Association of socioeconomic status with incident stroke in China

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Words: 300 in abstract, 3,896 in text, 5 tables, 1 figure, 3 supplement tables

Abstract

Background and Purpose: China has the highest risk of stroke and increased gap in income between poor and rich, but little is known the impact of socioeconomic status (SES) on the risk of stroke. We assessed the association of multiple measurements of SES with incident stroke in the population and their gender differences.

Methods: We examined data from the Anhui cohort of 2,852 participants aged ≥60 years who were followed up for 10 years and from the four-province cohort of 3,016 older people who were followed up for 3 years. Their SES and risk factors were recorded at baseline, and cases of incident stroke were documented from follow-up interviews and cause of death.

Results: In the Anhui cohort, participants living in rural versus urban areas had increased risk of incident stroke (fully-adjusted hazard ratio 2.49, 95% CI 1.19-5.22; women 3.64, 1.17-11.32, and men 2.23, 0.81-6.19). Levels of education, occupation, satisfactory income and financial problems were not significantly associated with incident stroke, except increased stroke in women with low education. In the four-province cohort, these five SES measurements were not significantly associated with incident stroke, except for increased stroke in men with high occupation, while in additional measurement of actual income, incident stroke was increased in women with low personal income and in men with high family income. Pooled data from the two cohorts demonstrated an increased risk of stroke in participants living in rural areas (1.66, 1.08-2.57) and having high occupational class (1.56, 1.01-2.38), with no gender differences. Incident stroke was increased in women with low education (2.26, 1.41-3.63).

Conclusions: Rural living and being female with low SES are main factors contributing to stroke risk inequality in China. Strategies to improve health care access in the rural communities and gender specific targets for health inequality should be an integral component of stroke interventions.

Keywords: Socio-economic status, Urban-rural, Stroke, Incidence, Older people

Introduction

The burden of stroke has increased across the world over the past 30 years, with the disability-adjusted life years ranked at 3rd up from 5th.[1] Previous studies showed that low socioeconomic status (SES) increased the incidence of stroke in the general population.[2-4] People in low- and middle-income countries (LMICs) have a higher risk of stroke than in high income countries (HICs).[5] Knowledge of the impact of SES on incident stroke has been predominantly derived from HICs, which may not be applied to those in LMICs. There are fewer studies undertaken in LMICs to assess the association of SES with incident stroke.

China is the largest LMIC and has the highest estimated lifetime risk of stroke worldwide (39.3%, 95% CI 37.5 to 41.1).[6] There are around 5.5 million new stroke cases annually occurring in China in recent years.[5] Over the past decades, China has experienced rapid economic growth, along with increasing gap in income between rich and poor.[7] It is not known whether socioeconomic gaps are associated with increased risk of stroke. No study has been undertaken in China to investigate the impacts of socioeconomic status (SES) and income on incidence of stroke.

Previous studies in HICs showed some inconstant findings of the association between SES and incident stroke.[3, 8] Most of the studies did not adjust for other SES variables when examining incidence of stroke in relation to one indicator of SES. No study has assessed the impacts of different SES indicators on incident stroke simultaneously.[9] Few study has investigated gender differences in the impact of SES on the risk of stroke. In this paper we examine data of two large-scale cohort studies from China to assess the impacts of multiple measurements of SES on the incidence of stroke and their gender differences.

Methods

Studied populations were derived from the Anhui cohort study and the 4-province cohort study in China.

Anhui cohort study

The methods of the baseline investigation and the follow-up in the Anhui cohort study have been fully described previously.[10] Briefly, we randomly selected 1,810 older people aged >=65 years who had lived for at least 5 years in Yiming subdistrict of Hefei city in 2001 and 1,709 aged >=60 years from all 16 villages in Tangdian District of Yingshang county in 2003. A total of 3,336 older people participated in the study (urban n=1,736), with a response rate of 94.8%. Permission for interview and informed consent were obtained from each participant. In the case of those who were unable to provide informed consent such as disability or limited education level, their next of kin or care givers were invited to provide assent for participation.[11] Refusals were respected. The participants were interviewed at home by a trained survey team from the School of Health Administration, Anhui Medical University.

The main interview materials were a general health and risk factors questionnaire, and the Geriatric Mental Status (GMS) – a comprehensive semi-structured mental state interview.[12] In the general health and risk factors record, we collected data relating to socio-demography, social networks and support, psychosocial aspects, cardiovascular disease (CVD) and other disease risk factors.[12] We documented stroke from participants' self-report of having being diagnosed by a doctor. Previous studies showed that self-reported doctor's diagnosis of stroke was validated in older people.[13] Using the GMS interview data[14] and the Automated

Geriatric Examination for Computer Assisted Taxonomy (AGECAT)[15] we diagnosed depression and dementia for each participant. According to standard procedures[16] we measured systolic and diastolic blood pressure, weight and height, and waist circumferences for all participants at baseline interview (*wave* 1).

Baseline SES measurements

We measured SES from long-term resident location of urban and rural areas and from individual records of educational attainment level, occupational class, satisfactory income and a serious financial problem in the past two years.[17] The educational level for each participant was recorded at his/her highest actual schooling level (either primary school, secondary school, high secondary school, or university/college). Those without any formal school attainment were defined as illiterate. Occupational class of participants was classified as 'non-manual' or 'manual' on the basis of their current or last main job titles (including officer/teacher, businessman, manual worker, peasant, housewife or other). Each participant was asked to answer the questions 'Are you satisfied with your income?' (with answers either at "very satisfied", "satisfied", "average" or "poor") and 'Have you had any financial problems in the past two years' (with answers "yes" or "no").[18]

Follow-up of cohort

One year after the baseline survey we re-interviewed 2,608 participants (*wave* 2) using the same protocol as at baseline, with a response rate of 78.2%. From 2007 to 2009 we successfully re-examined 1,757 cohort members (*wave 3*) (67.4%).[19] In 2011-2012, we carried out *wave 4* survey on surviving cohort members and re-interviewed 944 participants (53.7%). In *wave 3* and *4*, we added in the 10/66 dementia algorithm research package and more risk factors including dietary intakes,

passive smoking, and personal and family incomes. At each wave interview of the follow-up we documented incident stroke based on the self-reported doctor-diagnosis of stroke.

Vital status of the cohort members were monitored until January 2012. At each survey wave we conducted home visits to obtain information about participants′ survival status through multiple sources including resident committees, family members, neighbours, and friends. For the urban cohort, we also reviewed electronic registration databases from the local Centre for Disease Control and Police Registration centralised in Hefei city to identify mortality and causes of deaths. In total we identified 671 deaths during the follow up of the cohort. Using a standard Verbal Autopsy questionnaire[11] we interviewed the next of kin responsible for the deceased or reviewed the death certificate to ascertain causes of death, including stroke diagnosis.

Four province study

Using the same protocol as that in the Anhui study *wave 3*, we carried out a large-scale community-based household survey in four provinces of China (Guangdong, Heilongjiang, Shanghai and Shanxi) in 2008. Their methods of the baseline investigation have been fully described previously.[18] In brief, we randomly recruited no fewer than 500 residents aged ≥60 years from the urban and rural community separately from each province. In total 4,314 participants completed the interview in 2008-2009, with an overall response rate of 93.8%. We documented disease risk factors, and SES variables for each participant.[20]

In 2010-2012 we followed up the cohort, having identified 259 deaths and re-interviewed 2,892 survivals using the same questionnaire as that at baseline.[21]

Ethical approvals for the Anhui cohort study and the 4-province study were obtained from the Ethics Committees of University College London, and School of Health and Wellbeing at University of Wolverhampton, UK and the Research Ethics Committee of Anhui Medical University and the local governments in China.

Statistical analysis

In the Anhui cohort study, we analysed the data of 2,852 cohort members, after excluding 141 participants with stroke at baseline and 343 who were lost to follow-up. In the 4-province cohort study, the data of 3,016 cohort members were analysed, after excluding 166 participants who had stroke at baseline, 1,102 who were lost to follow-up, and 30 who had no SES indicator measured. We computed person-years at risk (PYARs) cohort members to the end of follow up, date of incident stroke, death or loss at follow up. Annual incidence rate was expressed as cases per 1,000 persons per year. We described baseline risk factors and characteristics of participants using mean (standard deviation, SD) and percentage (%) and examined differences in their distributions between men and women at baseline using a one-way ANOVA for continuous variables and a Chi-square test for category variables. We grouped individual SES variables into (1) low, (2) middle, and (3) high levels. They were in Education: (1) illiterate, (2) primary school, and (3) more than secondary school; in Occupational class: (1) peasant, (2) manual labourer or housewife, and (3) official/teacher or business/other; and in Satisfactory income: (1) poor or average, (2) satisfactory, and (3) very satisfactory. The financial problem was recorded as yes or

no. We also combined data of satisfactory income with financial problems into three levels for analysis at (1) low income - for those who had poor or average satisfactory income or experienced the financial problem, (2) middle - for those who had satisfactory income but not experienced the financial problem, and (3) high - for those who had very satisfactory income but not experienced the financial problem. In 4-province study, we divided baseline annual personal income and family income into three groups according to their tertile cut-off points.

We employed Cox regression models to calculate the hazard ratio (HR) and its 95% confidence intervals (CIs) of the impact of each of SES measurements on stroke incidence in the two cohorts respectively. In the models we adjusted for age, sex, body mass index (BMI), smoking status, alcohol consumption, marital status, frequency of visiting children/other relatives, hypertension status, heart disease, diabetes, activity of daily living (ADL), and depression and cognitive impairment/dementia. We further examined independent effect of one SES indicator from other SES and included all other SES indicators in the models for full adjustment. In the full model data analysis, we investigated the impacts in women and men separately.

We pooled the two-cohort findings where possible using a meta-analysis method as we did[22] to assess the impacts of different SES measurements on incident stroke and their gender differences were tested using a ratio of two HRs (i.e. RHRs).[23, 24] All analyses were performed using the SPSS statistical package (Windows version 20; SPSS Inc., Chicago, Illinois) and the STATA statistical software package (Windows version 14.2).

Results

Anhui cohort study

Of 2,852 participants, the average age was 71.7 years (SD 6.9), 51.8% were women, and 48.2% lived in rural areas. The distribution of baseline characteristics of participants is shown in Table 1. Compared with men, women were more likely to be never smoking and drinking, be obese, have low levels of education, occupation, and satisfactory income, be divorced, live with children and/or grandchildren, be daily visited by children or other relatives, and have a higher level of depression and cognitive impairment/dementia. There were no significant gender differences in age, urban-rurality, financial problem, ADL and cardiovascular comorbidities.

Over the 10 years follow-up, 211 participants developed stroke. Table 2 shows numbers, incidence and adjusted HRs of stroke in participants living in urban and rural areas. HR for stroke in participants living in rural was significantly increased, no matter how many confounders, including other SES were adjusted. Separate data analysis for women showed a fully-adjusted HR of 3.64 (95%CI 1.17-11.32) and for men 2.23 (0.81-6.19) (Table 3); the ratio of the two HRs was 1.63 (95% CI 0.36-7.49), p=0.529.

There were no significant associations of education, occupation, satisfactory income and financial problems with incident stroke, except for increased HRs in participants with low levels of education and occupation and the financial problem before adjustment for other SES (Supplement Table 1). However, separate data analysis by gender showed that there were significantly increased risks of stroke in women with low education or with high income (combination of satisfactory income and financial problems) (Table 3).

4-province cohort study

Of 3,016 participants, 113 cases of incident stroke occurred over the 3 years follow-up, with a total of 9,316.5 person years. Compared with those living in urban, participants in rural areas had a fully-adjusted HR of 1.34 (0.78-2.30) of incident stroke (Supplement Table 2). There were no significant associations of education, satisfactory income, financial problems and combined measurement of income with incident stroke, except for high occupational class having appeared to be associated with increased stroke (Supplement Table 2). Separate data analysis for women and men showed similar findings to their total and there were no gender differences in these associations, except for men with high occupation having increased the risk of stroke (2.17, 1.08-4.35) (Table 4).

Table 5 shows numbers, incident stroke and adjusted HRs of stroke in participants with annual personal and family incomes. Significantly increased risk of incident stroke was seen in women with low annual personal income (3.05, 1.17-8.00) and in men with high family income (2.38, 1.14-4.76).

Pooled data from the Anhui cohort and the 4-province cohort

Figure 1 showed pooled data of HRs of mortality in people with low SES from the two cohorts. There was a significantly increased risk of stroke in participants living in rural areas, before and after adjustment for other SES variables. The association of low education and financial problems with incident stroke was significant in the analysis before adjustment for other SES variables. High occupational class was

associated with increased risk of stroke after adjustment for other SES variables. Other HRs in Figure 1 were not statistically significant.

Pooled data for women and men separately showed that only in women rural living or having low education significantly increased risk of stroke, and other HRs were not statistically significant (Supplement Table 3). There were no gender differences in the associations of rural living, education, occupation, satisfactory income, financial problems and their combined measurement of income with incident stroke (Supplement Table 3).

Discussion

Our community-based cohort study in China examined the impact of different measurement of SES on incident stroke in men and women. It demonstrated that inequality in the risk of stroke in China was largely for people who lived in rural areas. Women who had low education or low personal income also had increased the risk of stroke, as were men with high occupational class or family income.

In this study, we have found that women who did not attain any school had significantly increased risk of stroke compared to their counterparts who attained at least primary school. Some but not all previous studies showed that increased risk of incident stroke was associated with low level of education.[25] A cohort of 21,443 US adults with a mean follow-up of 15.2 years showed that at ages greater than 50 years, the risk for incident stroke was higher in those with <=12 years education (HR 1.3, 1.0-1.6).[25] In Australia older women with least education versus highest education have also been found to have increased risk of stroke.[26] The data of women in our study was consistent with those in the HICs. However, our data from the male population did not show a significant association of low educational level with

increased risk of stroke. It is probably because other factors, e.g., smoking and alcohol drinking in Chinese men, have played a more important role in the aetiology of stroke, affecting the association of educational level with incident stroke.

Our study showed an increased risk of stroke in older people with high level of occupational class, mainly in men. This is inconsistent with those in previous studies undertaken in HICs.[4] One of the reasons for it could be attributed to epidemiological transition in the early stages that those with high occupational class are more likely to have adverse lifestyle including smoking and drinking,[27] psychological stress[28] and inadequate physical activities.[29] These unhealthy lifestyles would lead to greater prevalence of stroke risk factors such as hypertension, obesity and the metabolic syndrome.[30] In contrast, people with low occupational class (e.g. peasants in this study) were still engaged in a high level of normal physical work and probably had a healthy diet including lower animal protein intake and higher vegetables consumption.[31] In addition, compared to operational work, having a non-manual occupation (e.g., professionals and commercial and service workers) was often accompanied by high job strain.[32] These could contribute increased risk of stroke in people with high occupational class.

The current study did not find a significant association of satisfactory income or financial problems with incident stroke, while these self-reported measures of income were significantly associated with other health events in our previous studies, e.g., diabetes[33] and dementia[18]. Satisfactory level of income involved people's feeling about income, while the financial problem in the past two year reflected "the financial crisis". They are not actual income and are not reflective of resources available, which would reduce the sensitivity in their association with incidence of stroke. In the 4-province study which measured the actual income, older women with low personal

income had increased risk of stroke. This finding is consistent with those in previous studies. In USA, the Health and Retirement Study showed that the low decile of income was associated with increased stroke incidence in older people aged 65 to 74 years (HR 1.7, 1.0-2.8) and aged 75+ (HR 1.6, 1.0-2.6).[8] The similar effect of low actual income on stroke incidence was also found at ages 65 to 74 in the New Haven cohort study (HR 2.08, 1.01-4.27).[3] However, in older men high family income was associated with increased risk of stroke. This could be explained by lifestyle changes among them; the Chinese men with high income experienced and adopted unhealthy lifestyles, such as smoking, alcohol drinking, a diet with high caloric and sugar intakes, prolonged sedentary behaviours and inadequate physical activities.[29] The inverse pattern of high income with high risk was also observed in HICs. In USA, people aged above 75 the risk of incident stroke was increased with higher income (HR 2.33, 1.16-4.55).[3] In France, the Three-City Study (3C study) demonstrated that in those aged over 65 there was an 80% increased risk of ischemic stroke in higher income compared to lower income group after adjustment for all potential risk factors including education (HR 1.77, 1.20-2.61).[34] In our study, high income is partly in line with high occupational class, and to a large extent a man's earnings and occupation would determine his family's SES. Therefore, the explanations relating to some risk factors for incident stroke in high occupational class also could be applied to men with high family income.

Reviewing the existing literatures on the association of SES with incident stroke, we have found fewer studies examining the impact of the rural-urban disparity compared to other indicators of SES. In a Portuguese population-based cohort study of 123,313 participants, of whom 20% were aged over 65 years, Correia et al observed that in older people the annual incidence of stroke per 1000 population was

higher in rural (from 9.5 to 20.2) than in urban areas (from 6.8 to 10.9).[35] Data of 480,687 Chinese adults aged 20-65 years showed that incidence of stroke in rural areas (298.2/100 000) was significantly greater than that of their urban counterparts (203.6/100 000).[36] But in sub-Saharan Africa, a community-based study of the Tanzania Stroke Incidence Project showed that there was higher incidence of stroke in older people living in urban (315.9/100 000) versus rural areas (108.6/100 000).[37] This could be due to high prevalence of stroke risk factors at a community level in the urban region. However, all these studies did not adjust for any confounders to assess the rural-urban disparities in the risk of stroke, and the residual effects could not be removed. In our study, univariate and multivariate analysis including education, occupation and income showed a stronger association of rural living with increased risk of stroke.

In China, there was a wide inequality between rural and urban due to disparities in education, employment opportunities, income, political rights, social welfare, and healthcare services.[38] In rural areas some risk factors for stroke were common and uncontrolled (such as hypertension).[36] A large-scale survey study from 70 rural and 45 urban communities in China including 45,108 individuals aged 35-70 years showed that people living in rural areas had higher prevalence of hypertension, particularly its unaware, untreated and uncontrolled level.[39] People who live in rural areas could not receive adequate preventive interventions for high risk factors and thus would have increased the risk of stroke.[40] These could be some important explanations for an association of living in rural areas with incident stroke in China.

Our study has identified that women were more evident in the disparities of incident stroke in terms of levels of education and income, apart from rurality. Although the SES of Chinese women has risen substantially over the past decades,

older women are still among the most economically disadvantaged population groups. The women in our study were born in a turbulent age when most of them had no opportunities to attain schooling and work outside due to being affected by war environment. Also, female education was rarely given priority due to poverty and patriarchal attitudes, with particular reference to girls living in rural areas,[41] thus causing a high illiterate rate in older rural women.[42] In rural areas, they were mostly kept in their hometown with farming work when they grew up due to limitations of the household registration (*hukou*) system and thus many of whom are not eligible to receive pensions since they have never been formally employed. Consequently, the older women may experience serious economic burden due to increased living and medical expenses. Older women in rural areas and those who lack of education and source of income would be at risk of incident stroke.

Strengths and weaknesses of the study

The main contribution of this study, beyond the intrinsic importance of studying inequality in stroke risk in the largest LMIC with the world′s most populous, lies in what it tells us about the simultaneous impacts of multiple measurements of SES on incidence of stroke and their gender differences. Our study included important co-variables for adjustment such as ADL, depression and cognitive impairment/dementia and thus the confounding effect would be minimised. Particularly, we adjusted for each of these SES indicators (rurality, education, occupation, and income), and thus their residual effects from other SES parts were removed. As far as we know, our study is the first to report gender differences in the association of SES with incident stroke, addressing that women had more inequality in incident stroke in relation to

low SES. Our study has limitations. First, although each of two cohorts has enough number of participants to examine incidence of stroke in relation to SES, multiple adjustment analysis got a quite wider 95% CI of HR, reducing the statistical significance. But our pooled data could increase the power. Second, the impacts of SES on incidence of stroke subtypes were yet unclear due to data unavailable in our study. Previous studies in Korea showed similar effects of SES on these two types of stroke.[43] Nevertheless, in China further studies focused on this issue should require detailed data collection for stroke subtypes to clarify the effects of these SES indicators on the incident risk of ischemic and haemorrhagic stroke. Third, caution should be exercised in generalising the findings to the whole population of China. The impact of SES on the risk of stroke in our cohort study consists of participants aged >=60 years old in urban and rural community. Those aged <60 years is required for further research.

In *conclusions* this study demonstrates the impacts of multiple measurements of SES on the risk of stroke in China. The rurality and low education were main resources of incident stroke inequality. There were gender differences in the impact; in women increased risk of stroke was associated with low education and low personal income, while in men it was with high occupational class and high family income. The gender-specific strategies and preventive interventions of health promotion targeting people living in rural areas, through reducing socioeconomic deprivation, would be helpful in campaigns to reduce stroke incidence in China. Increasing public health education and improving stroke care access in rural areas, particularly in women, and constructing balanced policies for rural seniors could have large impacts in reducing the burden of stroke in China.

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Table 1. Distribution of socio-demographic and clinical characteristics of participants by gender at baseline in the Anhui cohort study, China

Variable	All Participants N=2852		Women n=1477	(%)	Men n=1375	(%)	P value
Age (years)							
Mean (SD)	71.7	(6.9)	71.6	(7.1)	71.9	(6.6)	*0.377*
Smoking							
Never-smoking	2070	72.6	1360	92.1	710	51.6	*<0.001*
Current- or Ex-smoking	782	27.4	117	7.9	665	48.4	
Alcohol drinking in the last 2 years							
No	2295	80.5	1377	93.2	918	66.8	*<0.001*
Yes	557	19.5	100	6.8	457	33.2	
BMI (kg/m^2)							
Cut-off point							
<20	393	13.8	212	14.4	181	13.2	*0.033*
20-<23	910	31.9	438	29.7	472	34.3	
23-<26	925	32.4	482	32.6	443	32.2	
>=26	624	21.9	345	23.4	279	20.3	
Socio-economic status							
Urban-rurality							
Urban	1478	51.8	770	52.1	708	51.5	*0.732*
Rural	1374	48.2	707	47.9	667	48.5	
Educational level							
>=High Secondary school	665	23.3	240	16.2	425	30.9	*<0.001*

Secondary school	388	13.6	181	12.3		207	15.1	
Primary school	361	12.7	183	12.4		178	12.9	
Illiterate	1438	50.4	873	59.1		565	41.1	
Main occupation								
Official/Teacher	892	31.3	334	22.6		558	40.6	*<0.001*
Business/Other	210	7.4	136	9.2		74	5.4	
Manual labourer/Housewife	428	15.0	299	20.2		129	9.4	
Peasant	1322	46.4	708	47.9		614	44.7	
Satisfactory income								
Very satisfactory	294	10.3	155	10.5		139	10.1	*0.035*
Satisfactory	1387	48.6	682	46.2		705	51.3	
Average	923	32.4	511	34.6		412	30.0	
Poor	248	8.7	129	8.7		119	8.7	
Financial problem in the past two years								
No	1547	54.2	803	54.4		744	54.1	*0.890*
Yes	1305	45.8	674	45.6		631	45.9	
Combination of satisfactory income with financial problem†								
High	251	8.8	135	9.1		116	8.4	*0.106*
Middle	955	33.5	468	31.7		487	35.4	
Low	1646	57.7	874	59.2	0	772	56.2	
Social network and support								
Marital status								
Married	2068	72.5	992	67.2		1076	78.3	*<0.001*
Never	116	4.1	13	0.9		103	7.5	

married/Divorcees							
Widowed	668	23.4	472	32.0	196	14.3	
Living with							
No-one	318	11.2	165	11.2	153	11.1	*<0.001*
Spouse only	1177	41.3	557	37.7	620	45.1	
Children and/or grandchildren only	428	15.0	302	20.4	126	9.2	
Spouse and/or grandchildren and/or parents	803	28.2	393	26.6	410	29.8	
Others	126	4.4	60	4.1	66	4.8	
Frequency of visiting children or other relatives							
<Yearly or Never	99	3.5	44	3.0	55	4.0	*0.001*
At least Monthly or less often	337	11.8	159	10.8	178	12.9	
At least weekly	766	26.9	368	24.9	398	28.9	
Everyday	1650	57.9	906	61.3	744	54.1	
Co-morbidities							
Hypertension							
No	1206	42.3	632	42.8	574	41.7	*0.573*
Yes	1646	57.7	845	57.2	801	58.3	
Heart disease							
No	2424	85.0	1256	85.0	1168	84.9	*0.854*
Yes	415	14.6	213	14.4	202	14.7	
Missing‡	13	0.5	8	0.5	5	0.4	
Diabetes							
No	2687	94.2	1384	93.7	1303	94.8	*0.341*
Yes	157	5.5	87	5.9	70	5.1	

Missing‡	8	0.3	6	0.4	2	0.1	
Activity of daily living (score)							
0	2643	92.7	1368	92.6	1275	92.7	*0.966*
1-4	123	4.3	65	4.4	58	4.2	
≥5	86	3.0	44	3.0	42	3.1	
GMS-AGECAT diagnosis							
"Well"	2150	75.4	1053	71.3	1097	79.8	*<0.001*
Depression-subcase	96	3.4	49	3.3	47	3.4	
Depression-case	112	3.9	80	5.4	32	2.3	
Dementia-subcase	293	10.3	175	11.8	118	8.6	
Dementia-case	201	7.0	120	8.1	81	5.9	

†Low level in the variable of "Combination of satisfactory income with financial problem" was defined as those who had a self-reported poor or average satisfactory income or experienced a serious financial problem in the last 2 years.

‡P-value in the chi-square test was calculated based on available data, not including these "missing" data.

Table 2. Number, rate and hazard ratio of incident stroke in older people with urban and rural living in China: the Anhui cohort study

Urban-rural SES variable	Nos of stroke /participants	PYAR† (Incidence)	HR[1] 95% CI	HR[2] 95% CI	HR[3] 95% CI	HR[4] 95% CI	HR[5] 95% CI	HR[6] 95% CI
Urban	100 / 1478	10210.1 (9.79)	1.00	1.00	1.00	1.00	1.00	1.00
Rural	111 / 1374	8427.6 (13.17)	1.88 1.38-2.56	2.07 1.45-2.96	1.58 1.00-2.48	2.27 1.24-4.17	2.44 1.41-4.24	2.49 1.19-5.22

†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.

HR[1]: adjusted for age (cont.), sex, BMI, smoking status, alcohol consumption;

HR[2]: adjusted for age (cont.), sex, BMI, smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension (yes or no), heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia;

HR[3]: Educational variable was included to be adjusted based on model 2 (HR[2]);

HR[4]: Occupational variable was included to be adjusted based on model 2 (HR[2]);

HR[5]: Combination of satisfactory income with financial variable was included to be adjusted based on model 2 (HR[2]);

HR[6]: All individual SES variables were included for adjustment based on model 2 (HR[2]).

Commented [DW1]: I would take out the results from this model.

Commented [DW2]: It would be useful to add the number of subjects included in each model.

Table 3. Hazard ratios of incident stroke by socioeconomic status in women and men: the Anhui cohort study

SES variable	Anhui cohort					
	Women			Men		
	Nos of stroke /participants	PYAR† (Incidence)	HR$ 95% CI	Nos of stroke /participants	PYAR† (Incidence)	HR$ 95% CI
Urban-rurality						
Urban	49/770	5415.2 (9.05)	1.00	51/708	4794.8 (10.64)	1.00
Rural	51/707	4490.4 (11.36)	3.64 1.17-11.32	60/667	3937.3 (15.24)	2.23 0.81-6.19
Educational level						
High	19/421	3050.3 (6.23)	1.00	45/632	4307.8 (10.45)	1.00
Middle	10/183	1253.7 (7.98)	1.59 0.66-3.85	16/178	1116.1 (14.34)	1.07 0.52-2.20
Low	71/873	5601.6 (12.67)	3.68 1.70-7.97	50/565	3308.1 (15.11)	0.93 0.44-1.98
Occupational class						
High	29/470	3333.9 (8.70)	1.00	43/632	4341.0 (9.91)	1.00
Middle	22/299	2074.2 (10.61)	0.73 0.36-1.47	14/129	788.1 (17.76)	1.53 0.77-3.06
Low	49/708	4497.5 (10.89)	0.43 0.16-1.18	54/614	3603.0 (14.99)	1.20 0.49-2.94

Satisfactory Income						
High	13/155	1066.5 (12.19)	1.00	12/139	960.4 (12.49)	1.00
Middle	41/682	4742.0 (8.65)	0.62 0.32-1.20	48/705	4637.4 (10.35)	0.74 0.38-1.44
Low	46/640	4097.1 (11.23)	0.62 0.30-1.28	51/531	3134.3 (16.27)	0.83 0.40-1.73
Financial problem in the past two years						
No	54/803	5618.0 (9.61)	1.00	52/744	4964.8 (10.47)	1.00
Yes	46/674	4287.5 (10.73)	0.68 0.31-1.49	59/631	3767.3 (15.66)	1.74 0.77-3.92
Combination of satisfactory income with financial problem						
High	12/135	935.3 (12.83)	1.00	9/116	809.6 (11.12)	1.00
Middle	30/468	3366.5 (8.91)	0.62 0.30-1.28	31/487	3320.8 (9.34)	0.74 0.34-1.60
Low	58/874	5603.8 (10.35)	0.31 0.11-0.83	71/772	4601.8 (15.43)	0.82 0.32-2.10

Classification of low, middle and high levels in SES variables: **Education** was classified as follows: (1) low: illiterate, (2) middle: primary school, and (3) high: more than secondary school; **Occupational**

class was classified as follows: (1) low: peasant, (2) middle: manual labourer or housewife, and (3) high: official/teacher or business/other; **Satisfactory income** was classified as follows: (1) low: poor or average, (2) middle: satisfactory, and (3) high: very satisfactory.
†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.
$Model 6 data analysis: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia, and **other all SES**.

Table 4. Hazard ratios of incident stroke by socioeconomic status in women and men: the 4-province cohort study

SES variable	4-province cohort					
	Women			Men		
	Nos of stroke /participants	PYAR† (Incidence)	HR$ 95% CI	Nos of stroke /participants	PYAR† (Incidence)	HR$ 95% CI
Urban-rurality						
Urban	19/773	2245.2 (8.46)	1.00	28/566	1624.7 (17.23)	1.00
Rural	28/915	2905.9 (9.64)	1.84 0.75-4.49	38/762	2387.8 (15.91)	1.25 0.60-2.58
Educational level						
High	7/278	831.2 (8.42)	1.00	17/477	1398.6 (12.16)	1.00
Middle	7/449	1333.5 (5.25)	0.37 0.11-1.21	29/486	1461.8 (19.84)	1.22 0.56-2.63
Low	33/961	2986.5 (11.05)	0.80 0.26-2.47	20/365	1152.1 (17.36)	1.06 0.44-2.58
Occupational class						
High	6/235	690.1 (8.69)	1.00	20/358	1029.0 (19.44)	1.00
Middle	15/541	1624.9 (9.23)	1.01 0.35-2.93	18/267	797.8 (22.56)	1.20 0.59-2.44
Low	26/912	2836.1 (9.17)	0.69 0.22-2.12	28/703	2185.7 (12.81)	0.46‡ 0.23-0.93

Satisfactory Income						
High	3/144	420.9 (7.13)	1.00	4/128	360.3 (11.10)	1.00
Middle	20/792	2357.3 (8.48)	1.07 0.30-3.76	38/655	1919.9 (19.79)	1.88 0.64-5.52
Low	24/752	2372.9 (10.11)	1.20 0.34-4.25	24/545	1732.3 (13.85)	1.34 0.43-4.19
Financial problem in the past two years						
No	46/1612	4932.3 (9.33)	1.00	63/1277	3873.5 (16.26)	1.00
Yes	1/76	218.8 (4.57)	0.49 0.06-3.79	3/51	138.9 (21.60)	0.91 0.25-3.25
Combination of satisfactory income with financial problem						
High	3/141	413.5 (7.26)	1.00	4/122	343.6 (11.64)	1.00
Middle	19/768	2289.4 (8.30)	1.04 0.29-3.66	38/645	1893.5 (20.07)	1.86 0.63-5.47
Low	25/779	2448.1 (10.21)	1.21 0.34-4.27	24/561	1775.4 (13.52)	1.25 0.40-3.90

Classification of low, middle and high levels in SES variables: **Education** was classified as follows: (1) low: illiterate, (2) middle: primary school, and (3) high: more than secondary school; **Occupational**

class was classified as follows: (1) low: peasant, (2) middle: manual labourer or housewife, and (3) high: official/teacher or business/other; **Satisfactory income** was classified as follows: (1) low: poor or average, (2) middle: satisfactory, and (3) high: very satisfactory.

†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.

$^{\$}$Model 6 data analysis: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia, and **other all SES**.

‡HR for incident stroke in men with high occupation vs low occupation was 2.17 (1.08-4.35).

Table 5. Number, rate and hazard ratio of incident stroke in older people with actual measurement of income in China: the 4-province cohort study

SES variable	All participants			Women			Men		
	Nos of stroke /participants	PYAR† (Incidence)	HR[6] 95% CI	Nos of stroke /participants	PYAR† (Incidence)	HR[$] 95% CI	Nos of stroke /participants	PYAR† (Incidence)	HR[$] 95% CI
Annual personal income[@] (RMB)									
High (>=10000)	48/1377	4061.7 (11.82)	1.00	12/682	2019.9 (5.94)	1.00	36/695	2041.8 (17.63)	1.00
Middle (4800-<10000)	21/568	1744.3 (12.04)	1.14 0.60-2.19	10/334	1008.1 (9.92)	2.14 0.78-5.91	11/234	736.2 (14.94)	0.87 0.37-2.07
Low (<4800)	43/969	3078.2 (13.97)	1.54 0.83-2.86	24/603	1932.9 (12.42)	3.05 1.17-8.00	19/366	1145.3 (16.59)	0.96 0.41-2.24
Family annual income per person[@] (RMB)									

Commented [DW3]: The sample size should be provided.

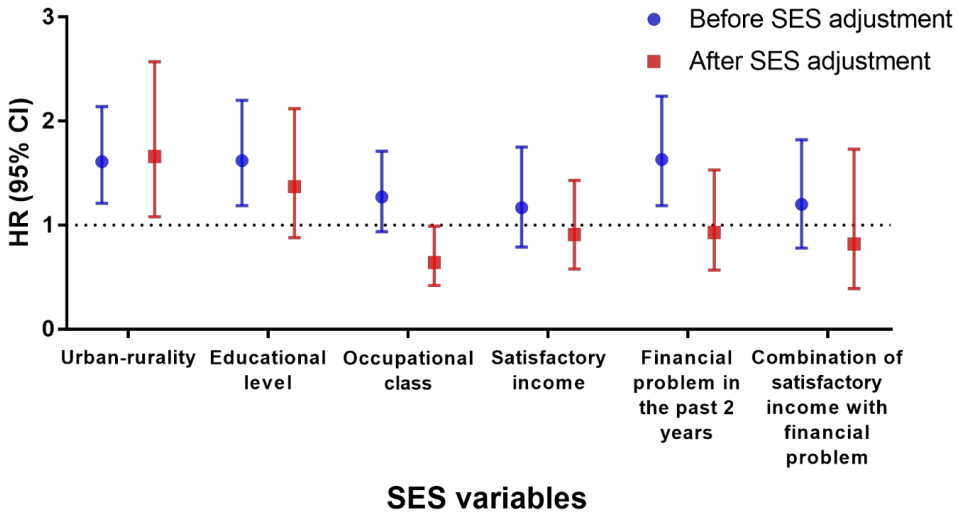
High (>=12000)	53/1133	3575.4 (14.82)	1.00	15/595	1914.1 (7.84)	1.00	38/538	1661.3 (22.87)	1.00
Middle (4800-<12000)	25/737	2307.1 (10.84)	0.66 0.40-1.10	13/419	1308.5 (9.94)	1.02 0.45-2.33	12/318	998.6 (12.02)	0.42 0.21-0.88
Low (<4800)	24/755	2174.7 (11.04)	0.75 0.37-1.50	13/416	1199.4 (10.84)	1.71 0.62-4.71	11/339	975.2 (11.28)	0.37 0.13-1.07

@The top tertile of actual personal and family income were treated as the high level. Of 3,016 eligible participants in the 4-province cohort study, 102 missing occurred in Annual personal income and 391 missing in Family annual income per person.

†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.

$^{\$}$Model 6 data analysis: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia, and **other all SES**.

Figure 1. Pooled HRs for the risk of incident stroke in low SES before and after adjustment for SES from the Anhui cohort and the 4-province cohort studies



HR for before SES adjustment: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia;
HR for after SES adjustment: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia, and **other all SES**.

Supplement Table 1. Number, rate and hazard ratio of incident stroke in older people with individual SES measurement in China: the Anhui cohort study

Individual SES variable	Nos of stroke/participants	PYAR† (Incidence)	HR[1] 95% CI	HR[2] 95% CI	HR[3] 95% CI	HR[4] 95% CI	HR[5] 95% CI	HR[6] 95% CI
Educational level								
High	64/1053	7358.1 (8.70)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	26/361	2369.8 (10.97)	1.40 0.88-2.23	1.43 0.89-2.31	1.33 0.78-2.26	1.38 0.85-2.25	1.31 0.80-2.13	1.27 0.75-2.18
Low	121/1438	8909.7 (13.58)	2.07 1.49-2.88	2.06 1.43-2.95	1.78 1.06-2.97	1.99 1.31-3.02	1.56 0.99-2.48	1.63 0.96-2.77
Occupational class								
High	72/1102	7674.9 (9.38)	1.00	1.00	1.00	1.00	1.00	1.00

Middle	36/428	2862.3 (12.58)	1.46 0.96-2.20	1.41 0.93-2.15	1.40 0.92-2.14	1.11 0.69-1.81	1.35 0.88-2.05	1.15 0.71-1.88
Low	103/1322	8100.5 (12.72)	1.83 1.32-2.54	1.89 1.30-2.73	1.77 1.12-2.82	1.24 0.73-2.08	0.98 0.54-1.78	0.78 0.40-1.50
Satisfactory Income								
High	25/294	2026.9 (12.33)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	89/1387	9379.4 (9.49)	0.76 0.49-1.19	0.82 0.52-1.29	0.75 0.47-1.18	0.75 0.48-1.19	0.74 0.47-1.16	0.72 0.46-1.14
Low	97/1171	7231.4 (13.41)	1.28 0.82-2.00	1.17 0.74-1.86	0.87 0.53-1.42	0.89 0.54-1.46	0.84 0.51-1.37	0.79 0.48-1.31
Financial problem in the past two years								
No	106/1547	10582.8 (10.02)	1.00	1.00	1.00	1.00	1.00	1.00

Yes	105/1305	8054.8 (13.04)	1.73 1.28-2.34	1.77 1.27-2.47	1.34 0.90-1.98	1.46 0.92-2.31	1.03 0.58-1.82	0.99 0.56-1.73
Combination of satisfactory income with financial problem								
High	21/251	1744.9 (12.04)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	61/955	6687.3 (9.12)	0.70 0.43-1.16	0.75 0.45-1.26	0.72 0.43-1.20	0.73 0.44-1.21	0.72 0.43-1.20	0.70 0.42-1.17
Low	129/1646	10205.6 (12.64)	1.31 0.82-2.10	1.22 0.74-1.99	0.85 0.49-1.46	0.88 0.50-1.54	0.64 0.34-1.23	0.58 0.30-1.11

Classification of low, middle and high levels in SES variables: **Education** was classified as follows: (1) low: illiterate, (2) middle: primary school, and (3) high: more than secondary school; **Occupational class** was classified as follows: (1) low: peasant, (2) middle: manual labourer or housewife, and (3) high: official/teacher or business/other; **Satisfactory income** was classified as follows: (1) low: poor or average, (2) middle: satisfactory, and (3) high: very satisfactory.

†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.

HR^1: adjusted for age (cont.), sex, BMI, smoking status, alcohol consumption;

HR^2: adjusted for age (cont.), sex, BMI, smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension (yes or no), heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia;

HR^3, HR^4, HR^5, and HR^6 adjustments were the same as those in Table 2 footnotes.

Supplement Table 2. Number, rate and hazard ratio of incident stroke in older people with different socioeconomic status measurement in China: the 4-province cohort study

SES variable	Nos of stroke/participants	PYAR† (Incidence)	HR[1] 95% CI	HR[2] 95% CI	HR[3] 95% CI	HR[4] 95% CI	HR[5] 95% CI	HR[6] 95% CI
Urban-rurality								
Urban	47/1339	3869.8 (12.15)	1.00	1.00	1.00	1.00	1.00	1.00
Rural	66/1677	5293.7 (12.47)	1.05 0.67-1.65	1.01 0.62-1.63	1.07 0.64-1.79	1.32 0.79-2.20	1.05 0.64-1.71	1.34 0.78-2.30
Educational level								
High	24/755	2229.8 (10.76)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	36/935	2795.2 (12.88)	0.96 0.55-1.68	0.86 0.49-1.53	0.99 0.54-1.82	0.89 0.50-1.58	0.85 0.47-1.53	0.93 0.50-1.74

Low	53/1326	4138.5 (12.81)	0.94 0.53-1.65	0.84 0.46-1.51	1.13 0.58-2.18	0.87 0.48-1.60	0.81 0.43-1.53	1.03 0.52-2.05
Occupational class								
High	26/593	1719.1 (15.12)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	33/808	2422.6 (13.62)	1.10 0.65-1.87	1.04 0.61-1.79	1.04 0.61-1.78	1.04 0.59-1.82	1.06 0.62-1.82	1.07 0.61-1.88
Low	54/1615	5021.8 (10.75)	0.61 0.37-1.01	0.61 0.37-1.01	0.61 0.36-1.03	0.58 0.33-1.02	0.56 ‡ 0.33-0.95	0.56 ‡ 0.32-0.99
Satisfactory Income								
High	7/272	781.2 (8.96)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	58/1447	4277.2 (13.56)	1.60 0.72-3.55	1.43 0.64-3.18	1.42 0.64-3.17	1.44 0.65-3.22	1.43 0.64-3.19	1.47 0.66-3.28

Low	48/1297	4105.2 (11.69)	1.36 0.61-3.05	1.18 0.52-2.66	1.19 0.53-2.70	1.31 0.58-2.98	1.17 0.52-2.65	1.31 0.58-2.98
Financial problem in the past two years								
No	109/2889	8805.8 (12.38)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	4/127	357.7 (11.18)	0.85 0.31-2.35	0.70 0.24-1.98	0.70 0.25-2.00	0.76 0.27-2.15	0.70 0.24-1.98	0.75 0.26-2.13
Combination of satisfactory income with financial problem								
High	7/263	757.1 (9.25)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	57/1413	4183.0 (13.63)	1.54 0.70-3.43	1.40 0.63-3.12	1.39 0.62-3.11	1.41 0.63-3.14	1.40 0.63-3.13	1.44 0.64-3.21

Low	49/1340	4223.5 (11.60)	1.30 0.58-2.90	1.13 0.50-2.55	1.15 0.51-2.60	1.26 0.56-2.85	1.13 0.50-2.55	1.25 0.55-2.85

Classification of low, middle and high levels in SES variables: **Education** was classified as follows: (1) low: illiterate, (2) middle: primary school, and (3) high: more than secondary school; **Occupational class** was classified as follows: (1) low: peasant, (2) middle: manual labourer or housewife, and (3) high: official/teacher or business/other; **Satisfactory income** was classified as follows: (1) low: poor or average, (2) middle: satisfactory, and (3) high: very satisfactory.

†PYAR (Incidence): person-year at risk (Incidence rate); Incidence rate per 1000 person-years.

HR^1: adjusted for age (cont.), sex, BMI, province, smoking status, alcohol consumption;

HR^2: adjusted for age (cont.), sex, BMI, province, smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia;

HR^3, HR^4, HR^5, and HR^6 adjustments were the same as those in Table 2 footnotes.

‡Those HR for incident stroke in officials/teachers/businessmen/others vs peasants was (1.79, 1.01-3.13) in model 5, and 1.79 (1.01-3.13) in model 6.

Supplement Table 3. Pooled hazard ratio of incident stroke in different SES indicators among participants from the Anhui cohort and the 4-province cohort studies

SES variable	Women		Men		Ratio of HRs in women vs men
	HR[$]	95% CI	HR[$]	95% CI	RHR[&]
Urban-rurality					
Urban	1.00		1.00		
Rural	2.39	1.18-4.83	1.52	0.84-2.75	1.57
Educational level					
High	1.00		1.00		
Middle	0.95	0.47-1.94	1.14	0.67-1.93	0.83
Low	2.26	1.19-4.27	0.98	0.55-1.74	2.31
Occupational class					
High	1.00		1.00		
Middle	0.81	0.45-1.45	1.36	0.83-2.23	0.60
Low	0.53	0.25-1.12	0.66	0.38-1.15	0.80
Satisfactory Income					

High					
Middle	0.70	0.39-1.25	1.07	0.44-2.61	0.65
Low	0.73	0.39-1.37	0.96	0.52-1.77	0.76
Financial problem in the past two years					
No	1.00		1.00		
Yes	0.65	0.31-1.36	1.45	0.73-2.87	0.45
Combination of satisfactory income with financial problem					
High	1.00		1.00		
Middle	0.70	0.38-1.32	1.08	0.45-2.64	0.65
Low	0.53	0.24-1.16	0.97	0.47-2.01	0.55

[$]Model 6 data analysis: adjusted for age (cont.), sex, BMI, (province for the 4-province cohort,) smoking status, alcohol consumption, marital status, frequency of visiting children or other relatives, hypertension, heart disease, diabetes, activity of daily living, depression and cognitive impairment/dementia, and **other all SES**.

RHR[&]: All p-value >0.05.

*HR for incident stroke in all participants with high occupation vs low occupation was 1.56 (1.01-2.38).