


BMJ Open Epidemiological status quo of hypertension in elderly population in Changchun, China: a cross-sectional study

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ABSTRACT

Objectives To investigate the epidemiological status quo of hypertension in elderly population in Changchun, China, and provide a reference for the prevention and control strategies of hypertension of elderly population in this region.

Design A cross-sectional study, as a part of a comprehensive project in Northeast China, was designed to perform in 10 districts in Changchun.

Participants and setting A total of 6846 participants who were ≥60 years old were selected using a random sampling method.

Main outcome measures The epidemiological status quo of hypertension.

Results The prevalence of hypertension in Changchun was 52.6%. Among participants with hypertension enrolled in this study, 87.6% of the participants had been diagnosed with hypertension before the study, 69.1% was taking antihypertensive medications and 66.9% had effective blood pressure control. Obesity, widower/widow, history of diseases and family history of hypertension were risk factors of hypertension (all $p < 0.05$). Participants with obesity, a personal history of heart coronary disease, or a family history of hypertension were susceptible to realising risks of hypertension (all $p < 0.05$). However, participants with diabetes, hyperlipidaemia, or a family history of hypertension were difficult to control blood pressure within the normal range (all $p < 0.05$). In addition, 92.6% participants taking antihypertensive medications used a single medication, and calcium channel blockers was the most commonly used antihypertensive medications in monotherapy.

Conclusion The rates of awareness, treatment and control of hypertension are greater in Changchun than those in China, indicating that the prevention and control of hypertension in Changchun are effective. However, the prevalence of hypertension in the elderly population in China is lower than that in Changchun, also rendering Changchun a substantial challenge for the supervision of hypertension.

INTRODUCTION

Hypertension afflicts about 1.5 billion people, generating US\$370 billion of economic burden globally.^{1 2} A national survey

Strengths and limitations of this study

- This study investigated the epidemiological status quo of hypertension by assessing the prevalence, awareness, treatment and control of hypertension in elderly population in Changchun, China in 2019.
- A large number of participants were included in the study.
- The data other than anthropometric data in this study were based on self-reported questionnaires.
- The temporality of the association cannot be determined because of the cross-sectional nature of this study.

performed from 2003 to 2012 has shown that the prevalence of hypertension continues increasing in China.³ In 2012, the prevalence of hypertension among the population over the age of 18 was 23.2% (≈244.5 million) in China. Overall, 46.9% knew whether they had hypertension, 40.7% received antihypertensive medications, and 15.3% controlled blood pressure.⁴ Hypertension has been one of the leading risk factors of mortality in China.⁵

The status quo in patients with hypertension, including awareness, treatment and control, is different among different regions in China.^{6–8} Previous regional studies on hypertension mainly focused on southeast region in China.^{9 10} Changchun is in the northeast of China, and winter in Changchun is cold and long. Changchun has been a heavy industry city since 1949, affecting a special environment and lifestyle for residents in this region.¹¹ Blood pressure increases steadily with age, leading to that hypertension is more common in people over the age of 60 years with the increasing of ageing.¹² However, there are few studies focusing on the elderly in China. We, in this study, investigated the epidemiological status quo of hypertension by assessing the prevalence, awareness,

treatment and control of hypertension in elderly population in Changchun, China.

METHODS

Study design and enrolment of participants

We conducted this survey of prevention and control of major chronic non-communicable diseases in Northeast China from 1 July 2019 to 31 October 2019. The survey was supported by the Comprehensive Project of Epitome for Major Chronic Disease Prevention and Control Technology in Northeast China, and approved by the Ethics Committee of China Medical University. After inspecting data from 11 119 participants, we found that blood pressure data of less than 0.3% of participants were missing. We, according to the principle of simple random sampling, chose 10 community health centres from 12 ones in Changchun, China. Thereafter, we performed this survey, with the help of staffs of the 10 community health centres. Finally, we enrolled 6846 participants according to following criteria: (1) over the age of 60 years, (2) with registered permanent residence (a record officially identifying area residents), and (3) living in Changchun for more than 6 months. Each participant filled out a questionnaire, provided a written informed consent, and was performed a physical examination.

Data collection

The questionnaire was designed by the committee of Comprehensive Project of Epitome for Major Chronic Disease Prevention and Control Technology in Northeast China. Staff collecting information from participants was trained by this committee. The questionnaire included the basic characteristics of the participants (age, sex, ethnicity, place of residence, marital status, education level, occupation, and annual income), health behaviours (smoking, drinking and physical exercise), history of diseases (hypertension, diabetes, hyperlipidaemia, coronary heart disease and stroke), and medication history. The staff performed anthropometric measurements, including height, weight and blood pressure. The blood pressure was measured twice on the right upper arm of the participants after sitting for 5 min using OMRON HEM-7200 Professional Portable Blood Pressure Monitor (OMRON, Japan), and the average of these two readings represented datum of blood pressure of one participant. The sphygmomanometers and weight scales were calibrated by the Bureau of Quality and Technical Supervision before use.

Definition of variables

According to 2018 Chinese Guidelines for the Management of Hypertension,¹³ hypertension was defined as an average systolic blood pressure (SBP) ≥ 140 mm Hg and/or an average diastolic blood pressure (DBP) ≥ 90 mm Hg, or self-reported use of antihypertensive medications in past 2 weeks. Stage 2 or stage 3 hypertension was defined as an average SBP ≥ 160 mm Hg and/or an

average DBP ≥ 100 mm Hg. Awareness of hypertension was defined as a participant knowing diagnosed hypertension before this study. Treatment of hypertension was defined as currently taking antihypertensive medications in patients with hypertension. Control of hypertension was defined as effectively maintaining an average SBP < 140 mm Hg and an average DBP < 90 mm Hg in patients with hypertension.

Body mass index (BMI) was obtained by dividing body weight by the square of height. According to the recommendations of the Chinese Obesity Working Group,¹⁴ BMI was divided into following categories: underweight: < 18.5 , normal: 18.5 – 23.9 , overweight: 24.0 – 27.9 and obesity: ≥ 28.0 .

Statistical analysis

We established the database of this survey using Epidata V.3.1, and IBM SPSS V.24.0 was used for statistical analyses. The 2020 China population census data were used to confer weight on variables, evaluating the status quo of elderly population in Changchun. The description of measurement data was expressed by mean \pm SD; the comparison between measurement data was performed using t test; the description of count data was expressed by rate or composition ratio; and the comparison between count data was by χ^2 test. Multivariate Logistic regression was used to analyse the risk factors relating to hypertension. A p value less than 0.05 was considered statistically significant.

Patient and public involvement

Patients and public were not involved in the design, recruitment and conduct of the study.

RESULTS

Multilevel analysis of the prevalence, awareness, treatment and control of hypertension

A total of 6846 participants (3465 men, 3381 women) were enrolled in this study, with a mean age of 70.31 years (SD 6.115). Among them, 6669 (97.4%) are Han nationality, 4013 (58.6%) had retired, and 3599 (52.6%) were patients with hypertension (289 (4.2%) patients with stage 2 or stage 3 hypertension). There were significant differences in age, sex, BMI, marital status, occupation, educational level, annual income, physical exercise, smoking, family history of hypertension and history of other diseases (coronary heart disease, stroke, diabetes, or hyperlipidaemia) between hypertensive and non-hypertensive participants ($p < 0.05$). The proportion of female participants suffering from hypertension was higher than that of male ones. Compared with non-hypertensive participants, hypertensive participants exhibited high proportions in following items (widowed/widowed; overweight or obesity; engaged in manual work; an annual income of less than ¥30 000; with a lower educational level; with history of coronary heart disease, stroke, diabetes, hyperlipidaemia, or family history of

Table 1 General characteristics of study participants aged ≥ 60 years

Characteristics	Total (n=6846)	No hypertension (n=3247)	All hypertension (n=3599)	Stage 2 or stage 3 hypertension (n=289)	P value
Age (years)	70.31 \pm 6.115	69.65 \pm 5.895	70.90 \pm 6.249	72.03 \pm 6.519	<0.001*
Sex					0.002
Male	3465 (50.6%)	1704 (52.5%)	1761 (48.9%)	139 (48.1%)	
Female	3381 (49.4%)	1543 (47.5%)	1838 (51.1%)	150 (51.9%)	
Ethnicity					0.466
Han	6669 (97.4%)	3162 (97.4%)	3507 (97.4%)	277 (95.8%)	
Others	177 (2.6%)	85 (2.6%)	92 (2.6%)	12 (4.2%)	
Body mass index (BMI)					<0.001
Underweight	104 (1.5%)	72 (2.2%)	32 (0.9%)	5 (1.7%)	
Normal	2569 (37.5%)	1445 (44.5%)	1124 (31.2%)	94 (32.5%)	
Overweight	3071 (44.9%)	1363 (42.0%)	1708 (47.4%)	131 (45.3%)	
Obesity	1103 (16.1%)	367 (11.3%)	736 (20.4%)	59 (20.4%)	
Marital status					0.010*
Unmarried	32 (0.5%)	16 (0.5%)	16 (0.4%)	2 (0.7%)	
Married/cohabitation	6117 (89.4%)	2942 (90.6%)	3175 (88.2%)	232 (80.6%)	
Divorced/separated	78 (1.1%)	34 (1.0%)	44 (1.2%)	2 (0.7%)	
Widowed/widowed	619 (9.0%)	255 (7.9%)	364 (10.1%)	52 (18.1%)	
Occupation					0.012
Manual worker	1876 (27.4%)	861 (26.5%)	1015 (28.2%)	96 (33.3%)	
Mental worker	958 (14.0%)	495 (15.2%)	463 (12.9%)	41 (14.2%)	
Retirement	4013 (58.6%)	1891 (58.2%)	2122 (58.9%)	151 (52.4%)	
Educational level					0.018
Primary school or below	1014 (14.8%)	441 (13.6%)	573 (15.9%)	50 (17.4%)	
Junior middle school	2346 (34.3%)	1096 (33.8%)	1250 (34.7%)	106 (36.8%)	
Senior middle school	1889 (27.6%)	913 (28.1%)	976 (27.1%)	68 (23.6%)	
Undergraduate or above	1564 (22.8%)	777 (23.9%)	787 (21.9%)	62 (21.5%)	
Unknown	35 (0.5%)	20 (0.6%)	15 (0.4%)	2 (0.7%)	
Annual income (¥)					<0.001*
<30 000	3481 (50.9%)	1571 (48.4%)	1910 (53.1%)	148 (51.2%)	
30 000–50 000	2914 (42.6%)	1471 (45.3%)	1443 (40.1%)	106 (36.7%)	
>50 000	450 (6.6%)	204 (6.3%)	246 (6.8%)	35 (12.1%)	
Physical exercise					0.030*
Never	1360 (19.9%)	628 (19.3%)	732 (20.3%)	79 (27.2%)	
Sometimes	185 (2.7%)	72 (2.2%)	113 (3.1%)	11 (3.8%)	
Often	5300 (77.4%)	2546 (78.4%)	2754 (76.5%)	200 (69.0%)	
Current smoking	1081 (15.8%)	549 (16.9%)	532 (14.8%)	42 (14.6%)	0.009
Current drinking	1014 (14.8%)	500 (15.4%)	514 (14.3%)	43 (14.9%)	0.102
Systolic blood pressure (mm Hg)	132.29 \pm 11.938	126.86 \pm 8.217	137.19 \pm 12.629	167.15 \pm 10.547	<0.001*
Diastolic blood pressure (mm Hg)	77.43 \pm 8.014	74.84 \pm 6.997	79.77 \pm 8.153	88.29 \pm 11.233	<0.001*
History of coronary heart disease	759 (11.1%)	284 (8.7%)	475 (13.2%)	49 (17.0%)	<0.001*
History of stroke	204 (3.0%)	84 (2.6%)	120 (3.3%)	17 (5.9%)	0.040*
History of diabetes	2296 (33.5%)	892 (27.5%)	1404 (39.0%)	138 (47.8%)	<0.001*
History of hyperlipidaemia	3015 (44.0%)	1350 (41.6%)	1665 (46.3%)	157 (54.3%)	<0.001*
Family history of hypertension	653 (9.5%)	125 (3.8%)	528 (14.7%)	52 (18.0%)	<0.001

*The difference between stage 1 hypertension and stage 2 or stage 3 hypertension is statistically significant.

Table 2 Investigation of awareness, treatment, control of hypertension

	Awareness (n=3151)	Treatment (n=2488)	Control (n=2408)
Age (years)	70.90±6.214	70.82±6.069	70.77±6.142
P value	0.894	0.276	0.086
Sex			
Male	1525 (48.4%)	1185 (47.6%)	1156 (48.0%)
Female	1626 (51.6%)	1303 (52.4%)	1252 (52.0%)
P value	0.050	0.011	0.062
Ethnicity			
Han	3069 (97.4%)	2421 (97.3%)	2355 (97.8%)
Others	82 (2.6%)	67 (2.7%)	53 (2.2%)
P value	0.503	0.255	0.037
Body mass index (BMI)			
Underweight	25 (0.8%)	16 (0.6%)	18 (0.7%)
Normal	961 (30.5%)	716 (28.8%)	752 (31.2%)
Overweight	1507 (47.8%)	1208 (48.6%)	1153 (47.9%)
Obesity	659 (20.9%)	548 (22.0%)	486 (20.2%)
P value	0.015	<0.001	0.537
Marital status			
Unmarried	12 (0.4%)	10 (0.4%)	11 (0.5%)
Married/cohabitation	2785 (88.4%)	2203 (88.5%)	2148 (89.2%)
Divorced/separated	33 (1.0%)	27 (1.1%)	29 (1.2%)
Widowed/widowed	321 (10.2%)	248 (10.0%)	221 (9.2%)
P value	0.012	0.606	0.067
Occupation			
Manual worker	894 (28.4%)	705 (28.3%)	663 (27.5%)
Mental worker	381 (12.1%)	308 (12.4%)	289 (12.0%)
Retirement	1876 (59.5%)	1475 (59.3%)	1456 (60.5%)
P value	0.001	0.428	0.016
Educational level			
Primary school or below	500 (15.9%)	388 (15.6%)	397 (16.5%)
Junior middle school	1088 (34.5%)	858 (34.5%)	833 (34.6%)
Senior middle school	861 (27.3%)	683 (27.4%)	659 (27.4%)
Undergraduate or above	687 (21.8%)	552 (22.2%)	510 (21.2%)
Unknown	15 (0.5%)	8 (0.3%)	10 (0.4%)
P value	0.582	0.520	0.535
Annual income (¥)			
<30 000	1713 (54.4%)	1349 (54.2%)	1308 (54.3%)
30 000–50 000	1243 (39.5%)	984 (39.5%)	975 (40.5%)
>50 000	194 (6.2%)	155 (6.2%)	126 (5.2%)
P value	<0.001	0.026	<0.001
Physical exercise			
Never	627 (19.9%)	462 (18.6%)	461 (19.1%)
Sometimes	91 (2.9%)	74 (3.0%)	61 (2.5%)
Often	2433 (77.2%)	1952 (78.5%)	1887 (78.3%)
P value	0.009	<0.001	<0.001
Current smoking	463 (14.7%)	379 (15.2%)	347 (14.4%)
P value	0.376	0.135	0.198

Continued

Table 2 Continued

	Awareness (n=3151)	Treatment (n=2488)	Control (n=2408)
Current drinking	452 (14.3%)	348 (14.0%)	345 (14.3%)
P value	0.371	0.243	0.479
Systolic blood pressure (mm Hg)	135.63±11.967	135.50±11.469	130.94±6.282
P value	<0.001	<0.001	<0.001
Diastolic blood pressure (mm Hg)	79.32±7.865	79.23±7.779	77.77±6.722
P value	<0.001	<0.001	<0.001
History of coronary heart disease	436 (13.8%)	345 (13.9%)	294 (12.2%)
P value	0.001	0.041	0.008
History of stroke	112 (3.6%)	84 (3.4%)	76 (3.2%)
P value	0.028	0.516	0.225
History of diabetes	1240 (39.4%)	976 (39.2%)	901 (37.4%)
P value	0.157	0.351	0.003
History of hyperlipidaemia	1443 (45.8%)	1135 (45.6%)	1052 (43.7%)
P value	0.081	0.125	<0.001
Family history of hypertension	494 (15.7%)	394 (15.8%)	307 (12.7%)
P value	<0.001	0.002	<0.001

hypertension). The age of patients with stage 2 or stage 3 hypertension was significantly higher than that of patients with stage 1 hypertension ($p<0.05$). The patients with stage 2 or stage 3 hypertension significantly differed from the ones with stage 1 hypertension in marital status, annual income, physical exercise and history of other diseases (coronary heart disease, stroke, diabetes, or hyperlipidaemia) ($p<0.05$) (table 1).

Among the patients with hypertension, 3151 (87.6%) who were diagnosed with hypertension before this survey were aware of hypertension, 2488 (69.1%) were currently taking antihypertensive medications and 2408 (66.9%) were effective in controlling blood pressure. The treatment rate in female patients with hypertension was statistically higher than that in male ones ($p<0.05$). Compared with normal or underweight participants, overweight or obese ones had significantly high rates of awareness and treatment of hypertension ($p<0.05$). Participants with diabetes or hyperlipidaemia had a significantly higher control rate of hypertension than those without diabetes or hyperlipidaemia ($p<0.05$). Participants with stroke had a significantly higher awareness rate of hypertension than those without stroke ($p<0.05$). Participants with coronary heart disease or family history of hypertension had significantly higher awareness, treatment and control of hypertension than those without corresponding diseases or family history ($p<0.05$) (table 2).

Multivariate logistic analysis of prevalence, awareness, treatment and control of hypertension

Multivariate logistic regression was used to analyse the association of population characteristics with the prevalence, awareness, treatment and control of hypertension. We identified that BMI, marital status, occupation, annual income, history of disease (coronary

heart disease, diabetes, or hyperlipidaemia), and family history of hypertension were all significantly associated with risks of hypertension ($p<0.05$). In detail, overweight (OR=1.640, 95% CI 1.475 to 1.824) or obesity (OR=2.582, 95% CI 2.225 to 2.996), widowed/widowed (OR=1.296, 95% CI 1.088 to 1.545), coronary heart disease (OR=1.451, 95% CI 1.237 to 1.702), diabetes (OR=1.636, 95% CI 1.474 to 1.816), hyperlipidaemia (OR=1.119, 95% CI 1.014 to 1.235), and family history of hypertension (OR=4.013, 95% CI 3.283 to 4.906) were revealed as higher risk factors of hypertension. However, underweight participants (OR=0.549, 95% CI 0.358 to 0.842), participants who were engaged in mental work (OR=0.820, 95% CI 0.696 to 0.964), or participants with an annual income from ¥30 000 to ¥50 000 (OR=0.845, 95% CI 0.759 to 0.940), had lower risks of hypertension than normal participants, participants who were engaged in manual work, or participants with an annual income of less than ¥30 000 (table 3).

For awareness of hypertension, participants with overweight (OR=1.282, 95% CI 1.021 to 1.611) or obesity (OR=1.408, 95% CI 1.046 to 1.896), exercise regularly (OR=1.355, 95% CI 1.061 to 1.729), personal history of coronary heart disease (OR=1.610, 95% CI 1.131 to 2.291), or with a family history of hypertension (OR=2.263, 95% CI 1.561 to 3.279) were more likely to realise their risks of hypertension. Whereas participants who were divorced/separated (OR=0.310, 95% CI 0.153 to 0.628), engaged in mental work (OR=0.654, 95% CI 0.474 to 0.901), or had a high annual income (¥30 000–50 000: OR=0.639, 95% CI 0.509 to 0.801; >¥50 000: OR=0.402, 95% CI 0.280 to 0.575), were more likely to ignore their risks of hypertension.

Table 3 Multivariate logistic regression analysis of factors associated with hypertension

	β	SE	χ^2	P value	OR	95% CI
Sex (female)	0.095	0.056	2.864	0.092	1.100	0.985 to 1.228
Body mass index (BMI)						
Underweight	-0.599	0.218	7.556	0.006	0.549	0.358 to 0.842
Normal			196.969	<0.001	1	
Overweight	0.495	0.054	83.045	<0.001	1.640	1.475 to 1.824
Obesity	0.949	0.076	156.1371	<0.001	2.582	2.225 to 2.996
Marital status						
Unmarried	0.001	0.362	0.000	0.998	1.001	0.492 to 2.036
Married/cohabitation			8.473	0.037	1	
Divorced/separated	0.072	0.234	0.094	0.759	1.074	0.679 to 1.700
Widowed/widowed	0.260	0.089	8.431	0.004	1.296	1.088 to 1.545
Occupation						
Manual worker			9.860	0.007	1	
Mental worker	-0.199	0.083	5.739	0.017	0.820	0.696 to 0.964
Retirement	0.033	0.060	0.297	0.586	1.033	0.918 to 1.163
Educational level						
Primary school or below			3.694	0.449	1	
Junior middle school	-0.070	0.079	0.789	0.374	0.932	0.799 to 1.088
Senior middle school	-0.090	0.083	1.185	0.276	0.914	0.777 to 1.075
Undergraduate or above	-0.135	0.088	2.347	0.125	0.874	0.735 to 1.038
Unknown	-0.469	0.359	1.714	0.190	0.625	0.310 to 1.263
Annual income (¥)						
<30 000			13.465	0.001	1	
30 000–50 000	-0.169	0.054	9.637	0.002	0.845	0.759 to 0.940
>50 000	0.111	0.105	1.110	0.292	1.117	0.909 to 1.372
Physical exercise						
Never			5.672	0.059	1	
Sometimes	0.230	0.164	1.972	0.160	1.259	0.913 to 1.737
Often	-0.089	0.063	2.005	0.157	0.915	0.809 to 1.035
Current smoking	-0.109	0.076	2.070	0.150	0.896	0.772 to 1.040
Current drinking	0.001	0.079	0.000	0.986	1.001	0.857 to 1.170
History of coronary heart disease	0.372	0.081	20.933	<0.001	1.451	1.237 to 1.702
History of stroke	0.144	0.149	0.932	0.334	1.155	0.862 to 1.546
History of diabetes	0.492	0.053	85.768	<0.001	1.636	1.474 to 1.816
History of hyperlipidaemia	0.112	0.050	5.016	0.025	1.119	1.014 to 1.235
Family history of hypertension	1.390	0.102	183.960	<0.001	4.013	3.283 to 4.906

1:the reference cell

With respect to treatment of hypertension, female participants paid more attention to the treatment of hypertension than male ones (OR=1.319, 95% CI 1.118 to 1.556). Participants with overweight (OR=1.403, 95% CI 1.191 to 1.651) or obesity (OR=1.678, 95% CI 1.359 to 2.070), exercise regularly (OR=1.454, 95% CI 1.220 to 1.732), or with family history of hypertension (OR=1.323, 95% CI 1.066 to 1.641) were more active in the treatment of hypertension. However, participants with high annual income (¥30 000–50,000: OR=0.839,

95% CI 0.715 to 0.984; >¥50 000: OR=0.665, 95% CI 0.499 to 0.888), or with personal history of hyperlipidaemia (OR=0.850, 95% CI 0.733 to 0.984) were more likely to ignore hypertension treatment.

In terms of control of hypertension, the hypertension control for widowed/widowed participants was poor (OR=0.685, 95% CI 0.542 to 0.866). Participants who exercised regularly (OR=1.313, 95% CI 1.103 to 1.564) had better blood pressure control. However, participants with annual income of more than ¥50 000

Table 4 Individual characteristics associated with awareness, treatment and control of hypertension

	Awareness		Treatment		Control	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sex (female)	1.281 (1.018 to 1.613)	0.035	1.319 (1.118 to 1.556)	0.001	1.255 (1.066 to 1.478)	0.006
Body mass index (BMI)						
Underweight	0.463 (0.196 to 1.096)	0.080	0.563 (0.275 to 1.152)	0.116	0.582 (0.281 to 1.204)	0.145
Normal	1	0.010	1	<0.001	1	0.407
Overweight	1.282 (1.021 to 1.611)	0.033	1.403 (1.191 to 1.651)	<0.001	1.056 (0.895 to 1.244)	0.520
Obesity	1.408 (1.046 to 1.896)	0.024	1.678 (1.359 to 2.070)	<0.001	1.002 (0.818 to 1.228)	0.981
Marital status						
Unmarried	0.436 (0.139 to 1.367)	0.155	0.814 (0.295 to 2.247)	0.691	0.978 (0.343 to 2.792)	0.967
Married/cohabitation	1	0.006	1	0.380	1	0.018
Divorced/separated	0.310 (0.153 to 0.628)	0.001	0.617 (0.332 to 1.148)	0.127	0.938 (0.496 to 1.772)	0.843
Widowed/widowed	0.994 (0.699 to 1.414)	0.975	0.899 (0.705 to 1.146)	0.389	0.685 (0.542 to 0.866)	0.002
Occupation						
Manual worker	1	0.002	1	0.405	1	0.033
Mental worker	0.654 (0.474 to 0.901)	0.010	0.862 (0.675 to 1.101)	0.234	0.929 (0.732 to 1.180)	0.547
Retirement	1.080 (0.841 to 1.387)	0.546	0.996 (0.836 to 1.186)	0.960	1.183 (0.996 to 1.404)	0.055
Educational level						
Primary school or below	1	0.690	1	0.274	1	0.893
Junior middle school	1.033 (0.758 to 1.408)	0.837	1.084 (0.870 to 1.351)	0.471	0.918 (0.736 to 1.146)	0.450
Senior middle school	1.203 (0.863 to 1.677)	0.275	1.196 (0.947 to 1.511)	0.133	0.948 (0.750 to 1.198)	0.653
Undergraduate or above	1.199 (0.841 to 1.709)	0.316	1.254 (0.974 to 1.614)	0.079	0.881 (0.686 to 1.133)	0.325
Unknown	–	0.999	0.635 (0.220 to 1.835)	0.401	0.905 (0.290 to 2.822)	0.864
Annual income (¥)						
<30 000	1	<0.001	1	0.008	1	<0.001
30 000–50 000	0.639 (0.509 to 0.801)	<0.001	0.839 (0.715 to 0.984)	0.031	0.900 (0.768 to 1.053)	0.189
>50 000	0.402 (0.280 to 0.575)	<0.001	0.665 (0.499 to 0.888)	0.006	0.472 (0.357 to 0.624)	<0.001
Physical exercise						
Never	1	0.002	1	<0.001	1	<0.001
Sometimes	0.651 (0.385 to 1.102)	0.110	1.033 (0.677 to 1.577)	0.881	0.745 (0.495 to 1.123)	0.160
Often	1.355 (1.061 to 1.729)	0.015	1.454 (1.220 to 1.732)	<0.001	1.313 (1.103 to 1.564)	0.002
Current smoking	1.015 (0.740 to 1.393)	0.926	1.358 (1.077 to 1.712)	0.010	0.967 (0.774 to 1.209)	0.768
Current drinking	1.235 (0.883 to 1.725)	0.217	0.888 (0.703 to 1.123)	0.323	1.107 (0.876 to 1.399)	0.394
History of heart coronary disease	1.610 (1.131 to 2.291)	0.008	1.189 (0.952 to 1.484)	0.127	0.842 (0.684 to 1.036)	0.104
History of stroke	1.885 (0.901 to 3.943)	0.092	0.973 (0.650 to 1.455)	0.892	0.919 (0.623 to 1.355)	0.670
History of diabetes	1.088 (0.879 to 1.346)	0.439	1.000 (0.861 to 1.163)	0.996	0.839 (0.724 to 0.972)	0.019
History of hyperlipidaemia	0.796 (0.647 to 0.979)	0.030	0.850 (0.733 to 0.984)	0.030	0.725 (0.627 to 0.838)	<0.001
Family history of hypertension	2.263 (1.561 to 3.279)	<0.001	1.323 (1.066 to 1.641)	0.011	0.677 (0.557 to 0.822)	<0.001

1:the reference cell

(OR=0.472, 95% CI 0.357 to 0.624), history of diabetes (OR=0.839, 95% CI 0.724 to 0.972), hyperlipidaemia (OR=0.725, 95% CI 0.627 to 0.838), or family history of hypertension (OR=0.677, 95% CI 0.557 to 0.822) were difficult in controlling blood pressure within the normal range (table 4).

Analysis of use of antihypertensive medications in patients with hypertension

Among participants taking antihypertensive medications, 2304 (92.6%) used a single medication, and 184 (7.4%) used two or more combined medications. Among the hypertensive patients receiving medical treatment, 1945

Table 5 The use of antihypertensive medications among treated population with hypertension

		Total	Male	Female	P value
Monotherapy	DIU	83 (3.3%)	41 (3.5%)	42 (3.2%)	0.414
	CCB	1835 (73.8%)	871 (73.5%)	964 (74.0%)	0.410
	ACEI	124 (5.0%)	69 (5.8%)	55 (4.2%)	0.041
	BB	150 (6.0%)	66 (5.6%)	84 (6.4%)	0.202
	ARB	272 (10.9%)	140 (11.8%)	132 (10.1%)	0.100
	TCM	162 (6.5%)	64 (5.4%)	98 (7.5%)	0.019
	Others	61 (2.5%)	29 (2.4%)	32 (2.5%)	0.548
Total monotherapy		2304 (92.6%)	1096 (92.5%)	1208 (92.7%)	0.447
Combination therapy		184 (7.4%)	89 (7.5%)	95 (7.3%)	

ACEI, ACE inhibitors; ARB, angiotensin receptor blockers; BB, beta blockers; CCB, calcium channel blockers; DIU, diuretics; TCM, traditional Chinese medicine.

(78.2%) maintained their blood pressure under control. Among patients with grade 2 or grade 3 hypertension, 151 (52.2%) took antihypertensive medications. Among commonly used antihypertensive medications, calcium channel blockers were used in 73.8% participants, angiotensin receptor blockers were used in 10.9% participants, traditional Chinese medicine were used in 6.5% participants, beta blockers were used in 6.0% participants, ACE inhibitors were used in 5.0% participants, and diuretics (DIU) were used in 3.3% participants. The types of medication in men were not different from those in women. In parallel, the composition ratios of single medication and combined medications in men did not differ from those in women correspondingly (table 5).

DISCUSSION

In this paper, we corroborated that the prevalence of hypertension in the elderly population in Changchun was still greater than that in China; moreover, the rates of awareness, treatment and control of hypertension were at a higher level in Changchun than those in China.

Compared with the prevalence (about 60.0%) of hypertension in Changchun in 2012,¹⁵ the prevalence of hypertension in the elderly population in Changchun decreased to 52.6% in 2019. Compared with those in other regions in China,¹⁶ the rates of awareness, treatment and control of patients with hypertension in Changchun were high. These discrepancies documented that the effectiveness of efforts of Changchun Government, including enhanced primary management, strengthen education, and increased medical funds for patients with hypertension in Changchun. Notably, the prevalence of hypertension in elderly population decreased 58.9%¹⁷ in 2012 to 50.1%⁸ in 2017 in China, suggesting that Changchun Government needs further efforts for controlling hypertension.

Stage 2 or stage 3 hypertension causes much more serious problems for heart. Patients with stage 2 or stage 3 hypertension accounted for 7.3% in whole patients with hypertension in USA,¹⁸ 5.7% in those in China,¹⁹ and 4.2% in those in Changchun. Of note, low temperatures lead to narrowing

blood vessels, increasing blood pressure by forcing blood through narrowed veins and arteries. Thus, blood pressure is generally higher in population in northeast of China.²⁰ Unexpectedly, our results showed the prevalence of patients with stage 2 or stage 3 hypertension in Changchun was less than that in China. This discrepancy may arise from low participation rate of patients with stage 2 or stage 3 hypertension in Changchun.

Our results of risk factors for hypertension matched closely with the ones observed in other studies in China, including overweight or obesity, widower/widow, coronary heart disease, diabetes and hyperlipidaemia.^{21 22} As opposed to discoveries from Southern China,²³ the proportion of women with hypertension was higher than that of men in Changchun. Women have a higher ratio of surface area to volume, leading to a rapid loss of heat; moreover, metabolic rate is lower in women than that in men.²⁴ In contrast, men have a greater muscle mass than women; thus, men generate more heat than women. Cumulatively, these confirmed more women afflicted by hypertension than men in Changchun. Additionally, both our study and clinical investigations have shown that genetic factors are associated with the onset of hypertension; thus, people with a family history of hypertension are more susceptible to hypertension.²⁵ Although smoking and drinking are considered as common risk factors for hypertension,²⁶ our study did not find that smoking and drinking were risk factors of hypertension, partially because of the small number of people smoking and drinking among the elderly in Changchun.

We also found that, for the patients with hypertension, women better controlled blood pressure than men, because women much more valued their health and had higher treatment compliance. In concert with the results of a multicentre registration study based on hospital patients in China,²⁷ our results also showed blood pressure was not controlled well in the participants with family history of hypertension, although these participants were more likely to realise that they had high blood pressure. As combined medication has better effect controlling hypertension than single medication,²⁸ we found that combined medication was used in only 7.4% in

the patients of hypertension, reflecting long-term prescription habits of cardiovascular physicians in Changchun.

Our results can be used to refine the prevention and control strategies of hypertension of elderly population for the Changchun government. In addition, epidemiological investigation of hypertension should be further strengthened for elderly residents; moreover, the cardiovascular physicians should focus on combined medication in Changchun.

Our research has some limitations. First, our research data were based on self-reported questionnaires; thus, the accuracy of the reported results cannot be determined. Hypertension diagnosed during one visit may overestimate the true prevalence of hypertension. Second, because of the cross-sectional nature of the design of this study, the temporality of the association cannot be determined, and long-term follow-up of these participants is needed to conduct. Third, the feasibility of the 2017 American College of Cardiology/American Heart Association Guidelines about the prevention and treatment of hypertension needs to be re-evaluated.

CONCLUSIONS

The rates of awareness, treatment and control of hypertension are greater in Changchun than those in China, indicating that the prevention and control of hypertension in Changchun are effective. However, the prevalence of hypertension in the elderly population in China is lower than that in Changchun, also rendering Changchun a substantial challenge for the supervision of hypertension.

Contributors YaL and YC were involved in the study's conception and design. YR, JS, YQ, YG, YoL and YuL collected the data. YR, JS, YQ and YG performed data analysis and interpretation. YR wrote the paper. YaL is the guarantor. All authors read and approved the final manuscript.

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Competing interests None declared.

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Patient consent for publication Not applicable.

Ethics approval This study was approved by the Ethics Committee of China Medical University, and reference number is [2018] 083. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. For data access, researchers can contact the Department of Epidemiology and Biostatistics, School of Public Health of Jilin University, Changchun 130021, China.

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