The prevalence and risk factors associated with hypertension subtypes among ethnic Dai adults in rural China

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ABSTRACT

This study was conducted from June to September 2020 and conducted a population-based study of 2149 rural Dai residents aged 50 years or above in Xishuangbanna. The definition of hypertension was a systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg, or a current treatment plan with an anti-hypertensive medication. High blood pressure (HBP) included the following subtypes: SDH, ISH and IDH. All participants were interviewed, had physical examinations performed, and had blood pressure measurements taken. **Multivariable** logistic regression analysis was applied to analyse the risk factors for hypertension. The prevalence of HBP was 43.2 %. The subtype-specific prevalence of hypertension was 16.5 % for SDH, 24.2 % for ISH and 2.5 % for IDH. Among hypertensive participants, 38.2 % were SDH, 56.0 % were ISH and 5.8 % were IDH. Older age is a risk factor for HBP and ISH. Obesity, smoking, drinking and history of hypertension are risk factors for HBP and its subtypes including SDH and ISH (OR >1). Among all the hypertensive participants, only 25.0 % of the participants were aware of their hypertension while 34.7 % of SDH participants, 20.0 % of ISH participants and 9.3 % of IDH participants knew the individual subtype of hypertension. Among Dai people, the prevalence of hypertension is high, while the awareness and the rate of adequate treatment of hypertension is low. ISH stood out as the most prevalent type of HBP among the rural elderly. Rising ageing population in China, ISH remains an important public health problem and a challenging management issue in rural China.

1. Introduction

Hypertension is a risk factor for cardiovascular events, such as stroke, myocardial infarction, heart failure, and renal disease. The data from the China Health and Nutrition Survey (CHNS) showed that the prevalence of hypertension increased from 14.5 % in 1991 to 21.4 % in 2009 (Xi et al., 2012) to 25.2 % in 2012 (Disease Prevention and Control Bureau of the State Health and Family Planning Commission, 2015). In particular, the prevalence of hypertension in rural China was 23.5 %, and it increased with age. The number of people with hypertension in China reached 270 million in 2012 (China Cardiovascular Disease Report Writing Group, 2018). Hypertension is related to a wide phenotypic variability. Hypertension subtypes include isolated systolic

hypertension (ISH), isolated diastolic hypertension (IDH) and systolic–diastolic hypertension (SDH) (Franklin et al., 2005, 2001). These subtypes may offer information about the predisposition of haemodynamic and/or structural abnormalities that lead to hypertension. The development of ISH is associated with increased large artery stiffness (Verdecchia and Angeli, 2005; Saladini et al., 2009). IDH and SDH are related to increased peripheral vascular resistance (Verdecchia and Angeli, 2005; Saladini et al., 2009).

In China, more than half of the population resides in rural areas. Limited data are available regarding the epidemiology of hypertension subtypes among ethnic minorities in rural China. Yunnan Province is an economically developing province located in the southwestern part of China. Twenty-five ethnic groups live in Yunnan, which provides the

perfect opportunity for studying ethnic disparities in various health outcomes (China Today, 2016). The Dai ethnic minority is the 18th largest of 55 ethnic minority groups in China (National Bureau Statistics, 2000). They have their own spoken language and written script (China Ethnicity Net, 2014). Most of the Dai population live in the Xishuangbanna Autonomous Prefecture in the southern part of Yunnan Province. The prefecture is called "Aerial Garden" because of its abundant flora, fauna and tropical rain forests (China Highlights, 2015). The Dai people usually make their living through agriculture (China Highlights, 2015). This study aims to determine the prevalence of hypertension subtypes and associated risk factors among the Dai ethnic people to implement early, specific, and individualized preventive strategies.

2. Methods

2.1. Ethical considerations

This study was approved by the Ethical Review Committee of the First Affiliated Hospital of Kunming Medical University (2022 LUN L No. 206). It was conducted in accordance with the principles of the Declaration of Helsinki of the World Medical Association, and all participants signed an informed consent form before participating in the study.

2.2. Study population and design

In previous reports, we have described the prevalence of hypertension in adult rural Chinese populations of the Bai nationality in Dali (Zhang et al., 2013) and the Yi nationality in Shilin (Chen et al., 2015). To facilitate the comparison among different nationalities, our data collection process in the Dai ethnicity is the same as that of the Bai and Yi nationalities. This study was carried out from June to September 2020. The method of random cluster sampling was used to investigate the hypertension epidemiology of 2149 Dai ethnic groups aged ≥50 years in Xishuangbanna rural area. The majority of Dai nationals in China reside here, and its socioeconomic profile is representative of the Dai nationality as a whole. Information about ethnicity comes from the subjects' identity cards. The hamlet with a population of approximately 1000 served as a sample cluster. Hamlets with a population of greater than 1500 were divided and regrouped, and those with fewer than 750 were combined. Then, 10 % of the total sample clusters were randomly chosen, and all Dai people over the age of 50 years in the chosen clusters were invited to participate in a physical measurement and survey questionnaire related to this study. The sample framework consisted of 111 clusters (26,328 adults over the age of 50 years), and 11 clusters (2688 adults ≥50 years of age) were randomly chosen. Eventually, 2163 ethnic Dai people participated in this study with a participation rate of 80.5 %.

2.3. Questionnaire

To understand the purpose of the study and the methods used, all researchers and staff participated in rigorous training before the commencement of the study. Data were gathered by trained research staff who were in charge of a pre-designed questionnaire. Demographic information (such as age, gender, etc.), smoking history, drinking history, hypertension history and general medical history was collected for all participants using a combined questionnaire. A face-to-face survey questionnaire included information about the diagnosis, awareness, and treatment of hypertension. The categories of smoking were modified due to a low number of participants in certain categories. Namely, "occasional smoking (1–2 cigarette per month)" was classified as nonsmoking. Alcohol consumption ≥80 g/week was defined as drinking (National institute on Alcohol Abuse and Alcoholism, 2000). One parent having hypertension was defined as a family history of hypertension.

2.4. Blood pressure and hypertension subtype measurement

Blood pressure measurements were conducted on a village basis, with the majority of people being measured at the village health center and a few people with mobility problems being measured at home. Based on a standardized process, a trained researcher measured the resting blood pressure of all participants. Cuff sizes were chosen according to the subjects' arm circumference. Subjects were sitting for at least 15 min to rest before the measurements were taken. At the same time, 30 min before their blood pressure was measured, subjects were asked to avoid smoking, drinking, caffeinated beverages, and exercise. Measurements were repeated at a time interval of every three minutes. Hypertension was defined as a systolic blood pressure (SBP) greater than or equal to 140 mmHg, and/or a diastolic blood pressure (DBP) greater than or equal to 90 mmHg, or a current treatment with an antihypertensive medication (Chobanian et al., 2003). Hypertension subtypes were included in the following categories: (1) isolated systolic hypertension (ISH) was defined as a SBP greater than or equal to 140 mmHg and a DBP less than 90 mmHg; (2) isolated diastolic hypertension (IDH) was defined as a SBP less than 140 mmHg and a DBP greater than or equal to 90 mmHg; (3) systolic–diastolic hypertension (SDH) was defined as a SBP greater than or equal to 140 mmHg and a DBP greater than or equal to 90 mmHg (Franklin et al., 2005, 2001). Hypertension awareness was defined as the subject's self-report of any previous diagnosis of hypertension by a medical professional. Hypertension treatment was defined as the subject's self-report of taking hypertensive drugs. Hypertensive participants who were under treatment and had a blood pressure less than 140/90 mmHg were defined as hypertension control subjects.

2.5. Measurement of body size

When wearing no shoes and light clothing, the height and weight of participants were measured. Body mass index (BMI) was equal to weight in kilograms divided by height in square metres. BMI<18.50, 18.5–24.99 and ≥25.00 kg/m^2 represent the categories of a leanness, normal weight, and overweight plus obesity respectively (WHO, 2023).

2.6. Statistical analysis

In each subgroup, continuous variables were expressed as the mean ± SD and categorical variables were expressed as the rate or percentage. Continuous variables between two groups were analysed by applying the *t*-test, while those among three groups or more were analysed by applying one-way ANOVA. Associations between categorical variables were analysed using Chi-square tests. Applying **multivariable** logistic regression models, we calculated the adjusted odds ratios (OR) with 95 % confidence intervals (95 % CI) for high blood pressure status. All data were calculated by applying SAS software (Version 9.1; SAS Institute Inc., Cary, NC, USA). All statistical data were two-tailed, and a p-value less than 0.05 was regarded as being statistically significant.

3. Results

3.1. Basic characteristics of the sample population

In total, 2688 Dai people aged ≥50 years were included, and 2163 (80.5 %) subjects were successfully examined. The final participants were more women than men (women vs. men: 96.7 % vs. 62.5 %) (Table2). The main reasons for fewer male participants and fewer younger subjects were a lack of interest in the study or being unavailable to participate. The average age of both gender was 63.6 ± 10.0 years. The average age between males and females (63.5 ± 9.4 vs 63.6 ± 10.4 years) was not significantly different (p > 0.05). Compared to females, the males demonstrated higher mean values of DBP, height, weight and proportions of obesity, smoking, drinking, and family history of

hypertension (p < 0.05) (Table 1).

3.2. Hypertension subtype prevalence

The prevalence of HBP was 43.2 % (928/2149; 95 % CI: 41.1–45.3). The subtype-specific prevalence of hypertension was 16.5 % (354/2149; 95 % CI: 14.9–18.0) for SDH, 24.2 % (520/2149; 95 % CI: 22.4–26.0) for ISH and 2.5 % (54/2149; 95 % CI: 1.9–3.2) for IDH. Among hypertensive participants, 38.2 % (354/928) were SDH, 56.0 % (520/928) were ISH and 5.8 % (54/928) were IDH (Table 2).

The prevalence of HBP in the different age groups (50–59 years, 60–69 years and 70 years or older) was 34.4 %, 45.5 % and 52.5 % for HBP; 17.0 %, 18.0 % and 14.0 % for SDH; 14.5 %, 25.2 % and 36.3 % for ISH; and 2.9 %, 2.3 % and 2.3 % for IDH, respectively. The prevalence of HBP in the different gender (male and female) groups was 45.9 % and 41.6 % for HBP; 22.2 % and 13.2 % for SDH; 20.0 % and 26.6 % for ISH; and 3.7 % and 1.8 % for IDH, respectively (Table 2). The prevalence of HBP in the different body weight groups (lean, normal weight, obese) was 37.7 %, 44.4 % and 52.8 % for HBP; 10 %, 18.3 % and 25.5 % for SDH; 12.5 %, 17.3 % and 22.2 % for ISH; and 1.2 %, 2.7 % and 5.2 % for IDH, respectively. The prevalence of subjects with a family history of hypertension or those with drinking habits or smoking habits was 72.0 %, 55.1 % and 61.9 % for HBP; 38.2 %, 23.9 % and 27.2 % for SDH; 32.3 %, 26.0 % and 31.4 % for ISH; and 2.7 %, 5.2 % and 3.3 for IDH, respectively. However, the prevalence of those without a family history of hypertension or those without drinking habits or smoking habits was 38.1 %, 40.1 % and 36.3 % for HBP; 12.6 %, 14.5 % and 12.5 % for SDH; 22.8 %, 23.7 % and 21.6 % for ISH; and 1.6 %, 1.8 % and 2.2 % for IDH (Table 4).

3.3. SBP, DBP and pulse pressure among different groups

The SBP value in the age group 50–59 years (140.2 ± 24.8 mmHg) was lower than those of the other two groups (age group 60–69 years: 147.0 ± 26.9 mmHg, age group 70 years or older: 150.6 ± 24.7 mmHg) (p < 0.05). The values of DBP among different ages were not significantly different (p > 0.05). The values of SBP (142.3 ± 25.4 mmHg) and DBP (78.8 ± 13.4 mmHg) in the lean group were lower than those of the other two groups (normal group: 146.2 ± 26.1 mmHg for SBP, 83.3 ± 13.9 mmHg for DBP; obese group: 150.3 ± 25.4 mmHg for SBP, 87.9 ± 15.8 mmHg for DBP) (p < 0.05). The DBP readings of males (85.1 ± 15.3 mmHg) were higher than those of females (80.9 ± 13.4 mmHg) (p

< 0.05). Subjects with a family history of hypertension or those with a habit of smoking or drinking had higher SBP and DBP readings compared with those without a family history of hypertension or with no habit of smoking or drinking (p = 0.000). Pulse pressure readings increased with age (p = 0.000). Pulse pressure readings among subjects with a family history of hypertension or a habit of cigarette smoking were higher than those without a family history or smoking habit (p = 0.000) (Table 3).

3.4. Risk factors of hypertension subtypes

To further investigate the risk factors of various hypertension subtypes, HBP, SDH, ISH and IDH were applied as the dependent variable, while gender, age, BMI, smoking habit, alcohol consumption habit, and family history of HBP were used as the independent variables. The data were analysed by using **multivariable** logistic regression models (Table 4), with adjustments for all of the variables. Subjects in the age groups of 60–69 years and 70 years or older (60–69, 70+) tended to have a higher risk of HBP and ISH (OR >1.0) compared with the age group of 50–59 years. People with obesity were prone to a higher risk of developing HBP, SDH, ISH, and IDH (OR >1.0) than participants with a normal weight. Participants with a family history of hypertension or those who consumed alcohol or smoked cigarette had a much greater chance of developing HBP, SDH and ISH (OR >1.0) compared to those without a family history of hypertension or who did not consume alcohol or smoke cigarette. Females tended to have a higher risk of HBP and ISH (OR >1.0) compared to males. Alcohol consumption is a risk factor for IDH (OR >1.0) (Table 4).

3.5. Hypertension awareness, treatment, and control

The prevalence of awareness among subjects with hypertension was 25.0 % (232/928) for HBP, 34.7 % (123/354) for SDH, 20.0 % (104/520) for ISH and 9.3 % (5/54) for IDH. Of the participants with hypertension, 23.8 % (221/928) took antihypertensive medications, and 6.9 % (64/928) of them reached a normal blood pressure with the use of medications. Of the participants with SDH, 26.8 % (95/354) took antihypertensive drugs, and 7.9 % (28/354) of them had normal blood pressure. Among the participants with ISH, the rates of treatment and control were 23.1 % (120/520) and 6.3 % (33/520), respectively. Among the IDH participants, the rates of treatment and control were 11.1 % (6/54) and 5.6 % (3/54), respectively (Table 5).

4. Discussion

This study offers population-based data on the epidemiology of hypertension in older Dai adults in rural China. The rate of HBP among the Dai people aged 50 years or older was 43.2 %. The subtype-specific prevalence of hypertension was 16.5 % for SDH, 24.2 % for ISH and 2.5 % for IDH. Among all the hypertension patients, 37.9 % were SDH, 56.8 % were ISH and 5.8 % were IDH. ISH was the most prevalent type of HBP among the rural elderly, followed by SDH. In comparison with the age group of 50–59 years, Dai people in the age groups of 60–69 years and 70+ years were prone to develop ISH (OR >1.0). However, SDH and IDH prevalence did not indicate an increasing trend (P > 0.05) in the Dai elderly. Among Dai people aged over 50 years, the SBP value tended to increase while the DBP value tended to decrease, which led to a widening of the pulse pressure. The increasing rigidity and decreasing elasticity of large arteries (including the aorta) had been shown to increase with age (Park et al., 2015). The SBP value appeared to increase with age, which caused an increased incidence of ISH in elderly people (Saladini et al., 2009). SBP is one of the most important cardiovascular risks and reflects diffuse atherosclerotic processes (Verdecchia and Angeli, 2005). If SBP declines by 10 mmHg; major adverse cardiovascular events (MACE) will decline by 20 %, heart failure will decline by 18 %, coronary heart disease will decline by 17 %, stroke will decline by

Table 1
Basic characteristics of the Dai ethnic group aged ≥50 in Xishuangbanna in 2020.

	Male (n = 789)	Female(n = 1360)	Total(n = 2149)	P value
Age (years)	63.5 ± 9.4	63.6 ± 10.4	63.6 ± 10.0	0.644
Height (cm)	163.4 ± 8.1	154.2 ± 14.5	157.6 ± 13.3	0.000
Weight (kg)	56.0 ± 11.2	48.3 ± 9.9	51.1 ± 21.5	0.000
SBP (mmHg)	146.8 ± 21.2	144.6 ± 25.8	145.4 ± 25.9	0.062
DBP (mmHg)	85.1 ± 15.3	80.9 ± 13.4	82.4 ± 14.2	0.000
Pulse pressure (mmHg)	61.6 ± 19.9	63.8 ± 20.2	63.0 ± 20.1	0.015
BMI (kg/m^2)	21.4 ± 13.5	20.6 ± 7.8	20.9 ± 10.3	0.070
BMI ≥25 (n, %)	96(12.2)	116(8.5)	212(9.9 %)	0.002
Cigarette smoking	395(50.1)	182(13.4)	577(26.8)	0.000
Liquor consumption	360(45.6)	83(6.1)	443(20.6)	0.000
Family history of HBP	146(18.5)	176(12.9)	322 (15 %)	0.000

Note: data presented as the mean ± SD or %. P values for comparisons between males and females, continuous variables between two groups were analysed by applying the *t*-test, categorical variables between two groups were analysed using Chi-square tests.
SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index.

Table 2

Percentage (%) of hypertension subtypes by sociodemographic and risk factors in Dai people aged ≥50 years in Xishuangbanna, 2020.

	Prevalence of HBP n (%)	P value	Prevalence of SDH n (%)	P value	Prevalence of ISH n (%)	P value	Prevalence of IDH n (%)	P value
Gender								
Male(reference)	362(45.9)	0.03	175(22.2)	0.000	158(20.0)	0.000	29(3.7)	0.007
Female	566(41.6)		179(13.2)		362(26.6)		25(1.8)	
Total	928(43.2)		354(16.5)		520(24.2)		54(2.5)	
Age groups (years)								
50–59 (reference)	289(34.4)	0.000	143(17.0)	0.126	122(14.5)	0.000	24(2.9)	0.716
60–69	316(45.5)		125(18.0)		175(25.2)		16(2.3)	
70+	323(52.5)		86(14.0)		223(36.3)		14(2.3)	
BMI (kg/m²)								
Normal (BMI:18.5–24.9) (reference)	570(44.4)	0.000	235(18.3)	0.000	300(17.3)	0.002	35(2.7)	0.004
Lean (BMI<18.5)	246(37.7)		65(10.0)		173(12.5)		8(1.2)	
Overweight/obesity (BMI≥25)	112(52.8)		54(25.5)		47(22.2)		11(5.2)	
Cigarette smoking								
No (reference)	571(36.3)	0.000	197(12.5)	0.000	339(21.6)	0.000	35(2.2)	0.109
Yes	357(61.9)		157(27.2)		181(31.4)		19(3.3)	
Liquor consumption								
No (reference)	684(40.1)	0.000	248(14.5)	0.000	405(23.7)	0.041	31(1.8)	0.000
Yes	244(55.1)		106(23.9)		115(26.0)		23(5.2)	
Family history of HBP								
No (reference)	696(38.1)	0.000	231(12.6)	0.000	416(22.8)	0.000	49(2.7)	0.158
Yes	232(72.0)		123(38.2)		104(32.3)		5(1.6)	

Note: compared with the reference by Chi-square test, HBP, high blood pressure; ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic–diastolic hypertension.

Table 3

Comparison of SBP, DBP and pulse pressure values in different groups of Dai people aged ≥50 years in Xishuangbanna in 2020(n = 2149).

	n	SBP (mmHg)	T value	P value	DBP (mmHg)	T value	P value	pulse pressure(mmHg)	T value	P value
Gender										
Male	789	146.8 ± 26.2	1.866	0.062	85.1 ± 15.3	6.665	0.000	61.6 ± 19.9	−2.446	0.015
Female	1360	144.6 ± 25.8			80.9 ± 13.4			63.8 ± 20.2		
Age (years)										
50–59	840	140.2 ± 24.8	5.151 [a]	0.000[a]	83.0 ± 14.0	0.114 [a]	0.910[a]	57.2 ± 17.6	−6.881 [a]	0.000 [a]
60–69	692	147.0 ± 26.9	−2.626[b]	0.022[b]	83.0 ± 14.87	2.592[b]	0.059[b]	63.9 ± 20.6	−5.317[b]	0.000[b]
70+	617	150.6 ± 24.7	−8.010[c]	0.000[c]	81.32 ± 13.6	2.908[c]	0.033[c]	69.9 ± 20.4	−12.733[c]	0.000[c]
BMI (kg/m2)										
Normal (BMI:18.5–24.99)	1285	146.2 ± 26.1	3.153 [a]	0.002[a]	83.3 ± 13.9	6.912 [a]	0.000[a]	62.8 ± 20.1	−0.772 [a]	0.440 [a]
Lean (BMI <18.50)	652	142.3 ± 25.4	−3.952[b]	0.000[b]	78.8 ± 13.4	−8.252[b]	0.000[b]	63.5 ± 20.7	0.761[b]	0.447[b]
Overweight/obesity (BMI ≥25)	212	150.3 ± 25.4	−2.090[c]	0.000[c]	87.9 ± 15.8	−4.366[c]	0.037[c]	62.3 ± 18.7	0.314[c]	0.754[c]
Cigarette smoking										
No	1574	142.5 ± 25.3	−8.778	0.000	80.8 ± 13.7	−8.823	0.000	61.7 ± 19.7	−4.786	0.000
Yes	575	153.4 ± 26.0			86.8 ± 14.8			66.4 ± 20.9		
Liquor consumption										
No	443	144.3 ± 26.1	−3.891	0.000	81.3 ± 14.0	−7.019	0.000	62.9 ± 20.2	−0.157	0.875
Yes	1706	149.7 ± 24.7			86.6 ± 14.3			63.1 ± 19.8		
Family history of HBP										
No	320	142.2 ± 24.5	−14.3	0.000	80.9 ± 13.4	−12.3	0.000	61.4 ± 19.5	−9.030	0.000
Yes	1829	163.7 ± 26.5			91.2 ± 15.7			72.1 ± 21.1		

Note: a. P for Age 50–59 vs 60–69, or for Normal vs Lean, b. P for age 60–69 vs 70+, or for Lean vs Overweight/obesity, c. P for age 50–59 vs 70+, or for Normal vs Overweight/obesity. Continuous variables between two groups were analysed by applying the *t*-test, Continuous variables among three groups or more were analysed by applying one-way ANOVA.

Table 4
Logistic regression analysis of the prevalence of hypertension subtypes and related factors among Dai people ≥50 years old in Xishuangbanna in 2020 (n = 2149).

	HBP			SDH			ISH			IDH		
	OR	95 % CI	P value	OR	95 % CI	P value	OR	95 % CI	P value	OR	95 % CI	P value
Gender												
Male	reference			reference			reference			reference		
Female	0.84	0.71–1.00	0.521	0.92	0.68–1.23	0.623	1.51	0.91–2.31	0.122	0.76	0.38–1.52	0.456
Age groups (years)												
50–59	reference			reference			reference			reference		
60–69	1.58	1.26–1.98	0.018	0.96	0.73–1.28	0.454	1.98	1.52–2.57	0.005	0.91	0.47–1.74	0.656
70+	2.57	2.03–3.25	0.006	0.90	0.65–1.22	0.535	3.41	2.62–4.44	0.001	1.08	0.54–2.16	0.686
BMI (kg/m^2)												
Normal(BMI: 18.5–24.9)	reference			reference			reference			reference		
Lean (BMI <18.5)	0.72	0.58–0.89	0.012	0.57	0.42–0.78	0.010	0.68	0.58–0.98	0.020	0.45	0.20–0.98	0.020
Overweight/obesity (BMI ≥25)	1.33	1.07–1.84	0.014	1.26	1.07–1.80	0.016	3.41	2.62–4.44	0.001	1.90	1.03–3.85	0.018
Cigarette smoking												
No	reference			reference			reference			reference		
Yes	3.16	2.51–3.97	0.008	2.22	1.69–2.91	0.005	2.21	1.72–2.83	0.002	0.99	0.52–1.85	0.578
Liquor consumption												
No	reference			reference			reference			reference		
Yes	2.10	1.61–2.73	0.010	1.42	1.04–1.93	0.018	1.58	1.18–2.11	0.016	2.40	1.23–4.67	0.003
Family history HBP												
No	reference			reference			reference			reference		
Yes	4.46	3.38–5.89	0.001	4.00	3.04–5.27	0.001	1.70	1.30–2.24	0.014	0.49	0.19–1.25	0.665

Note: 95 % CI, 95 % confidence interval; OR, odds ratio; HBP, high blood pressure; ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic–diastolic hypertension.

17 % and all-cause mortality will decline by 13 % (Kengne et al., 2007). From 1979 to 2015, the Chinese government had carried out a one-child policy to curb China's population growth, which has led to changes in the demographic structure and ageing population in China. In accordance with the United Nations, an ageing society is one in which more than 7 % of the total population is over 65 years old. According to the 2010 census of the Chinese population, 13.31 % of the total population is aged 60 years, and 14.98 % of the rural population is aged over 60 years (National Bureau Statistics, 2019). It is estimated that a quarter of the population will be 60 years or older by 2030 in China. The increasing ageing population associated with rising prevalence of hypertension particularly ISH is anticipated to place a substantial and escalating social and economic burden because of the need to manage not only treatment of HBP but also the complications of HBP such as MACE, as recently demonstrated in a review about systolic hypertension management (Jani and Rajkumar, 2006).

In comparison with normal-weight individual, the prevalence of HBP, SDH, ISH and IDH among Dai people with obesity showed increasing trends (p < 0.05). The prevalence of HBP, SDH, ISH and IDH among Dai people with obesity was 52.8 %, 25.5 %, 22.2 % and 5.2 %, respectively. The increasing trends of BMI have been found in our study to be associated with both SBP and DBP values rise. The Dai people rely mainly on agriculture for a living and as the main source of income for the family and the community. During harvest seasons, their diet usually consists of a large amount of meat, which is high in saturated fat and cholesterol. There has been a local cultural belief that high-fat dairy foods give them strength. Most Dai people do not have the awareness of the benefits of regular exercise. Most of them remain sedentary in their leisure time. Therefore, it is essential to develop the culturally appropriate guideline of maintaining a healthy diet and regular exercise in helping Dai people control their weight and prevent hypertension. Dai people should take part in accumulated moderate-intensity aerobic physical exercise ≥150 min/week (Arnett et al., 2019). In terms of

dietary advice, they should keep adopt healthy diets abundant in dark green vegetables, fresh fruits, whole grains (instead of refined grains), and low-fat and low-sodium dairy options (Arnett et al., 2019).

Dai people who consumed alcohol or smoked had a higher prevalence of HBP, SDH and ISH (P < 0.05) compared with those who did not consume alcohol or smoke. Wine culture is an important part of the national etiquette, in which Dai people are particularly good at brewing liquor. Dai people like to consume alcohol in large bowls in their daily life, during festivals, for social reasons and entertainment. The percentage of alcohol consumption among Dai males over 50 years old is 45.6 %. Through this study, health education should be implemented to reduce the frequency and amount of each alcohol consumption episode in an effort to abstain from alcohol altogether. In addition, the smoking rate among Dai people over 50 years old is 26.8 % (50.1 % for males and 13.4 % for females). According to the Chinese Adult Tobacco Survey in 2015, the smoking rate of people over 15 years old was 27.7 % (52.1 % for males and 2.7 % for females) (China Cardiovascular Disease Report Writing Group, 2018). The smoking rate of elderly Dai women is obviously higher than that of the whole country. Dai people believe that it is a social norm for women to smoke, and some women have the habit of chewing tobacco as well. The high smoking rate is related to Dai people's cultural belief and insufficient awareness of smoking hazards. Smoking is an important independent risk factor for hypertension and premature death (Arnett et al., 2019). Research evidence has pointed out that tobacco dependence is a chronic disease (Joseph et al., 2011). Healthcare professionals should design treatment protocol including behavioural interventions and medicine to help people quit smoking (Arnett et al., 2019). In addition, it is important to reduce second-hand smoke exposure of non-smokers through government-led health campaigns.

Among all hypertensive participants, the rate of hypertension awareness in our study was 25.0 % (232/928) for HBP, 34.7 % (123/354) for SDH, 20.0 % (104/520) for ISH and 9.3 % (5/54) for IDH,

Table 5

Percentage (%) of subgroup awareness, treatment and control of hypertension subtypes among Dai people aged ≥50 years in Xishuangbanna in 2020.

	HBP			SDH			ISH			IDH		
	Awareness (n = 928) [a]	Treatment (n = 928) [a]	Control (n = 232) [b] [a]	Awareness (n = 354) [a]	Treatment (n = 354) [a]	Control (n = 123) [b] [a]	Awareness (n = 520) [a]	Treatment (n = 520) [a]	Control (n = 120) [b]	Awareness (n = 54) [a]	Treatment (n = 54) [a]	Control (n = 16) [b]
Gender												
Male (reference)	49.4	39.6	33.8	47.2	35.2	28.2	44.8	34.4	29.0	29.2	27.6	30.8
Female	44.8	30.7	27.4	39.4	27.3	23.5	38.8	20.0	22.2	22.8	15.8	21.6
total	47.0	34.8	31.5	44.7	30.8	26.8	41.3	28.1	26.7	25.9	20.3	25.0
Age (years)												
50–59 (reference)	54.2	48.8	42.3	49.9	38.7	31.9	49.7	30.5	33.9	30.2	28.1	18.4
60–69	35.4	28.5	29.2	39.2	29.6	20.5	36.9	24.1	25.2	26.2	18.0	33.2
70+	38.5	27.6	21.5	32.0	27.2	24.1	40.8	17.0	21.4	20.8	15.8	26.2
BMI (kg/m^2)												
Normal (reference)	38.5	30.2	30.1	38.2	25.1	21.1	38.5	22.5	20.7	21.7	19.7	21.9
Lean	29.9	28.1	26.4	32.6	26.3	22.0	34.3	21.6	29.0	20.9	17.0	28.6
Overweight/ obesity	58.4	46.9	36.8	52.1	40.8	34.6	51.9	34.8	25.1	32.8	25.1	26.4
Cigarette smoking												
No (reference)	43.4	32.5	27.2	40.2	25.3	23.0	37.6	27.3	25.2	20.4	18.4	22.5
Yes	50.1	36.7	36.7	47.9	34.9	29.9	44.5	29.4	28.4	30.2	22.2	27.2
Alcohol consumption												
No (reference)	44.2	32.2	28.6	47.3	24.6	25.2	37.4	25.6	24.8	29.9	16.2	28.6
Yes	49.1	38.6	33.0	42.8	38.1	28.1	44.8	31.3	30.9	20.9	22.8	21.0
Family history of HBP												
No (reference)	34.9	27.9	27.0	38.6	25.1	22.4	35.6	23.2	23.0	20.2	17.2	26.8
Yes	56.9*	48.6*	36.4	50.2	37.4	28.9	47.2	36.9	30.8	31.3	22.0	23.6

[a] Among participants with hypertension.
[b] Among participants taking medications for their hypertension.
* P < 0.01 in family history of HBP (compared with the reference by Chi-square test).

which was much lower than that reported in urban northwest China (42.9 %) (Meng et al., 2011), Thailand (43.9 %) (Porapakkham et al., 2008); the USA (69 %) (Burt et al., 1995), London (44 %) (Costanzo et al., 2008) and South Korea (60.1 %) (Lee et al., 2010). The discrepancy in the rate of hypertension awareness is most likely due to a lower level of patient knowledge among the Dai ethnic population resided in rural southwest China. Hypertension unawareness because of asymptomatic nature of the condition; thus reflecting a significant proportion of un-diagnosis hypertensive patients. Many Dai people are reluctant to go to the hospital due to financial constraints, which consequently lead to a large number of un-diagnosis and un-treated hypertensive patients.

Among all the participants with hypertension, 23.8 % (221/928) had HBP, 26.8 % (95/354) had SDH, 23.1 % (120/520) had ISH and 11.1 % (6/54) took antihypertensive medications. The rates of control were 6.9 % for HBP, 7.9 % for SDH, 6.3 % for ISH and 5.6 % for IDH. The rates of treatment and control of hypertension in the population aged over 18 years in 2012 in China were 41.1 % and 13.8 %, respectively (Disease Prevention and Control Bureau of the State Health and Family Planning Commission, 2015). Dai people have lower rates of treatment and control. There are numerous reasons for the fact that Dai people have lower rates of treatment and control. Firstly, the awareness of optimal hypertension management in those participants who were diagnosed with hypertension was lacking. The full diagnostic workup of HBP is still not fully covered by current health insurance in China (Health Network, 2019). Secondly; Dai people prefer to choose short-term antihypertensive medicines such as hydrochlorothiazide and captopril for economic reasons. When attempting to control SBP with antihypertensive medicine in the elderly, some physicians may worry about the excessive

decline in DBP and significant symptomatic postural hypotension. This lack of comprehensive understanding of the significance of optimal SBP control may lead to the suboptimal effectiveness of hypertension treatment. Thirdly, Xishuangbanna is a tropical rainforest with abundant natural sources of alternative treatment modalities. Some Dai people prefer Chinese herbal medicine to treat hypertension without undergoing a thorough investigation with an evidence-based treatment plan. In addition, the lack of understanding for the required lifelong commitment of anti-hypertensive treatment led to the nonadherence to pharmacological intervention. When their blood pressure was found to be "normal", they would cease antihypertensive therapy. The decreased guideline-based follow-ups and insufficient lifestyle changes were also accounting for lower rates of treatment and control.

There are a few limitations of this study in the light of being a prevalence or observational study. Firstly, white-coat hypertension would be accounting for a proportion of the cases due to a single visit for blood pressure measurement in this study. Secondary hypertension were not eliminated from the hypertensive group because of lacking a proper diagnostic workup. Secondly, our study conducted a population-based survey based on randomly selected samples without determining whether there was a nonresponse selection bias. Data on smoking habits, alcohol drinking habits, salt intake and exercise routines were based on self-reporting, which could lead to misclassification due to recall bias. Furthermore, we were unable to infer cause and effect due to the cross-sectional design of this study.

5. Conclusion and future perspectives

In conclusion, hypertension prevalence is high among Dai people in rural China in association with the low prevalence of treatment and control. Most of the hypertensive Dai people were not fully aware of their hypertension and potential target-organ damage if being left untreated. ISH was the most common type of hypertension in the rural elderly population. Coupled with China's ageing population, ISH remains to be a primary public health problem and a challenging issue for practising physicians in rural China. Older age, obesity, smoking, drinking and a history of hypertension are all risk factors for ISH. Public health strategies should regularly provide more evidence-based guideline and information to both local physicians and the general population on how to prevent hypertension and encourage people to monitor and track their blood pressure and to adhere to the expertise guideline. The future direction for research should focus on a combination of drugs and lifestyle modifications to reduce MACE.

Author contribution

Hua Zhong, Hongxia Li and Lixing Chen conceptualized and designed the survey, conducted the statistical analyses, drafted the first manuscript and approved the final manuscript as submitted. Dan Xu and Yilong Dong conducted the statistical analyses, was conducive to explaining the data analysis and drafted the first manuscript. Jun Li and Chen-Wei Pan have been involved in drafting the manuscript. Hua Zhong and Jun Li conducted the statistical analyses. Hongxia Li and Lixing Chen conducted the data collection.

CRediT authorship contribution statement

Hua Zhong: Writing – review & editing, Writing – original draft, Data curation. **Hongxia Li:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Dan Xu:** Writing – review & editing, Supervision, Conceptualization. **Yilong Dong:** Project administration, Data curation, Conceptualization. **Chenwei Pan:** Validation, Resources, Funding acquisition, Data curation. **Jun Li:** Software, Methodology, Data curation. **Lixing Chen:** Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Hua Zhong, Hongxia Li and Lixing Chen conceptualized and designed the survey, conducted the statistical analyses, drafted the first manuscript and approved the final manuscript as submitted. Dan Xu and Yilong Dong conducted the statistical analyses, was conducive to explaining the data analysis and drafted the first manuscript. Jun Li and Chen-Wei Pan have been involved in drafting the manuscript. Hua Zhong and Jun Li conducted the statistical analyses. Hongxia Li and Lixing Chen conducted the data collection. All authors agreed to the submission of the final manuscript. They claim that they have no competing interests. All authors agreed to the submission of the final manuscript.

Data availability

The authors are unable or have chosen not to specify which data has been used.

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