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Stage 1 hypertension defined by the 2017 ACC/AHA guideline predicts future cardiovascular events in elderly Chinese individuals

Yanxia Xie MD[1] | Jinyue Gao MD[1] | Rongrong Guo MD[1] | Jia Zheng MD[1] | Yali Wang MD[1] | Yue Dai MD[1] | Zhaoqing Sun MD[2] | Liying Xing MD[3] | Xingang Zhang MD, PhD[4] | Ying Xian Sun MD, PhD[2] | Liqiang Zheng MD, PhD[1]

[1]Department of Clinical Epidemiology, Library, Shengjing Hospital of China Medical University, Shenyang, China

[2]Department of Cardiology, Shengjing Hospital of China Medical University, Shenyang, China

[3]Institute of Chronic Disease, Liaoning Provincial Center for Disease Control and Prevention, Shenyang, China

[4]Department of Cardiology, the First Affiliated Hospital of China Medical University, Shenyang, China

Correspondence
Liqiang Zheng, Department of Clinical Epidemiology, Library, Shengjing Hospital of China Medical University, Shenyang 110004, China.
Email: liqiangzheng@126.com

Ying Xian Sun, Department of Cardiology, Shengjing Hospital of China Medical University, 36 Sanhao Street, Heping District, Shenyang 110004, China.
Email: sunyingxian12@126.com

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Abstract

The 2017 American College of Cardiology and American Heart Association (ACC/AHA) hypertension guideline updated stage 1 hypertension defined as systolic blood pressure (SBP) of 130-139 mm Hg or diastolic blood pressure (DBP) of 80-89 mm Hg. However, the impact of 1 hypertension that affects future cardiovascular risk remains unclear among older adults in rural China. The prospective cohort study included 7503 adults aged ≥60 years with complete data and no cardiovascular disease (CVD) at baseline. Follow-up for the new adverse events was conducted from the end of the baseline survey to the end of the third follow-up survey (2007.01-2017.12). Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (95% CIs) for blood pressure (BP) classifications and adverse events with normal BP as reference (< 120/80 mm Hg). During the 57 290 person-years follow-up period, 2261 all-cause mortality, 1271 CVD mortality, 1159 stroke, and 347 myocardial infarctions (MI) occurred. Patients with stage 1 hypertension versus normal BP had HRs (95% CI) of 1.068 (0.904-1.261) for all-cause mortality, 1.304 (1.015-1.675) for CVD mortality, 1.449 (1.107-1.899) for stroke, and 1.735 (1.051-2.863) for MI, respectively. In conclusion, among adults aged ≥60 years, stage 1 hypertension revealed an increased hazard of CVD mortality, stroke, and MI, which is complementary evidence for the application of 2017 ACC/AHA hypertension guidelines in an older Chinese population. Therefore, BP control in patients with stage 1 hypertension may be beneficial to reduce the hazard of CVD in elderly Chinese individuals.

1 | INTRODUCTION

On November 13, 2017, the American College of Cardiology/American Heart Association (ACC/AHA) Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults was published. An updated guideline defined stage 1 hypertension as systolic blood pressure (SBP) of 130 to 139 mm Hg or diastolic blood pressure (DBP) of 80 to 89 mm Hg.[1] The validity of stage 1 hypertension defined by 2017 ACC/AHA guideline that affects future cardiovascular disease (CVD) risks in different populations plays a very important role in applying the new definition.

Yanxia Xie, Jinyue Gao and Rongrong Guo contributed equally to this work.

Wang et al[2] showed that the implementation of the new stage 1 cutoff increased the prevalence of hypertension from 23.2% to 46.4%, and according to the 2010 census, the elderly populations (aged ≥60 years) account for 13.19% of the total population in China.[3] These data indicated that more attention should be paid to the blood pressure (BP) status of the elderly populations. However, few studies have been able to show the association between stage 1 hypertension and CVD risk among older adults. Qi Y et al[4] demonstrated that stage 1 hypertension increased the risk of cardiovascular events in young and middle-aged adults, but not in those aged ≥60 years. In addition, Mohammad Talaei, et al[5] indicated that stage 1 hypertension was associated with increased cardiovascular risk only in those <65 years of age and without a history of CVD (hazard ratio [HR], 1.40; 95% confidence interval [CI], 1.01-1.94), excluding those ≥65 years of age or with a history of CVD. These authors also claimed that further validation of their results using a larger sample size of older people is still required.

The aim of the present study was to validate the association between stage 1 hypertension and adverse events and to explain the applicability of the new guideline in those aged ≥60 years of rural China based on a large representative sample.

2 | METHODS

2.1 | Study population

This is a prospective cohort study performed in rural areas of Fuxin county, Liaoning province.[6,7] Briefly, we adopted a multistage, randomly stratified, cluster-sampling scheme that included 45 925 samples aged ≥35 years from 8 towns and 84 rural villages from various regions of the county in 2004-2006, which have been designed to assess the prevalence, incidence, and risk factors of cardiovascular diseases. The follow-up procedure was conducted from January to July 2008, from July to December 2010, and from March to December 2017. New cases of adverse events (mortality, stroke, and myocardial infarctions [MI]) were collected from the end of the baseline survey to the end of the third follow-up survey (2007.01-2017.12). Of the 45 925 participants at baseline, 3883 subjects had missing contact information or refused to attend the follow-up, and 42 042 (91.5%) of participants were eligible to attend the follow-up at least one time. The study population inclusion and exclusion process are illustrated in Figure 1. In the current study, 9959 participants aged ≥60 years were selected. Of these, participants meeting the following criteria were also excluded: (a) incomplete follow-up (n = 1151), (b) participants with CVD before baseline or at baseline survey (CVD history [stroke and coronary heart disease [CHD], including MI, arrhythmia, and angina] according to the participants self-report) (n = 1117), and (c) missing physical activity at baseline (n = 188), leaving 7503 participants for final analysis.

The research protocol was approved by the China Medical University Research Ethics Committee, and written informed consent was formally obtained from all the participants or their guardians.

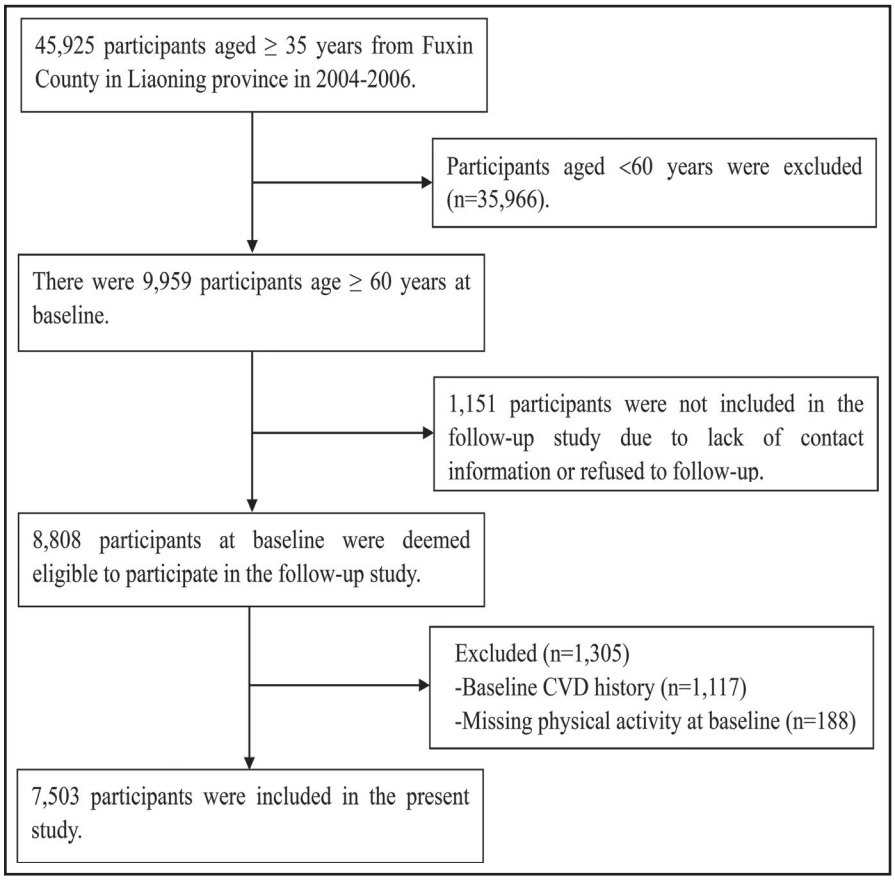

FIGURE 1 Flow chart of participant recruitment and derivation of the population used in the final analysis. CVD, cardiovascular disease

2.2 | Blood pressure measurement and classification

Blood pressure measurements were performed using a standard electronic automated sphygmomanometer (HEM-741C; Omron) by trained and professional staff according to the American Heart Association protocol.[8]

Participants were advised to avoid alcohol consumption, cigarette smoking, drinking coffee/tea, and exercise for at least 30 minutes and to rest at least 5 minutes prior to BP measurement. For each subject, three readings of measured BP were recorded, and the average of the BP readings was then calculated for final analysis.

According to the 2017 ACC/AHA guideline, subjects were categorized into 4 groups: normal BP (SBP <120 mm Hg and DBP <80 mm Hg); elevated BP (SBP 120-129 mm Hg and DBP <80 mm Hg); stage 1 hypertension (SBP 130-139 mm Hg or DBP 80-89 mm Hg); and stage 2 hypertension (SBP ≥140 mm Hg or DBP ≥90 mm Hg, or taking anti-hypertensive medications).

2.3 | Data collection and measurements

Data on demographic variables (age, gender, and ethnicity), lifestyle factors (current smoking, current drinking status, and physical activity), history of the disease (stroke, CHD, family history of hypertension, diabetes, or hyperlipemia), and information on anti-hypertensive medications were obtained by trained investigators through a standard questionnaire. Body weight and height were measured with subjects wearing light clothing and without shoes. Body mass index (BMI) was calculated by the weight in kilograms divided by height in square meters. Current smoking was defined as smoking at least one cigarette per day and lasting for at least a year.[6] Current drinking was defined as men and women were drinking beer, wine, or liquor ≥2 cups/day and ≥1 cup/day, respectively.[9] Based on the engaging in occupational and leisure time, the physical activity was defined in three levels as low, moderate, and high.[7] Family history of hypertension was defined as one of the parents of the participant with hypertension. The histories of stroke, CHD, diabetes, or hyperlipemia were self-reported and collected by the participants if they have been diagnosed by a physician. The information on adverse events, and concurrent medication use were collected at each follow-up.

2.4 | Study outcomes

The present study outcomes were adverse events, including all-cause mortality, CVD mortality, stroke incidence, and MI incidence. The number of mortality was determined by contacting family and viewing hospital records. According to the International Classification of Diseases, Ninth Revision (ICD-9), deaths resulted from CVD events were assigned a code from 400 through 444 including CHD, stroke, and others. The definition of stroke was defined as rapidly developing signs of focal (or global) disturbance of cerebral function lasting >24 hours (unless interrupted by surgery or death) with no apparent nonvascular cause, which including ischemic, hemorrhage, and uncategorized. According to the consensus document of the Joint European Society of Cardiology/American College of Cardiology Committee, MI was defined as a transient increase in laboratory markers specific of myocardial necrosis (CK-MB, or troponin T) in combination with ischemic symptoms and/or typical ECG signs (development of pathologic Q waves or ST segment elevation or depression). The information about the main outcome was collected regularly by qualified investigators every 3 months. The relevant information regarding new adverse events was obtained by direct reference to medical records.

All materials were independently reviewed by the end-point assessment committee, whose members were blinded to the study participants' baseline risk factor information.

2.5 | Statistical analysis

Continuous variables were presented as the means and standard deviations (SD), and categorical variables were expressed as percentages. The incidence rate was denoted by case load/1000 person-years. Chi-square test was used to test the rate difference among the four BP levels. The ANOVA or chi-square test was performed to observe whether there was a statistical difference between the groups. If so, the post hoc analysis further be used pairwise comparison.

The HRs and 95% CIs were estimated for all-cause mortality, CVD mortality, stroke, and MI by BP categories using Cox proportional hazards models, with the group of normal BP as the reference. We established 3 models: model 1 was unadjusted; model 2 was adjusted for sex, age, ethnicity, and education levels; and model 3 was adjusted for baseline BMI, current smoking, current drinking, anti-hypertensive treatment, physical activity, history of diabetes and hyperlipidemia, and family history of hypertension on the basis of model 2. The proportional hazard assumption of the Cox models was confirmed using Schoenfeld residuals. In addition, sensitivity analyses were performed after excluding participants who were taking anti-hypertensive medications. The difference in β coefficients between MI and stroke derived from the *Z* value was examined using the Fisher *Z* test.[10] All analyses were performed using IBM SPSS statistical software version 22.0. A 2-sided *P*-value <.05 was accepted as statistically significant.

3 | RESULTS

Our results included 7503 adults aged ≥60 years, approximately one half (49.4%) were women, and the mean age was 68.77 ± 6.91 years. Table 1 shows the mean values and percentages of study variables at baseline. The proportion of stage 1 hypertension was 1902 (25.3%) according to the 2017 ACC/AHA guideline. The mean values of SBP and DBP of the present study participants were 144.86 ± 25.58 and 84.31 ± 13.12 mm Hg, respectively. Compared with the normal BP level, patients with stage 1 hypertension showed more Mongolians, more moderate physical activity, and less higher physical activity.

Figure 2 shows the incidence of adverse events according to 2017 ACC/AHA guideline. During a median follow-up of 12.5 years,

TABLE 1 Baseline characteristics of study participants aged ≥60 y (N = 7503)

Characteristics	Total (N = 7053)	Blood pressure groups				*P*-Value
		Normal (n = 779)	Elevated (n = 636)	Stage 1 (n = 1902)	Stage 2 (n = 4186)	
Age,(y)	68.77 ± 6.91	67.76 ± 6.57[d]	68.34 ± 6.52[d]	68.07 ± 6.90	69.35 ± 6.97[a,b]	<.001
Women, n (%)	3709 (49.4)	384 (49.3)	320 (50.3)[c]	839 (44.1)[b,d]	2166 (51.7)[c]	<.001
Ethnicity, n (%)						
Han	5932 (79.1)	662 (85.0)[b,d]	506 (79.6)[a]	1537 (80.8)[d]	3227 (77.1)[a,c]	<.001
Mongolian	1485 (19.8)	110 (14.1)[c,d]	123 (19.3)	349 (18.3)[a,d]	903 (21.6)[a,c]	
Others	86 (1.1)	7 (0.9)	7 (1.1)	16 (0.8)	56 (1.3)	
Education level, (n) %						
Primary school or below	5832 (77.7)	605 (77.7)	485 (76.3)	1461 (76.8)	3281 (78.4)	.552
Middle school	1367 (18.2)	145 (18.6)	129 (20.3)	361 (19.0)	732 (17.5)	
High school or above	304 (4.1)	29 (3.7)	22 (3.5)	80 (4.2)	173 (4.1)	
Body mass index, kg/m^2						
<25	6276 (83.6)	703 (90.2)	576 (90.6)	1653 (86.9)[d]	3344 (79.9)[c]	<.001
25 ~ 30	1101 (14.7)	69 (8.9)[d]	52 (8.2)[c,d]	230 (12.1)[b,d]	750 (17.9)[a,b,c]	
≥30	126 (1.7)	7 (0.9)	8 (1.3)	19 (1.0)[d]	92 (2.2)[c]	
Physical activity, (n) %						
Low	4917 (65.5)	480 (61.6)	412 (64.8)	1144 (60.1)[d]	2881 (68.8)[c]	<.001
Moderate	1984 (26.4)	200 (25.7)[d]	173 (27.2)	597 (31.4)[d]	1014 (24.2)[a,c]	
High	602 (8.0)	99 (12.7)[b,c,d]	51 (8.0)[a]	161 (8.5)[a]	291 (7.0)[a]	
Systolic blood pressure (mm Hg)	144.86 ± 25.58	108.65 ± 8.16[b,c,d]	123.98 ± 3.13[a,c,d]	129.81 ± 7.42[a,b,d]	161.61 ± 20.98[a,b,c]	<.001
Diastolic blood pressure (mm Hg)	84.31 ± 13.12	68.45 ± 6.73[b,c,d]	71.86 ± 5.56[a,c,d]	80.16 ± 5.81[a,b,d]	91.04 ± 12.51[a,b,c]	<.001
Anti-hypertensive medications, n (%)	902 (12.0)	0 (0.0)	0 (0.0)	0 (0.0)	902 (21.5)	-
Current drinking, n (%)	1898 (25.3)	196 (25.2)	143(22.5)	454 (23.9)	1105 (26.4)	.060
Current smoking, n (%)	3060 (40.8)	320 (41.1)	262 (41.2)	744 (39.1)	1734 (41.4)	.396
History of diabetes, n (%)	37 (0.5)	2 (0.3)	3 (0.5)	7 (0.4)	25 (0.6)	.489
History of hyperlipidemia, n (%)	261 (3.5)	12 (1.5)[d]	10 (1.6)[d]	36 (1.9)[d]	203 (4.8)[a,b,c]	<.001
Family history of hypertension, n (%)	366 (4.9)	17 (2.2)[d]	12 (1.9)[d]	51 (2.7)[d]	286 (6.8)[a,b,c]	<.001

Note: Values are mean ± SD or n (%). *P*-values from ANOVA for continuous variables.
Normal: <120/80 mm Hg; Elevated: 120-129/<80 mm Hg; Stage 1:130-139/80-89 mm Hg; Stage 2: ≥140/90 mm Hg or accepted anti-hypertensive treatment.
[a]vs normal $P < .05$.
[b]vs elevated $P < .05$.
[c]vs stage 1 $P < .05$.
[d]vs stage 2 $P < .05$.

2261 all-cause mortality, 1,271 CVD mortality, 1,159 strokes, and 347 MI occurred. In terms of the overall trend, the incidence risk of all-cause mortality, CVD mortality, stroke, and MI were positively correlated with BP levels. In post hoc analyses, compared with normal BP level, patients with stage 1 hypertension indicated a higher incidence of CVD mortality (18.4 vs 12.9/1000 person-years) and

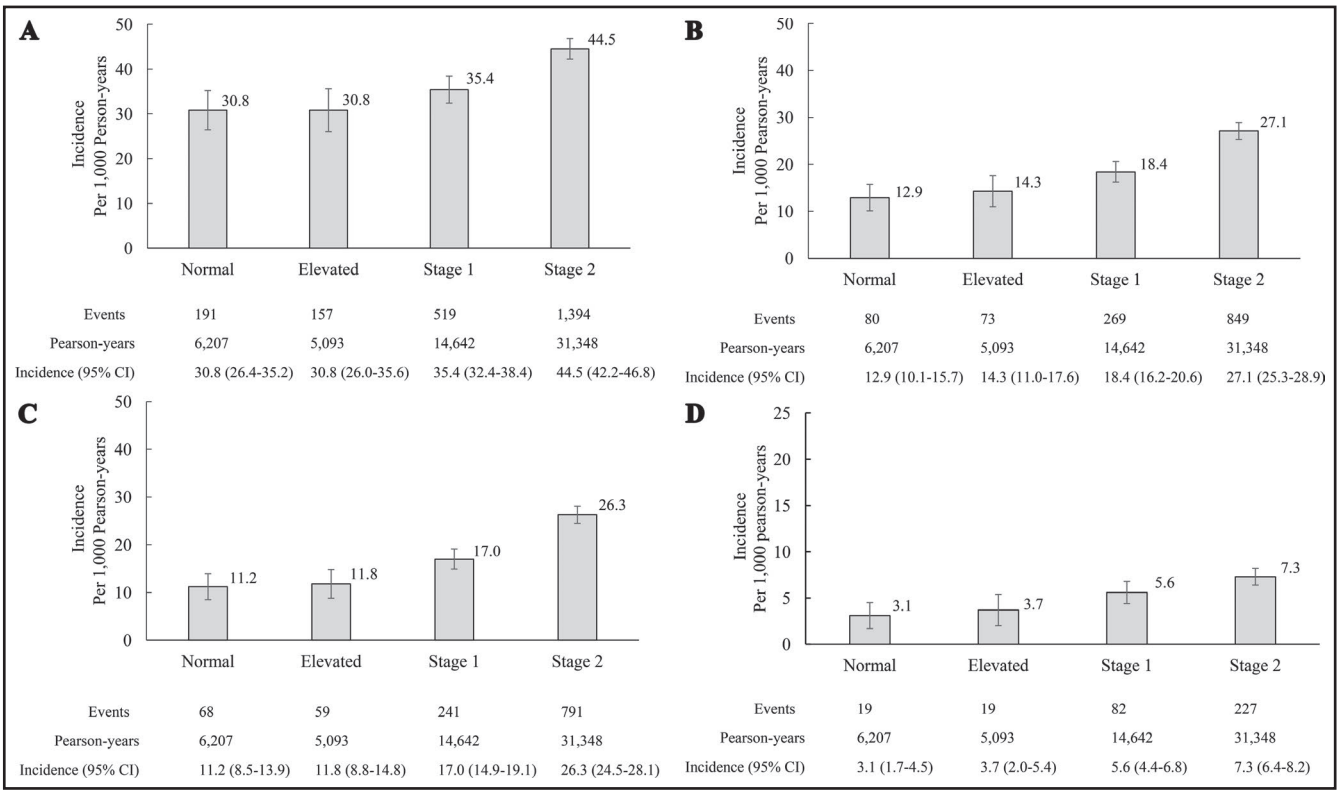

FIGURE 2 The incidence of adverse events (A, all-cause mortality; B, cardiovascular mortality; C, stroke incidence; D, myocardial infarction incidence) according to new defined BP levels. CI: Confidence interval; MI, myocardial infarction. Error bars represents 95% CI. Normal, SBP <120 mm Hg and DBP <80 mm Hg; Elevated, SBP 120-129 mm Hg and DBP <80 mm Hg; Stage 1, SBP 130-139 mm Hg or DBP 80-89 mm Hg; Stage 2, SBP ≥140 mm Hg /DBP 90 mm Hg, or taking anti-hypertensive medications

stroke (17.0 vs 11.2/1000 person-years), with no statistically significant difference between all-cause mortality and MI (Table S1).

We tested the association between different BP levels and the hazard of all-cause mortality, CVD mortality, stroke, and MI using Cox proportional hazard models (Table 2). In unadjusted model (Model 1), patients with stage 1 hypertension were significantly associated with a higher hazard of CVD mortality (HR = 1.439, 95% CI: 1.121-1.849), stroke (HR = 1.537, 95% CI: 1.174-2.011), and MI (HR = 1.884, 95% CI: 1.144-3.103), respectively. In multivariable-adjusted model (Model 3), compared with normal BP, stage 1 hypertension conferred an increased hazard of CVD mortality (HR = 1.304, 95% CI: 1.015-1.675), stroke (HR = 1.449, 95% CI: 1.107-1.899), and MI (HR = 1.735, 95% CI: 1.051-2.863), respectively. Furthermore, the result of β coefficients from Cox proportional hazards models showed that stage 1 hypertension was strongly associated with an increased hazard of MI than stroke (β = .551 *vs* β = 0.371, P < .001). However, the statistical association between stage 1 hypertension and all-cause mortality was not significant in the unadjusted and multivariable-adjusted model. Moreover, stage 2 hypertension revealed a greater hazard of all adverse events; however, there was no significant association between elevated BP classification and an increased hazard of all adverse events in the unadjusted and multivariable-adjusted model. Similar results were found following excluding participants with anti-hypertensive treatments (n = 6601) (Table 3). In addition, we have conducted two subgroup analyses between different age groups (Table S2) and different physical activity groups (Table S3). In terms of the overall trend, the results of the subgroup analyses were similar to the whole population.

4 | DISCUSSION

In this study, patients with stage 1 hypertension were at significantly higher hazard of CVD events (CVD mortality, stroke, MI) than normal BP participants. However, stage 1 hypertension was not related to an increased all-cause mortality hazard compared with normal BP among participants age ≥60 years.

To evaluate the practicability and appropriateness of stage 1 hypertension, several studies have investigated the association between the new threshold and adverse events.[4,5,11-13] A national prospective cohort study from Korea including 2 488 101 adults showed that the new stage 1 hypertension cutoff increased the incidence of subsequent CVD events compared with those with normal BP (men HR: 1.25, women HR: 1.27, both P < .05).[11] Lloyd-Jones et al demonstrated that after multivariable adjustment, HR for CVD events for stage 1 hypertension vs normal BP was 1.75 (95% CI, 1.22-2.53).[12] Comparable to the previous study, the results of the current study implied the necessity of localized hypertension guideline. Recently, a study from China reported that stage 1 hypertension was not correlated with the hazard of cardiovascular

TABLE 2 Cox proportional hazards models for association between BP levels and adverse events in the participants

SBP/DBP categories (mm Hg)	All-cause mortality		CVD mortality		Stroke incidence		MI incidence	
	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value
Model 1								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.996 (0.807, 1.231)	.973	1.103 (0.804, 1.515)	.543	1.051 (0.742, 1.490)	.779	1.206 (0.639, 2.278)	.564
130-139/80-89	1.161 (0.984, 1.371)	.078	1.439 (1.121, 1.847)	.004	1.537 (1.174, 2.011)	.002	1.884 (1.144, 3.103)	.013
≥140/≥90	1.475 (1.268, 1.716)	<.001	2.162 (1.719, 2.720)	<.001	2.431 (1.898, 3.115)	<.001	2.526 (1.582, 4.035)	<.001
Model 2								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.989 (0.801, 1.222)	.919	1.080 (0.786, 1.484)	.635	1.032 (0.728, 1.463)	.859	1.158 (0.613, 2.188)	.651
130-139/80-89	1.091 (0.924, 1.288)	.303	1.340 (1.044, 1.720)	.022	1.470 (1.123, 1.924)	.005	1.738 (1.055, 2.863)	.030
≥140/≥90	1.295 (1.112, 1.507)	.001	1.850 (1.470, 2.329)	<.001	2.297 (1.792, 2.945)	<.001	2.165 (1.354, 3.464)	.001
Model 3								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.974 (0.789, 1.204)	.810	1.062 (0.773, 1.460)	.710	1.026 (0.724, 1.455)	.885	1.155 (0.611, 2.184)	.658
130-139/80-89	1.068 (0.904, 1.261)	.442	1.304 (1.015, 1.675)	.038	1.449 (1.107, 1.899)	.007	1.735 (1.051, 2.863)	.031
≥140/≥90	1.197 (1.025, 1.399)	.023	1.652 (1.307, 2.089)	<.001	2.041 (1.585, 2.629)	<.001	2.040 (1.265, 3.289)	.003

Note: Model 1: Unadjusted.
Model 2: Adjusted for age, sex, ethnicity, and education.
Model 3: Adjusted for age, sex, ethnicity, education, body mass index, smoking, drinking, anti-hypertension treatment, physical activity, history of diabetes and hyperlipidemia, and family history of hypertension.
Abbreviations: BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; DBP, diastolic blood pressure; HR, hazard ratios; MI, myocardial infarction; SBP, systolic blood pressure.

events in subjects aged ≥60 years.[4] At the same time, these authors also claimed that the results should be further validated due to limited sample size. On this basis, our study is supplemental evidence. In addition, Mohammad Talaei et al indicated that stage 1 hypertension was associated with increased cardiovascular risk only in those <65 years of age and without a history of CVD, without those of aged ≥65 years or with a history of CVD.[5] Based on the relative larger sample size, our findings demonstrated that patients with stage 1 hypertension showed a 30.4% increased hazard of CVD mortality, a 44.9% increased hazard of stroke, 77.5% increased hazard of MI, but not independently with all-cause mortality compared with normal BP, which was completely different from previous studies. In this study, the findings in subgroup analysis among different age groups (every additional 5 years old) indicated that stage 1 hypertension was associated with increased stroke risk only in those 60-64 years of age and 75-79 years of age. Further analysis discovered that stage 1 hypertension was associated with increased CVD mortality only in those 75-79 years of age. The possible explanation of different outcomes might be related to the fact that the source of the sample is different, our subjects are mainly rural populations in northeastern of China, and the serum lipid-related information was not included, which were not adjusted during the analysis.

In addition, the present finding indicated that stage 1 hypertension showed a greater impact on MI than stroke. This finding is in agreement with the previous results, which may be related to serum lipids. Previous studies have shown that serum cholesterol is positively associated with the hazard of MI, and the strength of this association is stronger than that observed for stroke (ischemic stroke).[14,15] It has been reported that serum cholesterol is inversely correlated with the hazard of hemorrhagic stroke.[16] However, the incidence of stroke is still higher than MI (17.0 /1000 person-years vs 5.6/1000 person-years). Great attention should be paid to strengthen the management of stage 1 hypertension in rural Chinese to reduce the incidence and the burden of stroke and MI on treatment, medical expenditures, and the national economy.

The dramatic changes in the new defined stage 1 hypertension may have an impact on the management of global hypertension, its

TABLE 3 Sensitivity analyses were performed after excluding participants who were taking anti-hypertensive medications (N = 6601)

SBP/DBP categories (mm Hg)	All-cause mortality		CVD mortality		Stroke incidence		MI incidence	
	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value
Model 1								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.996 (0.806, 1.230)	.970	1.103 (0.803, 1.515)	.545	1.049 (0.740, 1.487)	.786	1.207 (0.639, 2.279)	.562
130-139/80-89	1.161 (0.984, 1.371)	.078	1.440 (1.121, 1.848)	.004	1.539 (1.175, 2.014)	.002	1.882 (1.142, 3.100)	.013
≥140/≥90	1.466 (1.257, 1.709)	<.001	2.085 (1.653, 2.631)	<.001	2.277 (1.771, 2.928)	<.001	2.495 (1.554, 4.006)	<.001
Model 2								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.988 (0.800, 1.220)	.909	1.077 (0.784, 1.480)	.647	1.027 (0.725, 1.456)	.879	1.160 (0.614, 2.191)	.648
130-139/80-89	1.089 (0.922, 1.285)	.316	1.335 (1.040, 1.713)	.024	1.467 (1.121, 1.921)	0.005	1.727 (1.048, 2.846)	.032
≥140/≥90	1.229 (1.053, 1.435)	.009	1.698 (1.344, 2.144)	<.001	2.071 (1.610, 2.665)	<.001	2.040 (1.268, 3.282)	.003
Model 3								
<120/<80	1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)		1.000 (Ref.)	
120-129/<80	0.973 (0.787, 1.202)	.798	1.059 (0.771, 1.456)	.723	1.028 (0.725, 1.458)	.877	1.146 (0.606, 2.168)	.675
130-139/80-89	1.068 (0.904, 1.262)	.439	1.302 (1.013, 1.674)	.039	1.466 (1.119, 1.921)	.006	1.702 (1.031, 2.810)	.038
≥140/≥90	1.203 (1.029, 1.405)	.020	1.657 (1.310, 2.096)	<.001	2.065 (1.602, 2.660)	<.001	2.001 (1.240, 3.229)	.004

Note: Model 1: unadjusted.
Model 2: adjusted for age, sex, ethnicity, and education.
Model 3: adjusted for age, sex, ethnicity, education, body mass index, smoking, drinking, physical activity, history of diabetes and hyperlipidemia, and family history of hypertension.
Abbreviations: BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; DBP, diastolic blood pressure; HR, hazard ratios; MI, myocardial infarction; SBP, systolic blood pressure.

scientific, and preventive advancement which has been recognized by most scholars. However, as to whether the new guideline can be generalized around the world, scholars in many countries have also made careful considerations (Canada, Japan, Italy, Switzerland, etc).[17-20] Majority of the developed countries believe that the newly defined stage 1 hypertension threshold can improve people's awareness of CVD hazard and benefit to vascular health. The opinions of developing countries (China and India) are facing enormous public health challenges, which were not exactly consistent with developed countries.[21,22] Due to the different ways of monitoring and measuring BP and the high prevalence of hypertension based on the original guideline, scholars believe that the 2017 ACC/AHA new guidelines are difficult to apply widely in India. The present study showed that the 2017 ACC/AHA stage 1 hypertension definition significantly increases the hazard of cardiovascular disease morbidity and mortality, and a large proportion of CVD events and deaths are attributable to this BP stratum in Chinese people age ≥60 years.

Strengths of the present study include the large sample size and a long period of follow-up and generate a large-scale sample size and many incident cases which improved the statistical power. Some limitations should also be considered in this study. Firstly, we lack information on other potential confounders, such as blood biochemical data, and will encourage further research. Secondly, this study was conducted on a rural sample of Northeast China, which limits the generalization of our results and requires a more diverse populations to confirm our results. Thirdly, there may be some cases which were not recorded owing to unclear clinical signs and poor awareness of timely medical treatment; the numbers of real cases may be underestimated.

5 | CONCLUSION

The following conclusion can be drawn from the present study. Stage 1 hypertension based on 2017 ACC/AHA guideline was independently associated with the increased hazard of CVD mortality, stroke, and MI among older adults (aged ≥60 years), which is complementary evidence for the application of 2017 ACC/AHA hypertension guidelines in an older Chinese population. Therefore, BP control in patients

with stage 1 hypertension may be beneficial to reduce the hazard of CVD in elderly Chinese individuals. Meanwhile, public health initiatives are required to focus on the current status of hypertension in China because of its high prevalence and concomitant vascular risks.

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CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

Liqiang Zheng and Yingxian Sun had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis; Liqiang Zheng contributed to study concept and design; Yanxia Xie, Jinyue Gao, and Rongrong Guo contributed to acquisition, analysis, or interpretation of data and drafting of the manuscript; Jia Zheng, Yali Wang, Yue Dai, Zhaoqing Sun, Liying Xing, and Xingang Zhang contributed to critical revision of the manuscript for important intellectual content; Liqiang Zheng and Yingxian Sun contributed to supervision; All the authors approved this study finally.

ORCID

Ying Xian Sun https://orcid.org/0000-0002-7961-4229

Liqiang Zheng https://orcid.org/0000-0003-0101-9398

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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