Socioeconomic Status and the Quality of Acute Stroke Care

The China National Stroke Registry

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Background and Purpose—The association of socioeconomic status (SES) with quality of stroke care is not well understood, and few studies have examined the association with different indicators of SES simultaneously. We assessed the impacts of low levels of education, occupation, and income on the quality of stroke care.

Methods—We examined data from the China National Stroke Registry recording consecutive stroke patients between September 2007 and August 2008. Baseline low SES was measured using educational level <6 years, occupation as manual workers or no job, and average family income per capita at ≤¥1000 per month. Compliance with 11 performances was summarized in a composite score defined as the proportion of all needed care given. Poor quality of care was defined as having a composite score of 0.71 or less.

Results—Among 12 270 patients with ischemic stroke, 38.6% had <6 educational years, 37.6% had manual workers/no job, and 34.7% had income ≤¥1000 per month. There was an increased chance of receiving poor quality of care in patients with low education (adjusted odds ratio 1.15, 95% confidence interval 1.03–1.28), low occupation (adjusted odds ratio 1.16, 95% confidence interval 1.01–1.32), and low income (adjusted odds ratio 1.18, 95% confidence interval 1.06–1.30), respectively. People with low SES had poor performances on some aspects of care quality. Combined effects existed among these SES indicators; those with low SES from all 3 indicators had the poorest quality of care.

Conclusions—There was a social gradient in the quality of stroke care. Continuous efforts of socioeconomic improvement will increase the quality of acute stroke care. **(*Stroke*. 2016;47:00-00. DOI: 10.1161/STROKEAHA.116.013292.)**

Key Words: income ■ occupation ■ quality of care ■ socioeconomic position ■ stroke

Stroke is the leading cause of disability and the second cause of death in the world.[1,2] There is evidence that increased quality of care during the early phase of stroke is significantly associated with reduced risk of disability and mortality.[3] However, the quality of stroke care has varied globally; high-income countries have better quality of stroke care than low- and middle-income countries[4,5]; and even in the same country, inequalities in stroke care exist across populations.

Although stroke patients with low socioeconomic status (SES) have an increased mortality[6–8] and poorer functional recovery,[9] the association between SES and quality of stroke care remains unclear. Recent findings from the United Kingdom suggest that lower SES was associated with reduced odds of being admitted to hospital (stroke unit or otherwise).[10] The association was also found in other studies undertaken in high-income countries.[11–13] However, other studies[14,15] did not detect such a social gradient association. These inconsistent findings may be because of different measurements of the quality of stroke care and SES. Few studies have used levels of education, occupation, and income or other SES indicators simultaneously to examine their associations with quality of stroke care. It is unknown whether there are interactions and combined effects of these SES indicators on the quality of stroke care. There is lack of data from low- and middle-income countries, where quality of stroke care is much poorer and stroke mortality is higher than that in high-income countries.[5,16,17] The association of SES with the quality of stroke care has not been well studied. In this article, we examined a large cohort data from China to assess the impacts of SES indicated

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by levels of education, occupational class, and average family income per capita on quality of care in stroke patients.

Methods

Study Participants

The study participants were derived from the China National Stroke Registry (CNSR).[18] Details of the design and baseline characteristics of the CNSR have been published previously.[18] In brief, the CNSR is a nationwide, multicenter, prospective registry study including consecutive patients with acute cerebrovascular events from 132 hospitals covering 27 provinces and 4 municipalities across China between September 2007 and August 2008. The survey included 22 216 patients with acute cerebrovascular events who aged ≥18 years and presented to hospital within 14 days after onset. After excluding patients with undetermined diagnosis, those transferred from other hospitals, those with missing or incomplete information at baseline, and those who did not consent for participation and follow-up, 18 580 patients were included in the CNSR, of which 12 415 were ischemic strokes. The details of these selection is shown in Figure. Acute ischemic stroke was diagnosed according to the World Health Organization criteria[19] and confirmed by magnetic resonance imaging or brain computerized tomography. Pathogenesis of ischemic stroke was classified according to the TOAST (Trial of Org 10172 in Acute Stroke Treatment) criteria.[20] The data collection of the CNSR study was approved by ethics committee at Beijing Tiantan Hospital and all centers. Written informed consent was given by all patients or his/her representatives before being entered into the study.

Baseline SES and Other Risk Factors Measurement

Data on demographics, SES, cardiovascular risk factors, and other baseline information were collected through face-to-face interviews by trained interviewers (neurologists). We documented the details of educational level, occupational class, and average family income in each patient.[21] Educational level was recorded to 5 groups according to the educational year: >12 years, 10 to 12 years, 6 to 9 years, 1 to 5 years, and illiteracy. Occupational class was determined as non-manual workers, manual workers, no job, or retired based on their main job title. Income level was recorded to 6 groups according to the average family income per capita per month (ie, the family's actual income per month is divided by the number of family members): <¥500, ¥500 to ¥1000, ¥1001 to ¥3000, ¥3001 to ¥5000, ¥5001 to ¥10 000, and >¥10 000 (to convert ¥ to US$, divide by 6.5). We recorded cardiovascular risk factors, history of diseases, stroke severity according to the National Institutes of Health Stroke Scale score, and prestroke modified Rankin Scale scores (dichotomized to >1 and ≤1). Patients with lack of knowledge of medical history or risk factor were classified as unknown. The data of teaching/nonteaching hospital and total beds of the hospital were also collected.

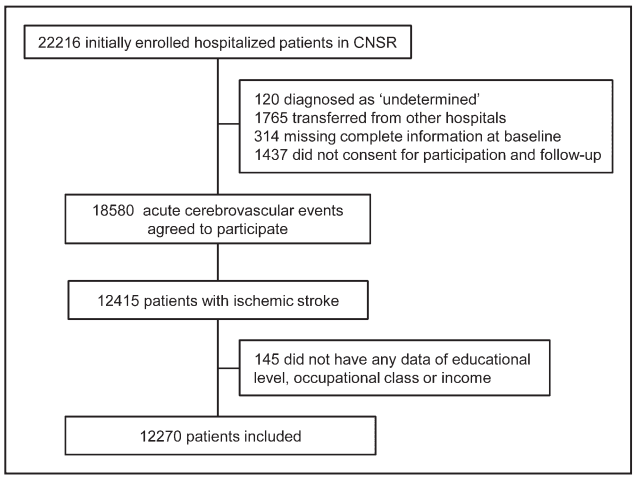

Figure. Patient flow diagram. CNSR indicates China National Stroke Registry.

Quality of Care

Our trained interview team used the 9 The Get With The Guidelines (GWTG)-Stroke performance measures and 2 additional evidence-based interventions (antihypertensive and antidiabetic agents at discharge)[22,23] to document the care of stroke for each of the patients with acute ischemic stroke. It includes (1) intravenous recombinant tissue-type plasminogen activator in patients who arrived <2 hours after symptom onset with no contraindications; (2) antithrombotic medication within 48 hours of admission; (3) deep vein thrombosis prophylaxis within 48 hours of admission if nonambulatory; (4) counseling or medication for smoking cessation if current smoker; (5) dysphagia screening before any oral intake during hospitalization; (6) rehabilitation services during hospitalization; (7) discharge on antithrombotics among those with no contraindications; (8) discharge on anticoagulants if atrial fibrillation present among those with no contraindications; (9) discharge on statins if dyslipidemia present, low-density lipoprotein ≥100 mg/dL, or low-density lipoprotein not documented among those with no contraindications; (10) discharge on antihypertensive agents if hypertension present among those with no contraindications; and (11) discharge on antidiabetic agents if diabetes mellitus present among those with no contraindications.

We calculated an opportunity-based composite score to reflect the summary composite measure of quality of stroke care for each patient. The composite score was defined as the total number of above interventions performed in each patient divided by the total number of interventions the patient was eligible for (range 1–11).[23,24]

Statistical Analysis

We included 12 270 ischemic stroke patients who had data of education, occupation, or income in this study (Figure). We defined patients with <6 years education, manual laboring/no job, or family income ≤¥1000 per month as having socioeconomic deprivation (SED).[21] The national data showed that average family income per capita per month is ¥1423 in the urban area and ¥559 in the rural area of China in 2008, and approximately half of residents live with family income ≤¥1000 per month.[25] Thus, it would be reasonable for us to use the family income ≤¥1000 per month as SED for analysis. We divided patients into 3 groups according to the tertiles of the composite score of the quality of care and took those who had low 2 tertiles of the score as having the poor quality of stroke care (because China has a generally poorer quality of stroke care than those in high income countries[5,26]). We examined differences between patients with poor versus good quality of stroke care in continuous variables using *t* test or Wilcoxon rank-sum test and in categorical variables using Chi-square test. We used multivariate adjusted logistic regression models to compute odds ratio (OR) and its 95% confidence intervals (CIs) for receiving the poor quality of stroke care in relation to SED. We adjusted patient's individual-level and hospital-level covariates, including for age, sex, heavy alcohol drinking, previous stroke, prestroke modified Rankin Scale, stroke subtype, National Institutes of Health Stroke Scale on admission, teaching hospital, and total beds of hospital. We also created a hospital-level variable that reflected the proportion of stroke patients who were classified as SED and then added it to the models to control for poor-performing hospitals. Apart from the composite score, we examined each of 11 performances measured in the quality of care in relation to SES to identify urgent specific areas for improving the quality of care after stroke. As the 3 SES indicators in China would not be highly correlated with each other (eg, some Chinese people were richer but had a low education), we investigated interaction effects between 2 indicators on these specific performances. We examined the combined effects from 3 indicators (scores summed up from each of SED) on the quality of stroke care and tested a social gradient trend in terms of the 3 SES indicators' cumulative impact.

Missing values for education, occupational class, and income level were imputed using multiple imputation techniques. We generated 5 imputed data sets replacing each missing value with a set of plausible

values and then combined the ORs with their 95% CIs across the 5 imputations with adjustment of standard errors to account for the additional uncertainty introduced by the imputation. Missing values for other covariates were not imputed using multiple imputation approaches but treated as a separate group in the models. Multilevel approaches in logistic regression models were performed considering the clustering effect at the hospital level. Using the same approaches, we performed a sensitivity analysis to examine complete data without imputation.

All analyses were performed with SAS software version 9.3 (SAS Institute Inc, Cary, NC).

Results

Among the 12 415 patients, 145(1.2%) were excluded for not having any data of educational level, occupational class, or income. The baseline characteristics of those included and excluded were well balanced (Table I in the online-only Data Supplement). In 12 270 patients, their average age was 65.5 (range 18–100) years, 38.2% were female. 38.6% had educational level <6 years, 37.6% were manual workers/jobless, and 34.7% had family income ≤¥1000 per capita per month. The median composite score of the patients was 0.60, with an interquartile range of 0.40 to 0.80, and the tertiled score points were 0.50 and 0.71.

Table 1 shows numbers and percentages of SES variables in patients receiving good or poor quality of stroke care. Patients with the poor quality of stroke care were more likely to have low levels of SES. We also observed that they were more likely to be older and never smoke and have atrial fibrillation and previous stroke, higher prestroke disability, cardioembolism and higher National Institutes of Health Stroke Scale score, and hospitalize in teaching hospitals or hospitals with less total beds, but have less diabetes mellitus. There were no significant differences in sex, heavy drink, hypertension, dyslipidemia, and coronary heart disease between 2 groups of patients (Table II in the online-only Data Supplement).

Table 2 shows numbers and adjusted ORs of poor quality of stroke care in relation to each individual of 3 SED indicators. Patients with educational level of <6 years had an increased odds of receiving the poor quality of stroke care (adjusted OR 1.15, 95% CI 1.03–1.28). This was similar in patients with manual working or no job (adjusted OR 1.16, 95% CI 1.01–1.32) and with averaged person family income of ≤¥1000 per month (adjusted OR 1.18, 95% CI 1.06–1.30).

We examined the association between SED and compliance with individual performance indicators of quality of stroke care and found that patients with low education were less likely to receive deep vein thrombosis prophylaxis <48 hours after admission, dysphagia screening, statins, and antihypertensive agents at discharge (Table 3). Patients with low

Table 1. Socioeconomic Status and Quality of Acute Stroke Care in the China National Stroke Registry

Socioeconomic Status	Total, % (N=12270)	Quality of Acute Stroke Care		*P* Value
		Good Quality of Care (N=4208)	Poor Quality of Care (N=8062)	
Educational level, y, n (%)				
>12	1180 (9.6)	435 (10.3)	745 (9.2)	<0.001
10–12	2248 (18.3)	816 (19.4)	1432 (17.8)	
6–9	2922 (23.8)	1074 (25.5)	1848 (22.9)	
1–5	3061 (25.0)	1023 (24.3)	2038 (25.3)	
Illiteracy	1666 (13.6)	471 (11.2)	1195 (14.8)	
Unknown	1193 (9.7)	389 (9.2)	804 (10.0)	
Occupational class, n (%)				
Nonmanual workers	1972 (16.1)	744 (17.7)	1228 (15.2)	<0.001
Manual workers	3308 (27.0)	1031 (24.5)	2277 (28.2)	
No job	1303 (10.6)	402 (9.5)	901 (11.2)	
Retired	5244 (42.7)	1868 (44.4)	3376 (41.9)	
Unknown	443 (3.6)	163 (3.9)	280 (3.5)	
Personal income, RMB/mo, n (%)				
>10 000	21 (0.2)	10 (0.2)	11 (0.1)	<0.001
5001–10 000	140 (1.1)	74 (1.8)	66 (0.8)	
3001–5000	665 (5.4)	288 (6.8)	377 (4.7)	
1001–3000	4160 (33.9)	1663 (39.5)	2497 (31.0)	
500–1000	2852 (23.2)	1020 (24.2)	1832 (22.7)	
<500	1407 (11.5)	424 (10.1)	983 (12.2)	
Unknown	3025 (24.7)	729 (17.3)	2296 (28.5)	

Table 2. Number and Adjusted OR of Poor Quality of Stroke Care

Socioeconomic Status	No. of Patients With Poor Quality of Care/ Total Patients, %	Adjusted OR* (95% CI)	*P* Value
Educational level, y			
≥6	4468/7009 (63.7)	1	
<6	3594/5261 (68.3)	1.15 (1.03–1.28)	0.01
Occupational class			
Nonmanual workers	1278/2047 (62.4)	1	
Manual workers or no job†	3282/4779 (68.7)	1.16 (1.01–1.32)	0.03
Retired	3502/5444 (64.3)	1.05 (0.91–1.20)	0.50
Income level, RMB/mo			
>1000	4005/6447 (62.1)	1	
≤1000	4057/5823 (69.7)	1.18 (1.06–1.30)	0.002

CI indicates confidence interval; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale; and OR, odds ratio.

*Multiple imputation, multilevel modeling, adjusted for age, sex, heavy alcohol drinking, previous stroke, prestroke mRS, stroke subtype, NIHSS on admission, teaching hospital, total beds of hospital, and a hospital-level variable reflecting the proportion of patients classified as socioeconomic deprivation.

†Manual workers: 2351/3430 (68.5%), OR=1.16 (95% CI: 1.01–1.33), *P*=0.04; in patients with no job: 931/1349 (69.0%), OR=1.16 (95% CI 0.97–1.38), *P*=0.10.

occupational class were less likely to receive antithrombotic and antihypertensive agents at discharge, while those with low income were less likely to receive dysphagia screening, rehabilitation services, antithrombotic agents, and statins at discharge. Rates of intravenous recombinant tissue-type plasminogen activator treatment, antithrombotics <48 hours after admission, smoking cessation, antidiabetic agents, and anticoagulants at discharge were similar across SES subgroups (Table 3). Possible reasons for nontreatment in each indicator were listed in Table III in the online-only Data Supplement, and only valid contraindication excluded patients from each measure according to the definition of performance measures.

Interactions and combined effects of educational level, occupational class, and income on the 11 performance measurement of the quality of stroke care are shown in Tables IV–VI in the online-only Data Supplement. Table 4 shows the combination of 3 SED indicators in relation to poor quality of care. There was a social gradient association of SED with receiving poor quality of care. Patients with a score of 2 and 3 had around 1.2- and 1.4-fold of odds to receive the poor quality of care with a trend $P<0.001$.

The sensitivity analyses using the complete data without SES variables imputed showed similar findings; for example, in Table 2, adjusted OR 1.17 (95% CI 1.05–1.29) in educational level of <6 years, adjusted OR 1.17 (95% CI 1.04–1.33) in manual workers or no job, and adjusted OR 1.12 (95% CI 1.01–1.26) in income of ≤1000 RMB, while in Table 4, adjusted OR 1.13 (95% CI 0.98–1.30) and adjusted OR 1.37 (95% CI 1.15–1.63) in patients with an SED score of 2 and 3, respectively.

Discussion

In this large-scale national stroke registry study, we found that low levels of education, occupation, and income were simultaneously associated with receiving poor quality of care in patients with ischemic stroke. There was evidence that higher the SED, the lower the quality of care the patients received.

The association of SES with the quality of stroke care has also been observed in some studies undertaken in high-income countries. A population-based registry in Denmark reported that individuals with low SES were associated with a lower chance of receiving optimal acute stroke care.[11] Results from the Registry of the Canadian Stroke Network showed that higher income was associated with improvements in some aspects of stroke care delivery, such as stroke unit admission and referrals to secondary prevention clinics.[13] However, other studies, for example, from the United Kingdom and Netherlands, did not show a significant association between SED and poor provision of stroke care.[14,15,27] This may be because these studies[14,15,27] had small sample sizes, only used one dimension of SES (education or occupation, respectively), and had a limited measurement of stroke care. Our CNSR study demonstrated that there were significant individual and combined effects of low level of education, occupational class, and income on receiving high quality of stroke care.

China has experienced rapid economic growth since its economic reform in 1978 and has had a large increase in income inequality between the rich and poor over the past 30 years.[28] The Gini coefficient (a most commonly used measure of inequality of income or wealth; a Gini coefficient of 0 expresses perfect equality and 1 expresses maximal inequality) for family income in China was reported to have now reached a level above 0.5,[28] compared with 0.36 in the United States and 0.358 in the United Kingdom.[29] The quality of stroke care in China is diverse across the country and on the whole poorer than that in western countries, especially for recombinant tissue-type plasminogen activator treatment and warfarin use.[5,26] Knowledge of existing disparities in the quality of stroke care is of importance for improving outcomes of stroke patients. Our study has shown that patients with SED have poorer quality of stroke care. The results would help target subgroups of stroke patients who would most likely benefit from interventions. We consider that general socioeconomic improvement and targeting groups with SED is likely to improve the quality of stroke care provision and then increase better outcomes of stroke. Our results may serve as a relevant reference for reducing inequality in health care, particularly in the low- and middle-income countries.

The findings of the current study may also help explain an association between SED and an increased mortality after stroke.[6–8] The possible mechanisms of SED increasing mortality could be through poorer quality of healthcare provision, apart from patient's higher risk-factor prevalence and severity of stroke.[11,30] The current study showed that patients with SED received poorer quality of some aspects of acute and secondary preventive care of stroke. These could be applied to target high-risk groups of stroke patients to improve the prognosis. Patients with low educational or income level might possibly be admitted to low-level hospitals, where services fall below

Table 3. Overall Compliance With Individual Performance Indicators Among Patients With Ischemic Stroke

Quality of Care: Performance Measures	Educational Level, y		Occupational Class			Income Level, RMB/mo	
	≥6	<6	Nonmanual Workers	Manual Workers or No Job	Retired	>1000	≤1000
IV r-tPA treatment							
% (N eligible)	13.6 (447)	8.7 (266)	14.6 (132)	8.4 (206)	12.7 (375)	13.5 (434)	9.0 (279)
OR (95% CI)*	1	0.57 (0.26–1.27)	1	0.56 (0.22–1.40)	1.19 (0.54–2.63)	1	0.71 (0.28–1.78)
Antithrombotics <48 h							
% (N eligible)	83.7 (6739)	82.7 (5042)	84.1 (1973)	84.8 (4584)	81.6 (5224)	84.0 (6189)	82.5 (5592)
OR (95% CI)*	1	0.97 (0.86–1.10)	1	1.02 (0.86–1.21)	0.99 (0.83–1.18)	1	0.91 (0.80–1.04)
DVT prophylaxis <48 h							
% (N eligible)	65.7 (2245)	62.2 (2133)	60.6 (572)	62.4 (1841)	66.5 (1965)	65.3 (2294)	62.5 (2084)
OR (95% CI)*	1	0.83 (0.70–0.99)	1	0.95 (0.75–1.21)	1.15 (0.90–1.47)	1	0.94 (0.75–1.17)
Smoking cessation							
% (N eligible)	73.0 (2281)	66.0 (1003)	73.3 (767)	70.1 (1368)	70.2 (1149)	71.7 (1713)	70.0 (1571)
OR (95% CI)*	1	0.96 (0.73–1.24)	1	0.98 (0.75–1.28)	0.96 (0.71–1.29)	1	0.97 (0.78–1.20)
Dysphagia screening							
% (N eligible)	39.6 (6520)	37.1 (4746)	37.1 (1926)	34.7 (4355)	42.5 (4985)	43.7 (5937)	32.8 (5329)
OR (95% CI)*	1	0.85 (0.74–0.98)	1	1.01 (0.86–1.18)	1.04 (0.88–1.23)	1	0.76 (0.67–0.86)
Rehabilitation services							
% (N eligible)	48.6 (7009)	48.2 (5261)	48.2 (2047)	45.4 (4779)	51.2 (5444)	52.3 (6447)	44.1 (5823)
OR (95% CI)*	1	1.00 (0.90–1.10)	1	0.98 (0.86–1.12)	1.06 (0.93–1.21)	1	0.83 (0.75–0.92)
Discharged on antithrombotics							
% (N eligible)	71.2 (6927)	67.9 (5163)	75.0 (2033)	70.6 (4723)	67.1 (5334)	71.8 (6336)	67.6 (5754)
OR (95% CI)*	1	0.96 (0.86–1.08)	1	0.86 (0.75–1.00)	0.95 (0.81–1.11)	1	0.88 (0.79–0.99)
Discharged on anticoagulants							
% (N eligible)	25.6 (371)	24.7 (345)	28.6 (83)	25.9 (246)	23.9 (387)	25.6 (417)	24.5 (299)
OR (95% CI)*	1	1.28 (0.81–2.01)	1	1.14 (0.57–2.26)	1.44 (0.73–2.85)	1	0.77 (0.44–1.36)
Discharged on statins							
% (N eligible)	33.6 (2413)	29.4 (1949)	36.1 (665)	31.4 (1803)	30.6 (1894)	33.7 (2278)	29.6 (2084)
OR (95% CI)*	1	0.79 (0.66–0.96)	1	0.80 (0.63–1.02)	0.93 (0.73–1.18)	1	0.84 (0.71–0.99)
Discharged on antihypertensive agents							
% (N eligible)	53.7 (4987)	49.6 (3727)	56.9 (1443)	50.8 (3148)	51.1 (4123)	53.9 (4726)	49.6 (3988)
OR (95% CI)*	1	0.87 (0.77–0.98)	1	0.85 (0.73–0.98)	0.95 (0.82–1.11)	1	0.94 (0.83–1.05)
Discharged on antidiabetic agents							
% (N eligible)	61.6 (1945)	59.3 (1379)	65.2 (574)	60.4 (1077)	59.2 (1673)	61.8 (1878)	59.2 (1446)
OR (95% CI)*	1	1.19 (0.98–1.44)	1	1.00 (0.78–1.29)	0.96 (0.75–1.23)	1	1.04 (0.81–1.35)
Composite score mean (SD)	0.58 (0.26)	0.55 (0.26)	0.59 (0.25)	0.56 (0.25)	0.57 (0.27)	0.60 (0.25)	0.54 (0.27)

CI indicates confidence interval; DVT, deep vein thrombosis; IV r-tPA, intravenous recombinant tissue-type plasminogen activator; OR, odds ratio; and SD, standard deviation.

*The same model and adjustment as in Table 2.

standards of care because of lack of awareness—for example, providing dysphagia screening before any oral intake for stroke patients. We think that providers may not recommend evidence-based therapies to patients if there was perception that the patient would not be able to pay for them, whether or not the patient refused. Furthermore, we consider that patients with SED were both unaware and lacking in economic capability to accept rehabilitation services and the evidence-based secondary preventive interventions of stroke, for example, statins, antithrombotic, and antihypertensive agents

Table 4. Number and Adjusted OR of Poor Quality of Stroke Care in Relation to SED Combinations in Patients With Stroke

Total Score of SED combined*	No. of Poor Quality of Care/Patients, %	Adjusted OR† (95% CI)	*P* Value
0	1995/3328 (59.9)	Ref.	
1	2537/3879 (65.4)	1.07 (0.95–1.21)	0.25
2	2193/3204 (68.4)	1.17 (1.03–1.33)	0.02
3	1337/1859 (71.9)	1.39 (1.19–1.63)	<0.001

CI indicates confidence interval; OR, odds ratio; and SED, socioeconomic deprivation.

*Added scores from each low levels of educational years: <6 (1 score), manual workers or no jobs (1 score), and income ≤1000 RMB (1 score).

†The same model and adjustment as in Table 2.

at discharge. Apart from reforming the current system of stroke care, including access to services, we urge the Chinese governments to increase educational level and reduce the poverty in population to improve the likelihood that high-quality stroke care will be affordable and attainable by the majority of Chinese citizens.

Strengths and Weaknesses of the Study

The strength of the current study is that the CNSR is a large scale national representative registry study, which was used to evaluate the quality of stroke care over time and its determinants.[18] It includes patients with a diversity of socioeconomic characteristics and hospitals with disparities in quality of stroke care, which reflects the high level of socioeconomic inequalities in China.[21] The unique data has helped us examine separate interactions and combined impacts of the 3 SES indicators on quality of stroke care. We used multiple imputation techniques to deal with missing data. Even in a high rate of missingness, such as income at ≈20%, the multiple imputation technique is valid.[31] Therefore, our findings of the association between 3 SED indicators and quality of stroke care are robust. Our study has limitations. First, the CNSR does not cover rural hospitals, and thus, we could not examine differences in the quality of stroke care between the rural and urban areas. Previous studies showed that rural hospitals have an overall poorer quality of care than urban hospitals.[32] Thus, the associations of low quality of stroke care with SED in this study may be underestimated. Second, of 22 216 patients, 1437 did not consent to follow up and were excluded for analysis. A study from the Canadian Stroke Registry suggested that excluding those patients could improve the performance because they were more likely to be with higher severity.[33] However, our CNSR data had only 6.5% of patients who did not consent to follow up, and thus, the effects of bias on the findings would be minimized. Third, we took patients with low two thirds of the composite score for the poor quality of care in analysis. The cutoff point is arbitrary based on our understanding that stroke patients in China have a poorer quality of stroke care in China than those in high-income countries.[5,26] However, if we used the median score of 0.6 or below defined as having a poor quality of care for data analysis, the findings were similar to the current ones (data now shown). Fourth, there might be some stroke patients who did not search for care from hospital or died before hospitalization. Although they are estimated to be low, these rates also could be socioeconomic patterned; those with lower level of SES may be less likely to be admitted to hospitals and receive care from the hospitals.[10] Thus, the findings of our current study could be more conservative.

Conclusions

In conclusion, the China nationwide stroke register study has demonstrated that low levels of education, occupation, and income were significantly associated with receiving poor quality of care in patients with ischemic stroke. Continuous efforts to reduce SED are warranted to improve quality of stroke care and, thus, to tackle health inequality.

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Disclosures

None.

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Socioeconomic Status and the Quality of Acute Stroke Care: The China National Stroke Registry

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SUPPLEMENTAL MATERIAL

Table I. Comparison of baseline characteristics of the included and excluded groups

Characteristics	The included group (N=12270)	The excluded group (N=145)	p value
Socio-demography			
Age (year), mean(SD)	65.5±12.3	65.1±12.6	0.46
Sex, n(%)			
Men	7583(61.8)	75(51.7)	0.01
Women	4687(38.2)	70(48.3)	
Medical history			
Hypertension, n(%)			
No	4339(35.4)	57(39.3)	0.16
Yes	7714(62.9)	83(57.2)	
Unknown	217(1.8)	5(3.5)	
Diabetes mellitus, n(%)			
No	9405(76.7)	106(73.1)	0.41
Yes	2607(21.2)	34(23.4)	
Unknown	258(2.1)	5(3.5)	
Dyslipidemia, n(%)			
No	8296(67.6)	102(70.3)	0.25
Yes	1380(11.3)	10(6.9)	
Unknown	2594(21.1)	33(22.8)	
Coronary heart disease, n(%)			
No	10503(85.6)	120(82.8)	0.33
Yes	1767(14.4)	25(17.2)	
Atrial fibrillation, n(%)			
No	10958(89.3)	131(90.3)	0.69
Yes	1312(10.7)	14(9.7)	
Stroke case, severity and acute care			
Previous stroke, n(%)			
No	8083(65.9)	98(67.6)	0.67
Yes	4187(34.1)	47(32.4)	
Subtype of stroke*, n(%)			
Large-artery atherosclerosis	5507(44.9)	80(55.2)	0.12
Small-vessel occlusion	2066(16.8)	24(16.6)	
Cardioembolism	756(6.2)	7(4.8)	
Other or undetermined	453(3.7)	5(3.5)	
Unknown	3488(28.4)	29(20.0)	
NIHSS on admission, median(IQR)	4(2-9)	5(2-10)	0.67

SD indicates Standard Deviation; IQR, Interquartile Range; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

* Stroke subtype was defined by the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification.

Table II. Characteristics of ischemic stroke patients and quality of acute stroke care in the China National Stroke Registry

Variable	Total, (%) (N=12270)	Quality of acute stroke care		p value
		Good quality of care (N=4208)	Poor quality of care (N=8062)	
Socio-demography				
Age (year), mean(SD)	65.5±12.3	65.1±12.0	65.6±12.5	0.01
Sex, n(%)				
Men	7583(61.8)	2640(62.7)	4943(61.3)	0.12
Women	4687(38.2)	1568(37.3)	3119(38.7)	
Medical history and risk factors				
Smoking status, n(%)				
Never-smoking	7060(57.5)	2337(55.5)	4723(58.6)	<0.001
Former-smoking	1610(13.1)	557(13.2)	1053(13.1)	
Current smoking	3284(26.8)	1225(29.1)	2059(25.5)	
Unknown	316(2.6)	89(2.1)	227(2.8)	
Heavy drink, n(%)				
No	10763(87.7)	3678(87.4)	7085(87.9)	0.19
Yes	1316(10.7)	473(11.2)	843(10.5)	
Unknown	191(1.6)	57(1.4)	134(1.7)	
Hypertension, n(%)				
No	4339(35.4)	1464(34.8)	2875(35.7)	0.33
Yes	7714(62.9)	2661(63.2)	5053(62.7)	
Unknown	217(1.8)	83(2.0)	134(1.7)	
Diabetes mellitus, n(%)				
No	9405(76.7)	3125(74.3)	6280(77.9)	<0.001
Yes	2607(21.2)	985(23.4)	1622(20.1)	
Unknown	258(2.1)	98(2.3)	160(2.0)	
Dyslipidemia, n(%)				
No	8296(67.6)	2817(66.9)	5479(68.0)	0.45
Yes	1380(11.3)	491(11.7)	889(11.0)	
Unknown	2594(21.1)	900(21.4)	1694(21.0)	
Coronary heart disease, n(%)				
No	10503(85.6)	3619(86.0)	6884(85.4)	0.36
Yes	1767(14.4)	589(14.0)	1178(14.6)	
Atrial fibrillation, n(%)				
No	10958(89.3)	3841(91.3)	7117(88.3)	<0.001
Yes	1312(10.7)	367(8.7)	945(11.7)	
Stroke case, severity and acute care				
Previous stroke, n(%)				
No	8083(65.9)	2831(67.3)	5252(65.1)	0.02
Yes	4187(34.1)	1377(32.7)	2810(34.9)	
Pre-stroke mRS >1, n(%)				
No	10952(89.3)	3800(90.3)	7152(88.7)	0.03
Yes	1158(9.4)	359(8.5)	799(9.9)	
Unknown	160(1.3)	49(1.2)	111(1.4)	
Subtype of stroke[*], n(%)				
Large-artery atherosclerosis	5507(44.9)	2185(51.9)	3322(41.2)	<0.001
Small-vessel occlusion	2066(16.8)	902(21.4)	1164(14.4)	
Cardioembolism	756(6.2)	242(5.8)	514(6.4)	
Other or undetermined	453(3.7)	149(3.5)	304(3.8)	
Unknown	3488(28.4)	730(17.4)	2758(34.2)	
NIHSS on admission, median(IQR)	4(2-9)	4(2-8)	5(2-10)	0.004
Teaching hospital, n(%)				
No	5458(44.5)	1934(46.0)	3524(43.7)	0.02

Yes	6812(55.5)	2274(54.0)	4538(56.3)	
Total beds of hospital, median(IQR)	1026(700-1400)	1100(700-1600)	1000(700-1400)	<0.001

SD indicates Standard Deviation; IQR, Interquartile Range; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

* Stroke subtype was defined by the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification.

Table III. Possible reasons for non-treatment in each indicator

Quality of care – performance measures	Possible reasons
IV rt-PA treatment	Contraindications of IV t-PA (such as active internal bleeding, systolic blood pressure > 185 mmHg or diastolic blood pressure > 110 mmHg despite treatment, seizure at onset, recent surgery/trauma (within 15 days), history of intracranial hemorrhage or brain aneurysm or vascular malformation or brain tumor, et al.) Patient/Family refused for economic reason Patient/Family refused for risk of bleeding IV t-PA was not available in this hospital Didn't know patient needed to be treated Others
Antithrombotics <48 hours	Didn't know patient needed to be treated Contraindications of antithrombotics (such as allergic, serious side effect of antithrombotic agents, concomitant diseases that cannot use antithrombotic agents, high risk for bleeding or discontinued due to bleeding, et al.) Patient/Family refused Others
DVT prophylaxis <48 hours	Didn't know patient needed to be treated Contraindications of anticoagulants (such as allergic, serious side effect of anticoagulant agents, concomitant diseases that cannot use anticoagulant agents, high risk for bleeding or discontinued due to bleeding, et al.) Contraindications of thrombosis pump Patient/Family refused Physician didn't know how to do Others
Smoking cessation	Didn't know patient needed to be treated Patient's condition not allowed Patient/Family refused Others
Dysphagia screening	Didn't know patient needed to be treated Didn't know how to evaluate it Symptom resolution Fasting Can't be evaluated due to coma Others
Rehabilitation services	No facilities No personnel Didn't know patient needed to be treated No permission due to patient's condition Patient/Family refused Others
Discharged on antithrombotics	Didn't know patient needed to be treated

	Contraindications of antithrombotics (such as allergic, serious side effect of antithrombotic agents, concomitant diseases that cannot use antithrombotic agents, high risk for bleeding or discontinued due to bleeding, et al.) Patient/Family refused Terminal illness/palliative care only Allergy Others
Discharged on anticoagulants	Didn't know patient needed to be treated Didn't know how to do Contraindications to anticoagulants (such as allergic, serious side effect of anticoagulant agents, concomitant diseases that cannot use anticoagulant agents, high risk for bleeding or discontinued due to bleeding, et al.) Risk of bleeding Risk of falls Liver disease Terminal illness/palliative care only Patient/Family refused Others
Discharged on statins	Contraindications to lipid-lowering treatment (such as allergic, serious side effect of lipid-lowering agents, concomitant diseases that cannot use lipid-lowering agents, et al.) Didn't know patient needed to be treated Patient/Family refused Others
Discharged on antihypertensive agents	Contraindications to antihypertensive treatment (such as allergic, serious side effect of antihypertensive agents, concomitant diseases that cannot use antihypertensive agents, et al.) Didn't know patient needed to be treated Patient/Family refused Others
Discharged on antidiabetic agents	Contraindications to antidiabetic treatment (such as allergic, serious side effect of antidiabetic agents, concomitant diseases that cannot use antidiabetic agents, et al.) Didn't know patient needed to be treated Patient/Family refused Others

Table IV. Overall compliance with individual performance indicators among patients with levels of education and income combined

Quality of care – performance measures	High education and high income*		High education and low income		Low education and high income		Low education and low income	
	% (N Eligible)	Ref	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†
IV rt-PA treatment	15.2(302)	Ref	10.3(145)	0.78(0.29-2.14)	9.7(132)	0.62(0.26-1.50)	7.6(134)	0.46(0.13-1.62)
Antithrombotics <48 hours	84.9(3996)	Ref	82.0(2743)	0.88(0.75-1.03)	82.4(2193)	0.94(0.78-1.13)	82.9(2849)	0.90(0.77-1.06)
DVT prophylaxis <48 hours	67.5(1357)	Ref	62.9(889)	0.96(0.70-1.30)	62.2(937)	0.83(0.66-1.05)	62.2(1195)	0.80(0.62-1.03)
Smoking cessation	74.4(1300)	Ref	71.1(981)	1.01(0.79-1.30)	62.9(413)	1.04(0.69-1.57)	68.2(590)	0.90(0.65-1.25)
Dysphagia screening	44.7(3869)	Ref	32.2(2651)	0.78(0.66-0.93)	41.9(2068)	0.89(0.74-1.08)	33.4(2678)	0.68(0.57-0.81)
Rehabilitation services	51.8(4154)	Ref	43.9(2856)	0.86(0.74-0.99)	53.1(2293)	1.07(0.92-1.24)	44.4(2967)	0.84(0.73-0.96)
Discharged on antithrombotics	72.9(4096)	Ref	68.7(2831)	0.93(0.79-1.10)	69.8(2240)	1.04(0.88-1.25)	66.5(2923)	0.86(0.75-0.99)
Discharged on anticoagulants	24.3(242)	Ref	27.9(129)	1.00(0.43-2.30)	27.4(175)	1.72(0.93-3.17)	21.9(170)	0.94(0.48-1.86)
Discharged on statins	34.4(1433)	Ref	32.4(980)	0.97(0.76-1.23)	32.5(845)	0.92(0.72-1.18)	27.1(1104)	0.68(0.54-0.86)
Discharged on antihypertensive agents	55.5(3024)	Ref	50.9(1962)	0.98(0.84-1.14)	51.1(1702)	0.91(0.77-1.07)	48.4(2025)	0.83(0.72-0.96)
Discharged on antidiabetic agents	63.2(1214)	Ref	59.0(731)	1.02(0.75-1.39)	59.2(664)	1.18(0.91-1.53)	59.4(715)	1.22(0.90-1.65)
Composite score mean (SD)	0.61(0.25)		0.55(0.27)		0.58(0.26)		0.54(0.26)	

CI indicates confidence interval; OR, odds ratio; IV rt-PA, intravenous recombinant tissue plasminogen activator; DVT, deep vein thrombosis; SD, Standard Deviation.

* High education: ≥6 years; high income: >1000 RMB/month; low education: <6 years; low income: ≤1000 RMB/month.

† The same model and adjustment in Table 2.

Table V. Overall compliance with individual performance indicators among patients with levels of education and occupation combined

	High education and high occupation*		High education and low occupation		Low education and high occupation		Low education and low occupation	
Quality of care – performance measures	% (N Eligible)	Ref	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†
IV rt-PA treatment	15.5(119)	Ref	10.8(94)	0.60(0.21-1.69)	6.0(13)	0.14(0.00-124.3)	6.3(112)	0.35(0.10-1.19)
Antithrombotics <48 hours	84.2(1693)	Ref	85.5(1881)	1.04(0.84-1.29)	83.1(281)	0.88(0.57-1.39)	84.3(2703)	0.97(0.79-1.19)
DVT prophylaxis <48 hours	61.2(469)	Ref	63.6(649)	1.05(0.78-1.39)	58.2(103)	0.97(0.57-1.64)	61.7(1193)	0.86(0.65-1.15)
Smoking cessation	73.5(690)	Ref	73.9(804)	1.07(0.78-1.46)	70.7(77)	1.17(0.59-2.32)	64.7(563)	0.90(0.63-1.28)
Dysphagia screening	38.1(1650)	Ref	34.9(1809)	1.02(0.84-1.24)	30.9(276)	0.72(0.49-1.03)	34.5(2546)	0.89(0.73-1.07)
Rehabilitation services	48.3(1755)	Ref	45.1(1954)	0.95(0.82-1.12)	47.3(293)	0.96(0.68-1.35)	45.6(2825)	1.00(0.85-1.18)
Discharged on antithrombotics	75.7(1742)	Ref	72.2(1940)	0.88(0.74-1.06)	70.8(291)	0.91(0.63-1.31)	69.5(2783)	0.82(0.68-0.98)
Discharged on anticoagulants	27.3(71)	Ref	33.5(77)	1.40(0.57-3.47)	36.8(11)	2.41(0.40-14.42)	22.4(169)	1.24(0.56-2.78)
Discharged on statins	36.8(569)	Ref	34.4(713)	0.88(0.65-1.20)	31.8(96)	0.70(0.40-1.22)	29.3(1090)	0.66(0.49-0.88)
Discharged on antihypertensive agents	56.4(1234)	Ref	52.1(1241)	0.91(0.75-1.10)	59.8(209)	1.19(0.83-1.70)	49.9(1906)	0.81(0.68-0.98)
Discharged on antidiabetic agents	65.2(483)	Ref	61.5(429)	0.97(0.71-1.33)	65.1(91)	1.36(0.76-2.45)	59.7(648)	1.17(0.86-1.61)
Composite score mean (SD)	0.60(0.25)		0.58(0.25)		0.57(0.25)		0.55(0.25)	

CI indicates confidence interval; OR, odds ratio; IV rt-PA, intravenous recombinant tissue plasminogen activator; DVT, deep vein thrombosis; SD, Standard Deviation.

* High education: ≥6 years; high occupation: non-manual workers; low education: <6 years; low occupation: manual workers or no jobs.

† The same model and adjustment in Table 2.

Table VI. Overall compliance with individual performance indicators among patients with levels of income and occupation combined

	High income and high occupation*		High income and low occupation		Low income and high occupation		Low income and low occupation	
Quality of care – performance measures	% (N Eligible)	Ref	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†	% (N Eligible)	OR(95% CI)†
IV rt-PA treatment	12.6(89)	Ref	13.5(95)	1.21(0.31-4.70)	18.6(43)	1.90(0.39-9.32)	4.0(111)	0.31(0.08-1.23)
Antithrombotics <48 hours	85.6(1239)	Ref	84.0(1723)	0.93(0.72-1.19)	81.5(734)	0.82(0.63-1.08)	85.2(2861)	0.96(0.77-1.19)
DVT prophylaxis <48 hours	61.6(361)	Ref	62.5(664)	0.90(0.65-1.24)	59.0(211)	0.83(0.50-1.40)	62.3(1177)	0.89(0.64-1.24)
Smoking cessation	75.3(486)	Ref	68.6(545)	0.93(0.63-1.38)	69.8(281)	0.87(0.56-1.34)	71.1(822)	0.93(0.65-1.33)
Dysphagia screening	41.3(1207)	Ref	40.6(1635)	1.03(0.83-1.28)	30.0(719)	0.67(0.52-0.87)	31.1(2720)	0.77(0.63-0.94)
Rehabilitation services	50.9(1288)	Ref	48.9(1792)	0.97(0.81-1.17)	43.6(760)	0.83(0.65-1.07)	43.3(2987)	0.88(0.73-1.07)
Discharged on antithrombotics	76.5(1278)	Ref	73.1(1767)	0.95(0.78-1.15)	72.4(755)	0.96(0.75-1.23)	69.1(2955)	0.78(0.64-0.94)
Discharged on anticoagulants	25.3(53)	Ref	25.2(104)	1.42(0.54-3.74)	34.5(30)	1.17(0.35-3.88)	26.4(142)	1.07(0.44-2.59)
Discharged on statins	37.3(430)	Ref	34.5(675)	0.89(0.65-1.21)	33.9(235)	0.85(0.56-1.28)	29.5(1128)	0.68(0.49-0.95)
Discharged on antihypertensive agents	67.6(904)	Ref	51.9(1223)	0.87(0.71-1.07)	55.7(540)	1.04(0.80-1.35)	50.0(1925)	0.84(0.68-1.02)
Discharged on antidiabetic agents	64.5(370)	Ref	61.9(458)	1.12(0.78-1.61)	66.6(204)	1.26(0.79-1.99)	59.3(619)	1.07(0.76-1.51)
Composite score mean (SD)	0.61(0.24)		0.58(0.25)		0.56(0.26)		0.55(0.25)	

CI indicates confidence interval; OR, odds ratio; IV rt-PA, intravenous recombinant tissue plasminogen activator; DVT, deep vein thrombosis; SD, Standard Deviation.

* High income: >1000 RMB/month; high occupation: non-manual workers; low income: ≤1000 RMB/month; low occupation: manual workers or no jobs.

† The same model and adjustment in Table 2.