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Liu F, Ma YT, Yang YN, Zhen YJ, Xie X, Li XM, Ma X, Chen BD, Huang Y, Shan CF, Gao XM. The prevalence of isolated systolic hypertension in adult populations from the Han, Uygur and Kazakh ethnic groups in Xinjiang, China. *Blood Press* 2014;23(3):154-9.

<http://hdl.handle.net/11187/2186>

The prevalence of isolated systolic hypertension in adult populations from the Han, Uygur, and Kazakh ethnic groups in Xinjiang, China

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Abstract

Objectives: To estimate the current prevalence and epidemiology of isolated systolic hypertension (ISH) among adult populations from different ethnic groups in Xinjiang province and to further establish a theoretical basis for developing personalized therapeutic strategies for hypertensive populations.

Methods: To analyze the prevalence and risk factors of ISH in different ethnic groups in Xinjiang province, a cluster sampling method was adopted to conduct a cross-sectional study on people aged 35 years and older from the Han, Uygur, and Kazakh populations in the Urumqi, Kalamayi, Hetian, Zhaosu, Fukang, Tulufan and Fuhai.

Results: A total of 14,618 adults were surveyed with a response rate of 88.80%. The overall prevalence of ISH was 11.95% (men: 10.84% vs. women: 12.92%); the prevalence of ISH in women was significantly higher ($\chi^2=15.06$, $P=0.00$) than that in men. The prevalence varied significantly with age ($\chi^2=822.71$, $P=0.00$) and increased in the elderly ($\chi^2=769.59$, $P=0.00$). A logistic regression analysis revealed that age, obesity, diabetes, and dyslipidemia are major risk factors for ISH; patients with hypertension combined with obesity or diabetes are at a high risk of ISH.

Conclusions: The prevalence of ISH in Xinjiang is higher than average and exhibits a gender difference. There is a trend of increased prevalence with increasing age. Populations with obesity, diabetes, or dyslipidemia and patients who have hypertension combined with obesity and/or diabetes should be aware of early preventive interventions.

Key words: isolated systolic hypertension (ISH), prevalence, epidemiology

Introduction

Hypertension is the major risk factor for cardiovascular disease in China and accounts for at least half of the 3 million cardiovascular mortality incidents every year^[1]. Isolated systolic hypertension (ISH) is a distinct type of hypertension characterized by elevated systolic blood pressure (SBP) and increased pulse pressure and is the most common type of uncontrollable hypertension. Studies of ISH have been limited due to the commonly accepted view that ISH is part of the natural physiological aging process^[2]. However, with the aging of the global population in recent years, there is an increasing awareness of the harm caused by ISH. New global studies have revealed that ISH is an independent risk factor for cardiovascular disease, which often causes left ventricular hypertrophy, heart failure, coronary artery disease, and stroke^[3]. Previous studies have demonstrated that the prevalence of hypertension is as high as 36.21% in Xinjiang adult populations and varies greatly among ethnic groups^[4]. However, the current situation regarding the prevalence of ISH is not fully understood. In this study, we focus on the prevalence of ISH in the Han, Uygur, and Kazakh populations in Xinjiang; the information will help to provide insights for the diagnosis of and therapeutic strategies for ISH in the clinic.

Methods

Subjects

From October 2007 to March 2010, the Cardiovascular Risk Survey (CRS) study is a multi-ethnic, community-based, cross-sectional study designed to investigate the

prevalence and risk factors for cardiovascular diseases and determine the genetic and environmental contributions to atherosclerosis, CAD and cerebral infarction (CI) of Chinese Han, Uygur and Kazakh population in Xinjiang of western China described in the previous study [5,6]. In the densely populated cities and countryside of the Urumqi, Kelamayi, Hetian, Zhaosu, Fukang, Tulufan and Fuhai, a cluster sampling method was adopted to survey the Han, Uygur, and Kazakh adult population aged of 35 and older. The surveyed regions have a representative economic development status were chosen and, based on the government record of registered residence, one participant was randomly selected from each household. In this way, a total of 16,460 participants were randomly selected from 26 villages of these seven cities and were invited to participate. The present study was conducted in accordance with the Declaration of Helsinki guidelines, and the participants signed informed consent forms before being questioned and examined according to a protocol approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University. Participants with an acute medical condition, such as fever, acute infection, surgery or trauma, were excluded.

Data collection

A unified trained research staff conducted the data collection; the same programs under strict quality controls were applied. The participants were well informed via a project briefing and gave signed informed consent before the interview and examination was performed. A questionnaire, a physical examination, and

biochemical tests were included in the survey. After standardized training, cardiovascular physicians performed the medical examination and inquiry. The questionnaire included questions regarding the following: general health status, occupation, labor intensity, personal and family history of cardiovascular diseases, etc. The physical examination included the following: height, weight, chest/ waist/ hip circumference, blood pressure, and heart rate measurements, electrocardiography, heart and neck vascular ultrasounds, and limbs Doppler analysis, etc.

Blood pressure measurements

The participants were advised in advance to avoid consuming tobacco and emptying their bladder for 15 min and to rest and relax for at least 5 min prior to the reading. Three readings were taken on the right arm in the seated position using a standard mercury sphygmomanometer, in which the mercury column drops approximately 2 mm per second. While the mercury column drops, the reading at Korotkoff phase I (sound appears) is the systolic pressure, while the reading at phase V (sound disappears) is the diastolic pressure; readings could only be even, such as 0, 2, 4, 6, 8. The second and third readings were obtained after at least 30 seconds intervals, and the average of the 3 readings was regarded as the blood pressure value for statistical analysis.

Staff training and quality control

All of the survey forms were reviewed daily and were kept secure by a

specially assigned staff member; any problems were handled within a reasonable timeframe. A person trained in the standard protocols created a local database to store the collected data. All of the data collected in the database were subjected to statistical analysis. Supervisors monitored the entire process during the survey. The data were entered twice by different keyboarding staff with unified database software; 100 questionnaires were saved as a batch file to double check the data entry, and inconsistent fields were corrected according to the original forms to ensure the accuracy of the survey.

Diagnostic criteria

Hypertension was defined as follows^[7]: the systolic blood pressure (SBP) was ≥ 140 mmHg and/or the diastolic blood pressure (DBP) was ≥ 90 mmHg without taking anti-hypertensive medications or there was a history of hypertension with daily or regular (≥ 3 days per week) use of anti-hypertensive medications within a year. The diagnosis of ISH required that the SBP was greater than 140 mm Hg and the DBP was lower than 90 mm Hg, on at least two separate occasions, or antihypertensive treatment^[8]. Hypercholesterolemia was defined as a documented total cholesterol (TC) of ≥ 240 mg/dl (≥ 6.2 mmol/l) or current treatment with cholesterol-lowering medication. Diabetes mellitus was defined as the presence of an active treatment with insulin or an oral antidiabetic agent or self-reported current diabetes treatments in the survey; for patients on dietary treatment, documentation of an abnormal FBG or glucose tolerance test

based on the World Health Organization criteria ^[9] was required to establish this diagnosis (fasting plasma glucose ≥ 7.0 mmol/L [≥ 126 mg/dL]). Body mass index (BMI) was calculated by dividing the weight in kilograms by the height in meters squared. Obesity was defined as BMI ≥ 25 kg/m² which was based on the WHO Asia-Pacific Area criterion for obesity described previously ^[10].

Biochemical analysis

Serum was separated from the samples within 30 min and stored at - 80 ° C until analysis. We measured the serum concentration of UA, creatinine, triglycerides (TG), TC, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and fasting glucose using equipment for chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA) employed by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University[11].

Statistical analysis

The collected data were independently recorded, verified and corrected by 2 staff members using EpiData3.02 software (EpiData Association, Odense, Denmark). Statistical Package for Social Sciences-SPSS for Windows version 17.0 (SPSS, Inc., Chicago, IL, USA) was utilized to analyze the data. Numerical data were expressed as rates, and a chi-square test was used to evaluate differences between groups. The risk factors for ISH were analyzed using a

multivariate unconditional logistic regression; the significance level alpha value was set to 0.05.

Results

General data analysis

A total of 16,460 adults aged 35 years and older were randomly selected, and among them, 14,618 completed the survey and examination, yielding a response rate of 88.80%. Among the respondents, 6,819 (46.65%) were men and 7,799 (53.35%) were women. The population distribution was as follows: 5,757 Han cases (39.38%); 4,767 Uighur cases (32.61%); and 4,094 Kazakh cases (28.01%). General information regarding the different ethnic groups is shown in Table 1. The mean age, BMI, SBP, DBP, FBG, triglyceride and total cholesterol was difference between each ethnic group (all $P < 0.05$).

Table 1 Participant characteristics (n=14,618).

group	Han (n=5757)	Uighur (n=4767)	Kazakh (n=4094)	Total (n=14618)
Age, years	52.47±12.71	50.7±12.98 [*]	48.63±11.69 ^{*,**}	50.82±12.62 ⁺
BMI, kg/m ²	25.13±3.50	25.84±4.42 [*]	26.56±4.76 ^{*,**}	25.76±4.22 ⁺
SBP, mmHg	132.74±19.96	131.48±21.23 [*]	140.35±25.12 ^{*,**}	134.43±22.21 ⁺
DBP, mmHg	84.97±15.58	80.10±14.88 [*]	88.33±19.69 ^{*,**}	84.30±16.92 ⁺
FBG, mmol/l	5.34±1.78	4.94±1.66 [*]	5.13±1.51 ^{*,**}	5.15±1.68 ⁺
TG, mmol/l	1.72±1.45	1.64±1.22 [*]	1.21±0.93 ^{*,**}	1.55±1.27 ⁺

TC, mmol/l	4.69±1.08	4.36±1.13 [*]	4.78±1.16 ^{*,**}	4.61±1.13 ⁺
HDL-c, mmol/l	1.26±0.45	1.26±0.47	1.29±0.43 ^{*,**}	1.27±0.45 ⁺
LDL-c, mmol/l	2.87±0.91	2.87±0.92	2.90±0.93	2.88±0.92

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBG, fasting blood glucose; TG, triglyceride ;TC, total cholesterol; HDL-C, highdensity lipoprotein-cholesterol; LDL-C, low-density lipoproteincholesterol; *Compared with Han P<0.05, **Compared with Uighur P<0.05, + Compared with different ethnic group P<0.05

The prevalence of ISH

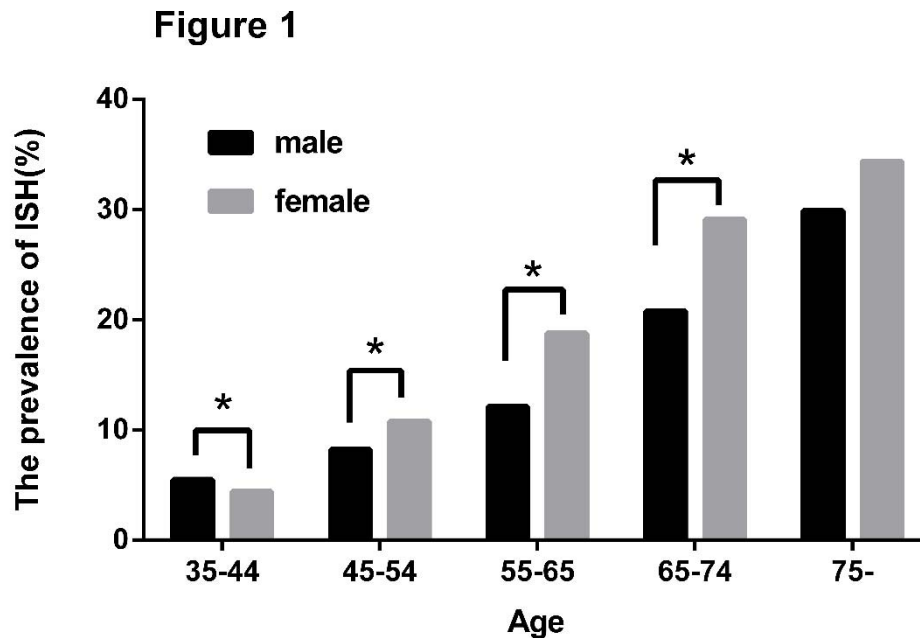
Among all of the respondents, 1,747 were ISH patients, with a prevalence rate of 11.95%. Regarding gender, 739 were men with a 10.84% prevalence rate, and 1,008 were women with a 12.92% prevalence rate; the prevalence of ISH among women was significantly higher than that among men ($\chi^2=15.06$, P=0.00).

The prevalence of ISH in different age groups:

The prevalence rate of ISH in different age groups varies significantly ($\chi^2=822.71$, P=0.00) and increases with increasing age ($\chi^2= 769.59$, P=0.00), as shown in Figure 1. The prevalence rate of ISH among women was significantly lower than that among men in the 35- to 44-year age group ($\chi^2=3.49$, P=0.036). However, the trend was reversed in the 45- to 54-year age group and up ($\chi^2=6.67$,

P=0.005); at the age of 75, no significant gender difference in the ISH prevalence rate was observed ($\chi^2=1.13$, P=0.168).

Figure 1 The prevalence of ISH in different age groups



The prevalence of ISH among ethnic groups:

The ISH prevalence rates in the adult population of the Han, Uyghur, and Kazakh ethnic groups were 12.44%, 11.75%, and 11.50%, respectively. No statistically significant differences were observed among the ethnic groups ($\chi^2=2.26$, P=0.32). The ISH prevalence rate among women was significantly higher than that among men in the Han group ($\chi^2=25.14$, P=0.00), while there were no significant gender differences in the Uyghur and Kazakh groups ($\chi^2=0.95$, P=0.17 and $\chi^2=0.09$, P=0.40, respectively).

Multivariate unconditional logistic regression analysis of ISH risk factors

Model 1: Table 2 shows the results from the analysis of 1,747 ISH patients

and 8,917 healthy controls. ISH was considered as the dependent variable, and age, gender, ethnicity, marital status, smoking, alcohol consumption, and blood sugar and cholesterol levels, etc. were regarded as independent variables. The results reveal that the risk of ISH occurrence increases significantly with increasing age. Using the 35- to 44-year age group as a reference [odds ratio (OR) = 1], the risk of occurrence increased by 1.50-fold in the 45- to 54-year age group [OR=2.50, 95% Confidence Interval (CI): 2.09-3.00], while the risk increased by 18.49-fold at the age of 75 and older (OR=19.49, 95% CI: 14.89-25.51). Using the Han group as a reference, the risk of ISH occurrence among Kazakhs is 0.82-fold (OR=1.82, 95% CI: 1.55-2.13). Using the population with a normal Body Mass Index (BMI) as a reference (OR = 1), being overweight increased the risk of ISH by 0.93-fold (OR=1.93, 95% CI: 1.67-2.23); however, in obese populations the risk of ISH occurrence is increased by 2.48-fold (OR=3.48, 95% CI: 2.97-4.07). Diabetes (OR=1.69, 95% CI: 1.36-2.09), high triglycerides hyperlipidemia (OR=1.17, 95% CI: 1.02-1.33), and high total cholesterol hyperlipidemia (OR=1.25, 95% CI: 1.09-1.43) were also found to be ISH risk factors.

Table 2 Multivariate unconditional logistic regression analysis of ISH risk factors with healthy controls

Factor	B	S.E.	Wald	df	P	OR	95% CL
sex	0.332	0.061	29.525	1	0.000	1.394	1.237-1.572
age			929.179	4	0.000		

35-44y						1	
45-54y	0.916	0.092	98.695	1	0.000	2.500	2.087-2.996
55-64y	1.729	0.091	358.192	1	0.000	5.633	4.710-6.738
65-74y	2.548	0.096	698.005	1	0.000	12.785	10.583-15.446
More than 75y	2.970	0.137	467.428	1	0.000	19.488	14.889-25.509
ethnic			73.428	2	0.000		
Han						1	
Uygur	-0.063	0.071	0.777	1	0.378	0.939	0.817-1.080
Kazakh	0.596	0.081	54.587	1	0.000	1.815	1.550-2.126
BMI			244.432	2	0.000		
Normal						1	
Overweight	0.657	0.075	77.192	1	0.000	1.929	1.666-2.234
Obesity	1.246	0.080	244.407	1	0.000	3.477	2.974-4.065
Diabetes	0.523	0.109	22.853	1	0.000	1.687	1.361-2.090
TG	0.154	0.069	5.011	1	0.025	1.166	1.019-1.334
TC	0.222	0.068	10.786	1	0.001	1.249	1.094-1.426
Constant	-3.879	0.106	134.33	1	0.000	0.021	

Model 2: Table 3 contains the results from the analysis of 1,747 ISH patients and 3,954 non-ISH hypertensive patients. The incidence of ISH among the hypertensive population was regarded as the dependent variable, and age, gender, ethnicity, marital status, smoking, alcohol consumption, and blood sugar and

cholesterol levels, etc. were regarded as independent variables. The results indicate that age, obesity, and diabetes are still counted as risk factors; using the 35- to 44-year age group as a reference (OR=1), the risk of ISH occurrence increased by 2.8-fold at the age of 75 and older (OR=3.8, 95% CI: 2.9-4.99).

Table 3 Multivariate unconditional logistic regression analysis of ISH risk factors with hypertensive patients

Factor	B	S.E.	Wald	df	P	OR	95% CL
Sex	0.331	0.056	35.118	1	0.000	1.393	1.248-1.554
Age			168.566	4	0.000		
35-44y						1	
45-54y	0.115	0.098	1.370	1	0.242	1.122	0.925-1.360
55-64y	0.410	0.095	18.623	1	0.000	1.508	1.251-1.817
65-74y	0.875	0.097	81.774	1	0.000	2.399	1.985-2.901
More than 75y	1.336	0.139	92.951	1	0.000	3.802	2.898-4.989
BMI			125.529	2	0.000		
Normal						1	
Overwaight	0.504	0.070	51.428	1	0.000	1.656	1.442-1.900
Obwsity	0.808	0.072	125.218	1	0.000	2.244	1.948-2.585
Diabetes	0.364	0.095	14.693	1	0.000	1.439	1.195-1.733
Constant	-3.620	0.088	168.73	1	0.000	0.027	

Discussion

The prevalence of hypertension in China has increased dramatically in the past 10 years. The prevention, treatment, and control of hypertension have already become major public health concerns^[12]. Previously, elevated DBP alone was regarded as the main risk factor for cardio- and cerebrovascular events and was believed to be a more important predictor for cerebrovascular and coronary heart disease than SBP. The risk of high SBP was ignored, leading to the misconception that the SBP increased with age in the elderly as a natural physiological process^[13]. However, in the 1990s, emerging studies revealed that both the systolic and diastolic readings for blood pressure were independent risk factors associated with the incidence of stroke and coronary heart disease. Rather than a normal physiological state in the elderly, ISH is a dangerous state that can lead to cardio- and cerebrovascular events. The impact of the SBP level on acute cardiovascular events, particularly the risk of stroke, is significantly greater than that of the DBP^[14]. Both epidemiological investigations and clinical trial results have indicated that an elevated SBP can significantly increase the risk of stroke, coronary heart disease, and end-stage renal disease, especially for those aged ≥ 65 years; furthermore, SBP is much more difficult to control^[15, 16].

The 3rd National Hypertensive Sample Survey indicated that the prevalence of ISH was 5.1% nationwide^[17]; the ISH prevalence rate in populations aged 18

years and older in Tianjin was 7.16% in 2006 (the standardized prevalence was 5.33%)^[18]. Our study indicated that the ISH prevalence rate among the Xinjiang adult population was 11.95%, which is significantly higher than the average level in China. This result is possibly associated with the high prevalence of hypertension in Xinjiang. Huang et al^[19] found that the prevalence of hypertension among the adult population nationwide was only 19.4%, while the rate was as high as 36.2% in the Xinjiang region, and in the Kazakh ethnic group, the prevalence was even as high as 48.7%^[4].

Recent studies have demonstrated that the prevalence of ISH increases significantly with increasing age. SBP and pulse pressure are the most important predictors for cardiovascular disease mortality and complication incidence in those aged 65 years and older; while elevated SBP was positively correlated with cardiovascular risk, elevated DBP was negatively correlated^[20-21]. The results of this study indicated that the prevalence of ISH increases with increasing age, which is consistent with previous reports. The multivariate regression analysis also indicated that the occurrence of ISH correlates with age, comparing either healthy controls or patients with other types of hypertension. Increased arterial stiffness, decreased baroreceptor sensitivity, and kidney dysfunction associated with aging might be responsible for this correlation.

Qian et al^[22] found that the prevalence of ISH increases with age for both

men and women. The prevalence of ISH among women aged 40-49 years or younger was lower than that of men. Above that age range, the rate of ISH occurrence is higher for women than for men. Franklin et al ^[23] studied 7,983 patients aged 55 years and older and found that the prevalence increased to 39% at the age of 80 for men, and the prevalence increased to 52% for women older than 85 years. Our study suggests that there are gender differences in the prevalence of ISH; the rate is higher in women aged 45-54 years, which is consistent with previous findings.

Studies of the prevalence of hypertension in different populations and evaluating the potential risk of hypertension are critical to developing preventive strategies aimed at hypertension-related diseases and complications. The results of this study indicate that differences exist in the prevalence of hypertension among the ethnic groups in Xinjiang. While no significant differences in the prevalence of ISH were found among the ethnic groups, comparing 8,917 healthy control and 1,747 ISH patients, the Kazakh and Han populations presented an increased susceptibility to ISH (OR =1.82, 95% CI: 1.55-2.13). These differences among the ethnic groups may be associated with genetic susceptibility.

The multivariate analysis suggests that the prevalence of ISH might be associated with abnormal blood sugar and lipid levels and being overweight or obese. It is critical for the different ethnic groups in Xinjiang to take actions to

prevent cardiovascular disease. It is worth mentioning that our study found that being overweight or obese has an impact on the prevalence of ISH, using a normal BMI population as a reference (OR=1). The prevalence of ISH in the overweight population was increased by 0.93-fold (OR=1.93, 95% CI: 1.67-2.23); the prevalence of ISH in the obese population was increased by 2.48-fold (OR=3.48, 95% CI: 2.97-4.07). In the hypertensive population, the impact of being overweight or obese on the prevalence of ISH remained apparent, suggesting that body weight control is an important intervention that may prevent ISH in the elderly population.

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