

ORIGINAL ARTICLE

Prevalence of atrial fibrillation and the risk of cardiovascular mortality among hypertensive elderly population in northeast China

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Abstract

Little is known about the epidemiology and impact of atrial fibrillation (AF) on cardiovascular diseases (CVD) mortality among hypertensive elderly population in northeast China. The community-based study included 4497 hypertensive elderly residents aged ≥ 65 years who lived in northeast China from September 2017 to March 2019. Information on CVD deaths was obtained from baseline until July 31, 2021. Cox proportional hazard regression models were performed in the evaluation of CVD mortality. We identified 101 persons with AF. The prevalence of AF was 2.2% among elderly hypertensive population, which increased significantly with age. The prevalence of AF was higher in men than in women. The awareness rate was 51.5%, higher in urban areas than in rural areas (68.8% vs 43.5%, $P = .018$). Only 4.0% patients received oral anticoagulant (OAC) therapy among AF patients. Moreover, diabetes (26.7%) and dyslipidemia (37.6%) were highly prevalent in AF patients. Furthermore, 212 persons died due to CVD (14.7/1000 person-years) during a median follow-up of 3.2 years. AF patients had a 3.42 (95% CI: 2.07-5.63) times higher risk of CVD mortality than the patients without AF in the fully adjusted model. Therefore, the burden of AF among hypertensive elderly population in northeast China was considerable. Long-term screening and management strategies for AF and related risk factors are required among hypertensive elderly in northeast China.

KEYWORDS

atrial fibrillation, cardiovascular diseases, hypertension, mortality

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1 | INTRODUCTION

Atrial fibrillation (AF) has been considered as the most common clinically relevant arrhythmia characterized by rapid disorganized excitation of the atria and irregular activation of the ventricles.¹ It affects patient cardiac performance, functional status, and quality of life, responsible for the increased risk of hospitalization, heart failure and stroke.² The burden of AF remains alarming. Nearly 33.5 million population had AF in 2010, responsible for 195 300 death in 2015 globally, and the numbers are likely increase significantly in the following years.³ In addition, the prevalence of AF varies widely due to different population and age group, which increased from 0.5% among population aged ≤ 50 years up to 10%-17% among people aged ≥ 80 years old.⁴ AF primarily affects the elderly. Seventy percent of patients with AF are over 75 years old.⁵ Therefore, screening and management AF in the elderly are imperative in terms of reducing cardiovascular mortality.

AF frequently coexists with hypertension, not only because hypertension increases the incidence of AF, but also because they share common risk factors such as diabetes, dyslipidemia, and obesity. Previous studies indicated that the incidence of AF was strongly associated with elevated systolic and diastolic blood pressure levels.^{6,7} Patients with hypertension were at a high risk of developing AF. Moreover, even in patients undergoing catheter ablation, well-controlled hypertension improved the long-term prognosis.⁸ Those findings suggested that adequate blood pressure management may decrease AF burden.

AF and hypertension have become major societal and public health challenges in China.⁹ With the rapid changing demographics of the Chinese population and economic progress, there will be a considerable increase in the proportion of elderly persons, which indicates the burden of AF and hypertension is increasing. Furthermore, AF is a major contributor to hospitalization and long-term disability and death resulting from thromboembolic complications, compared with persons without AF. Patients with AF have higher rates of in-hospital death.¹⁰ Therefore, screening and management of AF should be highlighted, especially in the elderly.

However, many of the previous population-based studies in AF were limited by population and racial diversity.¹¹ Accurate estimation of the epidemiology of AF and its relationship to mortality among elderly hypertensive population has important implications for formulating the current and future burden. Therefore, in the present study, we aimed to profile the up-to-date characteristics of AF among elderly hypertensive population, and to further evaluate whether AF contribute to CVD mortality in northeast China.

2 | METHODS

2.1 | Study population

The present study was a community-based prospective cohort study, with a median follow-up period of 3.2 years. Detailed information has

been provided previously.¹² Briefly, a multistage, random cluster sampling method was used to select a representative sample aged ≥ 40 years in rural and urban areas of Liaoning Province from September 2017 to March, 2019, in northeast China. All permanent residents aged ≥ 40 years in each village and community ($n = 22\ 009$) were eligible to participate, and a total of 18796 (85.4%) participants completed the study. We finally enrolled persons aged ≥ 65 years with hypertension ($n = 4497$) in the present study. All study participants were invited for follow-up until July 31, 2021, or death (Figure. 1). The study was approved by the Ethics Commission of the CPC Central Committee of the China Cardiovascular Disease Center (Beijing). All participants obtained written informed consent.

2.2 | Baseline data collection

As previously described, baseline data were collected using a self-administered questionnaire in a face-to-face interview during a single clinic visit.¹² After at least 5 minutes of rest, blood pressure (BP) was measured three times at 2-minute intervals in the sitting position, using a standardized automatic electronic sphygmomanometer (J30; Omron, Kyoto, Japan). During the interview, participants were asked whether they had antihypertensive medications in the past 2 weeks. According to the Chinese guidelines for the management of hypertension, hypertension was defined as a mean systolic BP ≥ 140 mmHg or a mean diastolic DBP ≥ 90 mmHg and/or self-reported use of antihypertensive medication in the past 2 weeks.¹³

Twelve-lead electrocardiographs (ECGs) were recorded for all persons after a 10 seconds rest by trained cardiologists, using a MAC 5500 (GE Healthcare; Little Chalfont, Buckinghamshire, UK). The ECGs were manually analyzed by at least two well-trained cardiologists using a magnifying glass and calipers.

AF is identified based on the American College of Cardiology (ACC)/American Heart Association (AHA)/European Society of Cardiology (ESC) guideline, including absence of consistent P waves; presence of rapid, irregular F waves with a frequency of 350–600 beats/min, and an irregular ventricular response.¹⁴ The ECG-based diagnoses of AF made during the survey were confirmed by at least two independent cardiologists. Those persons diagnosed with AF by a physician based on ECG findings previously were also identified as AF patients.¹⁵ Because each person was recorded as having a medical history of AF, awareness was defined as self-report of a previous AF diagnosis. Treatment of AF was defined as AF patient undergoing thromboembolic prophylaxis with oral anticoagulant (OAC) therapy according to 2012 ESC guidelines.¹⁶ Current smoking, current drinking, lack of exercise, stroke, overweight, or obesity have been described previously.¹⁷ Current smoking was defined as the consumption of ≥ 1 cigarette/day and lasted for ≥ 1 year, current drinking was considered as any alcohol consumption ≥ 1 time/week. Regular exercise was defined as moderate-intensity exercise or equivalent to walking for at least 30 minutes and three times per week; participants with moderate and heavy manual work were considered to fulfill the criteria. Lack of

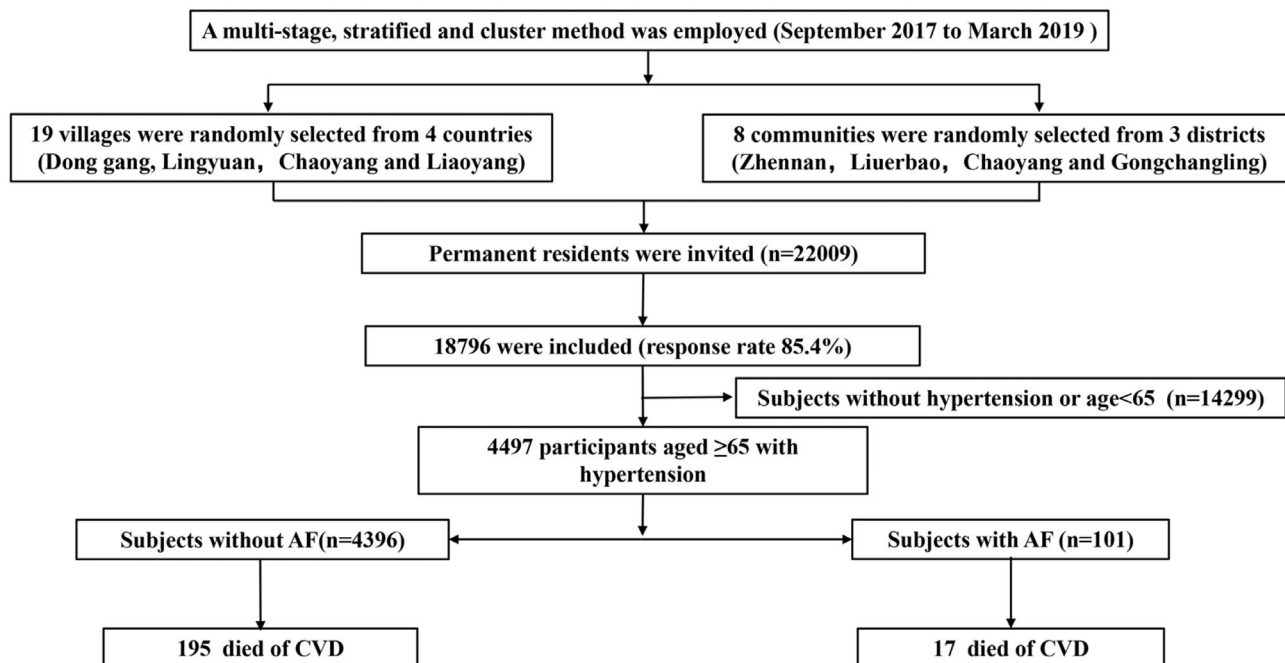


FIGURE 1 Flow chart of the patient selection process

exercise was identified when participants failed to meet the criteria for regular exercise.¹⁷

2.3 | Outcome measures

Information on CVD and all-cause deaths was obtained from baseline until July 31, 2021. Mortality data was obtained from the National Population Registry of the China National Statistical Office. We accessed the database containing death certificates for CVD and all-cause deaths that occurred between the date of undertaking the cross-sectional study and July 31, 2021. The cause of death was determined by reviewing and classifying the death certificates according to the death code (International Classification of Diseases, 10th Revision).

2.4 | Statistical analysis

The continuous variables with normal distribution are reported as means and standard deviations (SD), numerical data were expressed as rates. Multivariable-adjusted models include three models: Model 1 was unadjusted; Model 2 was adjusted for age, sex, and regions; Model 3 was age, sex, region, body mass index, diabetes, dyslipidemia, current smoking, current drinking, educational level, household income, lack of exercise, stroke, treatment of hypertension, use of OAC therapy. Cox proportional hazard regression models were used in the evaluation of risk of CVD death in patients who had AF and those who did not. SPSS22.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses; *P* values < .05 were considered statistically significant.

3 | RESULTS

3.1 | Characteristics of the study population at baseline

Totally, 4497 hypertensive participants aged ≥ 65 years (50.2% men, 49.8% women; 26.9% urban, 73.1% rural) were included in the analysis (Table 1). The average age of the population was 71.6 ± 5.4 years. A significant difference was observed between urban and rural areas as well as men and women for all characteristics such as age, education level, house-hold income, body mass index (BMI), prevalence of current smoking, drinking, and lack of exercise. When compared with urban residents, rural residents had a relatively higher prevalence of low education, low income, low BMI, current smoking, drinking, and lack of exercise.

3.2 | Prevalence of AF among hypertensive elderly at baseline

Of all the participants at baseline, 101 persons were diagnosed with AF. The prevalence of AF was 2.2%, increasing significantly with advancing age group and ranging from 1.7% among persons 65–69 years to 4.9% among participants ≥ 80 years. The prevalence of AF was higher in men than in women (3.0% vs 1.7%, *P* = .004). In women, the AF prevalence increased from 1.1% among participants aged 65–69 years to 4.5% among participants aged ≥ 80 years. In men, the prevalence increased from 2.6% among participants aged 65–69 years to 5.3% among those ≥ 80 years. Moreover, no significant difference was observed between urban and rural residents (2.6% vs 2.1%, *P* = .276, Table 2).

TABLE 1 Characteristics of the study population

Characteristics	Region		Sex		Total	P value for region	P value for sex
	Urban	Rural	Men	Women			
Participant, no. (%)	1211 (26.9)	3286 (73.1)	495 (50.2)	491 (49.8)	4497 (100.0)		
Mean age, years, no.%	71.4 ± 5.5	71.6 ± 5.4	71.9 ± 5.7	71.3 ± 5.3	71.6 ± 5.4	.126	<.001
65-69	569 (47.0)	1426 (43.4)	802 (42.2)	1193 (46.0)	1995 (44.4)	.040	.014
70-74	318 (26.3)	974 (29.6)	543 (28.5)	749 (28.9)	1292 (28.7)		
75-79	225 (18.6)	575 (17.5)	368 (19.3)	432 (16.6)	800 (17.8)		
≥ 80	99 (8.2)	311 (9.5)	189 (9.9)	221 (8.5)	410 (9.1)		
Education, no. (%)							
Primary school or lower	518 (42.8)	2602 (79.2)	1117 (58.7)	2003 (77.2)	3120 (69.4)	<.001	<.001
Middle school	508 (41.9)	572 (17.4)	589 (31.0)	491 (18.9)	1080 (24.0)		
High school or above	185 (15.3)	112 (3.4)	196 (10.3)	101 (3.9)	297 (6.6)		
Household income, yuan, no. (%)							
<5000	122 (10.1)	2247 (68.4)	931 (48.9)	1438 (55.4)	2369 (52.7)	<.001	<.001
5000-9999	111 (9.2)	557 (17.0)	287 (15.1)	381 (14.7)	668 (14.9)		
10 000-19 999	168 (13.9)	263 (8.0)	181 (9.5)	250 (9.6)	431 (9.6)		
≥ 20 000	810 (66.9)	219 (6.7)	503 (26.4)	526 (20.3)	1029 (22.9)		
Mean BMI, kg/m² no. (%)							
25.4 ± 3.4	25.4 ± 3.4	24.3 ± 3.8	24.0 ± 3.5	25.0 ± 3.9	24.6 ± 3.7	<.001	<.001
<18.5	19 (1.6)	161 (4.9)	84 (4.4)	96 (3.7)	180 (4.0)	<.001	<.001
18.5-23.9	392 (32.4)	1460 (44.4)	897 (47.2)	955 (36.8)	1852 (41.2)		
24.0-27.9	556 (46.0)	1146 (34.9)	687 (36.1)	1015 (39.1)	1702 (37.9)		
≥ 28.0	243 (20.1)	519 (15.8)	233 (12.3)	529 (20.4)	762 (16.9)		
Mean SBP, mmHg	153.9 ± 16.7	163.5 ± 19.2	160.0 ± 18.3	161.7 ± 19.6	160.9 ± 19.1	<.001	.002
Mean DBP, mmHg	87.0 ± 9.7	89.3 ± 11.2	90.0 ± 10.6	87.7 ± 11.0	88.7 ± 10.9	<.001	<.001
Current smoking, no. (%)	181 (14.9)	793 (24.1)	795 (41.8)	179 (6.9)	974 (21.7)	<.001	<.001
Current drinking, no. (%)	203 (16.8)	768 (23.4)	836 (44.0)	135 (5.2)	971 (21.6)	<.001	<.001
Lack of exercise, no. (%)	140 (11.6)	906 (27.6)	362 (19.0)	684 (26.4)	1046 (23.3)	<.001	<.001

Abbreviations: AF, atrial fibrillation; BMI, body mass index; DBP, diastolic blood pressure; FBG, fasting blood glucose; SBP, systolic blood pressure.

Note: Data are presented as mean ± standard deviation or *n* (%).

P for region: P values between urban and rural areas, P for sex: P values between men and women.

3.3 | Awareness of and OAC therapy for AF among hypertensive elderly at baseline

Among the participants with AF, 51.5% were aware of their diagnosis, and the rate was higher among urban residents than among rural residents (68.8% vs 43.5%, $P = .018$); however, the awareness of women versus men did not reach statistical significance (56.8% vs 47.4%, $P = .346$, Table 2).

The proportion of AF patients receiving OAC therapy was 4.0%. The OAC treatment rate was higher in urban areas than that in rural areas (9.4% vs 1.4%, $P = .059$). Moreover, the OAC treatment rates tended to be higher in women than in men (4.5% vs 3.5%, $P = .792$), although they did not reach statistical significance (Figure 2).

3.4 | Related risk factors in the AF population among hypertensive elderly at baseline

Among the elderly hypertensive patients with AF, 26.7% had diabetes, and 37.6% had dyslipidemia. In addition, a high percentage of AF patients had current smoking (18.8%) and drinking (20.8%), lack of exercise (27.7%), and overweight or obesity (59.4%, Table 3).

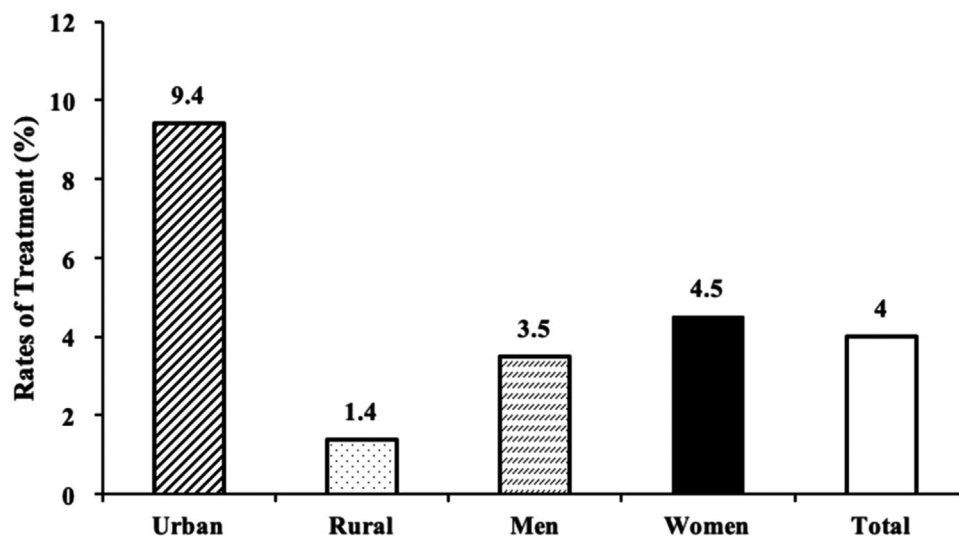
3.5 | The risk of CVD death among AF hypertensive elderly population

During the median follow-up of 3.2 years, 212 (14.7/1000 person-years) participants died due to CVD. Among persons with and without

TABLE 2 Prevalence and awareness of atrial fibrillation by region and sex among hypertensive elderly population in northeast China, 2017-2019

Age Group	No.	Region		Sex		Total	P for region	P for sex
		Urban	Rural	Men	Women			
Prevalence								
65-69	34	2.5	1.4	2.6	1.1	1.7	.099	.010
70-74	24	1.9	1.8	1.8	1.9	1.9	.965	.971
75-79	23	3.1	2.8	4.3	1.6	2.9	.803	.021
≥ 80	20	5.1	4.8	5.3	4.5	4.9	.927	.720
Overall	101	2.6	2.1	3.0	1.7	2.2	.276	.004
Awareness								
65-69	21	71.4	55.0	47.6	84.6	61.8	.332	.031
70-74	12	100.0	33.3	60.0	42.9	50.0	.005	.408
75-79	10	42.9	43.8	43.8	42.9	43.5	.968	.968
≥ 80	9	60.0	40.0	40.0	50.0	45.0	.436	.653
Overall	52	68.8	43.5	47.4	56.8	51.5	.018	.346

Note: Prevalence: Percentages represent the number of patients with atrial fibrillation/ total hypertensive elderly population Awareness: Percentages represent the number with self-report of a previous AF diagnosis/ the total number of patients with atrial fibrillation.

**FIGURE 2** Use of oral antithrombotic agents in atrial fibrillation patients requiring oral anticoagulant therapy**TABLE 3** Prevalence of cardiovascular risk factors in the AF population among hypertensive elderly (%)

	Urban	Rural	Men	Women	Total	P for region	P for sex
Diabetes	40.6	20.3	24.6	29.5	26.7	.032	.575
Dyslipidemia	46.9	33.3	35.1	40.9	37.6	.191	.549
Current smoking	15.6	20.3	29.8	4.5	18.8	.577	.001
Alcohol drinking	12.5	24.6	35.1	2.3	20.8	.162	<.001
Lack of Exercise	6.3	37.7	22.8	34.1	27.7	.001	.209
Overweight or Obesity	71.9	53.6	52.6	68.2	59.4	.082	.115

Note: Prevalence: Percentages represent the number patients with specific diseases / AF population among hypertensive elderly.

TABLE 4 Rates and rate ratios with 95% CI of cardiovascular diseases mortality according to the prevalence of atrial fibrillation at baseline

Category	Number of events	Follow-up (person-years)	Rate (per 1000 person-years)	Model 1	Model 2	Model 3
CVD Death						
HP (+)/AF (-)	195	14106.6	13.8	1.00	1.00	1.00
HP (+)/AF (+)	17	304.21	55.9	4.07 (2.48,6.68)	3.29 (2.00,5.41)	3.42 (2.07,5.63)

Model 1 unadjusted;

Model 2 adjusted for age, sex, region;

Model 3 adjusted for age, sex, region, body mass index, diabetes, dyslipidemia, current smoking, current drinking, educational level, household income, lack of exercise, stroke, treatment of hypertension, use of OAC therapy.

AF, the mortality rate of CVD was 55.9 and 13.8 per 1000 person-year (PY). AF patients had a 3.42 (95% CI: 2.07-5.63) times higher risk of CVD mortality than patients without AF after fully adjusted (Table 4).

4 | DISCUSSION

The present study provided a more accurate and reliable profile of AF among elderly hypertensive population in northeast China, which allows providing opportunities to formulate population-based care in those areas. The major findings of the study were (1) The crude AF prevalence was 2.2% among hypertensive elderly in northeast China, which increased significantly with advancing age group and ranged from 1.7% among persons 65–69 years to 4.9% among participants \geq 80 years. (2) 51.5% were aware of their AF diagnosis, and 4.0% received OAC therapy. The rates of awareness and treatment were higher in urban areas than in rural areas. (3) A high prevalence of comorbidities including diabetes, dyslipidemia, overweight, or obesity was revealed in AF persons, and control rates of diabetes and dyslipidemia were low. (4) AF significantly increased the risk of CVD mortality in hypertensive elderly. Those findings suggested the considerable cardiovascular burden among hypertensive elderly in northeast China. Therefore, efforts to promote OAC therapy and control of CVD risk factors in hypertensive elderly should be emphasized.

The prevalence is significantly related with geographic and racial or cultural variations. The prevalence of AF ranges from 0.4% to 1.5% in the general Asian population,¹⁸ which is lower than the 1–2% reported by the ESC 2010.^{19,20} It has been estimated that approximately 9 million will suffer AF in China by 2050, due to population aging, economic progress, and lifestyle changes. Therefore, AF should be actively screened, especially among patients at risk including hypertensive and elderly population.

Hypertension is a public health challenge globally, affecting approximately half of adults, and the number remains growing due to population aging.²¹ Hypertension is often accompanied by other cardiovascular diseases, and remains to be a well-established risk factor for AF, accounting for 14% of all AF cases.²² Hypertension and AF have an intimate association, and the previous study indicated that hypertension has doubled the risk for AF incidence when compared with normotensive population.²³ However, in the present study, we found the

prevalence of AF in hypertensive elderly population was 2.2%, significantly lower than 3.46% as previously reported in Thailand.²⁴ In that large national cross-sectional study, they enrolled 13 207 hypertensive patients aged \geq 20 years with available ECG from 831 hospitals under the Thai universal coverage scheme.²⁴ In contrast, our study population was generated from general population, despite the mean age was higher in our study. In addition, geographic and racial or cultural variations, as well as economic progress and lifestyle might also contribute to the difference.

Moreover, consistent with previous study,²⁵ we found the AF prevalence was higher in men than in women among elderly hypertensive population in northeast China. This sex-associated discrepancy might be related to differences in lifestyle and distribution of risk factors between men and women.²⁶ Additionally, no significant difference was observed between urban and rural residents, and rapid urbanization of rural populations is likely to contribute to this urban-rural convergence in China. Furthermore, the overall awareness of AF was 51.5% among elderly hypertensive population, which is roughly consistent with general population as we previously studied,²⁷ indicating the monitoring of AF remains inadequate in northeast China, even in population at high-risk.

Current guidelines suggested AF patients with CHA₂DS-VASc \geq 1 for men or CHA₂DS-VASc \geq 2 for women need ongoing thromboembolic prophylaxis with OAC therapy in terms of reducing cardiovascular risks.¹⁴ However, in our study, only 4.0% actually received OAC therapy. Although the OAC therapy rate was similar with previously reported 4.1% in general population,²⁷ it remained significantly lower than the rate reported in developing countries ranging from 50% to 71%.²⁸ Therefore, long-term education and management of AF among hypertensive population in northeast China should be highlighted.

Previous research identified that AF is usually accompanied by other risk factors such as diabetes, dyslipidemia, obesity, and current smoking.^{29–31} The impact of AF will be amplified as risk factors continue to risk, given the fact AF confers a great burden on patients. In our study, we revealed that a large percentage of our elderly AF hypertensive population had diabetes and dyslipidemia as well as other risk factors, suggesting the cardiovascular risk in the coming years remains increasing in northeast China.

Detection of AF in high-risk populations is imperative in regarding of improving prognosis according to Framingham Heart Study.²⁹ AF

is related to age-adjusted 1-year mortality rates, significantly higher than patients without AF.³² Although AF is significantly contributed to increased mortality in different population, the excess mortality among hypertensive elderly population in northeast China remains unknown. In the present study, we found that AF independently increased CVD mortality 3.42-fold, indicating great effort should be made on the screening and management of AF in hypertensive elderly population.

4.1 | Limitations

The strength of the present study is that we provided prospective population-based data on evaluating the AF status in northeast China, which allows a relatively reliable estimation of AF burden in elderly hypertensive population. However, the study still has several limitations. First, some paroxysmal AF cases were likely to be missing in the study, because both continuous ambulatory ECG monitoring and frequent repeated ECG were not suitable for large-scale population-based studies. The prevalence of AF was likely to be underestimated as other studies.³² In addition, the differences in medical conditions between rural and urban areas might lead to underestimation of paroxysmal atrial fibrillation, however, with the rapid economic progression and urbanization of Chinese population, the urban-rural gap gradually narrowed.³³ Moreover, previous study showed convergence in urban-rural prevalence of hypertension at a national level,⁶ therefore, the study bias between urban and rural areas was greatly minimized. Second, we did not evaluate AF incidence in the present study. However, the study is ongoing, and further analysis will be performed recently. Third, the number of AF patients in the study population was relatively small, and the follow-up period was relatively short. Nevertheless, the relationship between AF and CVD mortality was statistically significant in hypertensive elderly population. Moreover, the study was undertaken in northeast China, and generalizability of our results might be limited in other regions or race. Therefore, more researches are needed to replicate the findings in other populations. Lastly, the determination of hypertension was based on readings from a single day, which might lead to an overestimate or underestimate of the hypertension prevalence in the present study, although three measurements were taken on the single visit.

5 | CONCLUSION

The present study revealed the overall AF prevalence of 2.2% among hypertensive elderly population in northeast China. A large proportion AF patients coexisted with other cardiovascular risk factors, and the control rates of major comorbidities remain far below satisfactory. Moreover, AF was independently related to high risk of CVD mortality. Therefore, strategies for focusing on screening and management of AF as well as risk factors should be emphasized in order to reduce cardiovascular burden in northeast China.

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CONFLICT OF INTEREST

The authors declared they have no competing interests.

AUTHOR CONTRIBUTIONS

LY and HC were responsible for the concept and design of the study. ZX was responsible for the study coordination and conduct. ZX, LY, and HC contributed to the drafting of the manuscript. WD, XY, QS, JS, and LS collected and analyzed the data. SS, LA, XL, HP, and SL interpreted the data. All authors read and approved the final manuscript.

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