Recovery (Barthel Index 100) 3 Months After Stroke |
|--------------------------------------------------|------------------|------------------|------------------|
| Education level                                  | Unadjusted OR%   | Model 1 Adjusted OR* | Model 2 Adjusted OR† |
| No completed education                           | 1.00             | 1.00             | 1.00             |
| Basic/secondary education/no training            | 0.90 (0.57–1.43) | 0.95 (0.58–1.55) | 0.92 (0.54–1.58) |
| Basic/secondary education and training           | 1.39 (0.99–1.94) | 1.22 (0.86–1.74) | 1.22 (0.83–1.80) |
| High school degree                               | 1.97 (1.21–3.21) | 1.86 (1.11–3.11) | 1.80 (1.02–3.15) |
| College/university degree                        | 2.55 (1.72–3.78) | 2.41 (1.59–3.65) | 2.18 (1.39–3.42) |
| Age group                                        |                  |                  |                  |
| Younger than 65                                  | 1.00             | 1.00             | 1.00             |
| 65–74                                           | 0.53 (0.40–0.70) | 0.53 (0.40–0.70) | 0.65 (0.48–0.87) |
| 75–84                                           | 0.26 (0.20–0.34) | 0.26 (0.19–0.34) | 0.34 (0.25–0.46) |
| 85 or older                                     | 0.12 (0.08–0.18) | 0.13 (0.09–0.19) | 0.19 (0.12–0.29) |
| Female                                          | 0.59 (0.48–0.72) | 0.76 (0.61–0.94) | 0.81 (0.63–1.03) |
| NIHSS score                                      |                  |                  |                  |
| <5                                              | 1.00             | 1.00             | 1.00             |
| 5–15                                            | 0.31 (0.25–0.39) | 0.37 (0.29–0.47) | 0.37 (0.29–0.47) |
| 16–25                                           | 0.37 (0.21–0.63) | 0.33 (0.18–0.61) | 0.33 (0.21–0.63) |
| >25                                             |                  |                  |                  |
| Prestroke dependency                             |                  |                  |                  |
| Independent                                     | 1.00             | 1.00             | 1.00             |
| Nursing care at home                             | 0.10 (0.06–0.16) | 0.17 (0.10–0.30) | 0.17 (0.10–0.30) |
| Nursing care in institution                      | 0.04 (0.01–0.13) | 0.10 (0.03–0.35) | 0.10 (0.03–0.35) |
| Comorbidity                                      |                  |                  |                  |
| Diabetes mellitus                               | 0.46 (0.37–0.57) | 0.59 (0.46–0.77) | 0.59 (0.46–0.77) |
| Previous stroke                                  | 0.44 (0.35–0.56) | 0.57 (0.43–0.75) | 0.57 (0.43–0.75) |
| Hypertension                                     | 0.35 (0.26–0.48) | 0.68 (0.49–0.96) | 0.68 (0.49–0.96) |
| Atrial fibrillation                              | 0.48 (0.38–0.60) |                  |                  |

CI indicates confidence interval; OR, odds ratio; NIHSS, National Institutes of Health Stroke Scale.

*Model 1 adjusted for age and sex.
†Model 2 adjusted for age, sex, stroke severity, prestroke dependency, diabetes mellitus, previous stroke, and hypertension.
results. However, bias would lead to an underestimation of socioeconomic differences, suggesting that the real differences in functional outcome between education groups are still greater than demonstrated on the basis of our data.

Conclusion
The study demonstrated that lower education is significantly associated with stronger functional deficit 3 months after stroke. Our findings, however, did not support conclusions from previous studies indicating socioeconomic differences in functional recovery could be mainly explained by differences in stroke severity or other clinical factors. These results stress the importance of obtaining comprehensive information concerning environmental, psychosocial, or lifestyle-related patient characteristics to further explain and allow interventions to reduce these differences to be targeted and developed.

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