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Hypertension Among Hemorrhagic Stroke Patients in Northeast China: A Population-Based Study 2017–2019

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Background: We aimed to profile the current epidemiology of hypertension among the survivors of hemorrhagic stroke in northeast China.


Material/Methods: Our cross-sectional study included 18 796 adults aged 40 years or older and residing in northeast China. Hemorrhagic stroke was identified according to the CT and/or MRI results. Hypertension was defined based on the Chinese hypertension guidelines.

Results: We identified 208 patients with previous hemorrhagic stroke in this population-based study. The overall prevalence of hypertension in the studied population was 88%. Out of all the survivors of hemorrhagic stroke, 80.9% were aware of their hypertensive condition, 70.5% of the patients were in antihypertensive medications treatment, and only 12% of the patients had their blood pressure under control. Furthermore, only 17.10% of the patients who took hypertensive medications achieved appropriate blood pressure. Calcium channel blockers were more commonly used than other medications. Patients with controlled hypertension had significantly higher percentages of comorbidities when compared to those with uncontrolled hypertension. In our patient sample, the rates of stage 2 and stage 3 hypertension in the hemorrhagic stroke population were 28.8% and 15.9%, respectively, and women had a significantly higher prevalence of stage 3 hypertension when compared with men (21.3% vs. 10.0%, $P=0.026$).

Conclusions: The high prevalence of uncontrolled hypertension and high rates of blood pressure at stages 2 and 3 in patients with prior hemorrhagic stroke indicated a considerable stroke burden in northeast China. Therefore, effective and long-time management of hypertension in stroke survivors should be a priority.

MeSH Keywords: **Hypertension • Population • Recurrence • Stroke**

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Background

Hemorrhagic stroke remains a significant cause of premature death and disability globally, although it only accounted for approximately 10-20% of all stroke [1]. The overall global burden of hemorrhagic stroke, expressed in disability-adjusted life years (DALYs) lost, was higher than the burden of ischemic stroke [2]. Medium- and long-term functional outcome and mortality after hemorrhagic stroke are greatly influenced by recurrence [1], and effective strategies for prevention of hemorrhagic stroke recurrence are essential for long-term rehabilitation and management programs.

Hypertension has long been recognized as the most important potentially modifiable risk factor for both hemorrhagic and ischemic stroke [3]. Previous studies consistently confirmed the association between both diastolic and systolic blood pressures and risk of all stroke subtypes, especially hemorrhagic stroke [4]. High blood pressure also significantly increases the possibility of recurrent stroke in people experiencing hemorrhagic or ischemic events [5]. Previous research proved that hypertension management could reduce the risk of stroke recurrence in hemorrhagic stroke survivors, as each 10-mmHg reduction in SBP decreases the risk of stroke recurrence by 33% [6]. Therefore, hypertension management hemorrhagic stroke survivors should be emphasized.

In recent years, a great proportion of hemorrhagic strokes have been diagnosed in low- and middle-income countries [2]. China, which has nearly one-fifth of the world population, has a noticeable geographic variation in stroke burden [7]. The stroke burden in northeast China is significantly higher, with a high incidence of stroke and high risk of recurrence [8,9]. According to our previous studies, hypertension was more prevalent in northeast China's stroke population, indicating that stroke recurrence is an ongoing health concern in those areas. Previous studies have reported that risk factors for hemorrhagic stroke recurrence should be a research priority [8,9]. Blood pressure is a strong risk factor for stroke recurrence, but detailed information on blood pressure in patients with hemorrhagic stroke in these areas is still lacking. Hence, the present study explored the epidemiology of hypertension in the hemorrhagic stroke population in northeast China to formulate effective strategies for prevention of stroke recurrence.

Material and Methods

Study population and design

Our survey was performed from September 2017 to March 2019 in northeast China, aiming to evaluate the status of cardiovascular disease. We included a total of 18 796 people aged 40

years or older. The study was approved by the Central Ethics Committee at the China National Center for Cardiovascular Disease (Beijing, China). Written informed consent was obtained from all participants.

Hemorrhage stroke was determined based on the criteria published by the World Health Organization [10], by an expert neurologist from the First Hospital of China Medical University. All patients' clinical case records, magnetic resonance imaging (MRI), and computed tomography (CT) were carefully examined during the hospitalization.

We assessed each patient's diastolic blood pressure (DBP) and systolic blood pressure (SBP) 3 times at 2-min intervals with a standardized automatic electronic sphygmomanometer (J30; Omron, Kyoto, Japan), after they rested in a seated position for at least 5 min. Hypertension was defined based on the following Chinese hypertension guidelines: Participants met any of the following criteria: 1) a mean SBP ≥ 140 mmHg; 2) a mean DBP ≥ 90 mmHg; and 3) self-report of using antihypertensive medication in the past 2 weeks [11]. Stage 1 hypertension was identified as SBP 140–159 mmHg and/or DBP 90–99 mmHg, and stage 2 as SBP 160–179 mmHg and/or a DBP 100–109 mmHg. Stage 3, it was identified as SBP ≥ 180 mmHg and/or DBP ≥ 110 mmHg [12]. Taking antihypertensive drugs in the past 2 weeks was regarded as treatment of hypertension. The definition of hypertension control was a mean SBP < 140 mmHg and a mean DBP < 90 mmHg [13]. The data collection and measurement strategy used has been described previously [12,14,15].

Statistical methods

Continuous variables with normal distribution are expressed as means and standard deviations. Descriptive statistics were calculated for all variables. The Kolmogorov-Smirnov test was used to analyze continuous data distribution, according to which appropriate tests were further used in analysis. Categorical variables were analyzed by using the chi-squared test or Fisher exact test to compare differences among groups. Corresponding 95% CIs (confidence intervals) were evaluated for the parameters. All statistical analyses were performed with SPSS22.0. *P* values less than 0.05 were considered statistically significant.

Results

Patient characteristics

The characteristics of the hemorrhagic stroke cohort are described in Table 1. Overall, 208 participants were diagnosed with hemorrhagic stroke (Figure 1). The 208 participants included 100 men (48.1%) and 108 women (51.9%), with an

Table 1. Characteristics of the study participants (≥40years) in 2017–2019.

	Region		Sex		Total
	Urban	Rural	Men	Women	
Stroke, n (%)	35 (16.8)	173 (83.2)	100 (48.1)	108 (51.9)	208
Mean age (mean±SD)	66.5±8.5	64.3±8.0	63.9±8.3	65.4±8.0	64.7±8.1
Age group (%)					
40–49	2.9	0.6	2.0	0.0	1.0
50–59	17.1	28.9	29.0	25.0	26.9
60–69	45.7	46.2	48.0	44.4	46.2
70–79	25.7	19.7	16.0	25.0	20.7
≥80	8.6	4.6	5.0	5.6	5.3
Education (%)					
Primary school or lower	31.4	72.3	57.0	73.1	65.4
Middle school	51.4	23.1	32.0	24.1	27.9
High school or above	17.1	4.6	11.0	2.8	6.7
Annual household income (%)					
<5000	17.1	62.4	57.0	52.8	54.8
5000–9999	17.1	22.0	20.0	22.2	21.2
10 000–19 999	8.6	9.8	8.0	11.1	9.6
≥20 000	57.1	5.8	15.0	13.9	14.4

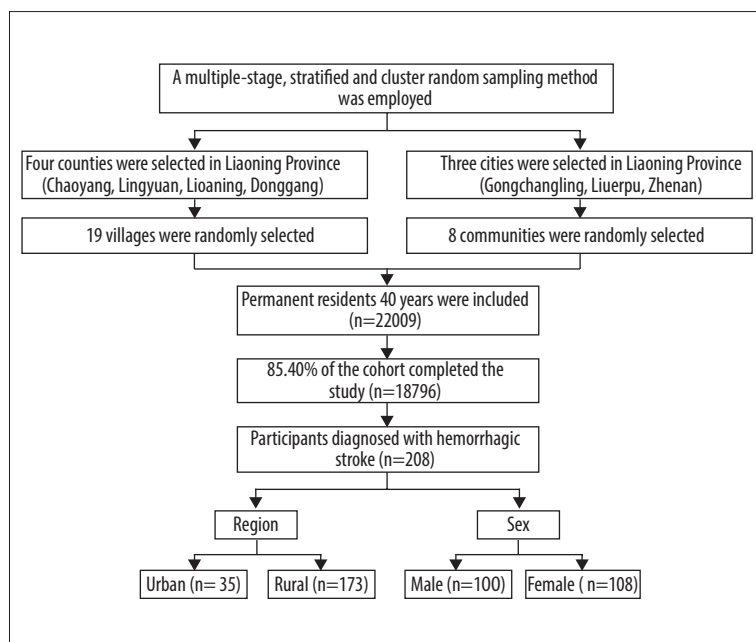


Figure 1. Flow chart of population selection.

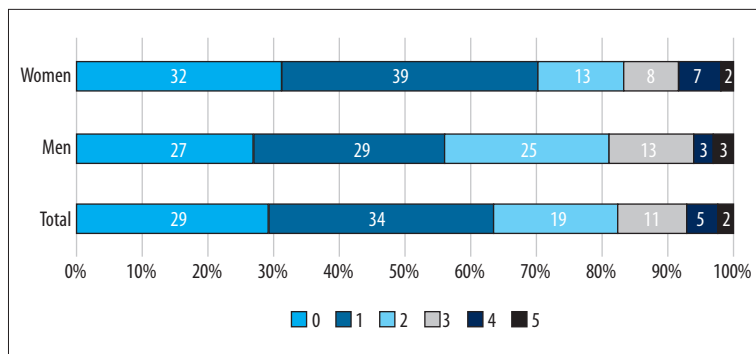


Figure 2. The distribution of modified Rankin Scale (mRS) scores in hemorrhagic stroke population.

Table 2. The prevalence of hypertension in patients with hemorrhagic stroke.

Characteristics	N	Region		Sex		Total (%)	P for region	P for sex
		Urban (%)	Rural (%)	Male (%)	Female (%)			
Age group								
40–49	2	100.0	100.0	100.0	–	100.0	–	–
50–59	56	66.7	88.0	82.8	88.9	85.7	0.158	0.512
60–69	96	87.5	90.0	85.4	93.8	89.6	0.765	0.181
70–79	43	88.9	85.3	81.2	88.9	86.0	0.782	0.485
≥80	11	100.0	87.5	100.0	83.3	90.9	0.521	0.338
Overall	208	85.7	88.4	85.0	90.7	88.0	0.651	0.203

Statistical significance ($P < 0.05$).

average age of 65.4 ± 8.0 years. We found that 66.4% received a primary school education or less, and 54.8% of the participants had a low socio-economic status, with an annual household income < 5000 yuan (approximately \$700). The proportion of disability according to modified Rankin Scale scores (mRS score ≥ 3) among the hemorrhagic stroke population was 17.8%, with men higher than women (19.0% vs. 16.7%, $P < 0.05$), as described in Figure 2.

Prevalence of hypertension among the hemorrhagic stroke population

In the hemorrhagic stroke population, 183 participants had a diagnosis of hypertension (Table 2). The overall prevalence of hypertension was 88%. We found no significant difference between rural and urban residents or between men and women. The prevalence of hypertension was highest in people over 80 years old (90.9%) and was lowest in people 50–59 years old (85.7%). The average SBP and DBP were 155.7 ± 24.0 mmHg and 92.3 ± 13.4 mmHg, respectively, in the stroke population.

Awareness, treatment, and control of hypertension in the hemorrhagic stroke population

Among hemorrhagic stroke patients with hypertension, 80.9% knew their hypertensive condition, 70.5% received

antihypertensive agent treatment, and only 12.0% had blood pressure lower than 140/90 mmHg, and even among those who received hypertensive medications, only 17.1% achieved the objective of blood pressure lower than 140/90 mmHg (Table 3).

However, there was no statistical significances in the rates of treatment and awareness between males and females, although the rates tended to be higher in women compared to men (82.7% vs. 78.8% and 73.5% vs. 67.1%, respectively). The control rate was significantly higher in woman than in men (17.3% vs. 5.0%, respectively, $P = 0.017$). Although the awareness, treatment, and control rates of urban and rural residents were similar, urban stroke survivors had higher awareness, treatment, and control rates than those living in rural areas. Annual household income and education levels among were not significantly associated with levels of awareness, treatment, or control.

Antihypertensive medication treatment was being received by 70.5% of all patients, but only 12% had good blood pressure control. In patients who achieved the blood pressure target, 37.5% were taking calcium channel blockers (CCB), 4.2% were taking angiotensin-converting enzyme inhibitors (ACEI), 20.8% were taking angiotensin II receptor blockers (ARB), and 37.5% were taking other medication such as traditional Chinese medicine and vasodilators. In contrast, among patients who failed

Table 3. Awareness, treatment, and control rates of patients with hemorrhagic stroke.

Characteristics	Awareness (%)	Treatment (%)	Control (%)	Controlled among treated patients (%)
Overall	80.9	70.5	12.0	17.1
Age Group				
40–49	100.0	100.0	0.0	0.0
50–59	87.5	79.2	18.8	23.7
60–69	81.4	75.6	7.0	9.2
70–79	70.3	51.4	13.5	26.3
≥80	80.0	50.0	20.0	40.0
<i>P</i> value	0.337	0.016	0.279	0.115
Sex				
Male	78.8	67.1	5.9	8.8
Female	82.7	73.5	17.3	23.6
<i>P</i> value	0.511	0.343	0.017	0.026
Education				
Primary school or lower	81.5	70.2	12.1	17.2
Middle school	80.9	74.5	14.9	20.0
High school or above	75.0	58.3	0.0	0.0
<i>P</i> value	0.863	0.544	0.367	0.437
Income				
<5000	79.8	69.7	13.1	18.8
5000–9999	82.5	80.0	10.0	12.5
10 000–19 999	64.7	52.9	11.8	22.2
≥20 000	92.6	70.4	11.1	15.8
<i>P</i> value	0.144	0.232	0.962	0.846
Region				
Urban	90.0	76.7	13.3	17.4
Rural	79.1	69.3	11.8	17.0
<i>P</i> value	0.165	0.417	0.809	0.962

to achieve the blood pressure target, the percentage those taking diuretics, CCB, ACEI, ARB, and other medication were 4.1%, 50.4%, 15.7%, 6.6%, and 23.1%, respectively. In addition, patients with controlled hypertension had significantly higher percentages of comorbidities when compared to those with uncontrolled hypertension ($P<0.05$) (Figure 3).

Blood pressure levels among hemorrhagic stroke survivors

In our patient sample, the prevalences of stage 1, 2, and 3 hypertension in patients with hemorrhagic stroke were 32.7%, 28.8%, and 15.9%, respectively. Compared to men, women had a significantly higher prevalence of stage 3 hypertension (21.3% vs. 10.0%, $P=0.026$). However, the prevalences of stages 1, 2, and 3 in rural and urban areas were similar (Figure 4).

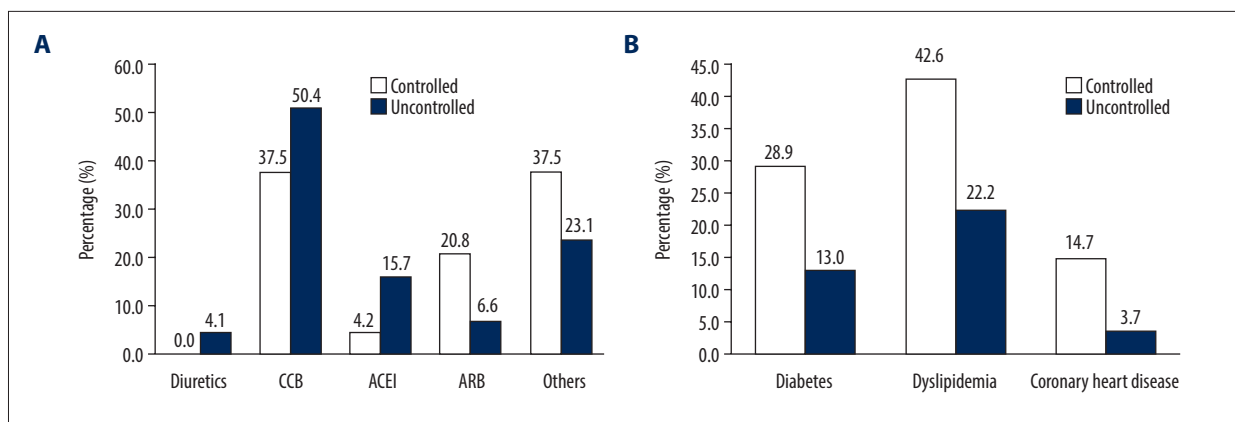


Figure 3. (A) The antihypertensive medications between patients with uncontrolled and uncontrolled high blood pressures. (B) The percentages of diabetes, dyslipidemia and coronary heart disease in patients with uncontrolled and uncontrolled high blood pressures. CCB – calcium channel blockers; ACEI – angiotensin-converting enzyme inhibitors; ARB – angiotensin II receptor blockers.

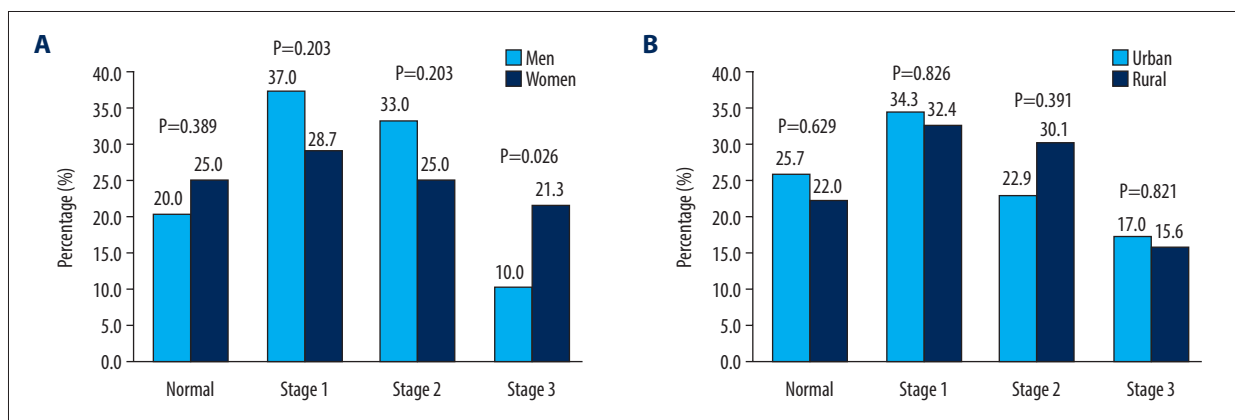


Figure 4. (A, B) The blood pressure levels in hemorrhagic stroke survivors by region and sex.

Discussion

The present study comprehensively assessed the epidemiological characteristics of hypertension among the hemorrhagic stroke population in northeast China. The high prevalence and low control rate of hypertension among hemorrhagic stroke survivors significantly increased the burden of stroke in this population. Moreover, the high proportions of stages 2 and above hypertension indicate considerable underlying risk of unfavorable cardiovascular outcomes in a population with hemorrhagic stroke, especially in women. Therefore, long-term follow-up and management of hypertension in the hemorrhagic stroke population are critically important for improving the prognosis in northeast China.

Stroke has become the leading cause of death in China, and hemorrhagic stroke accounts for 20.2% of all stroke types in the Chinese population [16]. According to our previous study, the prevalence of hemorrhagic stroke in people aged ≥ 40 years was 1.0% and 0.6% in rural and urban northeast China,

respectively, which is significantly higher than the national average levels [9,15]. In addition, the geographical variations and a north-to-south gradient in stroke was confirmed previously; northeast China had the highest incidence and mortality rates of stroke, and this may be attributed to the low socio-economic status and high prevalence of other risk factors in northeast China [16].

High blood pressure is the most important reversible risk factor for all kinds of stroke. Experts unanimously recommend identifying and controlling blood pressure in stroke patients in order to improve the prognosis and avoid recurrence of stroke [17]. In our study, the prevalence of hypertension among patients with prior hemorrhagic stroke was 88.0%, higher than the 75–82.5% reported in other studies [18,19], and significantly higher than the rate of hypertension in the general population (56.8%) of northeast China [12]. Therefore, long-term control of hypertension in the population with prior hemorrhagic stroke could have considerable benefits in northeast China.

Both diastolic hypertension and systolic hypertension are strongly related to the onset of primary or recurrent stroke, and even a slight decrease in blood pressure can greatly reduce the risk of stroke [20]. In our hemorrhagic stroke population, we found the mean SBP and DBP remain high, and many patients have stage 2 or above hypertension, especially women, suggesting that this population will be at a higher risk of adverse cerebrovascular events in the coming decades.

Previous studies indicated that in hemorrhagic stroke survivors, the most effective method to improve prognosis and reduce mortality is preventing recurrent stroke [21], and blood pressure should be well and intensively controlled to prevent stroke recurrence [22,23]. Although the reduction of blood pressure in the acute phase of hemorrhagic stroke is still controversial, we should still emphasize the importance of long-term treatment of hypertension in patients with previous hemorrhagic stroke. However, in our patient cohort, the treatment rate of hypertension was far from satisfactory, indicating that secondary stroke prevention was not sufficiently effective in northeast China.

Primary prevention of stroke through the management of hypertension has been well established, but the issue of lowering blood pressure after stroke remains uncertain [5]. However, previous studies reported that for patients with a history of stroke, antihypertensive therapy could significantly reduce the possibility of new stroke, myocardial infarction, or vascular events [5]. A previous study demonstrated that high blood pressure at hospital admission is a predictor for mortality in patients with hemorrhagic stroke, independent of any history of hypertension, and aggressive reduction of blood pressure to <140 mmHg can reduce the risk of hematoma expansion and leads to greater therapeutic benefit [24]. Several clinical trials showed that targeting an SBP of about 140 mmHg in patients with hemorrhagic stroke appears to be safe [25]. A previous study showed that a very low-normal SBP level (<120 mmHg) and high SBP (≥ 140) were both related to an increase of stroke recurrence risk [26]. Therefore, in our present study, the hypertension control rate was defined as 140/90 mmHg. Even so, in our study population, the control rate of hypertension remains unacceptably low, indicating the considerable stroke burden in those areas.

The present study comprehensively evaluated the epidemiology of hypertension among patients with a history of hemorrhagic stroke in northeast China, providing population-based evidence for developing effective stroke prevention and care

strategies in those areas. However, our study still has several limitations. Firstly, as it is a cross-sectional survey, we only obtained data on blood pressure at a certain point in time. Twenty-four-hour ambulatory blood pressure monitoring has become an important tool to improve the management of hypertension; however, current guidelines only recommend ambulatory blood pressure monitoring when identifying resistant hypertension, white-coat hypertension, and assessing drug efficacy [27,28]. Moreover, further studies focusing on the relationship between hypertension and long-term outcomes in the stroke population should be undertaken. In addition, the target blood pressure for stroke survivors remains uncertain. In the present study, hypertension control was defined as SBP <140 mmHg and DBP <90 mmHg. Finally, since we only focused on the epidemiology of cardiovascular diseases in northeast China, other risk factors and comorbidities, including diabetes and dyslipidemia, were not assessed. Further studies are needed to collect data on diseases such as COPD and cancer, and to assess the time of diagnosis of hypertension.

Conclusions

Our study shows the worrisome status of hypertension among patients with prior hemorrhagic stroke in northeast China. The high prevalence and poor management of hypertension, in addition to high rates of stage 2 and stage 3 hypertension, indicate the substantial stroke burden in northeast China. Therefore, effective strategies and long-term management of hypertension among this high-risk population should be strongly recommended in northeast China.

Availability of data and materials

The datasets used and analyzed during this study are available from the corresponding author on reasonable request.

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Conflict of interests

None.

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