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Prevalence of stroke and associated risk factors: a population-based cross-sectional study from northeast China

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Complete List of Authors:	Zhang, Fu-Liang; Stroke Center, Department of Neurology Guo, Zhen-Ni ; Neuroscience Center, Department of Neurology Wu, Yan-Hua; Division of Clinical Research Liu, Hao-Yuan; Stroke Center, Department of Neurology Luo, Yun; Stroke Center, Department of Neurology Sun, Ming-Shuo; Stroke Center, Department of Neurology Xing, Ying-Qi ; Neuroscience Center, Department of Neurology Yang, Yi
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Prevalence of stroke and associated risk factors: a population-based cross-sectional study from northeast China

Fu-Liang Zhang[1], MD; E-mail: zhangfl15@mails.jlu.edu.cn

Zhen-Ni Guo[2], MD; E-mail: zhen1ni2@163.com

Yan-Hua Wu[3], MD, PhD; E-mail: qswxwyh@163.com

Hao-Yuan Liu[1], MD; E-mail: liuhy010@163.com

Yun Luo[1], MD; E-mail: o9doctor@163.com

Ming-Shuo Sun[1], MD; E-mail: wf20050105@126.com

Ying-Qi Xing[2]*, MD, PhD; E-mail: xingyq2009@sina.com

Yi Yang[1]*, MD, PhD. E-mail: doctoryangyi@163.com

[1] Stroke Center, Department of Neurology, the First Hospital of Jilin University, Chang Chun, China.

[2] Neuroscience Center, Department of Neurology, the First Hospital of Jilin University, Chang Chun, China.

[3] Division of Clinical Research, the First Hospital of Jilin University, Changchun, China.

*Correspondence and reprint requests should be addressed to: Ying-Qi Xing, MD, PhD. Neuroscience Center, Department of Neurology, the First Hospital of Jilin University, Xinmin Street 71#, 130021, Chang Chun, China. Telephone: +86-15844047846; E-mail: xingyq2009@sina.com.

Or Yi Yang, MD, PhD. Stroke Center, Department of Neurology, the First Hospital of Jilin University, Xinmin Street 71#, 130021, Changchun, China. Telephone: +86-18186870008; Fax: 0086-431-88782378; E-mail: doctoryangyi@163.com.

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ABSTRACT

Objectives: Epidemiological studies aimed at stroke and its risk factors can help in identifying persons at higher risk, and therefore promoting stroke prevention strategies. We aimed to explore the up-to-date prevalence of stroke and its associated risk factors in northeast China.

Design: Population-based cross-sectional study.

Setting: Data were collected using a structured pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China between January and March 2016.

Participants: 4100 permanent residents 40 years or older who had lived in Dehui City of Jilin Province for more than 6 months and volunteered to participate in the study.

Main outcome measure: The questionnaire included demographic characteristics, stroke-related behavioral factors (e.g., smoking, drinking, exercise habits, and diet), personal and family medical history of stroke, physical examination, and laboratory testing.

Results: The overall prevalence of stroke in Jilin Province was 7.2% (95% CI: 6.3–8.2%). Of all stroke cases, 91.7% (95% CI 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI 5.4–12.6%) were hemorrhagic stroke. The prevalence rates of dyslipidemia, smoking, and hypertension were ranked as the top three cerebrovascular risk factors, the prevalence rates of which were 62.1%, 61.8%, and 57.3%, respectively. We found that hypertension, dyslipidemia, and lack of exercise (modifiable risk factors) were associated with ischemic stroke. However, only hypertension (OR=4.064, 95% CI 1.358–12.160) was significantly associated with hemorrhagic stroke.

Conclusions: The prevalence of stroke, especially ischemic stroke, and associated cerebrovascular risk factors among adults aged 40 years and over in northeast China were high. Higher regional prevalence of hypertension, dyslipidemia, and lack of exercise may be responsible. Health policy makers should place more emphasis on the effective prevention and control of stroke and its risk factors.

Keywords: Stroke, Risk factor, Prevalence, China

Strengths and limitations of this study

- This study was a population-based cross-sectional study, representing a large sample from northeast China: N=4052.
- Multistage stratified random cluster method was used in sampling process and complex weighted computation was used in data analysis to make the result more reliable.
- A low percentage of missing data in general.
- Limitations of the study were the properties of the cross-sectional study and the recall bias of the self-reported questionnaire.
- Another limitation was that the respondents' atrial fibrillation status was based on self-report and ordinary electrocardiogram, which may be underestimated for paroxysmal atrial fibrillation.

INTRODUCTION

The latest data from the Global Burden of Diseases Study 2013 (GBD 2013) ranked cerebrovascular disease as the second largest contributor to death and disability-adjusted life-years (DALYs) worldwide after ischemic heart disease[1 2]. In the past several decades within developed countries, greater reduction in the age-standardized stroke incidence has taken place because of good health services and effective strategies for cerebrovascular risk factor prevention; however, the converse has been shown for developing countries[3].

Despite the advent of reperfusion therapies, such as intravenous tissue-type plasminogen activator and endovascular therapy, for selected patients with acute ischemic stroke[4], there are still a proportion of patients with residual disability or cognitive deficits. Therefore, effective prevention, especially primary prevention, remains the best strategy for reducing the burden of stroke[5 6].

Within the global stroke belt, China's stroke burden mirrors the situation seen in many developing countries[7]. According to the report from World Health Organization (WHO), the incidence of stroke in China is still increasing at an annual rate of 8.7%, and has now become the leading cause of death in China[8 9]. In Jilin, a province of intermediate economic development located in the central part of northeast China, and within the China stroke belt, the stroke incidence was nearly two times more than that of other regions[10].However, the most widely cited data on stroke gathered by epidemiological investigation in Jilin Province were almost collected in the 1980s and 1990s[11-13]. The Chinese lifestyle has changed greatly, and the aging population has increased during the past few decades, which have led to changes in the prevalence of stroke and its associated risk factors. This study aims to estimate the prevalence of stroke and the pattern of its related risk factors in northeast China.

METHODS

Study design and participants

This population-based cross-sectional study was part of the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China, which was one of the National Key Technology Research and Development Programs in China (grant no.2011BAI08B01) and supervised by the Chinese National Center for Stroke Care Quality Control and Management[14].

From January to March 2016, we conducted a cross-sectional study in Dehui City, which located in the north-central part of Jilin Province. Multistage stratified random cluster sampling was used to select permanent residents 40 years or older who had lived in this area for more than 6 months. In the first stage, 30 villages and 10 towns were selected from 308 villages (rural) and 14towns (urban), respectively. In the second stage, cluster sampling was used in the selected areas. The respondents were interviewed in person using a structured pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China. The investigators had at least 5 years of education in medicine. They had been uniformly trained and passed the examination at the end of training.

Sampling size

There were 335,490 residents 40 years or older in Dehui City, according to the main data bulletin of the 6th national population census in 2010[15]. The expected sample size was 3355, which was 1% of the targeted population. Non-response rate was estimated as 20%, so the planned sample size was 4026, and 4100 residents participated in the survey. For the purpose of the present analysis, 48 subjects were excluded due to missing values, giving a total of 4052 people included in this analysis.

Data collection and measurement

All data were collected by face-to-face interviews. The questionnaire included demographic characteristics (e.g., gender, age, education level, and employment), stroke-related behavioral factors (e.g., smoking, drinking, exercise habits, and diet), personal and family medical history of stroke and chronic diseases (i.e., hypertension, diabetes mellitus, dyslipidemia, and atrial fibrillation), and physical examination and laboratory testing (e.g., height, weight, resting blood pressure, fasting blood glucose and lipid, and electrocardiogram).

Height and weight were measured according to standardized protocol and techniques, with the participants wearing no shoes. Blood pressure was measured by trained professionals using an electronic sphygmomanometer (OMRON HEM-7200), and each participant rested for at least 20 minutes before measuring. Participant was measured twice, and we took the average of the readings. A blood sample was drawn from the participant's antecubital vein for measuring fasting blood glucose (FBG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglyceride (TG), and high-density lipoprotein cholesterol (HDL-C), and the sample was uniformly measured by Changchun

Kingmed Center for Clinical Laboratory Co., Ltd. All participants underwent electrocardiograms for the detection of atrial fibrillation.

Assessment criteria

Pathological subtypes of stroke included ischemic stroke and hemorrhagic stroke. Transient ischemic attack was not included. The survey respondents with a history of stroke were asked to provide their medical records and the diagnosis according to the WHO clinical criteria for stroke[16].

The self-reporting of suffered chronic diseases (hypertension, diabetes mellitus, dyslipidemia, and atrial fibrillation) was verified by field investigation. Eight stroke-related risk factors were defined as follows: hypertension was defined as self-reported history and/or the use of antihypertensive medication in the past 2 weeks, or the average of two times resting systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg in the field survey[17]. Dyslipidemia was defined as using an antilipidemic medication or having one or more of the following in the field survey: TG ≥ 1.70 mmol/L, TC ≥ 5.18 mmol/L, HDL-C < 1.04 mmol/L, and LDL-C ≥ 3.37 mmol/L[18]. Diabetes mellitus was defined as the use of insulin and/or oral hypoglycemic medications or a self-reported history of diabetes or FBG ≥ 7.0 mmol/L in the field survey[19]. Atrial fibrillation was defined as either reported by the respondent or diagnosed by electrocardiogram result in the field survey[20]. A smoker was defined as one who reported having smoked one or more cigarettes or was passively exposed to tobacco smoke every day in general for more than 6 consecutive months[21]. A non-smoker was defined as never having smoked, and never having been passively exposed to tobacco smoke; or, had history of smoking but quit smoking for at least 6 consecutive months previous to the study. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), and overweight or obesity was defined as BMI ≥26 kg/m^2[22].Lack of exercise was defined as physical exercise < 3 times a week for < 30 min each time, and this included industrial and agricultural labor. Family history of stroke was restricted to immediate family members.

Subjects with at least three of aforementioned eight risk factors or a medical history of stroke or transient ischemic attack were classified in the high-risk stroke population. Subjects with fewer than three of these risk factors and with at least one of the three chronic diseases (i.e., hypertension, diabetes mellitus, and atrial fibrillation) were classified in the moderate-risk stroke population. Subjects with fewer than three of these risk factors but without one of the three chronic diseases (i.e., hypertension, diabetes mellitus, and atrial fibrillation) were classified in the low-risk stroke population[23].

Statistical methods

Complex weighted computation was used to make the sample more representative of the population in Dehui City of Jilin Province by post-stratification adjustment according to the following factors: age, residence, and gender groups, according to the standard population in Dehui City of Jilin Province[15]. Continuous data were presented as means± standard deviations (SD) and compared using the Student's t-test. Categorical variables were presented as proportions and compared using the Rao-Scott-χ^2 test between different subgroups. Finally, the ischemic and hemorrhagic stroke risk factors were analyzed through multivariate logistic regression (method ENTER). All statistical analyses were performed using the complex samples function of IBM SPSS 17.0 (SPSS Inc., New York, NY, USA). Statistical significance level was set at $p < 0.05$.

RESULTS

In total, 4052 participants (mean age was 54.85±9.30 years), including 1619 men and 2433 women, were involved in the analysis. Nearly half (49.0%) of the participants were from rural areas. Compared with women, men had higher SBP (142.89 vs. 139.77 mmHg), DBP (92.01 vs. 86.62 mmHg), BMI (24.83 vs. 24.23 kg/m^2), neck circumference (36.64 vs. 32.62 cm), waist circumference (88.23 vs. 83.84 cm), and hip circumference (98.87 vs. 94.44 cm) (all p <0.001). The laboratory features of the participants by gender are listed in Table 1.

Table 1 Anthropometric characteristics of the study sample stratified by gender.

Characteristics	All (n = 4052)	Male (n = 1619)	Female (n = 2433)	t	*p* value
Age (years)	54.85±9.30	55.72±9.43	54.27±9.17	4.867	<0.001
Residence					0.015
Urban, n (%)	2067(51.0)	788(48.7)	1279(52.6)		
Rural, n (%)	1985(49.0)	831(51.3)	1154(47.4)		
Education level, n (%)					0.011
Primary school and below	1446(35.7)	526(32.5)	920(37.8)		
Junior middle school	1696(41.9)	715(44.2)	981(40.3)		

Senior middle school	537(13.3)	222(13.7)	315(12.9)		
College and above	373(9.2)	156(9.6)	217(8.9)		
Blood pressure (mmHg)					
SBP	141.02±21.69	142.89±21.12	139.77±21.97	4.533	<0.001
DBP	88.78±11.81	92.01±11.96	86.62±11.20	14.414	<0.001
BMI (kg/m^2)	24.47±3.35	24.83±3.34	24.23±3.33	5.642	<0.001
Neck circumference (cm)	34.23±3.28	36.64±2.91	32.62±2.41	45.959	<0.001
Waist circumference (cm)	85.60±9.25	88.23±8.85	83.84±9.10	15.194	<0.001
Hip circumference (cm)	96.21±8.54	98.87±7.68	94.44±8.63	17.132	<0.001
TG CHOHDLLDL (mmol/L)					
TC	5.40±1.16	5.32±1.13	5.45±1.17	-3.483	0.001
TG	2.06±1.76	2.11±1.95	2.04±1.62	1.236	0.217
LDL-C	2.14±0.81	2.13±0.81	2.14±0.81	-0.637	0.524
HDL-C	1.25±0.24	1.23±0.25	1.27±0.24	-5.15	<0.001
FBG (mmol/L)	5.32±1.65	5.28±1.63	5.35±1.67	-1.392	0.164

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FBG, fasting blood-glucose.

As shown in Table 2, the overall prevalence of stroke was 7.2% (95% CI 6.3–8.2%).The prevalence of stroke increased with age (p < 0.001), but decreased with education level (p < 0.001). It was significantly higher in men than in women (8.8% vs. 5.7%, p = 0.001). However, there was no statistically significant difference between rural and urban residents. Of all stroke cases, 91.7% (95% CI 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI 5.4–12.6%) were hemorrhagic stroke.

Table 2 Prevalences of stroke and its' subtypes by demographic characteristics.

Category	Subcategory	Stroke	Stroke: Ischemic Stroke	Stroke: Hemorrhagic Stroke
		7.2(6.3–8.2)	6.7(5.9–7.7)	0.5(0.3–0.8)
Age	40–49	2.8(1.8–4.3)	2.7(1.7–4.2)	0.1(0.0–0.7)
	50–59	6.5(5.2–8.2)	5.8(4.5–7.4)	0.7(0.4–1.5)
	60–69	13.6(11.4–16.1)	12.6(10.5–15.0)	1.0(0.5–1.9)

	70–	15.9(11.8–21.1)	15.4(11.4–20.4)	0.6(0.1–3.8)
	p value	<0.001	<0.001	0.124
Gender	Male	8.8(7.3–10.4)	8.2(6.8–9.8)	0.6(0.3–1.0)
	Female	5.7(4.7–6.9)	5.2(4.3–6.4)	0.5(0.2–1.0)
	p value	0.001	0.001	0.661
Residence	Urban	6.6(5.5–7.8)	6.2(5.1–7.4)	0.4(0.2–0.8)
	Rural	7.5(6.3–8.7)	6.9(5.8–8.2)	0.5(0.3–1.0)
	p value	0.318	0.355	0.691
Education level	Primary school and below	9.5(8.0–11.3)	8.9(7.4–10.6)	0.6(0.3–1.2)
	Junior middle school	5.4(4.3–6.8)	5.0(3.9–6.3)	0.4(0.2–0.9)
	Senior middle school	4.9(3.1–7.5)	4.3(2.7–6.7)	0.6(0.4–3.0)
	College and above	4.2(2.5–6.9)	3.9(2.3–6.6)	0.3(0.0–2.0)
	p value	<0.001	<0.001	0.861

The data were presented as weighted prevalence (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

As shown in Table 3, the proportions of different types of stroke showed no significant differences by age group, gender, residence, and education level. According to the different-risk stroke levels, the participants were divided into three groups, with over half (57.3%, 95% CI 55.4–59.1%) in the high-risk stroke group. The proportions of different-risk stroke population differed significantly by age group, gender, residence, and education level.

Table 4 describes the prevalence of stroke risk factors by demographic characteristics. The prevalence rates of hypertension, diabetes mellitus, and atrial fibrillation increased with age ($p < 0.001$); however, dyslipidemia was more popular in adults aged 60 to 69 years ($p < 0.05$). The prevalence rates of other stroke risk factors differed significantly by gender, but not by residence, except for dyslipidemia, diabetes mellitus, smoking, and lack of exercise.

Table 3 Proportions of stroke subtypes and different-risk-stroke population by demographic characteristics.

Category	Subcategory	Stroke		*p* value	Different–risk–stroke population			*p* value
		Ischemic Stroke%	Hemorrhagic Stroke%		High–risk–stroke population %	Moderate–risk–stroke population %	Low–risk–stroke population %	
		91.7(87.4–94.6)	8.3(5.4–12.6)		57.3(55.4–59.1)	12.2(11.0–13.4)	30.6(28.9–32.3)	
Age	40–49	95.4(78.8–99.1)	4.6(0.9–21.2)	0.553	50.1(46.8–53.4)	9.9(8.1–11.9)	40.1(36.9–43.3)	<0.001
	50–59	88.8(78.6–94.5)	11.2(5.5–21.4)		58.1(55.1–60.9)	12.9(11.1–15.0)	29.0(26.4–31.8)	
	60–69	90.0(82.8–94.4)	10.0(5.6–17.2)		67.4(64.2–70.5)	13.3(11.2–15.7)	19.3(16.8–22.1)	
	70–	94.8(81.3–98.7)	5.2(1.3–18.7)		65.7(59.4–71.6)	17.1(12.8–22.4)	17.2(12.8–22.7)	
Gender	Male	92.3(86.8–95.6)	7.7(4.4–13.2)	0.662	59.5(56.7–62.3)	12.8(11.1–14.8)	27.6(25.1–30.3)	0.003
	Female	90.7(82.6–95.2)	9.3(4.8–17.4)		55.0(52.6–57.3)	11.5(10.1–13.1)	33.5(31.3–35.8)	
Residence	Urban	91.0(84.8–94.8)	9.0(5.2–15.2)	0.787	54.4(52.2–56.6)	14.5(13.0–16.2)	31.0(29.0–33.1)	0.008
	Rural	91.9(86.3–95.3)	8.1(4.7–13.7)		58.2(55.9–60.6)	11.4(10.0–13.0)	30.4(28.2–32.6)	
Education level	Primary school and below	91.4(85.2–95.2)	8.6(4.8–14.8)	0.952	62.4(59.5–65.1)	11.5(9.7–13.4)	26.7(24.0–29.6)	<0.001
	Junior middle school	91.7(85.9–96.4)	7.3(3.6–14.1)		52.9(50.0–55.9)	12.2(10.5–14.2)	36.6(33.5–39.8)	
	Senior middle school	89.9(54.1–98.5)	10.1(1.5–45.9)		53.8(48.9–58.7)	12.6(9.7–16.1)	34.9(30.1–40.1)	
	College and above	89.4(64.4–97.5)	10.6(2.5–35.6)		48.0(42.4–53.7)	18.0(13.9–23.0)	34.7(29.6–40.3)	

The data were presented as weighted proportion (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

Table 4 Prevalences of stroke risk factors by demographic characteristics.

Category	Subcategory	Hypertension	Dyslipidemia	Diabetes mellitus	Atrial fibrillation	Smoking	Overweight or obesity	Lack of exercise	Family history of stroke
Risk Factor		57.3(55.5–59.2)	62.1(60.3–63.9)	11.2(10.1–12.4)	0.7(0.5–1.1)	61.8(60.0–63.5)	31.0(29.3–32.8)	17.8(16.5–19.2)	33.4(31.7–35.2)
Age	40–49	47.1(43.8–50.4)	58.6(55.3–61.8)	7.7(6.1–9.7)	0(0–0)	60.9(57.7–63.9)	33.9(30.8–37.1)	14.0(12.1–16.1)	36.1(33.0–39.3)
	50–59	58.6(55.7–61.5)	64.4(61.4–67.2)	11.9(10.2–14.0)	0.7(0.4–1.5)	63.8(61.0–66.5)	30.3(27.7–33.1)	12.8(11.2–14.7)	33.0(30.3–35.8)
	60–69	68.5(65.3–71.6)	65.7(62.4–68.9)	14.6(12.4–17.2)	1.2(0.7–2.2)	62.6(59.4–65.7)	31.2(28.2–34.3)	21.9(19.3–24.7)	34.5(31.4–37.8)
	70–	74.1(68.0–79.3)	63.3(56.8–69.3)	16.7(12.3–22.1)	2.8(1.3–6.1)	57.9(51.6–64.0)	22.1(17.3–27.9)	40.1(34.0–46.6)	22.5(17.7–28.2)
	p value	<0.001	0.014	<0.001	<0.001	0.243	0.002	<0.001	<0.001
Gender	Male	60.7(57.8–63.5)	61.3(58.5–64.1)	9.8(8.3–11.6)	0.9(0.5–1.6)	70.3(67.7–72.8)	31.9(29.3–34.6)	15.7(13.8–17.7)	31.4(28.8–34.2)
	Female	53.9(51.5–56.3)	62.9(60.6–65.2)	12.6(11.0–14.3)	0.6(0.3–1.1)	53.2(50.8–55.5)	30.2(28.1–32.5)	20.0(18.2–21.9)	35.4(33.2–37.7)
	p value	<0.001	0.383	0.022	0.265	<0.001	0.356	0.002	0.028
Residence	Urban	59.2(57.0–61.4)	66.4(64.2–68.4)	9.3(8.1–10.7)	0.5(0.2–0.9)	34.7(32.5–36.9)	32.7(30.6–34.9)	29.7(27.7–31.8)	34.4(32.3–36.5)
	Rural	56.7(54.3–59.0)	60.7(58.3–63.0)	11.8(10.4–13.4)	0.8(0.5–1.4)	70.9(68.7–73.0)	30.5(28.3–32.7)	13.8(12.2–15.5)	33.1(30.9–35.4)
	p value	0.121	<0.001	0.015	0.137	<0.001	0.151	<0.001	0.425
Education	Primary school and below	60.7(57.9–63.5)	62.9(60.0–65.6)	12.7(10.9–14.7)	1.0(0.6–1.7)	72.8(70.2–75.2)	30.4(27.9–33.1)	16.6(14.6–18.8)	30.6(28.0–33.3)
	Junior middle school	54.0(51.0–56.9)	60.5(57.5–63.4)	10.1(8.4–12.0)	0.6(0.3–1.2)	56.6(53.6–59.4)	31.1(28.4–33.9)	16.3(14.4–18.4)	35.5(32.7–38.4)
	Senior middle school	53.9(48.9–58.8)	64.2(59.3–68.9)	11.1(8.4–14.6)	0.3(0.1–1.1)	44.3(39.3–49.4)	33.6(28.9–38.6)	25.5(21.5–29.9)	40.0(35.3–44.9)
	College and above	56.5(51.0–61.8)	63.9(58.5–69.0)	5.6(3.5–8.9)	0.3(0.0–2.0)	25.7(20.9–31.1)	32.6(27.4–38.3)	28.7(24.0–33.9)	33.0(28.1–38.3)
	p value	0.001	0.391	0.008	0.247	<0.001	0.681	<0.001	0.002

The data were presented as weighted prevalence (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

The multivariable logistic regression model indicated that multiple characteristics were positively associated with ischemic stroke, including age, gender, hypertension, dyslipidemia, lack of exercise, and family history of stroke. Table 5a shows that the adjusted ORs of age groups 50–59, 60–69, and ≥70years (vs. 40–49 years age group) increased significantly with age (p < 0.001), and men were more likely to have ischemic stroke than women (OR=1.935, 95% CI: 1.410–2.655). Patients with hypertension (OR=2.582, 95% CI: 1.720–3.877) or dyslipidemia (OR=1.513, 95% CI: 1.064–2.151) were more likely to have ischemic stroke. The ORs for lack of exercise and family history of ischemic stroke were 1.446 (95% CI: 1.011–2.068) and 1.941 (95% CI: 1.424–2.646), respectively. However, there was no significant difference between participants with different education level, atrial fibrillation, diabetes mellitus, smoking, and frequency of fruit consumption. In contrast, as shown in Table 5b, although the univariate analyses of risk factors showed that hemorrhagic stroke was associated with age, gender, hypertension and high level of total cholesterol, the multivariate analyses model found that only hypertension (OR=4.064, 95% CI: 1.358–12.160) was significantly associated with hemorrhagic stroke.

Table 5a Multivariate logistic analysis of the ischemic stroke risk factors among participants.

Category	Subcategory	Fully adjusted OR (95%CI)	Wald χ^2 value	p value
Age(years)	40–49	1.00 (Referent)	13.274	<0.001
	50–59	2.198(1.306–3.700)		
	60–69	4.245(2.520–7.151)		
	70–	5.252(2.873–9.600)		
Gender	Female	1.00 (Referent)	16.749	<0.001
	Male	1.935(1.410–2.655)		
Education level	College and above	1.00 (Referent)	2.339	0.072
	Senior middle school	0.876(0.406–1.890)		
	Junior middle school	1.063(0.561 –2.015)		
	Primary school and below	1.630(0.823–3.227)		
Atrial fibrillation	No	1.00 (Referent)	0.256	0.613
	Have	1.359(0.414–4.457)		
Hypertension	No	1.00 (Referent)	20.950	<0.001
	Have	2.582(1.720–3.877)		
Dyslipidemia	No	1.00 (Referent)	5.330	0.021

	Yes	1.513(1.064–2.151)		
Diabetes mellitus	No	1.00 (Referent)	2.828	0.093
	Have	1.385(0.947–2.023)		
Smoker	Not	1.00 (Referent)	2.492	0.115
	Yes	1.280(0.942–1.738)		
Lack of exercise	No	1.00 (Referent)	4.092	0.043
	Yes	1.446(1.011–2.068)		
Family history of stroke	No	1.00 (Referent)	17.639	<0.001
	Have	1.941(1.424–2.646)		
Fruit consumption	⩾5d/w	1.00 (Referent)	2.177	0.114
	3–4d/w	0.646(0.347–1.202)		
	⩽2d/w	1.707(0.832–3.503)		

Table 5b Multivariate logistic analysis of the hemorrhagic stroke risk factors among participants.

Category	Subcategory	Fully adjusted OR (95%CI)	Wald χ^2 value	*p* value
Age(years)	40–49	1.00 (Referent)	1.696	0.166
	50–59	5.417(0.869–33.768)		
	60–69	7.816(1.266–48.240)		
	70–	3.835(0.296–49.762)		
Gender	Female	1.00 (Referent)	0.819	0.365
	Male	1.597(0.579–4.406)		
Hypertension	No	1.00 (Referent)	6.290	0.012
	Have	4.064(1.358–12.160)		
High level of total cholesterol	No	1.00 (Referent)	2.674	0.102
	Yes	2.232(0.852–5.847)		

DISCUSSION

In this population-based cross-sectional study, we have identified a high prevalence of stroke, especially ischemic stroke, and cerebrovascular associated risk factors among adults aged 40 years or older in northeast China. Besides, we found that regions with higher prevalence of hypertension, dyslipidemia, and lack of exercise was associated with the high prevalence of stroke.

The prevalence of stroke in Dehui City of Jilin Province was almost three times more than the nationwide findings[24]. The prevalence of stroke increased with age, and this result was consistent with those of other studies[25]. China's rapid economic development in the past three decades has also increased life expectancies, according to the World Bank, and the proportion of elderly people in the population has increased. The effect of population aging on the prevalence of stroke has become more and more serious. Our study showed that the prevalence of stroke was significantly higher in men than in women, in accordance with past studies[13 25]. However, in challenge to a previous study[26], there was no statistically significant difference between rural and urban areas for stroke prevalence, suggesting disparities among residence was in line with rapid economic development.

Of all stroke cases in our survey, 91.7% (95% CI 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI 5.4–12.6%) were hemorrhagic stroke. The proportion of ischemic stroke was higher than those in developed countries, where ischemic stroke accounted for approximately 67.3–80.5% of all stroke cases[27]. This proportion was also markedly higher than that in three large cities in China in the 1990s[28]. Those findings were gathered from prospective register and monitoring, plus annual retrospective door-to-door investigation, which found that cerebral infarction accounted for 43.7–78.9% of the total number of stroke cases. In addition, the proportion of stroke subtypes was quite different from those in Changsha, a city in south central China, with 55.4% of all stroke cases were attributed to intracerebral hemorrhage[29]. This may reflect substantial geographic disparities and some underlying differences of dietary preferences and vascular risk factors[10 30]. However, this proportion was in accordance with the China Acute Cerebrovascular Events Register's (CACER-I) study, reporting that ischemic stroke cases were increasing, whereas intracerebral hemorrhage showed a decreasing trend[31]. The decrease in hemorrhagic stroke might be related to the improvement in hypertension control, as approximately 50% of acute hemorrhagic strokes can be attributed to hypertension in the Chinese population[8].

In the present population-based survey, we found the prevalence rates of dyslipidemia, smoking, and hypertension were ranked as the top three cerebrovascular risk factors, the prevalence rates of which were 62.1%, 61.8%, and 57.3%, respectively. We found that the prevalence of dyslipidemia was significantly higher than the national levels in a recent cross-sectional study[32].Further, the prevalence of hypertension in our study was also much higher than the nationwide average[33]and what was found in some other regional studies[34 35], but close to the recent study in the Sichuan Tibetan population[36]. The high prevalence of dyslipidemia and hypertension might be ascribed to the dietary preferences and other lifestyles of residents in Jilin Province. The cold weather limits people's outdoor physical activity during the long winter, consequently increasing the risk of overweight or obesity and related metabolic abnormalities. The present study also showed that the prevalence of smoking or being passively exposed to tobacco smoke, especially in rural areas, was higher than the rates from the China Global Adults Tobacco Survey in 2010[37]. This may be partly attributable to the fact that residents in Dehui City, in general, are undereducated (77.5% of residents had junior middle school and below education level, as shown in Table 1) and lack perceptions of smoking hazards.

Estimates from the GBD 2013 suggested that approximately 94% of the Chinese burden of stroke is attributable to the combined effects of modifiable risk factors, and that most stroke is attributable to behavioral factors (i.e., smoking, poor diet, and low physical activity) and metabolic factors (i.e., high SBP, high BMI, high FPG, high TC)[38], and these results were consistent with those of the INTERSTROKE study[39], in which roughly 86% of strokes could be attributed to nine potentially modifiable metabolic and behavioral risk factors. Thus, it is of vital importance to promptly identify these modifiable metabolic and behavioral risk factors among the residents to lessen the burden of stroke. In the present study, it was shown that hypertension, dyslipidemia (metabolic risk factors), and lack of exercise (behavioral risk factor) were associated with the ischemic stroke ($p < 0.05$)independently, which was consistent with several previous studies[40-44].In addition, age, gender and family history of stroke were also risk factors for ischemic stroke, which has been widely acknowledged nowadays[45 46]. However, only hypertension (OR/95% CI: 4.064/1.358–12.160) was significantly associated with hemorrhagic stroke in our survey when using the multivariate logistic regression model. That hypertension is an independent risk factor in the Chinese population has also been revealed in the Sino-MONICA-Beijing Project observational study[8].

As far as we know, this was the most recent investigation of stroke and associated risk factors in this region, and it filled the information gap in this field. This cross-sectional study involved a large representative sample of the Dehui City population. Strict training was done before the investigation, and we used a unified pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China[14]. The data analysis was performed using complex weighted computation. For all the aforementioned reasons, our survey probably provided accurate data on the prevalence of stroke and related risk factors in this region. Some limitations of this study should be noted. Limitations of the study were the properties of the cross-sectional study and the recall bias of the self-reported questionnaire. Another limitation was that the respondents' atrial fibrillation status was based on self-report and ordinary electrocardiogram, which may be underestimated for paroxysmal atrial fibrillation[47].

CONCLUSIONS

In conclusion, we have identified a high prevalence of stroke, especially ischemic stroke, and associated risk factors among adults aged 40 years and older in northeast China. A higher regional prevalence of hypertension, dyslipidemia, and lack of exercise (modifiable risk factors) may be responsible, and these factors are appropriate targets for population-based stroke prevention. Health policy makers should place more emphasis on the effective prevention and control of stroke and its risk factors.

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Authors' contributions

Conception and design: Ying-Qi Xing, Yi Yang. Acquisition of data: Fu-Liang Zhang, Hao-Yuan Liu, Yun Luo, Ming-Shuo Sun. Analysis: Fu-Liang Zhang, Yan-Hua Wu. Drafting the manuscript: Fu-Liang Zhang. Critical revision: Zhen-Ni Guo, Yan-Hua Wu, Yi Yang. All authors approved the final version to be published.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

Data sharing statement

No additional data are available.

Ethics approval and consent to participate

The study design was approved by the Human Ethics and Research Ethics committees of the First Hospital of Jilin University (Approval Number: 2015-R-250). Written informed consent was obtained from the participants in the survey.

References

1. Murray CJ, Barber RM, Foreman KJ, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990-2013: quantifying the epidemiological transition. Lancet (London, England) 2015;**386**(10009):2145-91 doi: 10.1016/s0140-6736(15)61340-x[published Online First: Epub Date]|.

2. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England) 2015;**385**(9963):117-71 doi: 10.1016/s0140-6736(14)61682-2[published Online First: Epub Date]|.

3. Feigin VL, Forouzanfar MH, Krishnamurthi R, et al. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2014;**383**(9913):245-54

4. Powers WJ, Derdeyn CP, Biller J, et al. 2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke; a journal of cerebral circulation 2015;**46**(10):3020-35 doi: 10.1161/str.0000000000000074[published Online First: Epub Date]|.

5. Sacco RL, Benjamin EJ, Broderick JP, et al. American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Risk factors. Stroke; a journal of cerebral circulation 1997;**28**(7):1507-17

6. Hankey GJ. Ischaemic stroke--prevention is better than cure. The journal of the Royal College of Physicians of Edinburgh 2010;**40**(1):56-63 doi: 10.4997/jrcpe.2010.111[published Online First: Epub Date]|.

7. Kim AS, Cahill E, Cheng NT. Global Stroke Belt: Geographic Variation in Stroke Burden Worldwide. Stroke 2015;**46**(12):3564-70 doi: 10.1161/strokeaha.115.008226[published Online First: Epub Date]|.

8. Zhao D, Liu J, Wang W, et al. Epidemiological transition of stroke in China: twenty-one-year observational study from the Sino-MONICA-Beijing Project. Stroke; a journal of cerebral circulation 2008;**39**(6):1668-74 doi: 10.1161/strokeaha.107.502807[published Online First: Epub Date]|.

9. Z C. *The Third Nationwide Survey on Causes of Death*: Beijing: The Peking Union Medical College Press, 2008.

10. Xu G, Ma M, Liu X, Hankey GJ. Is there a stroke belt in China and why? Stroke; a journal of cerebral circulation 2013;**44**(7):1775-83 doi: 10.1161/strokeaha.113.001238[published Online First: Epub Date]|.

11. Li ZS YQ, Chen SM, Shu Q, Fu YG. Epidemiological survey of cerebrovascular disease in rural areas of China. Zhong-Hua Shen-Jing Wai-ke Za-Zhi 1989;**5**:7-11

12. Wu GX, Wu ZS, He BL. Epidemiological characteristics of stroke in 16 provinces of China. Zhonghua yi xue za zhi 1994;**74**(5):281-3, 325

13. Cheng XM, Ziegler DK, Lai YH, et al. Stroke in China, 1986 through 1990. Stroke; a journal of cerebral circulation 1995;**26**(11):1990-4

14. Sun H, Zou X, Liu L. Epidemiological factors of stroke: a survey of the current status in china. Journal of stroke 2013;**15**(2):109-14 doi: 10.5853/jos.2013.15.2.109[published Online First: Epub Date]|.
15. Officefor the Sixth Population Census of Jilin Province JPBoS. *Tabulationon the 2010 Population Census of Jilin Province*: Beijing,China: China Statistics Press, 2013.
16. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. Bulletin of the World Health Organization 1980;**58**(1):113-30
17. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). Jama 2014;**311**(5):507-20 doi: 10.1001/jama.2013.284427[published Online First: Epub Date]|.
18. Chinese guidelines on prevention and treatment of dyslipidemia in adults. Zhonghua xin xue guan bing za zhi 2007;**35**(5):390-419
19. Diagnosis and classification of diabetes mellitus. Diabetes care 2013;**36 Suppl 1**:S67-74 doi: 10.2337/dc13-S067[published Online First: Epub Date]|.
20. Fuster V, Ryden LE, Cannom DS, et al. ACC/AHA/ESC 2006 guidelines for the management of patients with atrial fibrillation: full text: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Revise the 2001 guidelines for the management of patients with atrial fibrillation) developed in collaboration with the European Heart Rhythm Association and the Heart Rhythm Society. Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology 2006;**8**(9):651-745 doi: 10.1093/europace/eul097[published Online First: Epub Date]|.
21. Yang G, Wang Y, Wu Y, Yang J, Wan X. The road to effective tobacco control in China. Lancet 2015;**385**(9972):1019-28 doi: 10.1016/s0140-6736(15)60174-x[published Online First: Epub Date]|.
22. Rao W, Su Y, Yang G, et al. Cross-Sectional Associations between Body Mass Index and Hyperlipidemia among Adults in Northeastern China. International journal of environmental research and public health 2016;**13**(5) doi: 10.3390/ijerph13050516[published Online First: Epub Date]|.
23. Mi T, Sun S, Zhang G, et al. Relationship between dyslipidemia and carotid plaques in a high-stroke-risk population in Shandong Province, China. Brain and behavior 2016;**6**(6):e00473 doi: 10.1002/brb3.473[published Online First: Epub Date]|.
24. Jinlei Li LW, Baohua Chao, Yuanli Liu. Prevalence of stroke in China: an epidemiological study based on the National Stroke Screening Survey Lancet 2015:49
25. Li SC, Schoenberg BS, Wang CC, Cheng XM, Bolis CL, Wang KJ. Cerebrovascular disease in the People's Republic of China: epidemiologic and clinical features. Neurology 1985;**35**(12):1708-13
26. Xue GB, Yu BX, Wang XZ, Wang GQ, Wang ZY. Stroke in urban and rural areas of China. Chinese medical journal 1991;**104**(8):697-704

27. Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. The Lancet. Neurology 2003;**2**(1):43-53
28. Jiang B, Wang WZ, Chen H, et al. Incidence and trends of stroke and its subtypes in China: results from three large cities. Stroke; a journal of cerebral circulation 2006;**37**(1):63-8 doi: 10.1161/01.str.0000194955.34820.78[published Online First: Epub Date]|.
29. Yang QD, Niu Q, Zhou YH, et al. Incidence of cerebral hemorrhage in the Changsha community. A prospective study from 1986 to 2000. Cerebrovascular diseases (Basel, Switzerland) 2004;**17**(4):303-13 doi: 10.1159/000077341[published Online First: Epub Date]|.
30. He J, Klag MJ, Wu Z, Whelton PK. Stroke in the People's Republic of China. I. Geographic variations in incidence and risk factors. Stroke; a journal of cerebral circulation 1995;**26**(12):2222-7
31. Wu L, Wang A, Wang X, et al. Factors for short-term outcomes in patients with a minor stroke: results from China National Stroke Registry. BMC neurology 2015;**15**:253 doi: 10.1186/s12883-015-0505-z[published Online First: Epub Date]|.
32. Pan L, Yang Z, Wu Y, et al. The prevalence, awareness, treatment and control of dyslipidemia among adults in China. Atherosclerosis 2016;**248**:2-9 doi: 10.1016/j.atherosclerosis.2016.02.006[published Online First: Epub Date]|.
33. Bundy JD, He J. Hypertension and Related Cardiovascular Disease Burden in China. Annals of global health 2016;**82**(2):227-33 doi: 10.1016/j.aogh.2016.02.002[published Online First: Epub Date]|.
34. Wang Y, Zhang J, Ding Y, et al. Prevalence of Hypertension among Adults in Remote Rural Areas of Xinjiang, China. International journal of environmental research and public health 2016;**13**(6) doi: 10.3390/ijerph13060524[published Online First: Epub Date]|.
35. Hu M, Wan Y, Yu L, et al. Prevalence, awareness, treatment, and control of hypertension and associated risk factors among adults in Xi'an, China: A cross-sectional study. Medicine 2016;**95**(34):e4709 doi: 10.1097/md.0000000000004709[published Online First: Epub Date]|.
36. Huang X, Zhou Z, Liu J, et al. Prevalence, awareness, treatment, and control of hypertension among China's Sichuan Tibetan population: A cross-sectional study. Clinical and experimental hypertension (New York, N.Y. : 1993) 2016;**38**(5):457-63 doi: 10.3109/10641963.2016.1163369[published Online First: Epub Date]|.
37. Yang GH. Global Adult Tobacco Survey (GATS) China 2010 Country Report, 2011.
38. Feigin VL, Roth GA, Naghavi M, et al. 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**(9):913-24 doi: 10.1016/s1474-4422(16)30073-4[published Online First: Epub Date]|.
39. O'Donnell MJ, Xavier D, Liu L, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. Lancet 2010;**376**(9735):112-23 doi: 10.1016/s0140-6736(10)60834-3[published Online First: Epub Date]|.
40. He J, Klag MJ, Wu Z, Whelton PK. Stroke in the People's Republic of China. II. Meta-analysis of hypertension and risk of stroke. Stroke; a journal of cerebral circulation 1995;**26**(12):2228-32
41. Ebrahim S, Sung J, Song YM, Ferrer RL, Lawlor DA, Davey Smith G. Serum cholesterol, haemorrhagic stroke, ischaemic stroke, and myocardial infarction: Korean national health

system prospective cohort study. BMJ (Clinical research ed.) 2006;**333**(7557):22 doi: 10.1136/bmj.38855.610324.80[published Online First: Epub Date]|.

42. Tanne D, Yaari S, Goldbourt U. High-density lipoprotein cholesterol and risk of ischemic stroke mortality. A 21-year follow-up of 8586 men from the Israeli Ischemic Heart Disease Study. Stroke; a journal of cerebral circulation 1997;**28**(1):83-7
43. Soyama Y, Miura K, Morikawa Y, et al. High-density lipoprotein cholesterol and risk of stroke in Japanese men and women: the Oyabe Study. Stroke; a journal of cerebral circulation 2003;**34**(4):863-8 doi: 10.1161/01.str.0000060869.34009.38[published Online First: Epub Date]|.
44. Alevizos A, Lentzas J, Kokkoris S, Mariolis A, Korantzopoulos P. Physical activity and stroke risk. International journal of clinical practice 2005;**59**(8):922-30 doi: 10.1111/j.1742-1241.2005.00536.x[published Online First: Epub Date]|.
45. Sacco RL. Risk factors and outcomes for ischemic stroke. Neurology 1995;**45**(2 Suppl 1):S10-4
46. Knottnerus IL, Gielen M, Lodder J, et al. Family history of stroke is an independent risk factor for lacunar stroke subtype with asymptomatic lacunar infarcts at younger ages. Stroke; a journal of cerebral circulation 2011;**42**(5):1196-200 doi: 10.1161/strokeaha.110.602383[published Online First: Epub Date]|.
47. Koga M, Yoshimura S, Hasegawa Y, et al. Higher Risk of Ischemic Events in Secondary Prevention for Patients With Persistent Than Those With Paroxysmal Atrial Fibrillation. Stroke; a journal of cerebral circulation 2016 doi: 10.1161/strokeaha.116.013746[published Online First: Epub Date]|.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			**4**
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			**4-7**
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	7
Results			7-13

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	7-8
Outcome data	15*	Report numbers of outcome events or summary measures	Not applicable
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-13
		(*b*) Report category boundaries when continuous variables were categorized	8-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-11
Discussion			13-16
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			17
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence of stroke and associated risk factors: a population-based cross-sectional study from northeast China

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Prevalence of stroke and associated risk factors: a population-based cross-sectional study from northeast China

Fu-Liang Zhang[1], MD; E-mail: zhangfl15@mails.jlu.edu.cn

Zhen-Ni Guo[2], MD; E-mail: zhen1ni2@163.com

Yan-Hua Wu[3], MD, PhD; E-mail: qswxwyh@163.com

Hao-Yuan Liu[1], MD; E-mail: liuhy010@163.com

Yun Luo[1], MD; E-mail: o9doctor@163.com

Ming-Shuo Sun[1], MD; E-mail: wf20050105@126.com

Ying-Qi Xing[2]*, MD, PhD; E-mail: xingyq2009@sina.com

Yi Yang[1]*, MD, PhD. E-mail: doctoryangyi@163.com

[1] Stroke Center, Department of Neurology, the First Hospital of Jilin University, Chang Chun, China.

[2] Neuroscience Center, Department of Neurology, the First Hospital of Jilin University, Chang Chun, China.

[3] Division of Clinical Research, the First Hospital of Jilin University, Changchun, China.

*Correspondence and reprint requests should be addressed to: Ying-Qi Xing, MD, PhD. Neuroscience Center, Department of Neurology, the First Hospital of Jilin University, Xinmin Street 71#, 130021, Chang Chun, China. Telephone: +86-15844047846; E-mail: xingyq2009@sina.com.

Or Yi Yang, MD, PhD. Stroke Center, Department of Neurology, the First Hospital of Jilin University, Xinmin Street 71#, 130021, Changchun, China. Telephone: +86-18186870008; Fax: 0086-431-88782378; E-mail: doctoryangyi@163.com.

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ABSTRACT

Objectives: Epidemiological studies aimed at stroke and its risk factors can help in identifying persons at higher risk, and therefore promoting stroke prevention strategies. We aimed to explore the up-to-date prevalence of stroke and its associated risk factors in northeast China.

Design: Population-based cross-sectional study.

Setting: Data were collected using a structured pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China between January and March 2016.

Participants: 4100 permanent residents 40 years or older who had lived in Dehui City of Jilin Province for more than 6 months volunteered to participate in the survey, with an excellent response rate being 92.2%. For the purpose of the present analysis, 48 subjects were excluded due to missing values, giving a total of 4052 people included in this analysis.

Main outcome measure: The questionnaire included demographic characteristics, stroke-related behavioral factors, personal and family medical history of stroke, physical examination, and laboratory testing.

Results: The overall prevalence of stroke in Jilin Province was 7.2% (95% CI: 6.3–8.2%). Of all stroke cases, 91.7% (95% CI: 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI: 5.4–12.6%) were hemorrhagic stroke. The prevalence rates of dyslipidemia, smoking, and hypertension were ranked as the top three cerebrovascular risk factors, the prevalence rates of which were 62.1%, 61.8%, and 57.3%, respectively. We found that hypertension, dyslipidemia, and lack of exercise were associated with ischemic stroke. However, only hypertension (OR = 4.064, 95% CI: 1.358–12.160) was significantly associated with hemorrhagic stroke.

Conclusions: The prevalence of stroke, especially ischemic stroke, and associated cerebrovascular risk factors among adults aged 40 years or older in northeast China were high. Higher regional prevalence of hypertension, dyslipidemia, and lack of exercise may be responsible.

Keywords: Stroke, Risk factor, Prevalence, China

Strengths and limitations of this study

- This study was a population-based cross-sectional study, representing a large sample from northeast China: N=4052.
- Multistage stratified random cluster method was used in sampling process and complex weighted computation was used in data analysis to make the result more reliable.
- An excellent response rate and a low percentage of missing data in general.
- Limitations of the study were the properties of the cross-sectional study and the recall bias of the self-reported questionnaire.
- Another limitation was that the respondents' atrial fibrillation status was based on self-report and ordinary electrocardiogram, which may be underestimated for paroxysmal atrial fibrillation.

INTRODUCTION

The latest data from the Global Burden of Diseases Study 2013 (GBD 2013) ranked cerebrovascular disease as the second largest contributor to death and disability-adjusted life-years (DALYs) worldwide after ischemic heart disease[1 2]. In the past several decades within developed countries, greater reduction in the age-standardized stroke incidence has taken place because of good health services and effective strategies for cerebrovascular risk factor prevention; however, the converse has been shown for developing countries[3].

Despite the advent of reperfusion therapies, such as intravenous tissue-type plasminogen activator and endovascular therapy, for selected patients with acute ischemic stroke[4], there are still a proportion of patients with residual disability or cognitive deficits. Therefore, effective prevention, especially primary prevention, remains the best strategy for reducing the burden of stroke[5 6].

Within the global stroke belt, China's stroke burden mirrors the situation seen in many developing countries[7]. According to the report from World Health Organization (WHO), the incidence of stroke in China is still increasing at an annual rate of 8.7%, and has now become the leading cause of death in China[8 9]. In Jilin, a province of intermediate economic development located in the central part of northeast China, and within the China stroke belt, the stroke incidence was nearly two times more than that of other regions[10]. However, the most widely cited data on stroke gathered by epidemiological investigation in Jilin Province were almost collected in the 1980s and 1990s[11-13]. The Chinese lifestyle has changed greatly, and the aging population has increased during the past few decades, which have led to changes in the prevalence of stroke and its associated risk factors. This study aims to estimate the prevalence of stroke and the pattern of its related risk factors in northeast China.

METHODS

Study design and participants

This population-based cross-sectional study was part of the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China, which was one of the National Key Technology Research and Development Programs in China (grant no.2011BAI08B01) and supervised by the Chinese National Center for Stroke Care Quality Control and Management[14 15]. The main aim of the survey was to (1) obtain the updated and reliable data for the incidence, prevalence, and mortality of stroke in different regions of China; (2) access relevant data on stroke, including risk factors, treatment, and secondary prevention. Stroke is usually thought of as a disease of the elderly, and the cumulative effects of aging on the cardiovascular system and the progressive nature of stroke risk factors over a prolonged period substantially increase the risks of both ischemic stroke and intracerebral hemorrhage. Considering that the stroke incidence and prevalence rates showed a steep increase after the age of 39 years[16], the Stroke Screening and Prevention Project Committee, National Health and Family Planning Commission of China targeted residents aged 40 years or older as the screening population[15].

From January to March 2016, we conducted a cross-sectional study in Dehui City, which located in the north-central part of Jilin Province. The rationale for this period of time was that our team spent three months for this cross-sectional survey. On the other hand, the stroke prevalence rate in our survey referred to the lifetime prevalence by the end of 2015, and new-onset stroke cases during this three months of survey were not counted to avoid the influence of seasonal factor to the stroke prevalence. Finally, the reason for this period of January to March was to increase response rate and reduce sample selection bias, in order to make the study sample best representative of the adults aged 40 years or older in this area because many migrant workers living in this area would return home during this period of time for Spring Festival with their families. Multistage stratified random cluster sampling was used to select permanent residents 40 years or older who had lived in this area for more than 6 months. In the first stage, 30 villages and 10 towns were selected from 308 villages (rural) and 14 towns (urban), respectively. In the second stage, cluster sampling was used in the selected areas. The respondents were interviewed in person using a structured pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China. The investigators had at least 5 years of education in medicine. They had been uniformly trained and passed the examination at the end of training.

Sampling size

Considering the requirement of the Stroke Screening and Prevention Project Committee of National Health and Family Planning Commission of China, the screening should at least cover 1% of the local residents aged 40 years or older. There were 335,490 residents 40 years or older in Dehui City of Jilin Province, according to the main data bulletin of the 6th national population census in 2010[15], therefore, the expected sample size was 3355, which was 1% of the targeted population. Meanwhile, the sample size (N) necessary for this cross-sectional study was calculated based on an 2.37%

prevalence (p) of stroke among adults 40 years or older in China[17] with a 0.5% uncertainty level (d), using the formula $N = t\alpha^2 pq/d^2$ (where t = 1.96, α as 95% for both sides; q = 1-p). Using this equation, we estimated a required sample size of 3556 subjects. In consideration of the estimated follow-ups lost rate during the field investigation was as 20%, the planned sample size was 4445 (3556/0.80). Finally, 4100 permanent residents 40 years or older who had lived in Dehui City of Jilin Province for more than 6 months volunteered to participate in the survey, with an excellent response rate being 92.2% (4100/4445). For the purpose of the present analysis, 48 subjects were excluded due to missing values, giving a total of 4052 people included in this analysis.

Data collection and measurement

All data were collected by face-to-face interviews. The questionnaire included demographic characteristics (e.g., gender, age, education level, and employment), stroke-related behavioral factors (e.g., smoking, drinking, exercise habits, and diet), personal and family medical history of stroke and chronic diseases (i.e., hypertension, diabetes mellitus, dyslipidemia, and atrial fibrillation), and physical examination and laboratory testing (e.g., height, weight, resting blood pressure, fasting blood glucose and lipid, and electrocardiogram).

Height and weight were measured according to standardized protocol and techniques, with the participants wearing no shoes. Blood pressure was measured by trained professionals using an electronic sphygmomanometer (OMRON HEM-7200), and each participant rested for at least 20 minutes before measuring. Participant was measured twice, and we took the average of the readings. Blood sample were drawn from the participants' antecubital vein for measuring fasting blood glucose (FBG), triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). The blood samples were collected from the subjects in the morning after an overnight fast (at least 8 hours), and transported to the same laboratory (Changchun Kingmed Center for Clinical Laboratory Co., Ltd.) under refrigeration, and then stored at -20℃. The laboratory finished the blood examinations within 8 hours after receiving the samples and provided daily quality control charts. All data were double entered and validated. In addition, all participants underwent electrocardiograms for the detection of atrial fibrillation.

Assessment criteria

"Stroke" is defined by the World Health Organization as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 h or longer or leading to death, with no apparent cause other than of vascular origin." Pathological subtypes of stroke included ischemic stroke and hemorrhagic stroke[18]. By definition, silent stroke and transient ischemic attack were not included. The survey respondents with a history of stroke were asked to provide investigators with their paper-based medical records (inpatient or outpatient records), which contained the patient history, physical examination, and neurological imaging information, at least one computerized tomography (CT) scan when stroke onset, which can timely and accurately identify hemorrhagic stroke from ischemic stroke.

The self-reporting of suffered chronic diseases (hypertension, diabetes mellitus, dyslipidemia, and atrial fibrillation) was verified by field investigation. Eight stroke-related risk factors were defined as follows: hypertension was defined as self-reported history and/or the use of antihypertensive medication in the past 2 weeks, or the average of two times resting systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg in the field survey[19]. Dyslipidemia was defined as using an antilipidemic medication or having one or more of the following in the field survey: TG ≥ 1.70 mmol/L, TC ≥ 5.18 mmol/L, HDL-C < 1.04 mmol/L, and LDL-C ≥ 3.37 mmol/L[20]. Diabetes mellitus was defined as the use of insulin and/or oral hypoglycemic medications or a self-reported history of diabetes or FBG ≥ 7.0 mmol/L in the field survey[21]. Atrial fibrillation was defined as either reported by the respondent or diagnosed by electrocardiogram result in the field survey[22]. A smoker was defined as one who reported having smoked one or more cigarettes or was passively exposed to tobacco smoke every day in general for more than 6 consecutive months. A non-smoker was defined as never having smoked, and never having been passively exposed to tobacco smoke; or, had history of smoking but quit smoking for at least 6 consecutive months previous to the study[15]. Drinking status were divided into three categories according to the participants' self-report in the previous 6 months: non-drinkers, light/moderate drinkers, or heavier drinkers according to the National Institute on Alcohol Abuse and Alcoholism (NIAAA) guidelines, advising limits of no more than three drinks per day or seven drinks per week for men and women. These limits are based on a standard drink in the US, i.e. any drink containing 14 grams of pure alcohol. Using the NIAAA as a guideline, the following thresholds were applied: heavier drinkers: in excess of NIAAA limits, light/moderate drinkers: less than or up NIAAA limits[23]. In addition, we grouped fruit consumption into three categories for our study: less than or equal to two days per week (≤ 2 d/w), three to four days per week (3–4 d/w), and great than or equal to five days per week (≥ 5 d/w). And the weight of consumed fruits should reach or exceed one serving per day, with the definition of a serving was calculated as 80 g for fruit[24]. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), and overweight or obesity was defined as BMI ≥ 26 kg/m^2[25]. Lack of exercise was defined as physical exercise < 3 times a week for < 30 min each time, and this included industrial and agricultural labor. Family history of stroke was restricted to immediate family members.

Subjects with at least three of aforementioned eight risk factors or a medical history of stroke were classified in the high-risk stroke population. Subjects with fewer than three of these risk factors and with at least one of the three chronic diseases (i.e., hypertension, diabetes mellitus, and atrial fibrillation) were classified in the moderate-risk stroke population. Subjects with fewer than three of these risk factors but without one of the three chronic diseases (i.e., hypertension, diabetes mellitus, and atrial fibrillation) were classified in the low-risk stroke population[15 26]. The risk assessment scales of stroke referred were put forward by the Stroke Screening and Prevention Project Committee, National Health and Family Planning Commission of China[15]，and have been proved to have a good reliability and validity compared with modified scale of Framingham Stroke Profile (FSP), and can be used as an evaluation tool for Chinese people stroke risk assessment[27].

Statistical methods

Taking into account the study's complex sampling design, the study data were weighted by gender (male or female), age groups (40–49 years, 50–59 years, 60–69 years, 70– years), and place of residence (rural or urban area) according to the census data from Jilin Provincial Bureau of Statistics, to ensure that the study sample was best representative of adult population (40– years of age) in Dehui City of Jilin Province. The study sample was subdivided into 16 subgroups according to the above stratification factors. The formula for calculating the weighted value of each subgroup was as follows:

$$\omega_i = \frac{(\sum n_i) C_i}{n_i}$$

(Where ω_i = the weighted value of each subgroup; C_i = the constituent ratio of each subgroup in the overall; n_i = the actual sample size of each group; $\sum n_i$ = the actual total sample size). Complex samples function of IBM SPSS 17.0 (SPSS Inc., New York, NY, USA) was used for analysis. Continuous data were presented as means ± standard deviations (SD) and compared using the Student's t-test. Categorical variables were presented as proportions and compared using the Rao-Scott-χ^2 test between different subgroups. Estimates of prevalence rate, constituent ratio and their 95% confidence intervals (CIs) for stroke and risk factors were generated by a range of characteristics, such as age group, gender, place of residence, and level of education. Variables that were statistically significant at $p < 0.1$ in the univariate analysis were entered into multivariate logistic regression analyses (cslogistic command in SPSS), to examine the variables independently associated with ischemic and hemorrhagic stroke.

RESULTS

In total, 4052 participants (mean age was 54.85±9.30 years), including 1619 men and 2433 women, were involved in the analysis. Nearly half (49.0%) of the participants were from rural areas. Compared with women, men had higher SBP (142.89 vs. 139.77 mmHg), DBP (92.01 vs. 86.62 mmHg), BMI (24.83 vs. 24.23 kg/m^2), neck circumference (36.64 vs. 32.62 cm), waist circumference (88.23 vs. 83.84 cm), and hip circumference (98.87 vs. 94.44 cm) (all p <0.001). The laboratory features of the participants by gender are listed in Table 1.

Table 1 Anthropometric characteristics of the study sample stratified by gender.

Characteristics	All (n = 4052)	Male (n = 1619)	Female (n = 2433)	t	*p* value
Age (years)	54.85±9.30	55.72±9.43	54.27±9.17	4.867	<0.001
Residence					0.015
Urban, n (%)	2067(51.0)	788(48.7)	1279(52.6)		
Rural, n (%)	1985(49.0)	831(51.3)	1154(47.4)		
Education level, n (%)					0.011
Primary school and below	1446(35.7)	526(32.5)	920(37.8)		
Junior middle school	1696(41.9)	715(44.2)	981(40.3)		
Senior middle school	537(13.3)	222(13.7)	315(12.9)		
College and above	373(9.2)	156(9.6)	217(8.9)		
Blood pressure (mmHg)					
SBP	141.02±21.69	142.89±21.12	139.77±21.97	4.533	<0.001
DBP	88.78±11.81	92.01±11.96	86.62±11.20	14.414	<0.001
BMI (kg/m^2)	24.47±3.35	24.83±3.34	24.23±3.33	5.642	<0.001
Neck circumference (cm)	34.23±3.28	36.64±2.91	32.62±2.41	45.959	<0.001
Waist circumference (cm)	85.60±9.25	88.23±8.85	83.84±9.10	15.194	<0.001
Hip circumference (cm)	96.21±8.54	98.87±7.68	94.44±8.63	17.132	<0.001
TG CHOHDLLDL (mmol/L)					

TC	5.40±1.16	5.32±1.13	5.45±1.17	-3.483	0.001
TG	2.06±1.76	2.11±1.95	2.04±1.62	1.236	0.217
LDL-C	2.14±0.81	2.13±0.81	2.14±0.81	-0.637	0.524
HDL-C	1.25±0.24	1.23±0.25	1.27±0.24	-5.15	<0.001
FBG (mmol/L)	5.32±1.65	5.28±1.63	5.35±1.67	-1.392	0.164

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FBG, fasting blood-glucose.

As shown in Table 2, the overall prevalence of stroke was 7.2% (95% CI: 6.3–8.2%). The prevalence of stroke increased with age ($p < 0.001$), but decreased with education level ($p < 0.001$). It was significantly higher in men than in women (8.8% vs. 5.7%, $p = 0.001$). However, there was no statistically significant difference between rural and urban residents. Similar to the case of overall prevalence of stroke, the prevalence of ischemic stroke also increased with age ($p < 0.001$), but decreased with education level ($p < 0.001$). In addition, the ischemic stroke prevalence rate was higher among men than among women (8.2% vs. 5.2%, $p = 0.001$), however, no statistical significance was found between individuals in rural and urban areas.

Table 2 Prevalences of stroke and its' subtypes by demographic characteristics.

Category	Subcategory	Stroke	Stroke	
			Ischemic Stroke	Hemorrhagic Stroke
		7.2(6.3–8.2)	6.7(5.9–7.7)	0.5(0.3–0.8)
Age	40–49	2.8(1.8–4.3)	2.7(1.7–4.2)	0.1(0.0–0.7)
	50–59	6.5(5.2–8.2)	5.8(4.5–7.4)	0.7(0.4–1.5)
	60–69	13.6(11.4–16.1)	12.6(10.5–15.0)	1.0(0.5–1.9)
	70–	15.9(11.8–21.1)	15.4(11.4–20.4)	0.6(0.1–3.8)
	p value	<0.001	<0.001	0.124
Gender	Male	8.8(7.3–10.4)	8.2(6.8–9.8)	0.6(0.3–1.0)
	Female	5.7(4.7–6.9)	5.2(4.3–6.4)	0.5(0.2–1.0)
	p value	0.001	0.001	0.661
Residence	Urban	6.6(5.5–7.8)	6.2(5.1–7.4)	0.4(0.2–0.8)
	Rural	7.5(6.3–8.7)	6.9(5.8–8.2)	0.5(0.3–1.0)
	p value	0.318	0.355	0.691

Education level	Primary school and below	9.5(8.0–11.3)	8.9(7.4–10.6)	0.6(0.3–1.2)
	Junior middle school	5.4(4.3–6.8)	5.0(3.9–6.3)	0.4(0.2–0.9)
	Senior middle school	4.9(3.1–7.5)	4.3(2.7–6.7)	0.6(0.4–3.0)
	College and above	4.2(2.5–6.9)	3.9(2.3–6.6)	0.3(0.0–2.0)
	p value	<0.001	<0.001	0.861

The data were presented as weighted prevalence (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

As shown in Table 3, of all stroke cases, 91.7% (95% CI: 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI: 5.4–12.6%) were hemorrhagic stroke. In addition, the proportions of different types of stroke showed no significant differences by age group, gender, residence, and education level. According to the different-risk stroke levels, the participants were divided into three groups, with over half (57.3%, 95% CI: 55.4–59.1%) in the high-risk stroke group. The proportions of different-risk stroke population differed significantly by age group, gender, residence, and education level.

Table 4 describes the prevalence of stroke risk factors by demographic characteristics. The prevalence rates of hypertension, diabetes mellitus, and atrial fibrillation increased with age ($p < 0.001$); however, dyslipidemia was more popular in adults aged 60 to 69 years ($p < 0.05$). The prevalence rates of other stroke risk factors differed significantly by gender, but not by residence, except for dyslipidemia, diabetes mellitus, smoking, and lack of exercise. In addition, compared with the non-stroke group, we found that subjects with history of stroke had higher prevalence of hypertension, dyslipidemia, diabetes mellitus, smoking, lack of exercise, and family history of stroke ($p < 0.001$, except $p < 0.05$ for diabetes mellitus and smoking).

Table 3 Proportions of stroke subtypes and different-risk-stroke population by demographic characteristics.

Category	Subcategory	Stroke		*p* value	Different–risk–stroke population			*p* value
		Ischemic Stroke%	Hemorrhagic Stroke%		High–risk–stroke population %	Moderate–risk–stroke population %	Low–risk–stroke population %	
		91.7(87.4–94.6)	8.3(5.4–12.6)		57.3(55.4–59.1)	12.2(11.0–13.4)	30.6(28.9–32.3)	
Age	40–49	95.4(78.8–99.1)	4.6(0.9–21.2)	0.553	50.1(46.8–53.4)	9.9(8.1–11.9)	40.1(36.9–43.3)	<0.001
	50–59	88.8(78.6–94.5)	11.2(5.5–21.4)		58.1(55.1–60.9)	12.9(11.1–15.0)	29.0(26.4–31.8)	
	60–69	90.0(82.8–94.4)	10.0(5.6–17.2)		67.4(64.2–70.5)	13.3(11.2–15.7)	19.3(16.8–22.1)	
	70–	94.8(81.3–98.7)	5.2(1.3–18.7)		65.7(59.4–71.6)	17.1(12.8–22.4)	17.2(12.8–22.7)	
Gender	Male	92.3(86.8–95.6)	7.7(4.4–13.2)	0.662	59.5(56.7–62.3)	12.8(11.1–14.8)	27.6(25.1–30.3)	0.003
	Female	90.7(82.6–95.2)	9.3(4.8–17.4)		55.0(52.6–57.3)	11.5(10.1–13.1)	33.5(31.3–35.8)	
Residence	Urban	91.0(84.8–94.8)	9.0(5.2–15.2)	0.787	54.4(52.2–56.6)	14.5(13.0–16.2)	31.0(29.0–33.1)	0.008
	Rural	91.9(86.3–95.3)	8.1(4.7–13.7)		58.2(55.9–60.6)	11.4(10.0–13.0)	30.4(28.2–32.6)	
Education level	Primary school and below	91.4(85.2–95.2)	8.6(4.8–14.8)	0.952	62.4(59.5–65.1)	11.5(9.7–13.4)	26.7(24.0–29.6)	<0.001
	Junior middle school	91.7(85.9–96.4)	7.3(3.6–14.1)		52.9(50.0–55.9)	12.2(10.5–14.2)	36.6(33.5–39.8)	
	Senior middle school	89.9(54.1–98.5)	10.1(1.5–45.9)		53.8(48.9–58.7)	12.6(9.7–16.1)	34.9(30.1–40.1)	
	College and above	89.4(64.4–97.5)	10.6(2.5–35.6)		48.0(42.4–53.7)	18.0(13.9–23.0)	34.7(29.6–40.3)	

The data were presented as weighted proportion (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

Table 4 Prevalences of stroke risk factors by demographic characteristics.

Category	Subcategory	Hypertension	Dyslipidemia	Diabetes mellitus	Atrial fibrillation	Smoking	Overweight or obesity	Lack of exercise	Family history of stroke
Risk Factor		57.3(55.5–59.2)	62.1(60.3–63.9)	11.2(10.1–12.4)	0.7(0.5–1.1)	61.8(60.0–63.5)	31.0(29.3–32.8)	17.8(16.5–19.2)	33.4(31.7–35.2)
Age	40–49	47.1(43.8–50.4)	58.6(55.3–61.8)	7.7(6.1–9.7)	0(0–0)	60.9(57.7–63.9)	33.9(30.8–37.1)	14.0(12.1–16.1)	36.1(33.0–39.3)
	50–59	58.6(55.7–61.5)	64.4(61.4–67.2)	11.9(10.2–14.0)	0.7(0.4–1.5)	63.8(61.0–66.5)	30.3(27.7–33.1)	12.8(11.2–14.7)	33.0(30.3–35.8)
	60–69	68.5(65.3–71.6)	65.7(62.4–68.9)	14.6(12.4–17.2)	1.2(0.7–2.2)	62.6(59.4–65.7)	31.2(28.2–34.3)	21.9(19.3–24.7)	34.5(31.4–37.8)
	70–	74.1(68.0–79.3)	63.3(56.8–69.3)	16.7(12.3–22.1)	2.8(1.3–6.1)	57.9(51.6–64.0)	22.1(17.3–27.9)	40.1(34.0–46.6)	22.5(17.7–28.2)
	p value	<0.001	0.014	<0.001	<0.001	0.243	0.002	<0.001	<0.001
Gender	Male	60.7(57.8–63.5)	61.3(58.5–64.1)	9.8(8.3–11.6)	0.9(0.5–1.6)	70.3(67.7–72.8)	31.9(29.3–34.6)	15.7(13.8–17.7)	31.4(28.8–34.2)
	Female	53.9(51.5–56.3)	62.9(60.6–65.2)	12.6(11.0–14.3)	0.6(0.3–1.1)	53.2(50.8–55.5)	30.2(28.1–32.5)	20.0(18.2–21.9)	35.4(33.2–37.7)
	p value	<0.001	0.383	0.022	0.265	<0.001	0.356	0.002	0.028
Residence	Urban	59.2(57.0–61.4)	66.4(64.2–68.4)	9.3(8.1–10.7)	0.5(0.2–0.9)	34.7(32.5–36.9)	32.7(30.6–34.9)	29.7(27.7–31.8)	34.4(32.3–36.5)
	Rural	56.7(54.3–59.0)	60.7(58.3–63.0)	11.8(10.4–13.4)	0.8(0.5–1.4)	70.9(68.7–73.0)	30.5(28.3–32.7)	13.8(12.2–15.5)	33.1(30.9–35.4)
	p value	0.121	<0.001	0.015	0.137	<0.001	0.151	<0.001	0.425
Personal history of stroke	Yes	82.7(76.8–87.4)	73.5(67.1–79.0)	17.5(13.0–23.1)	1.8(0.6–4.9)	68.3(62.1–73.9)	35.4(29.1–42.1)	28.1(22.5–34.5)	44.8(38.2–51.6)
	No	55.3(53.4–57.3)	61.2(59.3–63.1)	10.7(9.6–11.9)	0.7(0.4–1.1)	61.3(59.4–63.1)	30.7(28.9–32.5)	17.0(15.7–18.4)	32.5(30.7–34.4)
	p value	<0.001	<0.001	0.002	0.085	0.031	0.165	<0.001	<0.001
Education	Primary school and below	60.7(57.9–63.5)	62.9(60.0–65.6)	12.7(10.9–14.7)	1.0(0.6–1.7)	72.8(70.2–75.2)	30.4(27.9–33.1)	16.6(14.6–18.8)	30.6(28.0–33.3)
	Junior middle school	54.0(51.0–56.9)	60.5(57.5–63.4)	10.1(8.4–12.0)	0.6(0.3–1.2)	56.6(53.6–59.4)	31.1(28.4–33.9)	16.3(14.4–18.4)	35.5(32.7–38.4)
	Senior middle school	53.9(48.9–58.8)	64.2(59.3–68.9)	11.1(8.4–14.6)	0.3(0.1–1.1)	44.3(39.3–49.4)	33.6(28.9–38.6)	25.5(21.5–29.9)	40.0(35.3–44.9)

College and above	56.5(51.0–61.8)	63.9(58.5–69.0)	5.6(3.5–8.9)	0.3(0.0–2.0)	25.7(20.9–31.1)	32.6(27.4–38.3)	28.7(24.0–33.9)	33.0(28.1–38.3)
p value	0.001	0.391	0.008	0.247	<0.001	0.681	<0.001	0.002

The data were presented as weighted prevalence (95% confidence intervals). *p* values were calculated with the Rao-Scott-χ^2 test.

The multivariable logistic regression model indicated that multiple characteristics were positively associated with ischemic stroke, including age, gender, hypertension, dyslipidemia, lack of exercise, and family history of stroke. Table 5a shows that the adjusted ORs of age groups 50–59, 60–69, and ≥ 70years (vs. 40–49 years age group) increased significantly with age (p < 0.001), and men were more likely to have ischemic stroke than women (OR = 1.935, 95% CI: 1.410–2.655). Patients with hypertension (OR = 2.582, 95% CI: 1.720–3.877) or dyslipidemia (OR = 1.513, 95% CI: 1.064–2.151) were more likely to have ischemic stroke. The ORs for lack of exercise and family history of ischemic stroke were 1.446 (95% CI: 1.011–2.068) and 1.941 (95% CI: 1.424–2.646), respectively. However, there was no significant difference between participants with different education level, atrial fibrillation, diabetes mellitus, smoking, and frequency of fruit and vegetables consumption. In contrast, as shown in Table 5b, although the univariate analyses of risk factors showed that hemorrhagic stroke was associated with age, gender, hypertension and high level of total cholesterol, the multivariate analyses model found that only hypertension (OR = 4.064, 95% CI: 1.358–12.160) was significantly associated with hemorrhagic stroke.

Table 5a Multivariate logistic analysis of the ischemic stroke risk factors among participants.

Category	Subcategory	Fully adjusted OR (95%CI)	Wald χ^2 value	p value
Age(years)	40–49	1.00 (Referent)	13.274	<0.001
	50–59	2.198(1.306–3.700)		
	60–69	4.245(2.520–7.151)		
	70–	5.252(2.873–9.600)		
Gender	Female	1.00 (Referent)	16.749	<0.001
	Male	1.935(1.410–2.655)		
Education level	College and above	1.00 (Referent)	2.339	0.072
	Senior middle school	0.876(0.406–1.890)		
	Junior middle school	1.063(0.561 –2.015)		
	Primary school and below	1.630(0.823–3.227)		
Atrial fibrillation	No	1.00 (Referent)	0.256	0.613
	Have	1.359(0.414–4.457)		
Hypertension	No	1.00 (Referent)	20.950	<0.001
	Have	2.582(1.720–3.877)		
Dyslipidemia	No	1.00 (Referent)	5.330	0.021

	Yes	1.513(1.064–2.151)		
Diabetes mellitus	No	1.00 (Referent)	2.828	0.093
	Have	1.385(0.947–2.023)		
Smoker	Not	1.00 (Referent)	2.492	0.115
	Yes	1.280(0.942–1.738)		
Lack of exercise	No	1.00 (Referent)	4.092	0.043
	Yes	1.446(1.011–2.068)		
Family history of stroke	No	1.00 (Referent)	17.639	<0.001
	Have	1.941(1.424–2.646)		
Fruit consumption	≥ 5 d/w	1.00 (Referent)	2.177	0.114
	3–4 d/w	0.646(0.347–1.202)		
	≤ 2 d/w	1.707(0.832–3.503)		

Table 5b Multivariate logistic analysis of the hemorrhagic stroke risk factors among participants.

Category	Subcategory	Fully adjusted OR (95%CI)	Wald χ^2 value	*p* value
Age(years)	40–49	1.00 (Referent)	1.696	0.166
	50–59	5.417(0.869–33.768)		
	60–69	7.816(1.266–48.240)		
	70–	3.835(0.296–49.762)		
Gender	Female	1.00 (Referent)	0.819	0.365
	Male	1.597(0.579–4.406)		
Hypertension	No	1.00 (Referent)	6.290	0.012
	Have	4.064(1.358–12.160)		
High level of total cholesterol	No	1.00 (Referent)	2.674	0.102
	Yes	2.232(0.852–5.847)		

DISCUSSION

In this population-based cross-sectional study, we have identified a high prevalence of stroke, especially ischemic stroke, and cerebrovascular associated risk factors among adults aged 40 years or older in northeast China. Besides, we found that regions with higher prevalence of hypertension, dyslipidemia, and lack of exercise was associated with the high prevalence of stroke.

The prevalence of stroke in Dehui City of Jilin Province was almost three times more than the nationwide findings[17]. The prevalence of stroke increased with age, and this result was consistent with those of other studies[28]. China's rapid economic development in the past three decades has also increased life expectancies, according to the World Bank, and the proportion of elderly people in the population has increased. The effect of population aging on the prevalence of stroke has become more and more serious. Our study showed that the prevalence of stroke was significantly higher in men than in women, in accordance with past studies[13 28]. However, in challenge to a previous study[29], there was no statistically significant difference between rural and urban areas for stroke prevalence, suggesting disparities among residence was in line with rapid economic development.

Of all stroke cases in our survey, 91.7% (95% CI: 87.4–94.6%) were ischemic stroke, and 8.3% (95% CI: 5.4–12.6%) were hemorrhagic stroke. The proportion of ischemic stroke was higher than those in developed countries, where ischemic stroke accounted for approximately 67.3–80.5% of all stroke cases[30]. This proportion was also markedly higher than that in three large cities in China in the 1990s[31]. Those findings were gathered from prospective register and monitoring, plus annual retrospective door-to-door investigation, which found that cerebral infarction accounted for 43.7–78.9% of the total number of stroke cases. In addition, the proportion of stroke subtypes was quite different from those in Changsha, a city in south central China, with 55.4% of all stroke cases were attributed to intracerebral hemorrhage[32]. This may reflect substantial geographic disparities and some underlying differences of dietary preferences and vascular risk factors[10 33]. However, this proportion was in accordance with the China Acute Cerebrovascular Events Register's (CACER-I) study, reporting that ischemic stroke cases were increasing, whereas intracerebral hemorrhage showed a decreasing trend[34]. The decrease in hemorrhagic stroke might be related to the improvement in hypertension control, as approximately 50% of acute hemorrhagic strokes can be attributed to hypertension in the Chinese population[8].

In the present population-based survey, we found the prevalence rates of dyslipidemia, smoking, and hypertension were ranked as the top three cerebrovascular risk factors, the prevalence rates of which were 62.1%, 61.8%, and 57.3%, respectively. We found that the prevalence of dyslipidemia was significantly higher than the national levels in a recent cross-sectional study[35]. Additionally, the prevalence of dyslipidemia was higher among those in urban areas than rural. This result was consistent with the large cross-sectional survey of domestic conducted from January 2007 to October 2010[35], and other regional study in China[36]. This was mainly attributed to the higher total cholesterol intake among urban residents than those living in rural areas[37]. By contrast, the prevalence of diabetes mellitus was higher among rural residents than among urban residents. This was different from a pooled analysis of fifty-six eligible studies in China[38], and the reason was worth further explored in the future study. Further, the prevalence of hypertension in our study was also much higher than the nationwide average[39]and what was found in some other regional studies[40 41], but close to the recent study in the Sichuan Tibetan population[42]. The high prevalence of dyslipidemia and hypertension might be ascribed to the dietary preferences and other lifestyles of residents in Jilin Province. The cold weather limits people's outdoor physical activity during the long winter, consequently increasing the risk of overweight or obesity and related metabolic abnormalities. The present study also showed that the prevalence of smoking or being passively exposed to tobacco smoke, especially in rural areas, was higher than the rates from the China Global Adults Tobacco Survey in 2010[43]. This may be partly attributable to the fact that residents in Dehui City, in general, were undereducated (77.5% of residents had junior middle school and below education level, as shown in Table 1) and lack perceptions of smoking hazards.

Estimates from the GBD 2013 suggested that approximately 94% of the Chinese burden of stroke is attributable to the combined effects of modifiable risk factors, and that most stroke is attributable to behavioral factors (i.e., smoking, poor diet, and low physical activity) and metabolic factors (i.e., high SBP, high BMI, high FPG, high TC)[44], and these results were consistent with those of the INTERSTROKE study[45], in which roughly 86% of strokes could be attributed to nine potentially modifiable metabolic and behavioral risk factors. Thus, it is of vital importance to promptly identify these modifiable metabolic and behavioral risk factors among the residents to lessen the burden of stroke. In the present study, it was shown that hypertension, dyslipidemia (metabolic risk factors), and lack of exercise (behavioral risk factor) were associated with the ischemic stroke ($p < 0.05$) independently, which was consistent with several previous studies[46-50]. Physical inactivity has been proved to be associated with an increased risk of stroke[51]. The benefits appear to occur from a variety of types of activity, including leisure time physical activity, occupational activity, such as agricultural work, and walking. In the present study, the prevalence rate of lack of exercise was 17.8% (95% CI: 16.5–19.2%) in total, and a difference in prevalence between urban and rural areas was noted with urban being higher than rural areas (29.7% vs. 13.8%, $p < 0.001$). This may be attributed to a sedentary lifestyle among urban residents. The protective effect of physical activity may be partly mediated by its role in reducing blood pressure and controlling other risk factors for stroke, such as diabetes, and excess body weight[52 53]. In addition, age, gender and family history of stroke were also risk factors for ischemic stroke, which has been widely acknowledged nowadays [54 55]. However, only hypertension (OR = 4.064, 95% CI: 1.358–12.160) was significantly associated with hemorrhagic stroke in our survey when using the multivariate logistic regression model. That hypertension is an independent risk factor in the Chinese population has also been revealed in the Sino-MONICA-Beijing Project observational study[8].

As far as we know, this was the most recent investigation of stroke and associated risk factors in this region, and it filled the information gap in this field. This cross-sectional study involved a large representative sample of the Dehui City population. Strict training was done before the investigation, and we used a unified pre-coded questionnaire designed by the Stroke Screening and Prevention Program of the National Health and Family Planning Commission of China[14]. The data analysis was performed using complex weighted computation. For all the aforementioned reasons, our survey probably provided accurate data on the prevalence of stroke and related risk factors in this region. Some limitations of this study should be noted. Limitations of the study were the properties of the cross-sectional study and the recall bias of the self-reported questionnaire. Another limitation was that the respondents' atrial fibrillation status was based on self-report and ordinary electrocardiogram, which may be underestimated for paroxysmal atrial fibrillation[56].

CONCLUSIONS

In conclusion, we have identified a high prevalence of stroke, especially ischemic stroke, and associated risk factors among adults aged 40 years and older in northeast China. A higher regional prevalence of hypertension, dyslipidemia, and lack of exercise (modifiable risk factors) may be responsible, and these factors are appropriate targets for population-based stroke prevention. Health policy makers should place more emphasis on the effective prevention and control of stroke and its risk factors.

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Authors' contributions

Conception and design: Ying-Qi Xing, Yi Yang. Acquisition of data: Fu-Liang Zhang, Hao-Yuan Liu, Yun Luo, Ming-Shuo Sun. Analysis: Fu-Liang Zhang, Yan-Hua Wu. Drafting the manuscript: Fu-Liang Zhang. Critical revision: Zhen-Ni Guo, Yan-Hua Wu, Yi Yang. All authors approved the final version to be published.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

Data sharing statement

No additional data are available.

Ethics approval and consent to participate

The study design was approved by the Human Ethics and Research Ethics committees of the First Hospital of Jilin University (Approval Number: 2015-R-250). Written informed consent was obtained from the participants in the survey.

References

1. Murray CJ, Barber RM, Foreman KJ, et al. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990-2013: quantifying the epidemiological transition. Lancet (London, England) 2015;**386**(10009):2145-91 doi: 10.1016/s0140-6736(15)61340-x[published Online First: Epub Date]|.
2. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England) 2015;**385**(9963):117-71 doi: 10.1016/s0140-6736(14)61682-2[published Online First: Epub Date]|.
3. Feigin VL, Forouzanfar MH, Krishnamurthi R, et al. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2014;**383**(9913):245-54
4. Powers WJ, Derdeyn CP, Biller J, et al. 2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke; a journal of cerebral circulation 2015;**46**(10):3020-35 doi: 10.1161/str.0000000000000074[published Online First: Epub Date]|.
5. Sacco RL, Benjamin EJ, Broderick JP, et al. American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Risk factors. Stroke; a journal of cerebral circulation 1997;**28**(7):1507-17
6. Hankey GJ. Ischaemic stroke--prevention is better than cure. The journal of the Royal College of Physicians of Edinburgh 2010;**40**(1):56-63 doi: 10.4997/jrcpe.2010.111[published Online First: Epub Date]|.
7. Kim AS, Cahill E, Cheng NT. Global Stroke Belt: Geographic Variation in Stroke Burden Worldwide. Stroke 2015;**46**(12):3564-70 doi: 10.1161/strokeaha.115.008226[published Online First: Epub Date]|.
8. Zhao D, Liu J, Wang W, et al. Epidemiological transition of stroke in China: twenty-one-year observational study from the Sino-MONICA-Beijing Project. Stroke; a journal of cerebral circulation 2008;**39**(6):1668-74 doi: 10.1161/strokeaha.107.502807[published Online First: Epub Date]|.
9. Z C. *The Third Nationwide Survey on Causes of Death*: Beijing: The Peking Union Medical College Press, 2008.
10. Xu G, Ma M, Liu X, Hankey GJ. Is there a stroke belt in China and why? Stroke; a journal of cerebral circulation 2013;**44**(7):1775-83 doi: 10.1161/strokeaha.113.001238[published Online First: Epub Date]|.
11. Li ZS YQ, Chen SM, Shu Q, Fu YG. Epidemiological survey of cerebrovascular disease in rural areas of China. Zhong-Hua Shen-Jing Wai-ke Za-Zhi 1989;**5**:7-11
12. Wu GX, Wu ZS, He BL. Epidemiological characteristics of stroke in 16 provinces of China. Zhonghua yi xue za zhi 1994;**74**(5):281-3, 325

13. Cheng XM, Ziegler DK, Lai YH, et al. Stroke in China, 1986 through 1990. Stroke; a journal of cerebral circulation 1995;**26**(11):1990-4
14. Sun H, Zou X, Liu L. Epidemiological factors of stroke: a survey of the current status in china. Journal of stroke 2013;**15**(2):109-14 doi: 10.5853/jos.2013.15.2.109[published Online First: Epub Date]|.
15. Stroke Screening and Prevention Project Committee NHaFPCoC. Technical specification of stroke screening and prevention in China. Chinese Journal of the Frontiers of Medical Science (Electronic Version) 2013(9):44-50 doi: 10.3969/j.issn.1674-7372.2013.09.017[published Online First: Epub Date]|.
16. Feigin VL, Krishnamurthi RV, Parmar P, et al. Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. Neuroepidemiology 2015;**45**(3):161
17. Li J, Wang L, Chao B, Liu Y. Prevalence of stroke in China: an epidemiological study based on the National Stroke Screening Survey. Lancet (London, England) 2015;**386**:S49
18. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. Bulletin of the World Health Organization 1980;**58**(1):113-30
19. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). Jama 2014;**311**(5):507-20 doi: 10.1001/jama.2013.284427[published Online First: Epub Date]|.
20. Chinese guidelines on prevention and treatment of dyslipidemia in adults. Zhonghua xin xue guan bing za zhi 2007;**35**(5):390-419
21. Diagnosis and classification of diabetes mellitus. Diabetes care 2013;**36 Suppl 1**:S67-74 doi: 10.2337/dc13-S067[published Online First: Epub Date]|.
22. Fuster V, Ryden LE, Cannom DS, et al. ACC/AHA/ESC 2006 guidelines for the management of patients with atrial fibrillation: full text: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Revise the 2001 guidelines for the management of patients with atrial fibrillation) developed in collaboration with the European Heart Rhythm Association and the Heart Rhythm Society. Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology 2006;**8**(9):651-745 doi: 10.1093/europace/eul097[published Online First: Epub Date]|.
23. Willenbring ML, Massey SH, Gardner MB. Helping patients who drink too much: an evidence-based guide for primary care clinicians. American Family Physician 2009;**80**(1):44-50
24. He FJ, Nowson CA, MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. Lancet (London, England) 2006;**367**(9507):320-6 doi: 10.1016/s0140-6736(06)68069-0[published Online First: Epub Date]|.
25. Rao W, Su Y, Yang G, et al. Cross-Sectional Associations between Body Mass Index and Hyperlipidemia among Adults in Northeastern China. International journal of environmental research and public health 2016;**13**(5) doi: 10.3390/ijerph13050516[published Online First: Epub Date]|.

26. Mi T, Sun S, Zhang G, et al. Relationship between dyslipidemia and carotid plaques in a high-stroke-risk population in Shandong Province, China. Brain and behavior 2016;**6**(6):e00473 doi: 10.1002/brb3.473[published Online First: Epub Date]|.
27. Shi-Yu WC-JRL-JH. Study on Reliability and Validity of the Risk Assessment Scale of Stroke. Chinese Journal of Stroke 2016;**0**(3):202-06
28. Li SC, Schoenberg BS, Wang CC, Cheng XM, Bolis CL, Wang KJ. Cerebrovascular disease in the People's Republic of China: epidemiologic and clinical features. Neurology 1985;**35**(12):1708-13
29. Xue GB, Yu BX, Wang XZ, Wang GQ, Wang ZY. Stroke in urban and rural areas of China. Chinese medical journal 1991;**104**(8):697-704
30. Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. The Lancet. Neurology 2003;**2**(1):43-53
31. Jiang B, Wang WZ, Chen H, et al. Incidence and trends of stroke and its subtypes in China: results from three large cities. Stroke; a journal of cerebral circulation 2006;**37**(1):63-8 doi: 10.1161/01.str.0000194955.34820.78[published Online First: Epub Date]|.
32. Yang QD, Niu Q, Zhou YH, et al. Incidence of cerebral hemorrhage in the Changsha community. A prospective study from 1986 to 2000. Cerebrovascular diseases (Basel, Switzerland) 2004;**17**(4):303-13 doi: 10.1159/000077341[published Online First: Epub Date]|.
33. He J, Klag MJ, Wu Z, Whelton PK. Stroke in the People's Republic of China. I. Geographic variations in incidence and risk factors. Stroke; a journal of cerebral circulation 1995;**26**(12):2222-7
34. Wu L, Wang A, Wang X, et al. Factors for short-term outcomes in patients with a minor stroke: results from China National Stroke Registry. BMC neurology 2015;**15**:253 doi: 10.1186/s12883-015-0505-z[published Online First: Epub Date]|.
35. Pan L, Yang Z, Wu Y, et al. The prevalence, awareness, treatment and control of dyslipidemia among adults in China. Atherosclerosis 2016;**248**:2-9 doi: 10.1016/j.atherosclerosis.2016.02.006[published Online First: Epub Date]|.
36. Wang S, Xu L, Jonas JB, You QS, Wang YX, Yang H. Prevalence and associated factors of dyslipidemia in the adult Chinese population. PloS one 2011;**6**(3):e17326 doi: 10.1371/journal.pone.0017326[published Online First: Epub Date]|.
37. Pang XH, Jiao SF, Huang L, Duan JL, Ren ZY, Liu ZJ. Nutritionan health status of the Beijing residents. Zhonghua yu fang yi xue za zhi [Chinese journal of preventive medicine] 2005;**39**(4):269-72
38. Li MZ, Su L, Liang BY, et al. Trends in prevalence, awareness, treatment, and control of diabetes mellitus in mainland china from 1979 to 2012. International journal of endocrinology 2013;**2013**:753150 doi: 10.1155/2013/753150[published Online First: Epub Date]|.
39. Bundy JD, He J. Hypertension and Related Cardiovascular Disease Burden in China. Annals of global health 2016;**82**(2):227-33 doi: 10.1016/j.aogh.2016.02.002[published Online First: Epub Date]|.
40. Wang Y, Zhang J, Ding Y, et al. Prevalence of Hypertension among Adults in Remote Rural Areas of Xinjiang, China. International journal of environmental research and public health 2016;**13**(6) doi: 10.3390/ijerph13060524[published Online First: Epub Date]|.

41. Hu M, Wan Y, Yu L, et al. Prevalence, awareness, treatment, and control of hypertension and associated risk factors among adults in Xi'an, China: A cross-sectional study. Medicine 2016;**95**(34):e4709 doi: 10.1097/md.0000000000004709[published Online First: Epub Date]|.
42. Huang X, Zhou Z, Liu J, et al. Prevalence, awareness, treatment, and control of hypertension among China's Sichuan Tibetan population: A cross-sectional study. Clinical and experimental hypertension (New York, N.Y. : 1993) 2016;**38**(5):457-63 doi: 10.3109/10641963.2016.1163369[published Online First: Epub Date]|.
43. Yang GH. Global Adult Tobacco Survey (GATS) China 2010 Country Report, 2011.
44. Feigin VL, Roth GA, Naghavi M, et al. 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**(9):913-24 doi: 10.1016/s1474-4422(16)30073-4[published Online First: Epub Date]|.
45. O'Donnell MJ, Xavier D, Liu L, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. Lancet 2010;**376**(9735):112-23 doi: 10.1016/s0140-6736(10)60834-3[published Online First: Epub Date]|.
46. He J, Klag MJ, Wu Z, Whelton PK. Stroke in the People's Republic of China. II. Meta-analysis of hypertension and risk of stroke. Stroke; a journal of cerebral circulation 1995;**26**(12):2228-32
47. Ebrahim S, Sung J, Song YM, Ferrer RL, Lawlor DA, Davey Smith G. Serum cholesterol, haemorrhagic stroke, ischaemic stroke, and myocardial infarction: Korean national health system prospective cohort study. BMJ (Clinical research ed.) 2006;**333**(7557):22 doi: 10.1136/bmj.38855.610324.80[published Online First: Epub Date]|.
48. Tanne D, Yaari S, Goldbourt U. High-density lipoprotein cholesterol and risk of ischemic stroke mortality. A 21-year follow-up of 8586 men from the Israeli Ischemic Heart Disease Study. Stroke; a journal of cerebral circulation 1997;**28**(1):83-7
49. Soyama Y, Miura K, Morikawa Y, et al. High-density lipoprotein cholesterol and risk of stroke in Japanese men and women: the Oyabe Study. Stroke; a journal of cerebral circulation 2003;**34**(4):863-8 doi: 10.1161/01.str.0000060869.34009.38[published Online First: Epub Date]|.
50. Alevizos A, Lentzas J, Kokkoris S, Mariolis A, Korantzopoulos P. Physical activity and stroke risk. International journal of clinical practice 2005;**59**(8):922-30 doi: 10.1111/j.1742-1241.2005.00536.x[published Online First: Epub Date]|.
51. Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. Stroke 2003;**34**(10):2475-81 doi: 10.1161/01.str.0000091843.02517.9d[published Online First: Epub Date]|.
52. Manson JE, Colditz GA, Stampfer MJ, et al. A prospective study of maturity-onset diabetes mellitus and risk of coronary heart disease and stroke in women. Archives of internal medicine 1991;**151**(6):1141-7
53. Blair SN, Kampert JB, Kohl HW, 3rd, et al. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. Jama 1996;**276**(3):205-10
54. Sacco RL. Risk factors and outcomes for ischemic stroke. Neurology 1995;**45**(2 Suppl 1):S10-4
55. Knottnerus IL, Gielen M, Lodder J, et al. Family history of stroke is an independent risk factor for lacunar stroke subtype with asymptomatic lacunar infarcts at younger ages. Stroke; a journal

of cerebral circulation 2011;**42**(5):1196-200 doi: 10.1161/strokeaha.110.602383[published Online First: Epub Date]|.
56. Koga M, Yoshimura S, Hasegawa Y, et al. Higher Risk of Ischemic Events in Secondary Prevention for Patients With Persistent Than Those With Paroxysmal Atrial Fibrillation. Stroke; a journal of cerebral circulation 2016 doi: 10.1161/strokeaha.116.013746[published Online First: Epub Date]|.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			**4**
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			**4-9**
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	5, 8-9
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8-9
		(*e*) Describe any sensitivity analyses	Not Applicable
Results			9-16

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	9-10
Outcome data	15*	Report numbers of outcome events or summary measures	Not applicable
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-16
		(*b*) Report category boundaries when continuous variables were categorized	10-14
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-16
Discussion			13-16
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			20
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.