10.1161/CIRCULATIONAHA.116.025250

Prevalence, Incidence and Mortality of Stroke in China: Results from a Nationwide Population-Based Survey of 480,687 Adults

Running Title: *Wang et al.; Stroke Epidemiology in China*

Wenzhi Wang, MD[1,2]; Bin Jiang, MD [1,2]; Haixin Sun, MD, PhD [1,2]; Xiaojuan Ru, PhD[1,2];

Dongling Sun, PhD[1,2]; Linhong Wang, MD[4]; Limin Wang, MD[4]; Yong Jiang, MD[3];

Yichong Li, PhD[4]; Yilong Wang, MD, PhD[3]; Zhenghong Chen, PhD[1,2];

Shengping Wu, MD[1]; Yazhuo Zhang, MD[1]; David Wang, DO,FAHA,FAAN[5];

Yongjun Wang, MD[3]; Valery L Feigin, MD, PhD[6]

for the NESS-China investigators

[1]Department of Neuroepidemiology, Beijing Neurosurgical Institute; Capital Medical University, Beijing, China; [2]Beijing Municipal Key Laboratory of Clinical Epidemiology, Beijing, China; [3]Beijing Tiantan Hospital, Capital Medical University, Beijing Institute for Brain Disorders, Beijing, China; [4]National Center for Chronic and Non-communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China;[5]Department of Neurology, OSF/INI Comprehensive Stroke Center at SFMC, University of Illinois College of Medicine at Peoria, IL; [6]National Institute for Stroke and Applied Neurosciences, School of Public Health and Psychosocial Studies, Faculty of Health and Environmental Sciences, Auckland University of Technology, Auckland, New Zealand

Address for Correspondence:
Wenzhi Wang, MD
Beijing Neurosurgical Institute
Capital Medical University
6 TiantanXili, Dongcheng District
Beijing, 100050, China
Tel: 86-10-65112838
Email: qgnfbwwz@163.com

Yongjun Wang, MD
Beijing Tiantan Hospital
Capital Medical University
6 TiantanXili, Dongcheng District
Beijing, 100050, China
Tel: 86-10-67098351
Email: Yongjunwang1962@gmail.com

Valery L. Feigin, MD, PhD
National Institute for Stroke and Applied Neurosciences
Auckland University of Technology
Auckland, New Zealand
Tel: +64 9 9219166
Fax: +64 9 921 9620
Email: valery.feigin@aut.ac.nz

Journal Subject Terms: Cerebrovascular Disease/Stroke

Abstract

***Background*—**China bears the biggest stroke burden in the world. However, little is known about the current prevalence, incidence, and mortality of stroke at the national level, and the trend in the last 30 years.

***Methods*—**In 2013 a nationally-representative door-to-door survey was conducted in 155 urban and rural centres in 31 provinces in China, totalling 480,687 adults aged ≥20 years. All stroke survivors were considered as prevalent stroke cases at the prevalent time (August 31, 2013). First-ever strokes that occurred during one year preceding the survey point-prevalent time were considered as incident cases. According to CT/MRI/autopsy findings, strokes were categorized into ischemic stroke (IS), intracerebral haemorrhage (ICH), subarachnoid haemorrhage (SAH), and stroke of undetermined type (UND).

***Results*—**Of 480,687 participants, 7,672 were diagnosed with a prevalent stroke (1596.0 per 100,000 people) and 1643 with incident strokes (345.1 per 100,000 person-years). The age-standardized prevalence, incidence and mortality rates were 1114.8 per 100,000 people, 246.8 and 114.8 per 100,000 person-years, respectively. Pathological type of stroke was documented by CT/MRI brain scanning in 90% of prevalent and 83% of incident stroke cases. Among incident and prevalent strokes, IS constituted 69.6% and 77.8%, ICH 23.8% and 15.8%, SAH 4.4% and 4.4%, and UND - 2.1% and 2.0%, respectively. Age-specific stroke prevalence in men aged ≥40 years was significantly greater than those in women ($p<0.001$). The most prevalent risk factors among stroke survivors were hypertension (88%), smoking (48%) and alcohol use (44%). Stroke prevalence estimates in 2013 were statistically greater than those reported in China three decades ago, especially among rural residents ($p=0.017$). The highest annual incidence and mortality of stroke was in Northeast(365 and 159 per 100,000 person-years), then Central areas (326 and 154 per 100,000 person-years), and the lowest incidence was in Southwest (154 per 100,000 person-years) and the lowest mortality– in South China (65 per 100,000 person-years) ($p<0.002$).

***Conclusions*—**Stroke burden in China has increased over the last 30 years, and remains particularly high in rural areas. There is a north-to-south gradient in stroke in China, with the greatest stroke burden observed in the northern and central regions.

Key-words: epidemiology; China

Clinical Perspective

What is new?

- The population-based large-scale national stroke survey demonstrated that stroke burden in China has increased over the last 30 years, and remains particularly high in rural areas, and that there is a north-to-south gradient in stroke in China, with the greatest stroke burden observed in the northern and central regions.

What are the clinical implications?

- The study estimates allow evidence-based health care planning for stroke patients in all major regions of China (e.g. number of hospital beds, stroke units, acute care and rehabilitation staff), with priority setting for stroke care (e.g. the need for greater resources required for northern and central regions of China, especially rural areas) and prevention (e.g. emphasis on blood pressure control).

Introduction

Stroke is the third most common cause of death in most Western countries, after coronary heart disease and cancer,[1, 2] but it has been the leading cause of death in China in recent years,[3, 4] constituting almost one third of the total number of deaths from stroke worldwide.[2] By 2013, 27 of 33 provinces in China had stroke as the leading cause of death.[5] However, previous studies of stroke epidemiology in China were either not population-based, or of limited scope and diagnostic accuracy (e.g. confined to the age group between 25-74 years, lacked neuroimaging verification of pathological type of stroke, suffered from selection bias or were based on small, not nationally-representative sample sizes), and most of them were conducted 20-30 years ago.[6-10] In addition, in the last two decades China has experienced rapid health transitions and socio-demographic changes,[5, 11] which have had an impact on the prevalence of common stroke risk factors.[11] For example, there was a large increase in the prevalence of hypertension, smoking, overweight and diabetes mellitus, all of which might have affected stroke burden in China.[11-18] Therefore, obtaining more up-to-date and accurate estimates of stroke burden (as measured by incidence, prevalence and mortality) and its secular trend across China is crucial for evidence-based and region-specific planning and evaluation of the effectiveness of the currently implemented treatment and prevention strategies. The goal of this national epidemiological survey of stroke in China (NESS-China) was to identify the true stroke burden (incidence, prevalence and mortality) in men and women of age 20 and above across all major regions of China in 2012-2013.

Methods

Study population and design

This study was based on the National Disease Surveillance Points (DSP) System, which represents the national geographical distribution, social and economic status, and population age and sex in China. The survey was conducted in 157 DSPs across all seven major regions of China including 64 urban and 93 rural areas (Supplement Figure 1). We defined all the survey districts in cities (large, middle or small cities) as the urban regions, and the other rural survey sites (engaged in agricultural labour) as the rural regions. In China, there are a lot of differences for those residents who live in urban areas compared to the residents living in rural areas. These differences include socio-economic conditions, education level, environmental conditions, medical care and lifestyles. In the first stage of sampling, one town/district proportional to the population size of that area was selected in each of the 157 survey sites. In the next stage, in each selected location, one or more urban communities/villages with a total population of at least 4,500 residents (approximately 1,500 households) were selected by using the random sampling method. The selected urban communities/villages in each town/district may have come from several different communities/villages adjacent to each other. All people who lived in the selected households and met our inclusion criteria were interviewed.

The study was designed as a door-to-door survey, and participants were people who had lived in that county (or district) for at least 6 months. Interviewers were required to have face-to-face meetings with all identified participants during the survey, and a response rate of 80% was expected. The point-prevalence day was determined as August 31, 2013. The survey consisted of two stages of face-to-face interviews/ screenings. During the first stage, all eligible study participants were initially screened by the CDC researchers for a history of stroke. The validated verbal autopsy technique[19-21] was used for members of the households who passed away during the twelve months preceding the survey, to identify stroke as a possible cause of death. At the second stage, study neurologists ascertained all study participants (including deceased ones) identified with stroke or suspected stroke to confirm or refute the diagnosis. The organization and coordination of both stages of survey were carried out by provincial and local Centres for Disease Control and Prevention (CDC). The specific details of survey procedures were as follows (Supplement Figure 2):

Preliminary screening by the CDC investigators

From September 1st to December 31st 2013，CDC investigators visited each household and collected the informed consent forms and completed *preliminary screening form* signed by the study participants. This questionnaire included basic information about their family members, symptoms and medical history of the individuals, and family members who died from stroke or presumed stroke between September 1st, 2012 and August 31st, 2013 according to the validated methodology for estimating population-based incidence and mortality rates from a large door-to-door survey,[22, 23] which has also been validated and used in China.[6,7,8,21]After the preliminary screening, participants with the symptoms or history suggestive of stroke were invited to see a neurologist in the town/village clinic of their choice. Their medical records (e.g. cardiovascular disease risk factors, computed head tomography (CT) or/and magnetic resonance imaging (MRI) scans, autopsy protocols) were carefully reviewed and relevant data recorded. When appropriate, some study participants were requested to have a brain neuroimaging examination (for example, to exclude brain disorders mimicking stroke) or/and another neurological examination.

Review/confirmation by neurologists

At this stage of the survey, neurologists interviewed 28,506 participants with suspected stroke/TIA (including all definite and possible cases) and completed the case adjudication forms. The neurological examination and review was completed in 97.4% of the eligible cases. Of all these study participants, 766 patients refused to be interviewed or were lost to follow-up (Supplement Figure 1). If participants died during the follow-up, the neurologists reviewed all available data/documentation and decided on the diagnosis of stroke. All subjects with confirmed first-ever stroke (either fatal or non-fatal) between September 1st, 2012 and August 31st, 2013 were considered as having an incident stroke (fatal cases of incident strokes were used to estimate stroke mortality rates). To enhance the accuracy of the self-reported stroke event dates, all dates reported by the study participants were crosschecked against medical records of the people concerned, including official statistics and death certificates (for fatal events). All alive subjects with confirmed stroke by August 31st, 2013 were considered as having a prevalent stroke.

Diagnostic criteria

Based on the WHO criteria, stroke was defined as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin.[24] Any nervous system abnormalities induced by trauma, metabolic disorder, tumour, or central nervous system infections were excluded.

Whenever brain imaging was used within the first week of stroke onset and the results of the imaging or autopsy protocol for deceased subjects were available for reviewing by the study neurologist, pathological type of stroke was classified into four major categories: a) subarachnoid haemorrhage (SAH; lumbar puncture was allowed for diagnosing SAH only); b) intracerebral haemorrhage (ICH); and c) ischaemic stroke (IS). Stroke cases with no brain imaging done within the first week of stroke onset or when the results of the imaging or autopsy was not available for reviewing by the study neurologist, were classified as stroke of undetermined pathological type (UND).

Self-reported information on education, marital status and current occupation was used. History of hypertension or diabetes mellitus was defined by patients' self-report of having being told by a doctor that they had high blood pressure (or documented systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg) or diabetes, or by the use of blood pressure lowering or anti-diabetic drugs, respectively. Atrial fibrillation was diagnosed by ECG, as per medical records. The diagnosis of coronary heart disease (CHD) included history of myocardial infarction or angina documented by medical records. Dyslipidaemia was diagnosed by medical records. Current smoking (≥1 cigarette/per day) and alcohol intake (any dose of alcohol,≥1 time per week) were defined by subjects' self-report.

Data collection

All questionnaires were sent to Beijing Neurosurgical Institute before the end of 2013, where they were reviewed by the research staff, and then entered into a database by specialized staff according to the standard procedure. All research staff was given standardized training and formally certified before taking part in the data collection. Each survey site had a professional quality controller to verify and monitor the quality and completeness of questionnaires and to ensure the adherence to the standardized study protocol. During the data collection and cleaning process, a strict double-entry system was adopted for quality control. The Clinical Research Organization monitored the whole process during the survey period in order to ensure the consistency of data collection across all study sites. Two of the 157 survey sites did not meet the requirements of the study design and were therefore excluded from the final data analysis. The study was approved by the ethical review committees of Beijing Tiantan Hospital and of all other participating institutes. Written informed consent was obtained from all study participants by interviewers before data collection began.

Sample size estimates and statistical analysis

To ensure that the subjects had national representation on socio-economic status, age, sex, and geographical location, a multistage stratified cluster sampling method was applied, based on the national census of 2010. The sample size was calculated by using the formula:

$$N = deff\,\frac{u^2 p(1-p)}{d^2}$$

Means and 95% confidence interval (CI; two-sided for u=1.96) were determined; the prevalence of stroke (1%) obtained in the China Non-communicable Disease Surveillance 2010 was used as a measure of probability (p); the design effect (deff) value was set at 5; and the relative error was: d=r×1%, r=15%. Based on these parameters, the sample size for each stratum was estimated to be 84,516 subjects. As there were six strata, and assuming a potential non-response rate of 15%, the sample size of all ages was calculated as 596,578 (approximately 600,000 subjects). Sample weighting was used to account for different proportions of age (10-year groups from 20–79, then ≥80 years), sex, urban or rural residence, and geographic regions.

Prevalence (per 100,000 people), incidence and mortality rates (per 100,000 people per year) were estimated by age and sex. Crude and age-standardized prevalence and annual incidence and mortality rates (direct method of standardization by using China census 2010 as a standard) were calculated together with 95% confidence intervals (CIs) by using Poisson distribution. Descriptive statistics were used to assess differences between men and women and between rural and urban populations: differences in the distribution of categorical variables were tested by the Cochrane-Armitage method. Calculation of weight coefficients were considered for sampling weights, non-response weights, and post stratification weights. Post-stratification weights that adjusted for age, rural/urban residence and geographic location in accordance with 2010 China census data were considered. All statistical analyses were conducted by using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

The characteristics of the study participants are shown in Table 1. The response rate was 81%. The mean age of the participants was 46.6 (SD 16.3) years; approximately one-third (35.1%) had only a primary school education or less; 81.0% were married or had a partner; the majority were farmers (54.1%), and 42.9% resided in an urban area. The socio-demographic characteristics of the study participants were similar to that of China as a whole. 6,616 people (86.2%) with prevalent stroke and 1,283 people with incident stroke (78.1%) were hospitalized for their stroke within seven days of stroke onset. Pathological type of stroke was verified by CT/MRI/autopsy findings in 90.3% and 82.5% of prevalent and incident stroke cases respectively.

Of the 480,687 study participants, 7,672 (4,217 men [55.0%], 3,455 women) were considered as having had a stroke as at the prevalence date. The mean age of people with prevalent stroke was 66.4 (SD 10.6) years: 66.2 (SD 10.6) years in men and 66.6 (SD 10.5) years in women. The crude prevalence of stroke (Table 2) was 1596.0 per 100,000 people (95% CI 1560.6–1631.5). Although the age-standardized prevalence of stroke did not differ significantly between men and women (1222.2/100,000 [95% CI 1094.8–1349.5]) and (1005.7/100,000 [95% CI 884.2–1127.1], respectively), the age-specific prevalence of stroke was markedly higher among men compared to women across all age groups except for those aged 20–39 years. The age-specific prevalence of stroke and all pathological types of stroke increased with increasing age in both men and women, with a particularly marked increase in those 50 years or older (Table 2; Supplement Table 1; Supplement Figure 3). Among risk factors analysed (Table 3), the most prevalent risk factors in stroke survivors were hypertension (84.2%), smoking (47.6%) and drinking alcohol (43.9%). The least prevalent were atrial fibrillation (2.7%) and CHD (16.8%). The prevalence of diabetes mellitus, dyslipidaemia, atrial fibrillation and CHD was significantly greater in women compared to men, but the prevalence of alcohol drinking and smoking was significantly greater in men. While there was no significant difference in the prevalence of hypertension, alcohol drinking and smoking between urban and rural subjects, the prevalence of diabetes, dyslipidaemia, atrial fibrillation and CHD were more prevalent among urban subjects.

There were 1,643 incident strokes (55.0% in men) identified over the 12-month period, of which IS constituted 1,144 (69.6%), ICH – 391 (23.8%), SAH – 73 (4.4%), and stroke of undetermined pathological type - 35 (2.1%). The mean age of people with incident stroke was 66.4 (SD 12.04) years: 65.5 (SD 11.95) years in men and 67.6 (SD 12.05) years in women. The overall crude incidence of first-ever stroke (Table 4) was 345.1 (95% CI 328.4-361.7) per 100,000 person-years. Although the incidence of stroke overall and of all stroke pathological types was numerically higher in men than women across all age groups (Table 4; Supplement Table 2; Supplement Figure 4), these differences did not reach a statistically significant level (except those aged 50-59 for stroke overall and IS) and there were no statistically significant sex-differences in the age-standardized incidence rates. Stroke incidence in rural residents (298.2/100,000) was significantly greater than in urban residents (203.6/100,000). Among pathological types of stroke (Supplement Table 2), incidence rates were highest for IS (166.9/100,000), followed by ICH (66.2/100,000) and SAH (9.8/100,000). The age-specific incidence of total stroke and the three major pathological types of stroke (IS, ICH and SAH) increased with increasing of age in both men and women (Supplement Figure 4).

The overall crude stroke mortality rate was 159.2 (95% CI 147.9-170.5) per 100,000 person-years (Table 5). The age-standardized mortality did not differ statistically significantly between men (122.0/100,000 [95% CI99.0–145.0]) and women (107.5 [95% CI85.3–129.7]), but in people aged 60 and above, the age-specific mortality rates of stroke in men were statistically significantly greater than that in women. The age-specific mortality of stroke increased with increasing of age. The prevalence, incidence and mortality rates of stroke were significantly higher in rural areas compared with urban areas (Figure 1). Further, rural versus urban areas experienced greater increases in stroke burden as evident by a comparison of estimates obtained in 1985 to those of the current study (Supplement Figure 5).

Of the 7 major geographic regions of China (Northeast, North China, East China, South China, Southwest, Northwest and Central China) (Figure 2), the highest age-standardized prevalence (Supplement Figure 3) was observed in Central China (1549.5/100,000); Northeast was ranked the second (1450.3/100,000), and the lowest prevalence (624.5/100,000) was in South China ($p < 0.001$). The highest incidence and mortality of stroke was in the Northeast region (365.2/100,000 person-years and 158.5/100,000 person-years, respectively), the next highest rates were in Central China (326.1/100,000 and 153.7/100,000), and the lowest regions of incidence and mortality rates were in South China (154.6/100,000 and 65.0/100,000, respectively) ($p < 0.002$). There were statistically significant differences in the prevalence of risk factors between the regions (Supplement Table 3). The prevalence of hypertension was highest in Northwest China (88.7%), followed by East China (88.1%), Central China (87.6%) and Northeast (85.6%). Diabetes mellitus prevalence was particularly high in South China (18.0%) and lowest in Southwest China (9.8%). The prevalence of dyslipidaemia was highest in Central areas (27.5%) and lowest in Southwest (12.0%). The prevalence of atrial fibrillation was highest in South China and lowest in Southwest (1.5%). CHD prevalence was highest in Northeast (25.9%) and lowest in Southwest (3.50%). Alcohol drinking and smoking were most prevalent in Northeast (52.2% and 56.6% respectively) and lowest in the Northwest for alcohol (35.1%) and East China for smoking (42.9%).

Discussion

Our study provides contemporary population-based estimates of the burden of stroke in China. The age-standardized prevalence, incidence and mortality rates for stroke in China in 2012-2013 were 1115/100,000 (95% CI 997-1233), 247/100,000 (95% CI 211-283) and 115/100,000 (95% CI 96-133), respectively. Compared to a previous survey in 1985, the incidence and prevalence of stroke has increased in China. The burden of stroke in China is substantial and our estimates when applied to the whole population suggest that there are approximately 2.4 million new strokes and1.1 million stroke-related deaths annually, with 11.1 million stroke survivors alive at any given time. We also found that there are gradients of stroke burden within China, both geographically (North to South) as well as in rural compared to urban areas.

The current stroke prevalence (1115/100,000 [95% CI 997-1233]) in China appears to be the highest among other low- to middle-income countries (range from 536 to 1040/100,000),[25-29] but significantly lower than that observed in high-income countries (range from 2600 to 8000/100,000).[30-32]Compared with other similar population-based surveys, the current stroke incidence (247/100,000 person-years [95% CI 211-283]) and mortality rates(115/100,000 person-years)in China appear to be the highest in the world (in two recent overviews, pooled stroke incidence and mortality rates varied between85 and 117/100,000 person-years[33] and 30 and 114/100,000 person-years,[34] respectively). Stroke incidence rates observed in the current study were greater than in previous comparable surveys in China where these rates varied between 76 and 205 per 100,000 person-years,[6, 8, 35] suggesting a noticeable increase of stroke incidence in China over the last three decades. Although there were differences in the methodologies between this and previous stroke surveys in China, a similar increase in stroke incidence and prevalence rates in other developing countries over the last three decades[2, 33]suggests that the observed increase in stroke incidence and prevalence rates in China is real. Previous reports have shown that stroke incidence in China, and particularly incidence of ICH, was greater than in other countries.[2, 36]

The burden of stroke in China appears to be increasing particularly in rural areas. In a study conducted among rural residents of China in 1985,[8]the age-standardized prevalence of stroke in all ages was 365/100,000 individuals; in the current study, it was 930/100,000 (age-standardised by WHO world population) in rural areas, demonstrating a 2.5-fold increase (Supplement Figure 5) over the last three decades. However, the prevalence of diabetes, dyslipidaemia, atrial fibrillation and CHD appeared to be greater in the urban versus rural areas (Table 3). The observed diverging trends in stroke incidence rates between rural and urban Chinese populations may be associated with the quality of stroke primary prevention in these areas (positive trends in urban and negative trends and poorer management of risk factors in rural areas of China). The higher stroke incidence in rural residents of China may also be related to their lower socio-economic status compared to urban residents.[37] It is also possible that stroke awareness in rural areas of China is less than in urban areas, therefore rural people who develop transient ischemic attacks(TIAs) do not seek medical attention until their TIAs result in stroke, while urban residents with TIAs seek earlier medical attention and do not progress to stroke.

The observed stroke mortality rates in China in 2013 were lower than those observed in China in 1985 (Supplement Figure 5), which is in line with previous observations in China[37, 38] and other countries.[2] Compared with results of the studies in the 1980s, stroke mortality in China had decreased by 31.0% in urban areas and by 11.4% in rural areas, which is similar to what was observed in the recent GBD Study.[2]

Surprisingly, unlike findings in other countries,[39] we found no sex-differences in the incidence of SAH in China possibly due to differences in the prevalence and/or relative significance of risk factors for SAH among countries. For example, the prevalence of smoking (the most important risk factor for SAH)[40, 41]among Chinese men (52%) is 18 times greater than in Chinese women (3%), while in the USA the gap in smoking prevalence between men and women is only about 6% (24% in men and 18% in women).[42]

Although the proportion of ICH in China (25%) in 2012-2013 is significantly greater than in high-income countries (9-13%)[33] and similar to that observed in other low- to middle-income countries (14-27%),[33] it is currently lower than that observed in China (28-55%) 20-30 years ago.[43, 44] An improved management of hypertension in China may explain this finding. However, the prevalence of hypertension in stroke survivors in China remains very high (84%) compared to most other countries,[45] and recent estimates suggest that 73% of the stroke burden in China is attributable to hypertension.[12] These data emphasize the crucial importance of improving blood pressure control in China.

Our study confirmed previously observed geographical variations and a North-to-South gradient in stroke in China,[46-49] with the greatest stroke burden observed in the northern and central regions of China. These geographical differences in stroke burden in China may be related to differences in socio-economic and other risk factors between the regions,[50, 51] as also suggested by the greater prevalence of hypertension in northern and central China compared to southern regions in our study (Supplement Table 3), as well as in prior studies.[47] Large geographical variations in the stroke burden were also observed in other countries.[2]

Our study has several limitations. In this cross-sectional study, recall bias may have resulted in the underestimates of stroke prevalence, incidence and mortality rates, especially for mild strokes. However, cross-checking of the data obtained during the door-to-door interviews with that from medical records should have minimized that possibility. Involving study neurologists to review all identified cases of stroke (including additional CT/MRI brain imaging studies when indicated) further enhanced the accuracy of diagnosis of stroke. However, we did not record and analyse MRI with DWI sequences, as this was not a focus of the study. It should also be noted that while neurologists ascertained the majority of stroke patients, some study participants did not have sufficient details in their medical records. We could have also missed incident fatal and non-fatal stroke cases if the person had lived alone, no-one answered the door for the survey and there was no stroke mentioned in death certificates in the study area. However, we do not believe that this case ascertainment bias played a significant role in our study. We also were not able to collect risk factors for all people who participated in the survey, and the list of risk factors in stroke survivors did not include many important risk factors (e.g., diet, physical activity etc.). The lack of measured blood pressure and potential under-recognition of atrial fibrillation (including paroxysmal atrial fibrillation) are also limitations of our study. The non-response rate (19%) was slightly (4%) greater than that we had accounted for in the sample size calculation, and was a limitation of the study. However, we believe this did not largely affect our results because socio-demographic characteristics of non-respondents were not significantly different from those who were interviewed for the study. The advantages of our study include: (1) national representativeness with very large sample size ensuring sufficient number of men, women, rural and urban study participants from all major regions of China; (2) very high study participation rate (81%), thus minimizing selection bias; (3) all individuals with suspected stroke were re-interviewed by trained neurologists and CT/MRI brain imaging was arranged when required, thus minimizing diagnostic bias; (4) applying standardized methodology and diagnostic criteria across all study sites in China, thus providing comparable estimates with other high-quality population-based studies; and (5) obtaining not only prevalence but also incidence and mortality estimates, thus conducting the door-to-door survey in the most cost-efficient manner. To the best of our knowledge it was the first prevalence study with such a high (90%) verification of pathological types of stroke.

By providing reliable age-specific estimates of prevalence, incidence and mortality for men and women in various rural and urban regions/settings across China, our findings have clear implications for practice by allowing priority setting (e.g. emphasis on blood pressure control for stroke prevention) and evidence-based region-specific estimates of resources required for acute stroke care and rehabilitation. For example, the greater burden of stroke in northern and central regions of China (especially in rural areas) implies greater stroke resources are required for these regions. Relatively low (compared to developed countries) prevalence of stroke and high stroke mortality rates are indicative of the lack of more effective acute stroke care and rehabilitation in China (e.g. insufficient number of acute stroke units, rehabilitation services). It should also be noted that in the current survey, we obtained data of asymptomatic stroke in the study population, and we found that 19.9% of subjects who had CT/MRI brain imaging had clinically silent lacunar infarction, which may lead to dementia. Since these people did not exhibit clinical signs of acute stroke, they were excluded from the calculation of the prevalence and incidence, but their large number and possible negative consequences on cognitive functioning, combined with the very high and increasing stroke burden identified in China, further underlines the significance of, and urgent need for, primary stroke prevention in China. The northern-south gradient in stroke burden and differences in the prevalence of risk factors across China warrant further research.

Acknowledgments

We thank Dr. LY. Wu, LZ. Kong from Ministry of Health, China; Dr. XF. Liang from Chinese Center for Disease Control and Prevention; Dr. Hao Li from Tiantan Hospital. We also thank all neurologists and CDC staff from 31 provinces who worked very hard in order to ensure the accuracy of the data (for The Ness-China Collaborative Study Group and Participating Hospitals and Principal Staff in the Diagnosing Group see supplement material pages 11-12).

Sources of Funding

This study was funded by the Ministry of Science and Technology of China (reference number 2011BAI08B01).

Disclosures

None

References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany EC, Biryukov S, Abbafati C, Abera SF, Abraham JP, Abu-Rmeileh NME, Achoki T, Albuhairan FS, Alemu ZA, Alfonso R, Ali MK, Ali R, Guzman NA, Ammar W, Anwari P, Banerjee A, Barquera S, Basu S, Bennett DA, Bhutta Z, Blore J, Cabral N, Nonato IC, Chang JC, Chowdhury R, Courville KJ, Criqui MH, Cundiff DK, Dabhadkar KC, Dandona L, Davis A, Dayama A, Dharmaratne SD, Ding EL, Durrani AM, Esteghamati A, Farzadfar F, Fay DFJ, Feigin VL, Flaxman A, Forouzanfar MH, Goto A, Green MA, Gupta R, Hafezi-Nejad N, Hankey GJ, Harewood HC, Havmoeller R, Hay S, Hernandez L, Husseini A, Idrisov BT, Ikeda N, Islami F, Jahangir E, Jassal SK, Jee SH, Jeffreys M, Jonas JB, Kabagambe EK, Khalifa SEAH, Kengne AP, Khader YS, Khang YH, Kim D, Kimokoti RW, Kinge JM, Kokubo Y, Kosen S, Kwan G, Lai T, Leinsalu M, Li Y, Liang X, Liu S, Logroscino G, Lotufo PA, Lu Y, Ma J, Mainoo NK, Mensah GA, Merriman TR, Mokdad AH, Moschandreas J, Naghavi M, Naheed A, Nand D, Narayan KMV, Nelson EL, Neuhouser ML, Nisar MI, Ohkubo T, Oti SO, Pedroza A, Prabhakaran D, Roy N, Sampson U, Seo H, Sepanlou SG, Shibuya K, Shiri R, Shiue I, Singh GM, Singh JA, Skirbekk V, Stapelberg NJC, Sturua L, Sykes BL, Tobias M, Tran BX, Trasande L, Toyoshima H, Van De Vijver S, Vasankari TJ, Veerman JL, Velasquez-Melendez G, Vlassov VV, Vollset SE, Vos T, Wang C, Wang X, Weiderpass E, Werdecker A, Wright JL, Yang YC, Yatsuya H, Yoon J, Yoon SJ, Zhao Y, Zhou M, Zhu S, Lopez AD, Murray CJL and Gakidou E. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*. 2014;384:766-781.
2. Feigin VL, Krishnamurthi RV, Parmar P, Norrving B, Mensah GA, Bennett DA, Barker-Collo S, Moran AE, Sacco RL, Truelsen T, Davis S, Pandian JD, Naghavi M, Forouzanfar MH, Nguyen G, Johnson CO, Vos T, Meretoja A, Murray CJL and Roth GA. Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. *Neuroepidemiology*. 2015;45:161-176.
3. Chen Z. *The Third Nationwide Survey on Causes of Death*. Beijing: The Peking Union Medical College Press; 2008.
4. Liu L, Wang D, Lawrence Wong KS and Wang Y. Stroke and stroke care in China huge burden, significant workload, and a national priority. *Stroke*. 2011;42:3651-3654.
5. Zhou M, Wang H, Zhu J, Chen W, Wang L, Liu S, Li Y, Wang L, Liu Y, Yin P, Liu J, Yu S, Tan F, Barber RM, Coates MM, Dicker D, Fraser M, González-Medina D, Hamavid H, Hao Y, Hu G, Jiang G, Kan H, Lopez AD, Phillips MR, She J, Vos T, Wan X, Xu G, Yan LL, Yu

C, Zhao Y, Zheng Y, Zou X, Naghavi M, Wang Y, Murray CJL, Yang G and Liang X. Cause-specific mortality for 240 causes in China during 1990-2013: A systematic subnational analysis for the Global Burden of Disease Study 2013. *The Lancet*. 2016;387:251-272.
6. Li SC, Schoenberg BS, Wang CC, Cheng XM, Bolis CL and Wang KJ. Cerebrovascular disease in the People's Republic of China: epidemiologic and clinical features. *Neurology*. 1985;35:1708-1713.
7. Wang CC. Epidemiology of cerebrovascular disease in an urban community of Beijing, People's Republic of China. *Neuroepidemiology*. 1983;2:121-134.
8. Wang CC, Cheng XM, Li SC, Wang WZ, Wu SP, Wang KJ, Zhou SS, Zhao F, Dai QS, Song JR, Cai Y. Epidemiological survey of neurological disorders in six urban areas of the People's Republic of China. *Zhong-Hua-Shen-Jing-Wai-ke-Za-Zhi*. 1985;1:2-7.
9. Zhao D, Liu J, Wang W, Zeng Z, Cheng J, Liu J, Sun J and Wu Z. Epidemiological transition of stroke in China: twenty-one-year observational study from the Sino-MONICA-Beijing Project. *Stroke*. 2008;39:1668-1674.
10. Zeng J, Hong Z, Huang MS, Zhou B, Wang B, Jin MH and Lv CZ. Surveillance of stroke incidence and case fatality in Shanghai, China. [Chinese]. *Fudan University Journal of Medical Sciences.*2002;29:101-104.
11. Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, Wan X, Yu S, Jiang Y, Naghavi M, Vos T, Wang H, Lopez AD and Murray CJL. Rapid health transition in China, 1990-2010: Findings from the Global Burden of disease study 2010. *The Lancet*. 2013;381:1987-2015.
12. Feigin VL, Roth GA, Naghavi M, Parmar P, Krishnamurthi R, Chugh S, Mensah GA, Norrving B, Shiue I, Ng M, Estep K, Cercy K, Murray CJL and Forouzanfar MH. Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet Neurology*. 2016;15:913-24.
13. Forouzanfar MH, Alexander L, Anderson HR, Bachman VF, Biryukov S, Brauer M, Burnett R, Casey D, Coates MM, Cohen A, Delwiche K, Estep K, Frostad JJ, Astha KC, Kyu HH, Moradi-Lakeh M, Ng M, Slepak EL, Thomas BA, Wagner J, Aasvang GM, Abbafati C, Abbasoglu Ozgoren A, Abd-Allah F, Abera SF, Aboyans V, Abraham B, Puthenpurakal Abraham J, Abubakar I, Abu-Rmeileh NME, Aburto TC, Achoki T, Adelekan A, Adofo K, Adou AK, Adsuar JC, Afshin A, Agardh EE, Al Khabouri MJ, Al Lami FH, Alam SS, Alasfoor D, Albittar MI, Alegretti MA, Aleman AV, Alemu ZA, Alfonso-Cristancho R, Alhabib S, Ali R, Ali MK, Alla F, Allebeck P, Allen PJ, Alsharif U, Alvarez E, Alvis-Guzman N, Amankwaa AA, Amare AT, Ameh EA, Ameli O, Amini H, Ammar W, Anderson BO, Antonio CAT, Anwari P, Argeseanu Cunningham S, Arnlöv J, Arsic Arsenijevic VS, Artaman A, Asghar RJ, Assadi R, Atkins LS, Atkinson C, Avila MA, Awuah B, Badawi A, Bahit MC, Bakfalouni T, Balakrishnan K, Balalla S, Balu RK, Banerjee A, Barber RM, Barker-Collo SL, Barquera S, Barregard L, Barrero LH, Barrientos-Gutierrez T, Basto-Abreu AC, Basu A, Basu S, Basulaiman MO, Batis Ruvalcaba C, Beardsley J, Bedi N, Bekele T, Bell ML, Benjet C, Bennett DA, Benzian H, Bernabé E, Beyene TJ, Bhala N, Bhalla A, Bhutta ZA, Bikbov B, Bin Abdulhak AA, Blore JD, Blyth FM, Bohensky MA, Bora Başara B, Borges G, Bornstein NM, Bose D, Boufous S, Bourne RR, Brainin M,

Brazinova A, Breitborde NJ, Brenner H, Briggs ADM, Broday DM, Brooks PM, Bruce NG, Brugha TS, Brunekreef B, Buchbinder R, Bui LN, Bukhman G, Bulloch AG, Burch M, Burney PGJ, Campos-Nonato IR, Campuzano JC, Cantoral AJ, Caravanos J, Cárdenas R, Cardis E, Carpenter DO, Caso V, Castañeda-Orjuela CA, Castro RE, Catalá-López F, Cavalleri F, Çavlin A, Chadha VK, Chang JC, Charlson FJ, Chen H, Chen W, Chen Z, Chiang PP, Chimed-Ochir O, Chowdhury R, Christophi CA, Chuang TW, Chugh SS, Cirillo M, Claßen TKD, Colistro V, Colomar M, Colquhoun SM, Contreras AG, Cooper C, Cooperrider K, Cooper LT, Coresh J, Courville KJ, Criqui MH, Cuevas-Nasu L, Damsere-Derry J, Danawi H, Dandona L, Dandona R, Dargan PI, Davis A, Davitoiu DV, Dayama A, De Castro EF, De La Cruz-Góngora V, De Leo D, De Lima G, Degenhardt L, Del Pozo-Cruz B, Dellavalle RP, Deribe K, Derrett S, Des Jarlais DC, Dessalegn M, DeVeber GA, Devries KM, Dharmaratne SD, Dherani MK, Dicker D, Ding EL, Dokova K, Dorsey ER, Driscoll TR, Duan L, Durrani AM, Ebel BE, Ellenbogen RG, Elshrek YM, Endres M, Ermakov SP, Erskine HE, Eshrati B, Esteghamati A, Fahimi S, Faraon EJA, Farzadfar F, Fay DFJ, Feigin VL, Feigl AB, Fereshtehnejad SM, Ferrari AJ, Ferri CP, Flaxman AD, Fleming TD, Foigt N, Foreman KJ, Fra Paleo U, Franklin RC, Gabbe B, Gaffikin L, Gakidou E, Gamkrelidze A, Gankpé FG, Gansevoort RT, García-Guerra FA, Gasana E, Geleijnse JM, Gessner BD, Gething P, Gibney KB, Gillum RF, Ginawi IAM, Giroud M, Giussani G, Goenka S, Goginashvili K, Gomez Dantes H, Gona P, Gonzalez De Cosio T, González-Castell D, Gotay CC, Goto A, Gouda HN, Guerrant RL, Gugnani HC, Guillemin F, Gunnell D, Gupta R, Gupta R, Gutiérrez RA, Hafezi-Nejad N, Hagan H, Hagstromer M, Halasa YA, Hamadeh RR, Hammami M, Hankey GJ, Hao Y, Harb HL, Haregu TN, Haro JM, Havmoeller R, Hay SI, Hedayati MT, Heredia-Pi IB, Hernandez L, Heuton KR, Heydarpour P, Hijar M, Hoek HW, Hoffman HJ, Hornberger JC, Hosgood H, Hoy DG, Hsairi M, Hu G, Hu H, Huang C, Huang JJ, Hubbell BJ, Huiart L, Husseini A, Iannarone ML, Iburg KM, Idrisov BT, Ikeda N, Innos K, Inoue M, Islami F, Ismayilova S, Jacobsen KH, Jansen HA, Jarvis DL, Jassal SK, Jauregui A, Jayaraman S, Jeemon P, Jensen PN, Jha V, Jiang F, Jiang G, Jiang Y, Jonas JB, Juel K, Kan H, Kany Roseline SS, Karam NE, Karch A, Karema CK, Karthikeyan G, Kaul A, Kawakami N, Kazi DS, Kemp AH, Kengne AP, Keren A, Khader YS, Ali Hassan Khalifa SE, Khan EA, Khang YH, Khatibzadeh S, Khonelidze I, Kieling C, Kim D, Kim S, Kim Y, Kimokoti RW, Kinfu Y, Kinge JM, Kissela BM, Kivipelto M, Knibbs LD, Knudsen AK, Kokubo Y, Kose MR, Kosen S, Kraemer A, Kravchenko M, Krishnaswami S, Kromhout H, Ku T, Kuate Defo B, Kucuk Bicer B, Kuipers EJ, Kulkarni C, Kulkarni VS, Kumar GA, Kwan GF, Lai T, Lakshmana Balaji A, Lalloo R, Lallukka T, Lam H, Lan Q, Lansingh VC, Larson HJ, Larsson A, Laryea DO, Lavados PM, Lawrynowicz AE, Leasher JL, Lee JT, Leigh J, Leung R, Levi M, Li Y, Li Y, Liang J, Liang X, Lim SS, Lindsay MP, Lipshultz SE, Liu S, Liu Y, Lloyd BK, Logroscino G, London SJ, Lopez N, Lortet-Tieulent J, Lotufo PA, Lozano R, Lunevicius R, Ma J, Ma S, Machado VMP, MacIntyre MF, Magis-Rodriguez C, Mahdi AA, Majdan M, Malekzadeh R, Mangalam S, Mapoma CC, Marape M, Marcenes W, Margolis DJ, Margono C, Marks GB, Martin RV, Marzan MB, Mashal MT, Masiye F, Mason-Jones AJ, Matsushita K, Matzopoulos R, Mayosi BM, Mazorodze TT, McKay AC,

10.1161/CIRCULATIONAHA.116.025250

McKee M, McLain A, Meaney PA, Medina C, Mehndiratta MM, Mejia-Rodriguez F, Mekonnen W, Melaku YA, Meltzer M, Memish ZA, Mendoza W, Mensah GA, Meretoja A, Apolinary Mhimbira F, Micha R, Miller TR, Mills EJ, Misganaw A, Mishra S, Mohamed Ibrahim N, Mohammad KA, Mokdad AH, Mola GL, Monasta L, Montañez Hernandez JC, Montico M, Moore AR, Morawska L, Mori R, Moschandreas J, Moturi WN, Mozaffarian D, Mueller UO, Mukaigawara M, Mullany EC, Murthy KS, Naghavi M, Nahas Z, Naheed A, Naidoo KS, Naldi L, Nand D, Nangia V, Narayan KMV, Nash D, Neal B, Nejjari C, Neupane SP, Newton CR, Ngalesoni FN, Ngirabega JDD, Nguyen G, Nguyen NT, Nieuwenhuijsen MJ, Nisar MI, Nogueira JR, Nolla JM, Nolte S, Norheim OF, Norman RE, Norrving B, Nyakarahuka L, Oh IH, Ohkubo T, Olusanya BO, Omer SB, Opio JN, Orozco R, Pagcatipunan RS, Jr., Pain AW, Pandian JD, Panelo CIA, Papachristou C, Park EK, Parry CD, Paternina Caicedo AJ, Patten SB, Paul VK, Pavlin BI, Pearce N, Pedraza LS, Pedroza A, Pejin Stokic L, Pekericli A, Pereira DM, Perez-Padilla R, Perez-Ruiz F, Perico N, Perry SAL, Pervaiz A, Pesudovs K, Peterson CB, Petzold M, Phillips MR, Phua HP, Plass D, Poenaru D, Polanczyk GV, Polinder S, Pond CD, Pope CA, Pope D, Popova S, Pourmalek F, Powles J, Prabhakaran D, Prasad NM, Qato DM, Quezada AD, Quistberg DAA, Racapé L, Rafay A, Rahimi K, Rahimi-Movaghar V, Ur Rahman S, Raju M, Rakovac I, Rana SM, Rao M, Razavi H, Reddy KS, Refaat AH, Rehm J, Remuzzi G, Ribeiro AL, Riccio PM, Richardson L, Riederer A, Robinson M, Roca A, Rodriguez A, Rojas-Rueda D, Romieu I, Ronfani L, Room R, Roy N, Ruhago GM, Rushton L, Sabin N, Sacco RL, Saha S, Sahathevan R, Sahraian MA, Salomon JA, Salvo D, Sampson UK, Sanabria JR, Sanchez LM, Sánchez-Pimienta TG, Sanchez-Riera L, Sandar L, Santos IS, Sapkota A, Satpathy M, Saunders JE, Sawhney M, Saylan MI, Scarborough P, Schmidt JC, Schneider IJC, Schöttker B, Schwebel DC, Scott JG, Seedat S, Sepanlou SG, Serdar B, Servan-Mori EE, Shaddick G, Shahraz S, Shamah Levy T, Shangguan S, She J, Sheikhbahaei S, Shibuya K, Shin HH, Shinohara Y, Shiri R, Shishani K, Shiue I, Sigfusdottir ID, Silberberg DH, Simard EP, Sindi S, Singh A, Singh GM, Singh JA, Skirbekk V, Sliwa K, Soljak M, Soneji S, Søreide K, Soshnikov S, Sposato LA, Sreeramareddy CT, Stapelberg NJC, Stathopoulou V, Steckling N, Stein DJ, Stein MB, Stephens N, Stöckl H, Straif K, Stroumpoulis K, Sturua L, Sunguya BF, Swaminathan S, Swaroop M, Sykes BL, Tabb KM, Takahashi K, Talongwa RT, Tandon N, Tanne D, Tanner M, Tavakkoli M, Te Ao BJ, Teixeira CM, Téllez Rojo MM, Terkawi AS, Texcalac-Sangrador JL, Thackway SV, Thomson B, Thorne-Lyman AL, Thrift AG, Thurston GD, Tillmann T, Tobollik M, Tonelli M, Topouzis F, Towbin JA, Toyoshima H, Traebert J, Tran BX, Trasande L, Trillini M, Trujillo U, Tsala Dimbuene Z, Tsilimbaris M, Tuzcu EM, Uchendu US, Ukwaja KN, Uzun SB, Van De Vijver S, Van Dingenen R, Van Gool CH, Van Os J, Varakin YY, Vasankari TJ, Vasconcelos AMN, Vavilala MS, Veerman LJ, Velasquez-Melendez G, Venketasubramanian N, Vijayakumar L, Villalpando S, Violante FS, Victorovich Vlassov V, Vollset SE, Wagner GR, Waller SG, Wallin MT, Wan X, Wang H, Wang J, Wang L, Wang W, Wang Y, Warouw TS, Watts CH, Weichenthal S, Weiderpass E, Weintraub RG, Werdecker A, Wessells KR, Westerman R, Whiteford HA, Wilkinson JD, Williams HC, Williams TN, Woldeyohannes SM, Wolfe CDA, Wong JQ, Woolf AD, Wright

JL, Wurtz B, Xu G, Yan LL, Yang G, Yano Y, Ye P, Yenesew M, Yentür GK, Yip P, Yonemoto N, Yoon SJ, Younis MZ, Younoussi Z, Yu C, Zaki ME, Zhao Y, Zheng Y, Zhou M, Zhu J, Zhu S, Zou X, Zunt JR, Lopez AD, Vos T, Murray CJ and Temesgen AM. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*. 2015;386:2287-2323.

14. Li W, Gu H, Teo KK, Bo J, Wang Y, Yang J, Wang X, Zhang H, Sun Y, Jia X, He X, Zhao X, Cheng X, Li J, Rangarajan S, Chen C, Yusuf S, Liu L, Liu B, Hu B, Jin G, Chen H, Yang J, Wang K, Zhang L, Deng Q, Bing R, Chen T, Xu T, Wang W, Zhao W, Chang X, Hou X, Bai X, Liu X, Zhai Y, Li D, Chen D, Jin H, Tian J, Ma Y, Li Y, He C, You K, Zhang S, Tian X, Xu X, Di J, Wu J, Wang M, Zhou Q, Zhang S, Han A, Cao M, Wu J, Jiang W, Qiang D, Qin J, Qian S, Shi S, Zhou Y, Qian Z, Liu Z, Dong C, Wan M, Li J, Tang J, Mo Y, Bian R, Lou Q, Lei R, Hu L, Xiong S, Zhong Y, Li N, Tang X, Ye S, Liu Y, Li C, Li Y, Fu M, Wang Q, Fu X, Xing X, Guo B, Feng H, Xu L, Yang Y, Wu HMR, Wang Y, Ma X, Liu H, Ma Y, Liao X, Yuan B, Zhao Q, Xu G, He H, Liu J, Chen M, Deng W, Lu F, Liu Z, Zhang H, Sun S, Wang S, Zhao Y, Diao Y, Shi X, Ren D, Wei C, Zhang L, Wang J, Fan L, Liu G, Hou Y, Wu C, Ma G, Wei H, Wang J, Bao X, Tang Y, Liu T, Zhi Y, Zhang P, Wang A, Wang H, Liu J, Liu Q, Wang R, Wu J, Aili A, Wula A, Bula A, Yang D, Wen Q, Reshalaiti, Xiao Y, Shi Q, Shao Y, He J, Li K, Bai W, Yang J, Jiang Y, Liu H and Yang S. Hypertension prevalence, awareness, treatment, and control in 115 rural and urban communities involving 47 000 people from China. *Journal of hypertension*. 2016;34:39-46.
15. Li D, Lv J, Liu F, Liu P, Yang X, Feng Y, Chen G and Hao M. Hypertension burden and control in mainland China: Analysis of nationwide data 2003-2012. *International Journal of Cardiology*. 2015;184:637-644.
16. Xu Y, Wang L, He J, Bi Y, Li M, Wang T, Wang L, Jiang Y, Dai M, Lu J, Xu M, Li Y, Hu N, Li J, Mi S, Chen CS, Li G, Mu Y, Zhao J, Kong L, Chen J, Lai S, Wang W, Zhao W and Ning G. Prevalence and control of diabetes in Chinese adults. *JAMA - Journal of the American Medical Association*. 2013;310:948-958.
17. Zhang YX, Wang ZX, Zhao JS and Chu ZH. Trends in overweight and obesity among rural children and adolescents from 1985 to 2014 in Shandong, China. *European Journal of Preventive Cardiology*. 2016;23:1314-1320.
18. Han J and Chen X. A meta-analysis of cigarette smoking prevalence among adolescents in China: 1981–2010. *International Journal of Environmental Research and Public Health*. 2015;12:4617-4630.
19. Yang G, Rao C, Ma J, Wang L, Wan X, Dubrovsky G and Lopez AD. Validation of verbal autopsy procedures for adult deaths in China. *International Journal of Epidemiology*. 2006;35:741-748.
20. Murray C, Lozano R, Flaxman A, Vahdatpour A and Lopez A. Robust metrics for assessing the performance of different verbal autopsy cause assignment methods in validation studies. *Popul Health Metrics*. 2011;9,28:1-11

21. Murray C, Lopez A, Black R, Ahuja R, Mohd Ali S, Baqui A, Dandona L, Dantzer E, Das V, Dhingra U, Dutta A, Fawzi W, Flaxman A, Gomez S, Hernandez B, Joshi R, Kalter H, Kumar A, Kumar V, Lozano R, Lucero M, Mehta S, Neal B, Ohno S, Prasad R, Praveen D, Premji Z, Ramirez-Villalobos D, Remolador H, Riley I, Romero M, Said M, Sanvictores D, Sazawal S and Tallo V. Population Health Metrics Research Consortium gold standard verbal autopsy validation study: design, implementation, and development of analysis datasets. *Popul Health Metrics*. 2011;9,27:1-15
22. Feigin VL. Stroke in developing countries: can the epidemic be stopped and outcomes improved? *The Lancet Neurology*. 2007;6:94-97.
23. Rocca WA, Reggio A, Savettieri G, Salemi G, Patti F, Meneghini F, Grigoletto F, Morgante L and Di PR. Stroke incidence and survival in three Sicilian municipalities. Sicilian Neuro-Epidemiologic Study (SNES) Group. *ItalJ NeurolSci*. 1998;19:351-356.
24. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE and Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. *Bulletin of the World Health Organization*. 1980;58:113-130.
25. Kalkonde YV, Sahane V, Deshmukh MD, Nila S, Mandava P and Bang A. High Prevalence of Stroke in Rural Gadchiroli, India: A Community-Based Study. *Neuroepidemiology*. 2016;46:235-239.
26. Chang T, Gajasinghe S and Arambepola C. Prevalence of stroke and its risk factors in urban Sri Lanka: Population-based study. *Stroke*. 2015;46:2965-2968.
27. Khedr EM, Fawi G, Abdela M, Mohammed TA, Ahmed MA, El-Fetoh NA and Zaki AF. Prevalence of ischemic and hemorrhagic strokes in Qena governorate, Egypt: Community-based study. *Journal of Stroke and Cerebrovascular Diseases*. 2014;23:1843-1848.
28. de Jesús Llibre J, Valhuerdi A, Fernández O, Llibre JC, Porto R, López AM, Marcheco B and Moreno C. Prevalence of stroke and associated risk factors in older adults in Havana City and Matanzas Provinces, Cuba (10/66 population-based study). *MEDICC review*. 2010;12:20-26.
29. Jaillard AS, Hommel M and Mazetti P. Prevalence of stroke at high altitude (3380 m) in cuzco, a town of peru: A population-based study. *Stroke*. 1995;26:562-568.
30. Aho K, Reunanen A, Aromaa A, Knekt P and Maatela J. Prevalence of stroke in Finland. *Stroke*. 1986;17:681-686.
31. Truelsen T, Piechowski-Jozwiak B, Bonita R, Mathers C, Bogousslavsky J and Boysen G. Stroke incidence and prevalence in Europe: a review of available data. *EurJ Neurol*. 2006;13:581-598.
32. Fang J, Shaw KM and George MG. Prevalence of stroke - United States, 2006-2010. *Morbidity and Mortality Weekly Report*. 2012;61:379-382.
33. Feigin VL, Lawes CM, Bennett DA, Barker-Collo SL and Parag V. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. *The Lancet Neurology*. 2009;8:355-369.
34. Thrift AG, Cadilhac DA, Thayabaranathan T, Howard G, Howard VJ, Rothwell PM and Donnan GA. Global stroke statistics. *International Journal of Stroke*. 2014;9:6-18.

35. Jiang B, Wang WZ, Chen H, Hong Z, Yang QD, Wu SP, Du XL and Bao QJ. Incidence and trends of stroke and its subtypes in China: results from three large cities. *Stroke*. 2006;37:63-68.
36. Chen D, Roman GC, Wu GX, Wu ZS, Yao CH, Zhang M and Hirsch RP. Stroke in China (Sino-MONICA-Beijing study) 1984-1986. *Neuroepidemiology*. 1992;11:15-23.
37. Zhang XH, Guan T, Mao J and Liu L. Disparity and its time trends in stroke mortality between urban and rural populations in China 1987 to 2001: changing patterns and their implications for public health policy. *Stroke*. 2007;38:3139-3144.
38. Jia Q, Liu LP and Wang YJ. Stroke in China. *Clinical and Experimental Pharmacology and Physiology*. 2010;37:259-264.
39. de Rooij NK, Linn FH, van der Plas JA, Algra A and Rinkel GJ. Incidence of subarachnoid haemorrhage: a systematic review with emphasis on region, age, gender and time trends. *J NeurolNeurosurgPsychiatry*. 2007;78:1365-1372.
40. Feigin VL, Rinkel GJ, Lawes CM, Algra A, Bennett DA, van GJ and Anderson CS. Risk factors for subarachnoid hemorrhage: an updated systematic review of epidemiological studies. [Review] [54 refs]. *Stroke*. 2005;36:2773-2780.
41. Feigin V, Parag V, Lawes CMM, Rodgers A, Suh I, Woodward M, Jamrozik K, Ueshima H and on behalf of the Asia Pacific Cohort Studies C. Smoking and Elevated Blood Pressure Are the Most Important Risk Factors for Subarachnoid Hemorrhage in the Asia-Pacific Region: An Overview of 26 Cohorts Involving 306 620 Participants. *Stroke*. 2005;36:1360-1365.
42. Rahilly CR and Farwell WR. Prevalence of smoking in the United States: A focus on age, sex, ethnicity, and geographic patterns. *Current Cardiovascular Risk Reports*. 2007;1:379-383.
43. Liu M, Wu B, Wang WZ, Lee LM, Zhang SH and Kong LZ. Stroke in China: epidemiology, prevention, and management strategies. *Lancet Neurol*. 2007;6:456-464.
44. Zhang LF, Yang J, Hong Z, Yuan GG, Zhou BF, Zhao LC, Huang YN, Chen J, Wu YF and Collaborative Group of China Multicenter Study of Cardiovascular E. Proportion of different subtypes of stroke in China. *Stroke*. 2003;34:2091-2096.
45. Qureshi AI, Ezzeddine MA, Nasar A, Suri MFK, Kirmani JF, Hussein HM, Divani AA and Reddi AS. Prevalence of elevated blood pressure in 563 704 adult patients with stroke presenting to the ED in the United States. *American Journal of Emergency Medicine*. 2007;25:32-38.
46. Wu Z, Yao C, Zhao D, Wu G, Wang W, Liu J, Zeng Z and Wu Y. Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation*. 2001;103:462-468.
47. He J, Klag MJ, Wu Z and Whelton PK. Stroke in the People's Republic of China. I. Geographic variations in incidence and risk factors. *Stroke*. 1995;26:2222-2227.
48. Wu GX, Wu ZS and He BL. Epidemiological characteristics of stroke in 16 provinces of China. *Zhong-hua-Yi-Xue-Za-Zhi*. 1994;74:281-283.
49. Xue GB, Yu BX, Wang XZ, Wang GQ and Wang ZY. Stroke in urban and rural areas of

China. *Chin Med J (Engl)*. 1991;104:697-704.

50. Liu L, Liu L, Ding Y, Huang Z, He B, Sun S, Zhao G, Zhang H, Miki T, Mizushima S, Ikeda K, Nara Y and Yamori Y. Ethnic and environmental differences in various markers of dietary intake and blood pressure among Chinese Han and three other minority peoples of China: results from the WHO Cardiovascular Diseases and Alimentary Comparison (CARDIAC) Study. *Hypertension Research - Clinical & Experimental*. 2001;24:315-322.
51. Yu Z, Nissinen A, Vartiainen E, Song G, Guo Z, Zheng G, Tuomilehto J and Tian H. Associations between socioeconomic status and cardiovascular risk factors in an urban population in China. *Bulletin of the World Health Organization*. 2000;78:1296-1305.

Table 1. Characteristics of the study participants (≥20 years) in 2013

Characteristics	Overall	Men	Women	P
Participants, n (%)	480,687 (100.0)	238,427 (49.6)	242,260 (50.4)	
Residence (urban, n (%)	231,554 (48.2)	112,893 (47.4)	118661 (49.0)	<0.001
Age groups, n (%)				
20-29	92,385 (19.2)	45,405 (19.0)	46,980 (19.4)	<0.001
30-39	87,965 (18.3)	44,446 (18.6)	43,519 (18.0)	
40-49	108,792 (22.6)	54,973 (23.1)	53,819 (22.2)	
50-59	83,151 (17.3)	41,294 (17.3)	41,857 (17.3)	
60-69	62,900 (13.1)	30,577 (12.8)	32,323 (13.3)	
70-79	33,476 (7.0)	16,290 (6.8)	17,186 (7.1)	
≥80	12,018 (2.5)	5,442 (2.3)	6,576 (2.7)	
Education, n (%)				
Primary school or lower	168,606 (35.1)	73,115 (30.7)	95,491 (39.4)	<0.001
Middle school	260,154 (54.1)	138,356 (58.0)	121,798 (50.3)	
College and higher	49,254 (10.3)	25,693 (10.8)	23,561 (9.7)	
Missing	2,673 (0.6)	1,263 (0.5)	1,410 (0.6)	
Marital status, n (%)				
Married	389,118 (81.0)	192,628 (80.8)	196,490 (81.1)	<0.001
Single	55,434 (11.5)	32,886 (13.8)	22,548 (9.3)	
Widowed	32,501 (6.8)	11,111 (4.7)	21,390 (8.8)	
Missing	3,634 (0.8)	1,802 (0.8)	1,832 (0.8)	
Occupation, n (%)				
Students	10,398 (2.2)	4,905 (2.1)	5,493 (2.3)	<0.001
Worker	43,567 (9.1)	24,935 (10.5)	18,632 (7.7)	
Farmer	259,967 (54.1)	130,013 (54.5)	129,954 (53.6)	
Employee	45,762 (9.5)	25,034 (10.5)	20,728 (8.6)	
Entrepreneurs	50,494 (10.5)	26,878 (11.3)	23,616 (9.8)	
Retired or unemployed	65,331 (13.6)	23,699 (9.9)	41,632 (17.2)	
Missing	5,168 (1.1)	2,963 (1.2)	2,205 (0.9)	

Table 2. Prevalence of stroke per 100,000 (with 95% CI) Chinese adults by sex in 2013

Age group (yrs)	Men			Women			Total		
	No. of strokes	Rate	95%CI	No. of strokes	Rate	95%CI	No. of strokes	Rate	95%CI
20–29	7	15.4	(4.0–26.8)	8	17.0	(5.2–28.8)	15	16.2	(8.0–24.5)
30–39	35	78.7	(52.7–104.8)	25	57.4	(34.9–80.0)	60	68.2	(51.0–85.5)
40–49	247	449.3	(393.4–505.2)	178	330.7	(282.2–379.2)	425	390.7	(353.6–427.7)
50–59	862	2087.5	(1949.6–2225.4)	680	1624.6	(1503.5–1745.7)	1542	1854.5	(1762.8–1946.2)
60–69	1441	4712.7	(4475.2–4950.2)	1238	3830.1	(3620.9–4039.3)	2679	4259.1	(4101.3–4417.0)
70–79	1223	7507.7	(7103.0–7912.3)	1010	5876.9	(5525.2–6228.5)	2233	6670.5	(6403.2–6937.7)
≥80	402	7387.0	(6692.1–8081.9)	316	4805.4	(4288.4–5322.3)	718	5974.4	(5550.6–6398.1)
Total	4217	1768.7	(1715.8–1821.6)	3455	1426.2	(1378.9–1473.4)	7672	1596.0	(1560.6–1631.5)
ASR*		1222.2	(1094.8–1349.5)		1005.7	(884.2–1127.1)		1114.8	(996.5-1233.1)

*ASR =Age-standardized rates to China census population 2010

Table 3. Prevalence of some risk factors in 7,672 people with prevalent stroke by sex and residency in China

		Sex			Urban and Rural			
		Men N (%)	Women N (%)	P	Urban N (%)	Rural N (%)	Total N (%)	P
Hypertension	Yes	3530(83.71)	2933(84.89)	0.247	2980(84.42)	3483(84.09)	6463(84.24)	0.385
	No	476(11.29)	349(10.10)		386(10.93)	439(10.60)	825(10.75)	
	Missed	211(5.00)	173(5.01)		164(4.65)	220(5.31)	384(5.01)	
Diabetes	Yes	539(12.78)	549(15.89)	<0.001	618(17.51)	470(11.35)	1088(14.18)	<0.001
	No	3232(76.64)	2556(73.98)		2647(74.99)	3141(75.83)	5788(75.44)	
	Missed	446(10.58)	350(10.13)		265(7.51)	531(12.82)	796(10.38)	
Dyslipidaemia	Yes	870(20.63)	801(23.18)	0.025	956(27.08)	715(17.26)	1671(21.78)	<0.001
	No	2222(52.69)	1751(50.68)		1898(53.77)	2075(50.10)	3973(51.79)	
	Missed	1125(26.68)	903(26.14)		676(19.15)	1352(32.64)	2028(26.43)	
Atrial fibrillation	Yes	99(2.35)	106(3.07)	0.002	123(3.48)	82(1.98)	205(2.67)	<0.001
	No	3602(85.42)	2852(82.55)		3062(86.74)	3392(81.89)	6454(84.12)	
	Missed	516(12.24)	497(14.38)		345(9.77)	668(16.13)	1013(13.20)	
CHD	Yes	628(14.89)	660(19.10)	<0.001	710(20.11)	578(13.95)	1288(16.79)	<0.001
	No	3030(71.85)	2311(66.89)		2433(68.92)	2908(70.21)	5341(69.62)	
	Missed	559(13.26)	484(14.01)		387(10.96)	656(15.84)	1043(13.59)	
Current smoker	Yes	3048(72.28)	606(17.54)	<0.001	1656(46.91)	1998(48.24)	3654(47.63)	0.495
	No	996(23.62)	2713(78.52)		1732(49.07)	1977(47.73)	3709(48.34)	
	Missed	173(4.10)	136(3.94)		142(4.02)	167(4.03)	309(4.03)	
Alcohol drinking	Yes	2769(65.66)	602(17.42)	<0.001	1569(44.45)	1802(43.51)	3371(43.94)	0.699
	No	1276(30.26)	2717(78.64)		1822(51.61)	2171(52.41)	3993(52.05)	
	Missed	172(4.08)	136(3.94)		139(3.94)	169(4.08)	308(4.01)	

Table 4. Incidence rates (with 95% CI) of stroke per 100,000 person-years of Chinese adults (≥20 years) by sex in 2012-2013

Age group (yrs)	Men			Women			Total		
	No. of strokes	Rate	95% CI	No. of strokes	Rate	95%CI	No. of strokes	Rate	95%CI
20–29	2	4.4	(0.0–10.4)	1	2.1	(0.0–6.2)	3	3.2	(0.0–6.8)
30–39	12	26.4	(11.5–41.3)	8	18.0	(5.5–30.5)	20	22.2	(12.5–32.0)
40–49	78	139.1	(108.3–170.0)	51	92.7	(67.3–118.1)	129	116.1	(96.1–136.1)
50–59	207	528.5	(456.7–600.3)	136	339.9	(282.8–396.9)	343	433.1	(387.4–478.9)
60–69	264	908.6	(799.5–1017.7)	224	738.0	(641.7–834.3)	488	821.4	(748.9–894.0)
70–79	234	1486.9	(1297.8–1676.0)	202	1219.7	(1052.6–1386.9)	436	1349.9	(1224.1–1475.8)
≥80	106	2216.6	(1799.4–2633.9)	118	1998.0	(1641.1–2354.8)	224	2095.8	(1824.2–2367.4)
Total	903	382.2	(357.3–407.0)	740	308.5	(286.3–330.7)	1643	345.1	(328.4–361.7)
ASR*		266.4	(226.7–306.1)		226.9	(187.5–266.3)		246.8	(211.2–282.5)

*ASR = Age-standardized rates to China census population 2010

Table 5. Mortality rates (with 95%CI) of stroke per 100,000 Chinese adults (≥20 years) by sex in 2012-2013

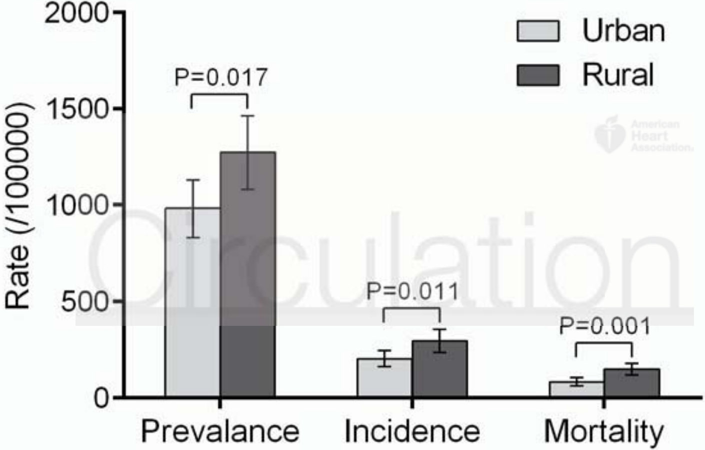
Age group (yrs)	Men			Women			Total		
	No. of strokes	Rate	95% CI	No. of strokes	Rate	95%CI	No. of strokes	Rate	95%CI
20–29	0	0.0	0.0–0.0	0	0.0	(0.0–0.0)	0	0.0	(0.0-0.0)
30–39	3	6.6	0.0–14.1	1	2.2	(0.0–6.7)	4	4.4	(0.1-8.8)
40–49	20	35.7	20.0–51.3	14	25.4	(12.1–38.8)	34	30.6	(20.3-40.9)
50–59	38	97.0	66.2–127.8	28	70.0	(44.1–95.9)	66	83.3	(63.2-103.4)
60–69	102	351.0	283.0–419.1	51	168.0	(122.0–214.1)	153	257.5	(216.8-298.3)
70–79	147	934.1	783.8–1084.4	104	628.0	(507.7–748.3)	251	777.1	(681.4-872.9)
≥80	107	2237.6	1818.4–2656.8	143	2421.3	(2029.3–2813.3)	250	2339.1	(2052.5-2625.6)
Total	417	176.5	159.6–193.4	341	142.2	(127.1–157.2)	758	159.2	(147.9-170.5)
ASR*		122.0	99.0–145.0		107.5	(85.3–129.7)		114.8	(96.3-133.3)

*ASR = Age-standardized rates to China census population 2010

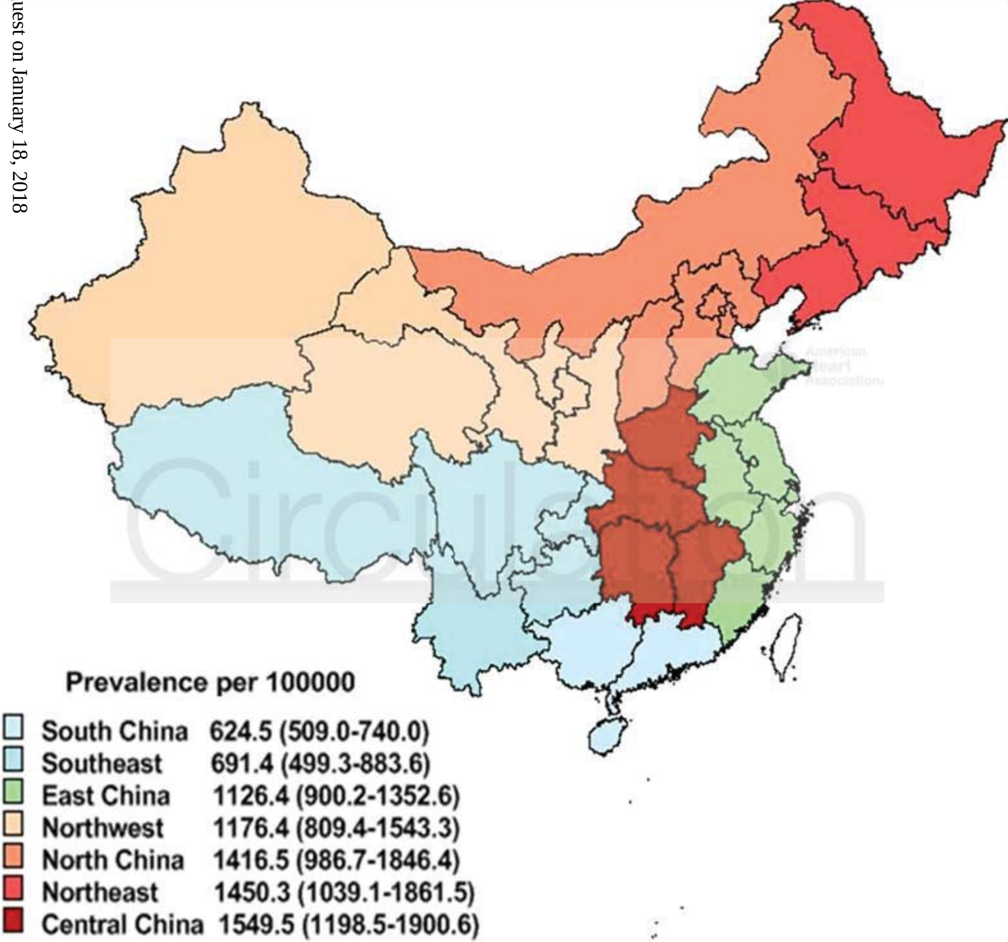
Figure Legends

Figure 1. Age-standardized prevalence, incidence and mortality of stroke in urban and rural areas of China in 2012-2013

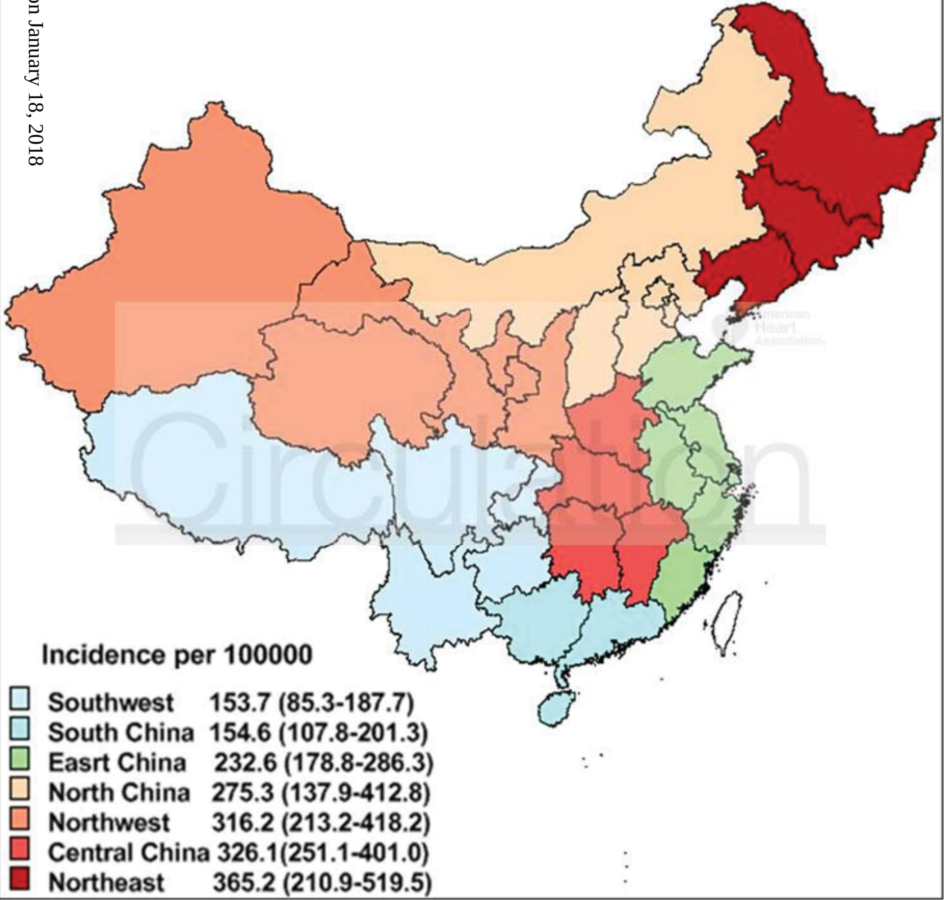
Figure 2. Age-standardized prevalence, incidence and mortality rates of stroke in the 7 major geographic regions in China in 2012-2013

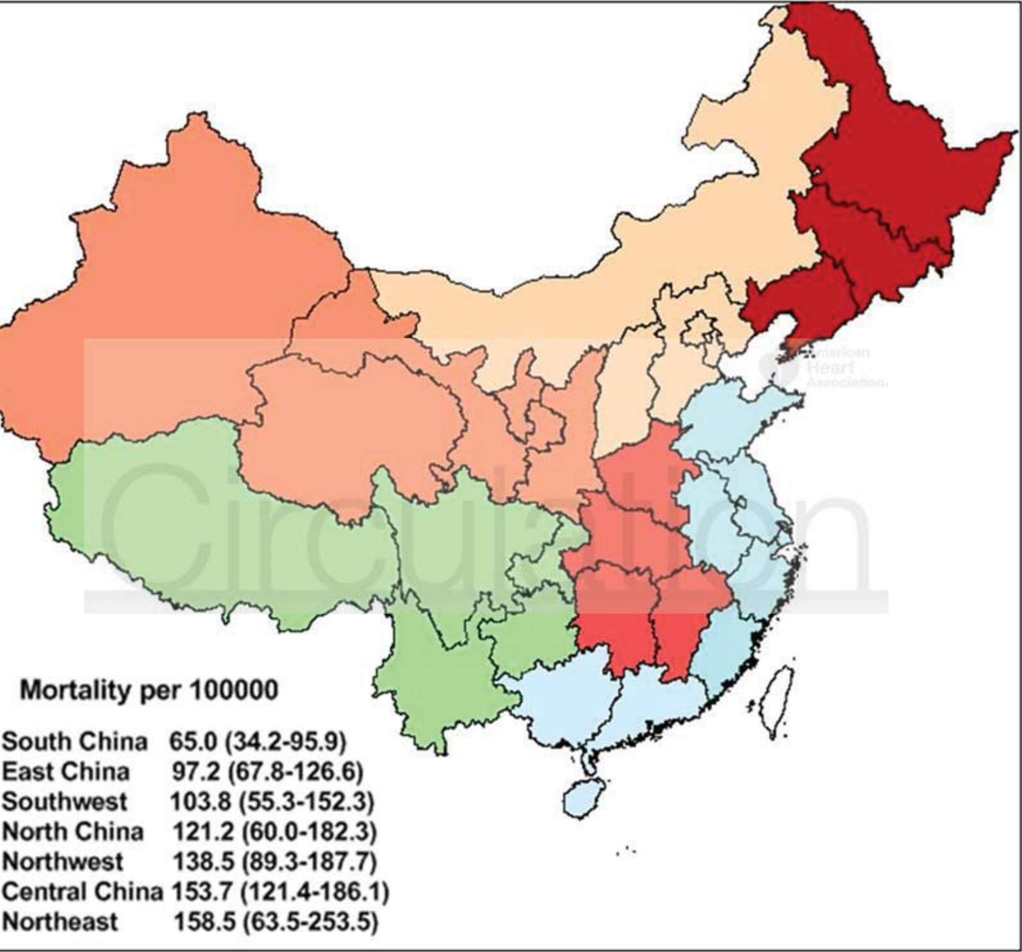


2000
1500
1000
500
0
Rate (/100000)
Urban
Rural
P=0.017
P=0.011
P=0.001
Prevalance
Incidence
Mortality



American Heart Association
Circulation
Prevalence per 100000
South China 624.5 (509.0-740.0)
Southeast 691.4 (499.3-883.6)
East China 1126.4 (900.2-1352.6)
Northwest 1176.4 (809.4-1543.3)
North China 1416.5 (986.7-1846.4)
Northeast 1450.3 (1039.1-1861.5)
Central China 1549.5 (1198.5-1900.6)


Incidence per 100000
Southwest 153.7 (85.3-187.7)
South China 154.6 (107.8-201.3)
Easrt China 232.6 (178.8-286.3)
North China 275.3 (137.9-412.8)
Northwest 316.2 (213.2-418.2)
Central China 326.1(251.1-401.0)
Northeast 365.2 (210.9-519.5)
Circulation


Mortality per 100000
South China 65.0 (34.2-95.9)
East China 97.2 (67.8-126.6)
Southwest 103.8 (55.3-152.3)
North China 121.2 (60.0-182.3)
Northwest 138.5 (89.3-187.7)
Central China 153.7 (121.4-186.1)
Northeast 158.5 (63.5-253.5)

Circulation

Prevalence, Incidence and Mortality of Stroke in China: Results from a Nationwide Population-Based Survey of 480,687 Adults

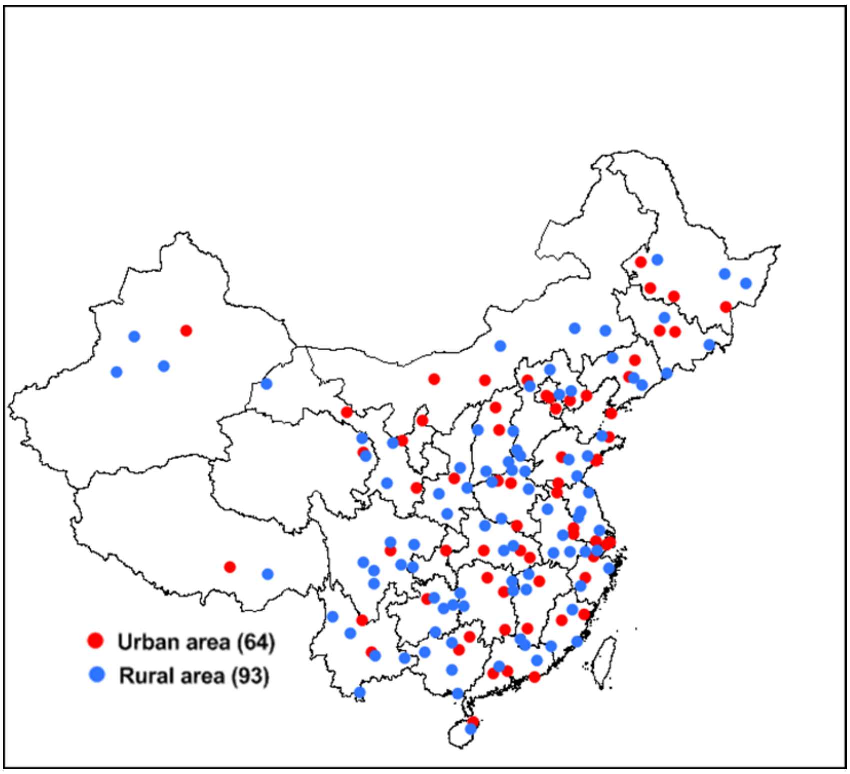
Wenzhi Wang, Bin Jiang, Haixin Sun, Xiaojuan Ru, Dongling Sun, Linhong Wang, Limin Wang, Yong Jiang, Yichong Li, Yilong Wang, Zhenghong Chen, Shengping Wu, Yazhuo Zhang, David Wang, Yongjun Wang and Valery L. Feigin
for the NESS-China investigators

Circulation. published online January 4, 2017;
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

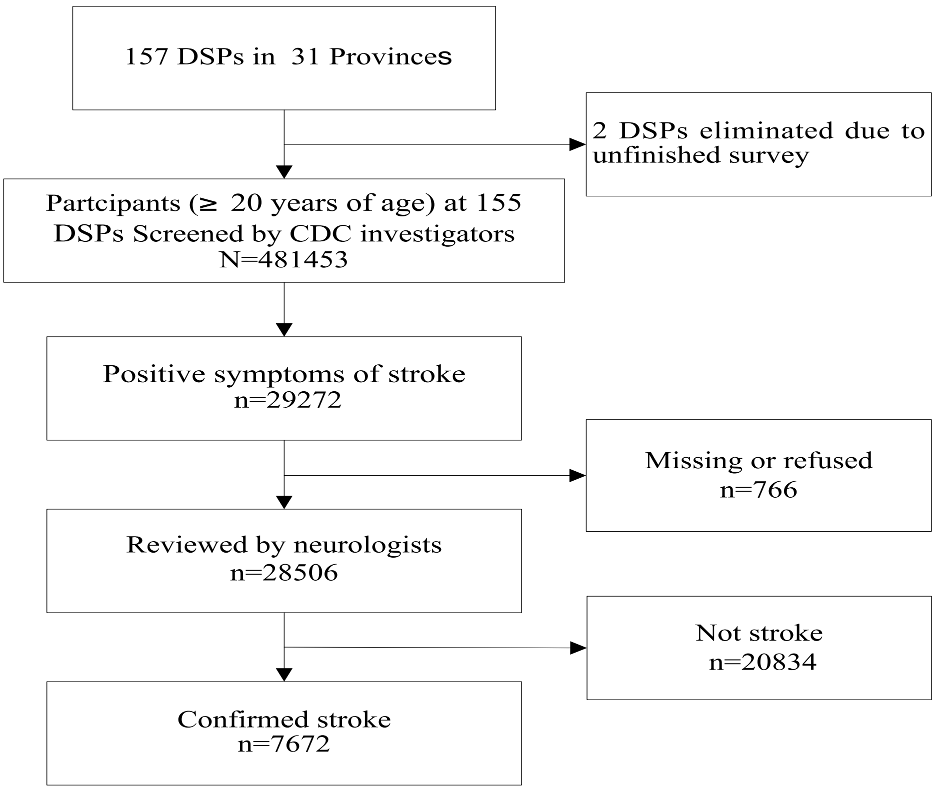
Print ISSN: 0009-7322. Online ISSN: 1524-4539

SUPPLEMENTAL MATERIAL

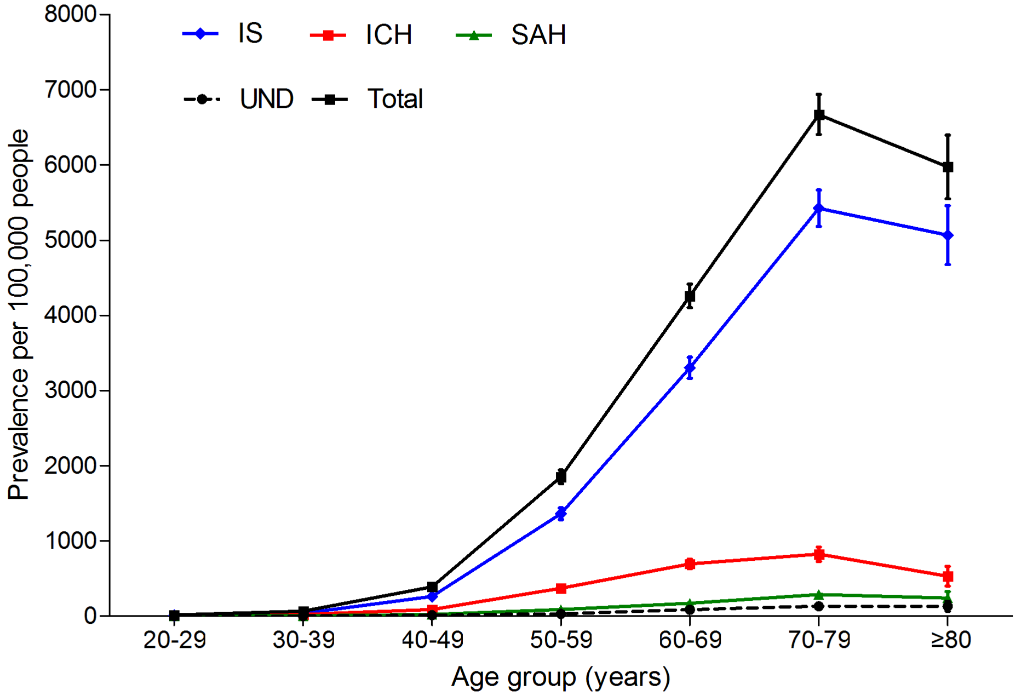
Supplemental Figure 1. 157 Survey Sites in 31 provinces of China



Supplemental Figure 2. Flowchart of stroke cases ascertainment

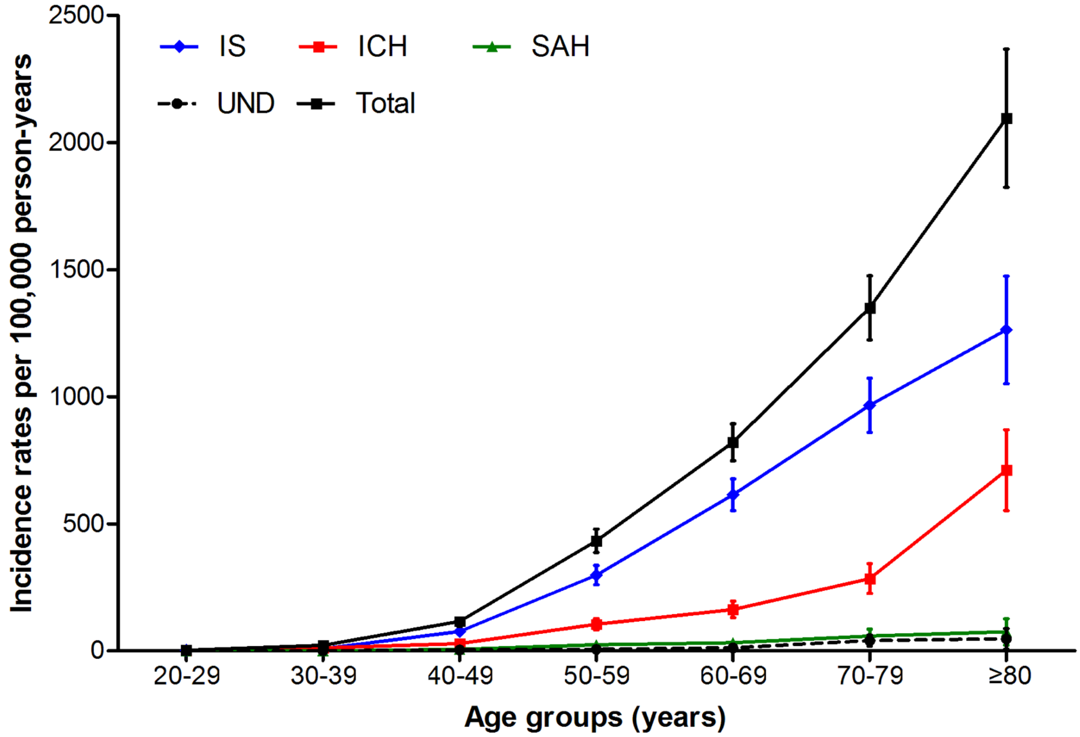


Supplemental Figure 3. Prevalence of stroke (with 95% CI) per 100,000 people in China in 2013 by age and pathological type of stroke



IS=ischaemic stroke; ICH=intracerebral haemorrhage; SAH=subarachnoid haemorrhage; UND= stroke of undetermined pathological type

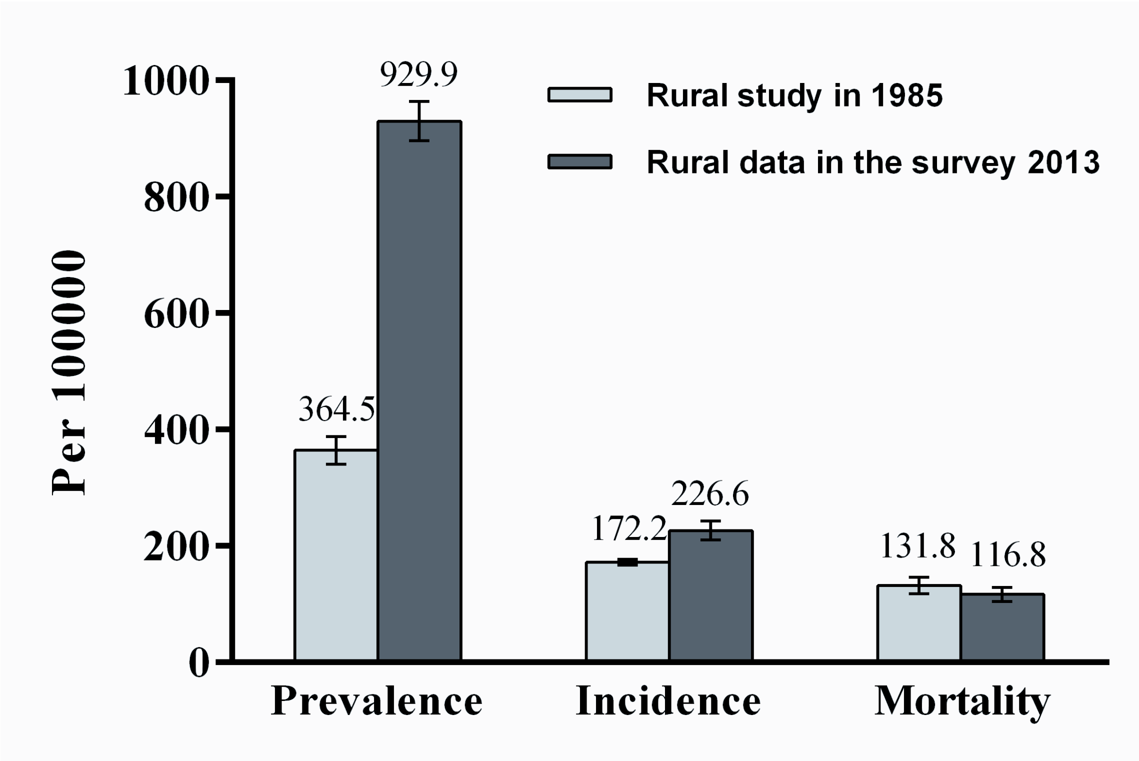
Supplemental Figure 4. Incidence rates (with 95% CI) of stroke per 100,000 person-years in China in 2012-2013 by age and pathological type of stroke

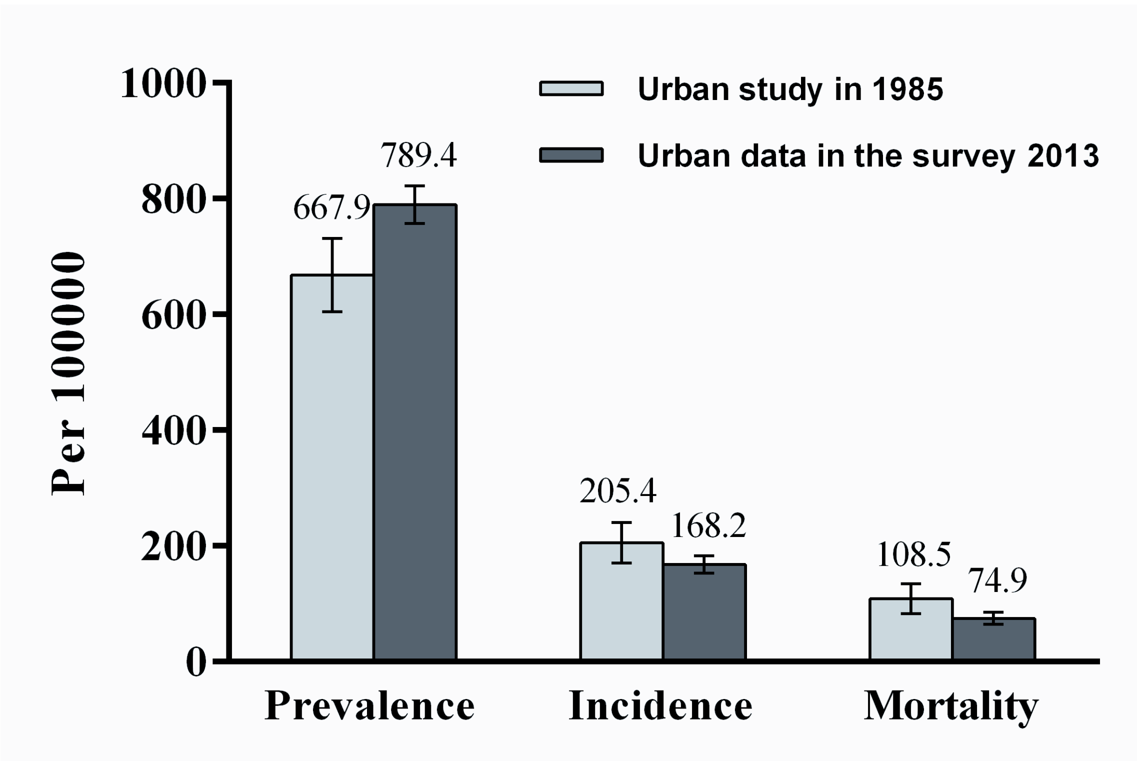


IS=ischaemic stroke; ICH=intracerebral haemorrhage; SAH=subarachnoid haemorrhage; UND= stroke of undetermined pathological type

Supplemental Figure 5. Age-standardized prevalence, incidence and mortality of stroke in urban

and rural areas of China in 2012-2013 compared to survey in 1985





The 1985 survey of 22 provinces in China was organized by Beijing Neurosurgical

Institute. The study design was almost the same as for the current survey, and included random cluster sampling, door-to-door survey, similar questionnaires, same diagnosis criteria and verification methods, including reviews of identified/suspected stroke cases by neurologists. Each survey site consisted of at least 10,000 people, and the total sample size was 246,812 individuals.

Supplemental Table 1. Age-specific and age-standardized stroke prevalence rates per 100,000 person-years (with 95% CIs) in China by sex and stroke pathological types in 2013

Men

Age group (yr)	People at risk	No. of IS*	IS* prevalence	No. of ICH	ICH** prevalence	No. of SAH	SAH*** prevalence	No. of UND¶	UND type prevalence	No. of Total	Total prevalence
20–29	45405	5	11.0 (1.4-20.7)	2	4.4 (0.0-10.5)	0	-	0	-	7	15.4 (4.0-26.8)
30–39	44446	18	40.5 (21.8-59.2)	15	33.7 (16.7-50.8)	2	4.5 (0.0-10.7)	0	-	35	78.7 (52.7-104.8)
40–49	54973	175	318.3 (271.2-365.4)	53	96.4 (70.5-122.4)	13	23.6 (10.8-36.5)	6	10.9 (2.2-19.6)	247	449.3 (393.4-505.2)
50–59	41294	642	1554.7 (1435.4-1674.0)	164	397.2 (336.5-457.8)	41	99.3 (68.9-129.7)	15	36.3 (17.9-54.7)	862	2087.5 (1949.6-2225.4)
60–69	30577	1123	3672.7 (3461.9-3883.5)	242	791.4 (692.1-890.8)	45	147.2 (104.2-190.1)	31	101.4 (65.7-137.1)	1441	4712.7 (4475.2-4950.2)
70–79	16290	995	6108.0 (5740.3-6475.8)	158	969.9 (819.4-1120.4)	48	294.7 (211.4-377.9)	22	135.1 (78.7-191.4)	1223	7507.7 (7103.0-7912.3)
≥80	5442	342	6284.5 (5639.7-6929.2)	33	606.4 (400.1-812.7)	21	385.9 (221.2-550.6)	6	110.3 (22.1-198.4)	402	7387.0 (6692.1-8081.9)
Total	238427	3300	1384.1 (1337.2-1431.0)	667	279.8 (258.5-301.0)	170	71.3 (60.6-82.0)	80	33.6 (26.2-40.9)	4217	1768.7 (1715.8-1821.6)
ASR§			934.7 (821.1-1048.3)		219.0 (181.1-256.9)		48.6 (34.4-62.8)		19.8 (11.4-28.3)		1222.2 (1094.8-1349.5)

Women

Age group (yr)	People at risk	No. of IS*	IS* prevalence	No. of ICH	ICH** prevalence	No. of SAH	SAH*** prevalence	No. of UND¶	UND type prevalence	No. of Total	Total prevalence
20–29	46980	5	10.6 (1.3-20.0)	3	6.4 (0.0-13.6)	0	-	0	-	8	17.0 (5.2-28.8)
30–39	43519	14	32.2 (15.3-49.0)	6	13.8 (2.8-24.8)	2	4.6 (0.0-11.0)	3	6.9 (0.0-14.7)	25	57.4 (34.9-80.0)
40–49	53819	113	210.0 (171.3-248.6)	45	83.6 (59.2-108.0)	12	22.3 (9.7-34.9)	8	14.9 (4.6-25.2)	178	330.7 (282.2-379.2)
50–59	41857	491	1173.0 (1069.9-1276.2)	147	351.2 (294.5-407.9)	32	76.5 (50.0-102.9)	10	23.9 (9.1-38.7)	680	1624.6 (1503.5-1745.7)
60–69	32323	955	2954.6 (2770.0-3139.1)	196	606.4 (521.7-691.0)	64	198.0 (149.5-246.5)	23	71.2 (42.1-100.2)	1238	3830.1 (3620.9-4039.3)
70–79	17186	821	4777.1 (4458.3-5096.0)	118	686.6 (563.1-810.1)	49	285.1 (205.4-364.8)	22	128.0 (74.6-181.5)	1010	5876.9 (5525.2-6228.5)
≥80	6576	267	4060.2 (3583.2-4537.2)	31	471.4 (305.9-637.0)	8	121.7 (37.4-205.9)	10	152.1 (57.9-246.2)	316	4805.4 (4288.4-5322.3)
Total	242260	2666	1100.5 (1058.9-1142.0)	546	225.4 (206.5-244.3)	167	68.9 (58.5-79.4)	76	31.4 (24.3-38.4)	3455	1426.2 (1378.9-1473.4)
ASR§			773.0 (671.9-874.2)		164.4 (137.5-191.2)		48.5 (37.7-59.4)		19.7 (13.2-26.3)		1005.7 (884.2-1127.1)

Both sexes combined

Age group (yr)	People at risk	No. of IS*	IS* prevalence	No. of ICH	ICH** prevalence	No. of SAH	SAH*** prevalence	No. of UND¶	UND type prevalence	No. of Total	Total prevalence
20–29	92385	10	10.8 (4.1-17.5)	5	5.4 (0.7-10.2)	0	-	0	-	15	16.2 (8.0-24.5)
30–39	87965	32	36.4 (23.8-49.0)	21	23.9 (13.7-34.1)	4	4.5 (0.1-9.0)	3	3.4 (0.0-7.3)	60	68.2 (51.0-85.5)
40–49	108792	288	264.7 (234.2-295.3)	98	90.1 (72.3-107.9)	25	23.0 (14.0-32.0)	14	12.9 (6.1-19.6)	425	390.7 (353.6-427.7)
50–59	83151	1133	1362.6 (1283.8-1441.4)	311	374.0 (332.5-415.5)	73	87.8 (67.7-107.9)	25	30.1 (18.3-41.8)	1542	1854.5 (1762.8-1946.2)
60–69	62900	2078	3303.7 (3164.0-3443.3)	438	696.3 (631.4-761.3)	109	173.3 (140.8-205.8)	54	85.9 (63.0-108.7)	2679	4259.1 (4101.3-4417.0)
70–79	33476	1816	5424.8 (5182.1-5667.4)	276	824.5 (727.6-921.3)	97	289.8 (232.2-347.3)	44	131.4 (92.6-170.2)	2233	6670.5 (6403.2-6937.7)
≥80	12018	609	5067.4 (4675.3-5459.5)	64	532.5 (402.4-662.7)	29	241.3 (153.6-329.0)	16	133.1 (67.9-198.3)	718	5974.4 (5550.6-6398.1)
Total	480687	5966	1241.1 (1209.8-1272.4)	1213	252.3 (238.2-266.5)	337	70.1 (62.6-77.6)	156	32.5 (27.4-37.5)	7672	1596.0 (1560.6-1631.5)
ASR§			854.5 (752.5-956.6)		191.9 (162.9-220.9)		48.6 (39.3-57.8)		19.8 (13.1-26.4)		1114.8 (996.5-1233.1)

*IS=ischaemic stroke; **ICH=intracerebral haemorrhage; ***SAH=subarachnoid haemorrhage; UND¶= stroke of undetermined pathological type

§ASR = age-standardized to the China census population 2010

Supplemental Table 2. Age-specific and age-standardized stroke incidence rates per 100,000 person-years (with 95% CIs) in China by sex and stroke pathological types in 2012-2013

Men

Age group (yr)	People at risk	No. of IS*	IS* incidence rates	No. of ICH	ICH** incidence rates	No. of SAH	SAH*** incidence rates	No. of UND¶	UND type incidence rates	No. of Total	Total Incidence rates
20–29	45961	2	4.4 (0.0-10.4)	0	0	0	0	0	0	2	4.4 (0.0-10.4)
30–39	45508	4	8.8 (0.2-17.4)	8	17.6 (5.4-29.8)	0	0	0	0	12	26.4 (11.5-41.3)
40–49	56068	55	98.1 (72.2-124.0)	16	28.5 (14.6-42.5)	4	7.1 (0.1-14.1)	3	5.4 (0.0-11.4)	78	139.1 (108.3-170.0)
50–59	39171	143	365.1 (305.3-424.8)	50	127.6 (92.3-163.0)	12	30.6 (13.3-48.0)	2	5.1 (0.0-12.2)	207	528.5 (456.7-600.3)
60–69	29056	203	698.7 (602.9-794.4)	49	168.6 (121.5-215.8)	9	31.0 (10.7-51.2)	3	10.3 (0.0-22.0)	264	908.6 (799.5-1017.7)
70–79	15737	160	1016.7 (860.0-1173.4)	54	343.1(251.8-434.5)	13	82.6 (37.7-127.5)	7	44.5 (11.5-77.4)	234	1486.9 (1297.8-1676.0)
≥80	4782	68	1422.0 (1086.4-1757.6)	29	606.4 (386.4-826.5)	7	146.4 (38.0-254.7)	2	41.8 (0.0-99.8)	106	2216.6 (1799.4-2633.9)
Total	236283	635	268.7 (247.9-289.6)	206	87.2 (75.3-99.1)	45	19.0 (13.5-24.6)	17	7.2 (3.8-10.6)	903	382.2 (357.3-407.0)
ASR§			181.7 (151.5-211.9)		69.6 (53.6-85.7)		11.7 (6.9-16.5)		3.4 (1.5-5.4)		266.4(226.7-306.1)

Women

Age group (yr)	People at risk	No. of IS*	IS* incidence rates	No. of ICH	ICH** incidence rates	No. of SAH	SAH*** incidence rates	No. of UND ¶	UND type incidence rates	No. of Total	Total Incidence rates
20–29	47553	1	2.1 (0.0-6.2)	0	-	0	-	0	0	1	2.1 (0.0-6.2)
30–39	44462	4	9.0 (0.2-17.8)	3	6.7 (0.0-14.4)	1	2.2 (0.0-6.7)	0	0	8	18.0 (5.5-30.5)
40–49	55022	30	54.5 (35.0-74.0)	16	29.1 (14.8-43.3)	3	5. (0.0-11.6)	2	3.6 (0.0-8.7)	51	92.7 (67.3-118.1)
50–59	40017	93	232.4 (185.2-279.6)	33	82.5 (54.3-110.6)	7	17.5 (4.5-30.4)	3	7.5 (0.0-16.0)	136	339.9 (282.8-396.9)
60–69	30352	162	533.7 (451.8-615.7)	48	158.1 (113.4-202.8)	10	32.9 (12.5-53.4)	4	13.2 (0.3-26.1)	224	738.0 (641.7-834.3)
70–79	16561	152	917.8 (772.6-1063.1)	38	229.5 (156.6-302.3)	6	36.2 (7.2-65.2)	6	36.2 (7.2-65.2)	202	1219.7 (1052.6-1386.9)
≥80	5906	67	1134.4 (864.3-1404.5)	47	795.8 (569.2-1022.4)	1	16.9 (0.0-50.1)	3	50.8 (0.0-108.3)	118	1998.0 (1641.1-2354.8)
Total	239873	509	212.2 (193.8-230.6)	185	77.1 (66.0-88.2)	28	11.7 (7.3-16.0)	18	7.5 (4.0-11.0)	740	308.5 (286.3-330.7)
AAR§			151.9 (122.1-181.8)		62.7 (47.5-78.0)		7.9 (3.8-12.0)		4.3 (1.4-7.3)		226.9 (187.5-266.3)

Both sexes combined

Age group (yr)	People at risk	No. of IS*	IS* incidence rates	No. of ICH	ICH** incidence rates	No. of SAH	SAH*** incidence rates	No. of UND¶	UND type incidence rates	No. of Total	Total Incidence rates
20–29	93514	3	3.2 (0.0-6.8)	0	-	0	-	0	-	3	3.2(0.0-6.8)
30–39	89970	8	8.9 (2.7-15.1)	11	12.2 (5.0-19.5)	1	1.1 (0.0-3.3)	0	-	20	22.2 (12.5-32.0)
40–49	111090	85	76.5 (60.3-92.8)	32	28.8 (18.8-38.8)	7	6.3 (1.6-11.0)	5	4.5 (0.6-8.4)	129	116.1 (96.1-136.1)
50–59	79188	236	298.0 (260.1-336.0)	83	104.8 (82.3-127.4)	19	24.0 (13.2-34.8)	5	6.3 (0.8-11.8)	343	433.1 (387.4-478.9)
60–69	59408	365	614.4 (551.6-677.2)	97	163.3 (130.8-195.7)	19	32.0 (17.6-46.4)	7	11.8 (3.1-20.5)	488	821.4 (748.9-894.0)
70–79	32298	312	966.0 (859.3-1072.7)	92	284.8(226.7-343.0)	19	58.8 (32.4-85.3)	13	40.3 (18.4-62.1)	436	1349.9 (1224.1-1475.8
≥80	10688	135	1263.1(1051.4-1474.8)	76	711.1(551.8-870.4)	8	74.9 (23.0-126.7)	5	46.8 (5.8-87.8)	224	2095.8 (1824.2-2367.4
Total	476156	1144	240.3 (226.4-254.2)	391	82.1(74.0-90.3)	73	15.3 (11.8-18.8)	35	7.4 (4.9-9.8)	1643	345.1 (328.4-361.7)
ASR§			166.9 (140.1-193.7)		66.2 (52.7-79.7)		9.8 (6.5-13.2)		3.9 (2.0-5.7)		246.8 (211.2-282.5)

*IS= ischaemic stroke; **ICH=intracerebral haemorrhage; ***SAH=subarachnoid haemorrhage; UND¶= stroke of undetermined pathological type

§ASR = age-standardized to the China census population 2010

Supplemental Table 3. Prevalence of some risk factors in 7,672 people with prevalent stroke in seven major districts of China in 2013

		East China N (%)	South China N (%)	Central China N (%)	North China N (%)	Northwest N (%)	Southwest N (%)	Northeast N (%)	P
Hypertension	Yes	1378(88.11)	318(81.54)	1389(87.58)	1052(74.03)	753(88.69)	442(81.70)	1131(85.62)	<0.001
	No	168(10.74)	55(14.10)	165(10.40)	126(8.87)	80(9.42)	68(12.57)	163(12.34)	
	Missed	18(1.15)	17(4.36)	32(2.02)	243(17.10)	16(1.88)	31(5.73)	27(2.04)	
Diabetes	Yes	222(14.19)	70(17.95)	227(14.31)	228(16.05)	99(11.66)	53(9.80)	189(14.31)	<0.001
	No	1250(79.92)	279(71.54)	1272(80.20)	848(59.68)	664(78.21)	434(80.22)	1041(78.80)	
	Missed	92(5.88)	41(10.51)	87(5.49)	345(24.28)	86(10.13)	54(9.98)	91(6.89)	
Dyslipidaemia	Yes	280(17.90)	105(26.92)	436(27.49)	331(23.29)	180(21.20)	65(12.01)	274(20.74)	<0.001
	No	855(54.67)	146(37.44)	808(50.95)	820(57.71)	359(42.29)	341(63.03)	644(48.75)	
	Missed	429(27.43)	139(35.64)	342(21.56)	270(19.00)	310(36.51)	135(24.95)	403(30.51)	
Atrial fibrillation	Yes	41(2.62)	17(4.36)	28(1.77)	54(3.80)	20(2.36)	8(1.48)	37(2.80)	<0.001
	No	1342(85.81)	301(77.18)	1412(89.03)	1262(88.81)	604(71.14)	447(82.62)	1086(82.21)	
	Missed	181(11.57)	72(18.46)	146(9.21)	105(7.39)	225(26.50)	86(15.90)	198(14.99)	
CHD	Yes	200(12.79)	47(12.05)	321(20.24)	226(15.90)	133(15.67)	19(3.51)	342(25.89)	<0.001
	No	1173(75.00)	268(68.72)	1058(66.71)	1042(73.33)	556(65.49)	434(80.22)	810(61.32)	
	Missed	191(12.21)	75(19.23)	207(13.05)	153(10.77)	160(18.85)	88(16.27)	169(12.79)	
Current smoker	Yes	671(42.90)	175(44.87)	691(43.57)	750(52.78)	369(43.46)	250(46.21)	748(56.62)	<0.001
	No	863(55.18)	200(51.28)	792(49.94)	599(42.15)	458(53.95)	254(46.95)	543(41.11)	
	Missed	30(1.92)	15(3.85)	103(6.49)	72(5.07)	22(2.59)	37(6.84)	30(2.27)	
Alcohol drinking	Yes	678(43.35)	187(47.95)	618(38.97)	644(45.32)	298(35.10)	256(47.32)	690(52.23)	<0.001
	No	856(54.73)	187(47.95)	867(54.67)	704(49.54)	529(62.31)	248(45.84)	602(45.57)	
	Missed	30(1.92)	16(4.10)	101(6.37)	73(5.14)	22(2.59)	37(6.84)	29(2.20)	

The Ness-China Collaborative Study Group

The following investigators participated in this study: *Steering Committee*: WZ. Wang (principal investigator), B. Jiang (co-principal investigator), HX. Sun, XJ. Ru, DL. Sun, LH. Wang, LM. Wang, YJ. Wang, Y. Jiang

Participating CDCs and Principal Staff in the Screening Group:

Beijing Center for Disease Control and Prevention (Zhong Dong); Tianjin Centers for Disease Control and Prevention (Guide Song); Hebei Provincial Center for Disease Control and Prevention (Junqing Zhu); Center for Disease Control and Prevention of Shanxi Province (Zeping Ren); Inner Mongolia Autonomous Region Center for Disease Control and Prevention (Yonggang Qian); Liaoning Provincial Center for Disease Control and Prevention (Guowei Pan); The Center for Disease Control and Prevention of Jilin Province (Yingli Zhu); Heilongjiang Provincial Centre for Disease Control and Prevention （Xue Zhou; Shanghai Municipal Center for Disease Control and Prevention (Xinjian Li); Jiangsu Provincial Center for Disease Control and Prevention (Ming Wu); Zhejiang Provincial Center for Disease Control and Prevention (Min Yu) ; Anhui Center for Disease Control and Prevention (Qingsheng Wu); Fujian Center for Disease Control and Prevention (Ying Ye); Jiangxi Province Center for Disease Control and Prevention (Liping Zhu); Shandong Center for Disease Control and Prevention (Xiaolei Guo); Henan Provincial Center for Disease Control and Prevention (Gang Zhou); Hubei Center for Disease Prevention and Control (Qingjun Zhang); Hunan Provincial Center for Disease Control and Prevention (Huilin Liu); Guangdong Provincial Center for Disease Control and Prevention (Yanjun Xu); Guangxi Zhuang Autonomous Region Center for Disease Prevention and Control (Hong Yang); Hainan Center for Disease Control and Prevention (Hongmei Wang); Chongqing Center for Disease Prevention and Control (Xianbin Ding); Sichuan Center for Disease Control and Prevention (Ying Deng); Guizhou Provincial Center for Disease Control and Prevention (Tao Liu); Yunnan Centers for Disease Control and Prevention (Qingping Shi);Tibet Autonomous Region Center for Disease Control and Prevention (GuoxiaBai); Shaanxi Center for Disease Control and Prevention (Jingang Ma); Gansu Center for Disease Control and Prevention (Pengfei Ge); Qinghai Center for Disease Prevention and Control (Minru Zhou); NingXia Center For Diseases Control and Prevention (Yine Zhang); The Center for Disease Control and Prevention of Xinjiang Uygur Autonomous Region (Laixin Liu); Center for Disease Control and Prevention, No. 2 Agriculture Division of Xinjiang Production and Construction Corps (Ying Li).

Participating Hospitals and Principal Staff in the Diagnosing Group:

Beijing Tiantan Hospital, Capital Medical University (Xingquan Zhao); Tianjin Medical University General Hospital (Jinghua Wang); The Second Hospital of Hebei Medical University (Li Guo); First Hospital, Shanxi Medical University (Xiaoyuan Niu); Hospital of Inner Mongolia Medical College (Guohua Zhang); First Affiliated Hospital of China Medical University (Zhiyi He); The First Hospital, Jilin University (Jiachun Feng); The First Hospital of Harbin Medical University (Liming Zhang); Huashan Hospital, Fudan University (Ding Ding); Nanjing First Hospital, Nanjing Medical University (Yingdong

Zhang); The Second Affiliated Hospital of Zhejiang University School of Medicine (Meiping Ding); The First Affiliated Hospital of Anhui Medical University (Kai Wang); The First Affiliated Hospital of Fujian Medical University (Ning Wang); Jiangxi Provincial People's Hospital (Xiaomu Wu); Qilu Hospital of Shandong University (Shengnian Zhou); The First Affiliated Hospital of Zhengzhou University (Yuming Xu); Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (Dengji Pan); Xiangya Hospital, Central South University (Yunhai Liu); The First Affiliated Hospital, Sun Yat-Sen University (Jinsheng Zeng); The First Affiliated Hospital of Guangxi Medical University (Chao Qin); Hainan Medical University Affiliated Hospital (Shurong Wang); The First Affiliated Hospital, Chongqing Medical University (Oumei Cheng); West China Hospital, Sichuan University (Li He); Guizhou Provincial Pepole's Hospital (Xiaoyi Li); The Second Affiliated Hospital of Kunming Medical University (Yuhong Zhu); The People's Hospital of Tibet Autonomous Region (Zhi Pu); Xijing Hospital, The Fourth Military Medical University (Xuedong Liu); Lanzhou University Second Hospital (Zhenghong Shi); Qinghai Provincial People' s Hospital (Shizheng Wu); The General Hospital of Ningxia Medical University (Yanhui Du); The First Teaching Hospital of Xinjiang Medical University (Xiaoning Zhang).