Socioeconomic deprivation and mortality in people after ischemic stroke: The China National Stroke Registry

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Running title: Socioeconomic status and poststroke mortality

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Tables: 4; **Figure:** 1; **Supplemental tables:** 5; **Words:** 4817.

Key Words: economics; mortality; outcomes; socioeconomic deprivation; socioeconomic factors; stroke;

ABSTRACT

Background

Previous findings of the association between socioeconomic deprivation (SED) and mortality after ischemic stroke are inconsistent. There is a lack of data on the association with combined low education, occupational class and income. We assessed the associations of three indicators with mortality.

Methods

We examined data from the China National Stroke Registry, recording all stroke patients occurred between September 2007 and August 2008. Baseline SED was measured using low levels of education at <6 years, occupation as manual laboring and average family income per capita at ≤¥1,000 per month. 12,246 patients with ischemic stroke were analyzed.

Results

In a 12-month follow-up 1640 patients died. After adjustment for age, sex, cardiovascular risk factors, severity of stroke and pre-hospital medications, odds ratio (OR) for mortality in patients with low education was 1.25(95%CI 1.05-1.48), manual laboring 1.37(1.09-1.72) and low income 1.19(1.03-1.37). Further adjustment for acute care and medications in and after hospital made no substantial changes in these ORs, except a marginal significant OR for low income (1.15, 0.99-1.33). The OR for low income was 1.27(1.01-1.60) within patients with high education. Compared with no SED, the OR in patients with SED determined by any 1 indicator was 1.33(1.11-1.59), by any 2 indicators 1.36(1.10-1.69) and by all 3 indicators 1.56(1.23- 1.97).

Conclusions

There are significant inequalities in survival after ischemic stroke in China in terms of social and material forms of deprivation. General socioeconomic improvement, targeting groups at high risk of mortality is likely to reduce inequality in survival after stroke.

INTRODUCTION

Stroke affects 62 million people worldwide and is the 2nd cause of death (1, 2). There is evidence that people with socioeconomic deprivation (SED) have an increased incidence of stroke (3, 4) and poorer functional recovery after stroke (5). However, the findings of the association between SED and mortality after stroke are not consistent (3, 6-10). Some (6-9) but not all studies (3, 10) have shown that there is an increased mortality after ischemic stroke in people with SED. The social gap in survival after ischemic stroke is not yet fully understood, although disparities in stroke incidence across socioeconomic groups have been tried to be explained by differences in the prevalence of major risk factors (11). Possible reasons include differences in stroke risk factors, severity or acute care between lower and higher socioeconomic groups. Previous studies investigating the association between SED and mortality after ischemic stroke insufficiently adjusted for these potential confounders (3, 8, 12, 13). The majority of studies examining the association were undertaken in high incomes countries (3, 6, 7, 10, 13), and their findings are difficult to be applied in low- and middle-income countries, where stroke is a leading cause of death (14, 15). Furthermore, few studies have examined contemporary effects of each of educational level, occupational class and income and their combinations on mortality. In this study, we examined a large stroke registry cohort data from China to assess the impacts of SED indicated by low levels of education, occupational class and average family income per capita on survival of people with ischemic stroke.

METHODS

Study Population

The study population was derived from the China National Stroke Registry (CNSR) (16). Details of the rational, design and baseline investigations of the CNSR have been published previously

(16). In brief, the CNSR is a nationwide, multicenter, prospective registry study of 22,216 consecutive patients with a diagnosis of acute cerebrovascular events from 132 hospitals covering 27 provinces and 4 municipalities across China between September 2007 and August 2008.

Acute ischemic stroke patients aged ≥18 years who presented to hospital within 14 days after the onset of symptoms were eligible for the study. Acute ischemic stroke was diagnosed according to the World Health Organization criteria (17) and confirmed by brain computerized tomography or Magnetic Resonance Imaging. Acute ischemic stroke was diagnosed when the following conditions were met: acute occurrence within 14 days of neurologic deficit, with focal or overall involvement of the nervous system, lasting for >24 hours and after excluding nonvascular causes (primary and metastatic neoplasms, postseizure paralysis, head trauma, etc) that led to brain function deficit, and excluding intracerebral hemorrhage by computed tomography or magnetic resonance imaging. The TOAST (Trial of Org 10172 in Acute Stroke Treatment) criteria were used to classify ischemic stroke etiology (18).

Baseline data on demographics, socioeconomic status (SES), cardiovascular risk factors and medical treatments were collected through face-to-face interviews by trained interviewers. We documented educational level, occupational class and income for each patient (19). Educational level was categorized to 5 groups according to the educational year: “>12 years”, “10-12 years”, “6-9 years”, “1-5 years” and “illiteracy”. The occupational class was determined as “non-manual workers”, “manual workers”, “retired” or “no job” based on their main job title. The income was recorded to 6 groups according to the average family income per capita per month: “ <¥500”, “¥500-¥1000”, “¥1001-¥3000”, “¥3001-¥5000”, “¥5001-¥10000”, and “ >¥10000”. We recorded cardiovascular risk factors, histories of cardiovascular disease and medications. We measured

stroke severity according to the National Institutes of Health Stroke Scale (NIHSS) score, and modified Rankin Scale (mRS) scores (dichotomized to >1 and ≤1) on admission, and acute care and medications on admission and discharge.

We followed up the cohort patients by telephone interview at 3 months, 6 months and 1 year after stroke onset. The central telephone follow-up was performed by trained interviewers for all patients based on a standardized interview protocol. All causes of death were documented.

The CNSR data collection was approved by ethics committee at Beijing Tiantan Hospital. Written informed consent was given by all patients or his/her representatives before being entered into the study.

Statistical Analysis

In this study we included all patients with ischemic stroke who had data of education, occupation or income. 12,246 ischemic patients were eligible for data analysis (Fig). In descriptive data analysis, we presented continuous variables as mean±SD or median with interquartile and categorical variables as percentages. We examined differences between survivors and patients who died in continuous variables using t test or wilcoxon rank sum test and in categorical variables using chi-square test.

We employed multivariate adjusted logistic regression models to calculate odds ratios (ORs) and their 95% confidence intervals (CI) of mortality in patients with SED. We adjusted for different sets of co-variables to clarify the confounding effects of cardiovascular risk factors and stroke severity and care on the association between SED and mortality. In this study we defined those with <6 years education, manual laboring or family income ≤¥1000 per month as having SED (19). After examining the association of mortality with each of 3 SED indicators, we

investigated combined effects between 2 indicators, and then from the 3 indicators (scores summed up from each of SED).

We used multiple imputation techniques to treat missing values for educational level, occupational class and income. Missing values for other covariates were not imputed using multiple imputation approaches but analyzed as a separate category in the models. We generated 5 imputed data sets, and the ORs with their 95% CIs were then combined across the 5 imputations with adjustment of standard errors to account for the additional uncertainty introduced by the imputation. Considering the clustering effect at the hospital level, multilevel approaches in logistic regression models were performed.

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

RESULTS

Among these 12,246 patients, the average age was 65.5 (range 18-100), and 61.8% were male. 38.6% had educational level <6 years, 27.0% were manual workers, 34.8% had family income ≤¥1000 per capita per month. Distributions of cardiovascular disease and risk factors, stroke case, severity and acute care and medications can be seen in Supporting Information Table S1. Over 1 year follow up, 1,640 (13.4%) patients died. They were more likely to be older, female, have low levels of SES, be never-smoking, non-heavy drink, have previous stroke, suffer diabetes mellitus, coronary heart disease and atrial fibrillation, have higher pre-stroke disability, cardio-embolism and higher NIHSS score, but less acute care of stroke and less medications in hospital or on hospital discharge (see Supporting Information Table S1). There was a social gradient in the mortality; the 1-year mortality was 8.0%, 9.7% 10.9%, 14.7% and 22.4% in patients with education of “>12 years”, “10-12 years”, “6-9 years”, “1-5 years” and “illiteracy” respectively (trend p<0.001), and was 10.0%, 10.1%, 12.0%, 12.6%, 13.1% in patients with monthly income

of “>¥5000”, “¥3001-¥5000”, “¥1001-¥3000”,. “¥500-¥1000” and “<¥500” respectively (trend p=0.03). Other baseline factors listed in Supporting Information Table S1 were not significantly different between patients surviving and deceased.

Supporting Information Table S2 shows the adjusted predicted probability of 3-month and 1-year mortality in each category of SED. Table 1 shows adjusted ORs of 1-year mortality in relation to the 3 indicators of SED. In adjustment for age, sex and previous stroke (Model 1) we found that increased mortality was significantly associated with educational level of <6 years, manual workers and people with no job, and income of ≤¥1000 per month. Further adjustment for smoking status, heavy alcohol drinking, cardiovascular risk factors score and stroke subtype and severity (Model 2) reduced the magnitude in the associations, but there remained significantly increased ORs in educational level of <6 years, manual laborers, and low income. After adding in the variables of acute stroke care and medications in-hospital and on discharge for adjustment (Model 3) we observed that these increased ORs were similar to those in Model 2, except for OR in patients with low income becoming marginally significant (adjusted OR 1.15, 95% CI: 0.99-1.33). The sensitivity analysis using data without imputed variables of SED indicators showed that the ORs were similar to those in Table 1; eg, the fully-adjusted OR (Model 3) was 1.15 (0.95-1.40) and 1.28 (1.08-1.53) in education of 6-9 and <6 years, 1.40 (1.11-1.78) in manual laborers and 1.16 (0.99-1.36) in monthly income of ≤1000 RMB. The patterns of 3-month mortality in relation to SED showed similar trends but were not significant in the full-adjusted models (see Supporting Information Table S3).

In the data analysis of combined educational level with occupational class or income (Table 2), we found that manual laborers with low education had the highest risk of 1-year mortality, and manual laborers with ≥6 years of education also had a significant excess in 1-year mortality

compared with non-manual laborers with ≥6 years of education. We did not observe an interaction effect between low education and low income (Table2). The impacts of low education or low income or both on 1-year mortality were similar. The data analysis of the combination of income with occupational class (Table 3) demonstrated a similar pattern to that in the combination of educational level with occupational class. Compared to those with high levels of income and occupation, patients who were manual laboring with low or high income had a significantly increased risk of 1-year mortality, but patients with high level of occupation and low income did not (Table 3). Only patients with both low education and low income had a significant excess in 3-month mortality compared with those with high education and high income (see Supporting Information Table S4 and Table S5).

Table 4 shows the combined data of 3 SED indicators in relation to mortality. There was a significantly increased risk of 1-year mortality with the SED scores, and patients with the highest score had about 50% increase in 1-year mortality. The patterns of 3-month mortality in relation to SED scores were similar to those of 1-year mortality (Table 4).

DISCUSSION

In this large-scale national stroke registry study, we found that low levels of education, occupation and income were significantly associated with increased mortality in patients with ischemic stroke. The severity of stroke and inequalities in acute care and medications use cannot entirely explain for the associations. There were some combined effects of educational or income level with occupational class on mortality, and those with SED from all 3 indicators had the highest risk of mortality. The impacts of SED on 3-month and 1-year mortality were similar.

China has the largest number of stroke patients in the world, and has an increased number of people suffering from ischemic stroke, which is due to population ageing and lifestyle changes

towards a western risk factor profile (14). China has also experienced an increased income inequality over time (14, 15). Knowledge of existing disparities in mortality after stroke is important for effective stroke care and management and improving outcomes. However, the association of SED with survival after ischemic stroke has been not well studied; either previous studies suffered from small sample size (20, 21), or did not include enough adjustment in their analyses (22, 23). Our nationally representative CNSR data has provided emerging evidence that there are persistent impacts of SED on survival after stroke in China.

The association of SED with mortality in people with ischemic stroke is also observed in some Western populations. A population-based cohort study in Canada showed that 1-year mortality was higher in those with low income than those with high income (6). Furthermore, examining the data of a Swedish stroke register, Lindmark et al (7) found that low levels of education and income were independently associated with higher case fatality after the acute phase in stroke patients. And a population-based registry in Denmark reported that individuals who were unemployed had an associated increase in 3-month and 1-year mortality (13). However, in the same study of the Danish population-based registry (13), there were no significant impacts of low levels of education and income on survival. Some other studies also showed no association between SED and mortality after ischemic stroke (3, 10). Our CNSR cohort study demonstrated that low levels of education and occupational class were significantly associated with mortality in patients with ischemic stroke, even after adjusting for acute care and medications. The low income was significantly associated with increased mortality in stroke patients with ≥6 years of education. In patients with <6 years of education no differences in the impact of low income on mortality may reflect the fact that compared to income, the educational level may be a more important factor of influencing survival after stroke in China (19).

The mechanisms through which SED affects stroke survival are unclear. Some studies reported that differences in risk-factor prevalence could account for part of the variation (4, 6, 10, 24, 25). Other studies suggested that lower SES was associated with a lower chance of receiving optimal acute and secondary preventive care of stroke (13, 26). In the current study, after baseline risk factors, acute stroke care and in-hospital and hospital discharge medications were adjusted in the analyses, we still found that SED, particularly using the combined scores from 3 indicators was significantly associated with increased mortality. One of the reasons for this could be due to long-term care after discharge. In China, many families of stroke patients may not cope with long-term care burden (see Supporting Information for more information about how ischemic stroke are managed in China). Those patients who had low educational level but had high income resulting from rapid economic transition in China may have unhealthy diet and lifestyle. This may result in more risk factors and less consciousness of receiving secondary prevention. One of the possible reasons for which the impact of low income on mortality can be seen in patients with high education but not in those with low education is psychological stress and uncertainty in self-identity resulting from SES inconsistency. The patients may be frustrated because their economic rewards were not consistent with their educational achievement (27). The effects of this on the association of SED with survival after ischemic stroke need further research.

Our study shows that occupational class may play more of an important role in predicting the risk of mortality in stroke patients, which would help target this particular group of patients for intervention. Our findings will be of benefit to the public health and clinical agenda to promote appropriate health interventions and strategies aimed at patient subgroups who would most likely

benefit from interventions. Innovative strategies reducing SED and tackling health inequality for stroke patients will improve the survival of patients after stroke.

Study strengths and limitations Our CNSR is a large scale national representative cohort study evaluating the individual and combined impacts of educational level, occupational class and income on mortality in patients with ischemic stroke. It includes patients with a diversity of socioeconomic characteristics, which reflects the high level of socioeconomic inequalities across the country (19). The unique data has helped us examine independent and separate impacts of each of 3 SES indicators on survival in stroke patients. Our study has limitations. Firstly, the CNSR does not cover rural hospitals and thus we could not examine differences in survival after ischemic stroke between patients living in the rural and urban areas. However, some stroke patients in the rural areas would be admitted to the urban hospitals, which have modern therapies, and could be grouped as "manual laborers" in the data analysis. Previous studies in China showed that people living in the rural community have an overall higher mortality than those in the urban (22, 23). Thus the impacts of low education, occupation or income on survival after ischemic stroke in this study may be under-estimated. Secondly, as the CNSR follow-up data does not include the date of death for all patients, we could not use Cox regression models to estimate a relative risk (RR) of mortality in relation to SED. However, there is a close relationship between OR and RR when the mortality rate is not high (28). Our study demonstrated a significant association of SED with increased mortality after stroke. Thirdly, like other studies (9), we did not further adjust for variables of stroke care after discharge and stroke recurrence. The residuals of the association between SES and mortality might exist, but would be minimized because they are related to other baseline risk factors such as smoking and acute care, which were included for adjustment. Finally, there might be some patients with stroke who died

before arrival at the hospital or at the emergency department. We have no data on the proportion of such patients in the whole stroke population in these areas of China, but estimated that it should be very low. Their mortalities could be socioeconomic ally patterned; those with lower level of socioeconomic status may be more likely to die before reaching the hospital or not hospitalized. Thus the findings of our current data analysis could be more conservative.

Conclusions Our nationwide stroke register study has demonstrated that there are significant inequalities in survival after stroke in China in terms of social and material forms of deprivation. Together with our previous studies (19), we consider that general socioeconomic improvement and targeting groups at high risk of mortality is likely to reduce inequality in survival in people with stroke. Continuous efforts are warranted to reduce SED and to tackle health inequality, thus improving survival for people with ischemic stroke.

Sources of Funding

This study is supported by grants from the Ministry of Science and Technology of the People's Republic of China (2006BAI01A11, 2011BAI08B01, 2011BAI08B02, 2012ZX09303-005-001, and 2013BAI09B03), a grant from the Beijing Biobank of Cerebral Vascular Disease (D131100005313003) and a grant from Beijing Institute for Brain Disorders (BIBD-PXM2013_014226_07_000084).

Acknowledgements

The authors thank the participants and all who were involved in the CNSR study. Dr R Chen would like to thank an undergraduate fellowship grant from King's College London, UK to run a population-based research project on stroke in Chinese.

Conflict of interest

Yuesong Pan reports no conflict of interest.

Tian Song reports no conflict of interest.

Ruoling Chen reports no conflict of interest.

Hao Li reports no conflict of interest.

Xingquan Zhao reports no conflict of interest.

Liping Liu reports no conflict of interest.

Chunxue Wang reports no conflict of interest.

Yilong Wang reports no conflict of interest.

Yongjun Wang reports no conflict of interest.

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FIGURE LEGENDS

Fig. Patient flow diagram.

TABLES

Table 1. Number and adjusted OR of 1-year mortality after stroke

Socioeconomic status	Nos of death/ patients (%)	Model 1		Model 2		Model 3	
		OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Educational Level (Years)							
>9	353/3778(9.3)	Ref.		Ref.		Ref.	
6-9	357/3221(11.1)	1.16(0.96- 1.40)	0.13	1.10(0.89- 1.36)	0.39	1.12(0.91- 1.39)	0.28
<6	930/5247(17.7)	1.39(1.18- 1.63)	<0.001	1.25(1.05- 1.48)	0.01	1.26(1.06- 1.51)	0.01
Occupational class							
Non-manual workers	148/2050(7.2)	Ref.		Ref.		Ref.	
Manual workers	432/3423(12.6)	1.72(1.40- 2.13)	<0.001	1.37(1.09- 1.72)	0.006	1.40(1.11- 1.77)	0.005
No job	221/1350(16.4)	1.55(1.21-1.98)	<0.001	1.18(0.91-1.55)	0.22	1.17(0.89-1.54)	0.26
Retired	839/5423(15.5)	1.18(0.96-1.45)	0.11	1.09(0.88-1.36)	0.42	1.09(0.87-1.36)	0.47
Income (RMB/month)							
>1000	819/6437(12.7)	Ref.		Ref.		Ref.	
≤1000	821/5809(14.1)	1.23(1.07-1.41)	0.005	1.19(1.03-1.37)	0.02	1.15(0.99-1.33)	0.06

CI, confidence interval; OR, odds ratio.

Model 1 – MI, multilevel modeling, adjusted for age, sex and previous stroke.

Model 2 – MI, multilevel modeling, adjusted for age, sex, smoking status, heavy alcohol drinking, cardiovascular diseases and risk factors score [hypertension + diabetes mellitus + dyslipidemia + coronary heart disease + atrial fibrillation], previous stroke, pre-stroke mRS, 5 medications before admission, stroke subtype, NIHSS on admission.

Model 3 – MI, multilevel modeling, adjusted for age, sex, smoking status, heavy alcohol drinking, cardiovascular diseases and risk factors score [hypertension + diabetes mellitus + dyslipidemia + coronary heart disease + atrial fibrillation], previous stroke, pre-stroke mRS, scores of 5 medications before admission, stroke subtype, NIHSS on admission, stroke unit admission, swallow test, scores of 5 medications in hospital and scores of 5 medications on hospital discharge.

Table 2. Combined Effects of educational level with occupational class or income on 1-year mortality in stroke patients

Socioeconomic status	Educational Level ≥6 years			Educational Level <6 years		
	Death	OR* (95% CI)	p value	Death	OR* (95% CI)	p value
Occupational class						
Non-manual workers	113/1757(6.4)	Ref.		35/293(11.9)	1.16(0.67- 1.99)	0.60
Manual workers	129/1533(8.4)	1.40(1.02- 1.90)	0.03	303/1890(16.0)	1.49(1.13- 1.97)	0.005
No job	44/422(10.4)	1.17(0.75-1.83)	0.48	177/928(19.1)	1.26(0.91-1.73)	0.16
Retired	424/3287(12.9)	1.07(0.81-1.40)	0.65	415/2136(19.4)	1.23(0.93-1.63)	0.14
Income Level (RMB/month)						
>1000	399/4143(9.6)	Ref.		420/2294(18.3)	1.31(1.07-1.60)	0.01
≤1000	311/2856(10.9)	1.27(1.01-1.60)	0.05	510/2953(17.3)	1.32(1.09- 1.60)	0.01

CI, confidence interval; OR, odds ratio.

* The same adjustment in Model 3 in Table 1.

Table 3. Combined effects of income level with occupational class on 1-year mortality in stroke patients

Socioeconomic Status	Income Level >1000 RMB/month			Income Level ≤1000 RMB/month		
	Death	OR* (95% CI)	p value	Death	OR* (95% CI)	p value
Occupational class						
Non-manual workers	84/1286(6.5)	Ref.		64/764(8.4)	1.32(0.81- 2.16)	0.27
Manual workers	141/1183(11.9)	1.58(1.12- 2.23)	0.009	291/2240(13.0)	1.57(1.13- 2.17)	0.008
No job	90/600(15.0)	1.20(0.81-1.78)	0.37	131/750(17.5)	1.39(0.93-2.07)	0.11
Retired	504/3368(15.0)	1.17(0.87-1.57)	0.31	335/2055(16.3)	1.28(0.94-1.75)	0.12

CI, confidence interval; OR, odds ratio.

* The same adjustment in Model 3 in Table 1.

Table 4. Number and adjusted OR of 1-year mortality in relation to SED combinations in patients with stroke

Total score of SED combined*	Nos of death/ patients (%)	Adjusted OR† (95% CI)	p value
For 1-year mortality			
0	347/3514(10.0)	Ref.	
1	617/4321(14.3)	1.33(1.11- 1.59)	0.003
2	462/3075(15.0)	1.36(1.10- 1.69)	0.005
3	214/1336(16.0)	1.56(1.23- 1.97)	<0.001
For 3-month mortality			
0	206/3514(5.9)	Ref.	
1	374/4321(8.7)	1.30 (1.05- 1.61)	0.02
2	292/3075(9.5)	1.36(1.05- 1.76)	0.02
3	148/1336(11.1)	1.65(1.23- 2.22)	0.001

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

* Added scores from each of low levels of educational years <6 (1 score), occupational class (manual laboring) (1 score) and income ≤1000 RMB (1 score).

† The same adjustment in Model 3 in Table 1.

SUPPLEMENTAL MATERIAL

Table S1. Characteristics of patients and 1-year mortality in the China National Stroke Registry

Variable	Total, (%) (N=12246)	One-year follow up		p value
		Alive (N=10606)	Dead (N=1640)	
Socio-demography				
Age (year), mean(SD)	65.5±12.3	64.4±12.1	72.5±11.4	<0.001
Sex, n(%)				<0.001
Men	7565(61.8)	6700(63.2)	865(52.7)	
Women	4681(38.2)	3906(36.8)	775(47.3)	
Educational level (years), n(%)				<0.001
>12	1178(9.6)	1084(10.2)	94(5.7)	
10-12	2243(18.3)	2025(19.1)	218(13.3)	
6-9	2915(23.8)	2596(24.5)	319(19.5)	
1-5	3057(25.0)	2607(24.6)	450(27.4)	
Illiteracy	1663(13.6)	1291(12.2)	372(22.7)	
Unknown	1190(9.7)	1003(9.5)	187(11.4)	
Occupational class, n(%)				<0.001
Non-manual workers	1972(16.1)	1831(17.3)	141(8.6)	
Manual workers	3301(27.0)	2884(27.2)	417(25.4)	
No job	1300(10.6)	1086(10.2)	214(13.0)	
Retired	5233(42.7)	4430(41.8)	803(49.0)	
Unknown	440(3.6)	375(3.5)	65(4.0)	
Income (RMB/month), n(%)				<0.001
>10000	21(0.2)	16(0.2)	5(0.3)	
5001-10000	139(1.1)	128(1.2)	11(0.7)	
3001-5000	665(5.4)	598(5.6)	67(4.1)	
1001-3000	4156(33.9)	3659(34.5)	497(30.3)	
500-1000	2849(23.3)	2489(23.5)	360(22.0)	
<500	1407(11.5)	1223(11.5)	184(11.2)	
Unknown	3009(24.6)	2493(23.5)	516(31.5)	
Cardiovascular disease and risk factors				
Smoking status, n(%)				<0.001
Never-smoking	7044(57.5)	5958(56.2)	1086(66.2)	
Former-smoking	1606(13.1)	1392(13.1)	214(13.0)	
Current smoking	3280(26.8)	2995(28.2)	285(17.4)	
Unknown	316(2.6)	261(2.5)	55(3.4)	
Heavy drink, n(%)				<0.001
No	10740(87.7)	9245(87.2)	1495(91.2)	
Yes	1315(10.7)	1214(11.4)	101(6.2)	
Unknown	191(1.6)	147(1.4)	44(2.7)	
Hypertension, n(%)				0.28
No	4329(35.3)	3770(35.5)	559(34.1)	
Yes	7701(62.9)	6655(62.8)	1046(63.8)	
Unknown	216(1.8)	181(1.7)	35(2.1)	
Diabetes mellitus, n(%)				0.04
No	9387(76.7)	8166(77.0)	1221(74.4)	
Yes	2601(21.2)	2226(21.0)	375(22.9)	
Unknown	258(2.1)	214(2.0)	44(2.7)	
Dyslipidemia, n(%)				<0.001
No	8279(67.6)	7194(67.8)	1085(66.2)	

Yes	1377(11.2)	1253(11.8)	124(7.6)	
Unknown	2590(21.2)	2159(20.4)	431(26.3)	
Coronary heart disease, n(%)				<0.001
No	10484(85.6)	9176(86.5)	1308(79.8)	
Yes	1762(14.4)	1430(13.5)	332(20.2)	
Atrial fibrillation, n(%)				<0.001
No	10937(89.3)	9755(92.0)	1182(72.1)	
Yes	1309(10.7)	851(8.0)	458(27.9)	
Medications prior to stroke				
Antihypertensive, n(%)				0.90
No	6507(53.1)	5638(53.2)	869(53.0)	
Yes	5739(46.9)	4968(46.8)	771(47.0)	
Antidiabetic, n(%)				0.38
No	10312(84.2)	8943(84.3)	1369(83.5)	
Yes	1934(15.8)	1663(15.7)	271(16.5)	
Lipid-lowering, n(%)				0.002
No	11784(96.2)	10204(96.2)	1580(96.3)	
Yes	317(2.6)	288(2.7)	29(1.8)	
Unknown	145(1.2)	114(1.1)	31(1.9)	
Antiplatelet, n(%)				0.04
No	10197(83.3)	8861(83.5)	1336(81.5)	
Yes	2049(16.7)	1745(16.5)	304(18.5)	
Anticoagulants, n(%)				0.01
No	11968(97.7)	10379(97.9)	1589(96.9)	
Yes	278(2.3)	227(2.1)	51(3.1)	
Stroke case, severity and acute care				
Previous stroke, n(%)				<0.001
No	8073(65.9)	7154(67.5)	919(56.0)	
Yes	4173(34.1)	3452(32.5)	721(44.0)	
Pre-stroke mRS >1, n(%)				<0.001
No	10932(89.3)	9638(90.9)	1294(78.9)	
Yes	1154(9.4)	831(7.8)	323(19.7)	
Unknown	160(1.3)	137(1.3)	23(1.4)	
Subtype of stroke*, n(%)				<0.001
Large-artery atherosclerosis	5501(44.9)	4860(45.8)	641(39.1)	
Small-vessel occlusion	2064(16.9)	1954(18.4)	110(6.7)	
Cardioembolism	756(6.2)	511(4.8)	245(14.9)	
Other or undetermined	453(3.7)	408(3.9)	45(2.7)	
Unknown	3472(28.4)	2873(27.1)	599(36.5)	
NIHSS on admission, median(IQR)	4(2-9)	4(2-8)	12(5-21)	<0.001
Stroke unit admission, n(%)				0.001
No	9830(80.3)	8464(79.8)	1366(83.3)	
Yes	2416(19.7)	2142(20.2)	274(16.7)	
Brain imaging exam, n(%)				0.58
No	247(2.0)	211(2.0)	36(2.2)	
Yes	11999(98.0)	10395(98.0)	1604(97.8)	
Swallow test, n(%)				<0.001
No	7367(60.2)	6290(59.3)	1077(65.7)	
Yes	4469(36.5)	3953(37.3)	516(31.5)	
Unknown	410(3.3)	363(3.4)	47(2.9)	
Five medications score†				
In hospital, n(%)				<0.001

0	1666(13.6)	1243(11.7)	423(25.8)	
1	3008(24.6)	2554(24.1)	454(27.7)	
2	4149(33.9)	3680(34.7)	469(28.6)	
3	2127(22.2)	2490(23.5)	231(14.1)	
4-5	702(5.7)	639(6.0)	63(3.8)	
On hospital discharge, n(%)				<0.001
0	3231(26.4)	2207(20.8)	1024(62.4)	
1	2374(19.4)	2170(20.5)	204(12.4)	
2	3511(28.7)	3287(31.0)	224(13.7)	
3	2430(19.8)	2291(21.6)	139(8.5)	
4-5	700(5.7)	651(6.1)	49(3.0)	

IQR, interquartile range; mRS, modified Rankin Scale; NIHSS, National Institutes of Health stroke scale; SD, standard deviation.

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

† Antihypertensive, Antidiabetic, Lipid-lowering, Antiplatelet and Anticoagulant.

Table S2. Adjusted predicted probability of mortality in each category

Socioeconomic status	3-month mortality* (95% CI), %	1-year mortality* (95% CI), %
Educational Level (Years)		
>9	3.4(2.8-4.0)	6.8(5.9-7.6)
6-9	3.4(2.8-4.0)	7.4(6.5-8.4)
<6	3.8(3.3-4.4)	8.1(7.3-8.9)
Occupational class		
Non-manual workers	3.7(2.9-4.6)	6.5(5.3-7.7)
Manual workers	4.3(3.6-5.0)	8.8(7.8-9.9)
No job	3.3(2.5-4.1)	7.4(6.1-8.7)
Retired	3.1(2.7-3.6)	7.0(6.3-7.8)
Income (RMB/month)		
>1000	3.2(2.8-3.7)	7.1(6.4-7.8)
≤1000	4.0(3.4-4.5)	7.9(7.2-8.7)
Total score of SED combined[†]		
0	2.9(2.3-3.4)	6.2(5.3-7.2)
1	3.6(3.0-4.2)	7.8(6.8-8.8)
2	3.8(3.1-4.4)	7.7(6.8-8.7)
3	4.7(3.7-5.8)	9.2(7.7-10.8)

CI, confidence interval; SED, socioeconomic deprivation.

* Adjusted for age, sex, smoking status, heavy alcohol drinking, cardiovascular diseases and risk factors score [hypertension + diabetes mellitus + dyslipidemia + coronary heart disease + atrial fibrillation], previous stroke, pre-stroke mRS, scores of 5 medications before admission, stroke subtype, NIHSS on admission, stroke unit admission, swallow test, scores of 5 medications in hospital and scores of 5 medications on hospital discharge.

[†] Added scores from each of low levels of educational years <6 (1 score), occupational class (manual laboring) (1 score) and income ≤1000 RMB (1 score).

Table S3. Number and adjusted OR of 3-month mortality after stroke

Socioeconomic status	Nos of death/ patients (%)	Model 1		Model 2		Model 3	
		OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Educational Level (Years)							
>9	228/3778(6.0)	Ref.		Ref.		Ref.	
6-9	218/3221(6.8)	1.08(0.87- 1.34)	0.46	1.00(0.79- 1.27)	1.00	1.02(0.80- 1.30)	0.87
<6	574/5247(10.9)	1.35(1.12- 1.63)	0.002	1.18(0.96- 1.45)	0.11	1.19(0.96- 1.47)	0.11
Occupational class							
Non-manual workers	108/2050(5.3)	Ref.		Ref.		Ref.	
Manual workers	285/3423(8.3)	1.51(1.18- 1.93)	0.001	1.15(0.88- 1.49)	0.31	1.18(0.89- 1.55)	0.25
No job	135/1350(10.0)	1.34(1.00-1.79)	0.05	0.98(0.71-1.34)	0.88	0.94(0.68-1.30)	0.71
Retired	492/5423(9.1)	0.98(0.78-1.25)	0.89	0.88(0.68-1.14)	0.35	0.87(0.67-1.14)	0.32
Income (RMB/month)							
>1000	477/6437(7.4)	Ref.		Ref.		Ref.	
≤1000	543/5809(9.3)	1.32(1.09-1.57)	0.007	1.28(1.04-1.58)	0.03	1.22(0.98- 1.52)	0.09

CI, confidence interval; OR, odds ratio.

Model 1 – MI, multilevel modeling, adjusted for age, sex and previous stroke.

Model 2 – MI, multilevel modeling, adjusted for age, sex, smoking status, heavy alcohol drinking, cardiovascular diseases and risk factors score [hypertension + diabetes mellitus + dyslipidemia + coronary heart disease + atrial fibrillation], previous stroke, pre-stroke mRS, 5 medications before admission, stroke subtype, NIHSS on admission.

Model 3 – MI, multilevel modeling, adjusted for age, sex, smoking status, heavy alcohol drinking, cardiovascular diseases and risk factors score [hypertension + diabetes mellitus + dyslipidemia + coronary heart disease + atrial fibrillation], previous stroke, pre-stroke mRS, scores of 5 medications before admission, stroke subtype, NIHSS on admission, stroke unit admission, swallow test, scores of 5 medications in hospital and scores of 5 medications on hospital discharge.

Table S4. Combined Effects of educational level with occupational class or income on 3-month mortality in stroke patients

Socioeconomic status	Educational Level ≥6 years			Educational Level <6 years		
	Death	OR* (95% CI)	p value	Death	OR* (95% CI)	p value
Occupational class						
Non-manual workers	80/1757(4.6)	Ref.		28/293(9.6)	1.38(0.69- 2.73)	0.37
Manual workers	86/1533(5.6)	1.19(0.82- 1.72)	0.35	199/1890(10.5)	1.32(0.94- 1.86)	0.11
No job	33/422(7.8)	1.18(0.71-1.94)	0.53	102/928(11.0)	1.00(0.67-1.48)	0.99
Retired	247/3287(7.5)	0.89(0.64-1.25)	0.50	245/2136(11.5)	1.03(0.73-1.46)	0.85
Income Level (RMB/month)						
>1000	237/4143(5.7)	Ref.		240/2294(10.5)	1.26(0.98-1.60)	0.07
≤1000	209/2856(7.3)	1.31(1.00-1.73)	0.06	334/2953(11.3)	1.38(1.09- 1.76)	0.01

CI, confidence interval; OR, odds ratio.

* The same adjustment in Model 3 in Table S2.

Table S5. Combined effects of income level with occupational class on 3-month mortality in stroke patients

Socioeconomic	Income Level >1000 RMB/month			Income Level ≤1000 RMB/month		
Status	**Death**	**OR* (95% CI)**	**p value**	**Death**	**OR* (95% CI)**	**p value**
Occupational class						
Non-manual workers	59/1286(4.6)	Ref.		49/764(6.4)	1.37(0.77- 2.43)	0.29
Manual workers	82/1183(6.9)	1.23(0.78- 1.93)	0.37	203/2240(9.1)	1.41(0.96- 2.07)	0.08
No job	53/600(8.8)	1.02(0.62-1.68)	0.94	82/750(10.9)	1.12(0.66-1.93)	0.67
Retired	283/3368(8.4)	0.94(0.64-1.36)	0.73	209/2055(10.2)	1.09(0.74-1.62)	0.66

CI, confidence interval; OR, odds ratio.

* The same adjustment in Model 3 in Table S2.

A brief description of management of ischemic strokes in China

Care of stroke in the acute phase:

Patients with ischemic stroke onset can access to emergency medical services by dialing either 1-2-0 or 9-9-9. They may arrive at hospital through ambulance, taxi or private vehicle. The median prehospital delay time is 15 hours which is much longer than that reported by Western countries (Stroke. 2012;43:362-370.).

Since 2001, specialized stroke units have been established across China, while only 20% patients with acute ischemic stroke can be admitted in stroke units in our study. Neurologists treat patients with acute ischemic stroke according to the Chinese guideline of early management of stroke. As soon as the patients arriving at the emergency room, neurologists will evaluate whether they are eligible for thrombolytic therapy, including i.v. tissue plasminogen activator (tPA) and intra-arterial therapy. However, only about 2% patients with ischemic stroke (or 1 in 5 patients with stroke presenting within 3 hours) received thrombolytic therapy, partly because of high prehospital delay and the expensive cost of tPA (Stroke. 2011;42:1658- 1664.). No matter patients with acute ischemic stroke treated with or without thrombolytic therapy, they will be admitted into the stroke unit or department of neurology if they consent to. After that, Neurologists will perform MRI exam, swallow test, language assessment, et al for further assessment. Also, other secondary prevention treatments include antihypertensive, antidiabetic, lipid-lowering, antiplatelet and anticoagulant therapy will be given to patients.

Care of stroke after discharge:

Secondary prevention of stroke after discharge will refer to Chinese guideline of secondary prevention of stroke. Eligible patients will receive antihypertensive, antidiabetic, lipid-lowering, antiplatelet and anticoagulant agents to prevent recurrence of stroke after discharge. However, persistent uses of secondary prevention interventions are not optimistic. Almost one-third of patients of ischemic stroke had stopped one or more secondary prevention medications by 3-month postdischarge according to our previous study (Neurol Res. 2013; 35:29-36.). For those with disability or sequela after stroke, the proportion of receiving rehabilitation service from professional rehabilitation center is low. Our study shows that most of ischemic stroke patients went to home (about 91%) and very few patients transferred

to rehabilitation center (only about 4%) after discharge. In China, family care of stroke patients plays an important role in the long-term care of stroke patients.