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ORIGINAL ARTICLE

Prevalence of hypertension and associated risk factors in Dehui City of Jilin Province in China

Q Wei[1,7], J Sun[2,7], J Huang[3], H-Y Zhou[2], Y-M Ding[4], Y-C Tao[5], S-M He[2], Y-L Liu[2] and J-Q Niu[6]

To evaluate the prevalence, awareness, treatment and control of hypertension and its risk factors in Dehui City of Jilin Province in China. The study was performed among 3778 subjects (male = 1787) in Dehui city, Jilin Province of China. The subjects completed a standard questionnaire, biochemical tests and physical examinations. Logistic regression analyses were used to identify risk factors for hypertension. The prevalence of hypertension was 41.00% in this area. The awareness, treatment and the control of hypertension were 21.82, 15.56 and 1.10%, respectively, with city areas being significantly higher than rural areas. Significant risk factors for hypertension included age, sex, central obesity, alcohol consumption, family history of hypertension, dyslipidemia, education level and type of work. Further analysis showed that diabetes for urban participants and cigarette smoking for rural participants were risk factors but were not statistically significant at the multi-variate level. The prevalence of hypertension in Dehui Ctiy of Jilin Province is higher than in other areas of China. In addition, rates of awareness and treatment of the condition are much lower than in other populations, with the control rate only 1.10%.

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INTRODUCTION

Hypertension is an important public health concern given that it is highly prevalent, is a risk factor for cardiovascular diseases (CVD)[1] and is associated with morbidity and mortality. The prevalence of hypertension in European countries ranges between 28.00% and 44.00%, and the disease is highly correlated with stroke mortality and more modestly with CVD.[2] Hypertension has emerged as an important cause of morbidity and mortality in several Mediterranean countries with an adult prevalence varying between 20.00% and 30.00%.[3] According to data from the Chinese Health and Nutrition Survey in 2002, the prevalence of hypertension in Chinese adults was 18.80%.[4] The lifestyles of Chinese adults have changed recently with people of the North-East engaging in behaviors that are independent risk factors for hypertension, for example, increasing dietary salt intake. It is important to explore other demographic and lifestyle factors that could be associated with hypertension. It has been 10 years since the Third National Nutrition Survey in China, so an update on information on hypertension and its risk factors would be beneficial. The current study explores the prevalence of hypertension in Dehui City of Jilin Province in China, located in the North-East of China.

METHODS

Study design

Sampling methods. The cross-sectional, population-based study was conducted in the city of Dehui, a city-level division of Jilin Province of North-East China. Dehui city was selected with reference to its socio-economic status in relation to that of the overall province of Jilin. Dehui has a population of 807 000 in 14 towns (urban) and 308 villages (rural). The socio-economic status of the city is above mid-level compared with other areas in Jilin Province. The sampling was multi-staged. In the first stage, 9 villages and 11 towns were selected from 308 villages and 14 towns, respectively, in the city of Dehui. In the second stage, cluster sampling was used in the areas selected above. The second stage was divided into two tiers or phases. In phase 1, participants completed a questionnaire administered by door-to-door interviewers, and in phase 2, participants completed a physical examination and ultrasound liver examination.

The sample size (N) necessary for this study was calculated based on an 18.80% prevalence (p) of hypertension with a 2.00% uncertainty level (d), using the formula $N = t^2pq/d^2$ (where t^2 with 95% confidence; $q = 1 - p$). Using this equation, we estimated a required sample size of 1466–5864 subjects. A total of 6043 eligible subjects were selected from the district and a total of 3778 subjects completed questionnaires and physical examinations for the study. Participation in the study was voluntary, and informed consent was obtained from each person who agreed to participate in the study. The study was approved by the Ethics Committee of The First Hospital of Jilin University.

Population and setting. Selection criteria required the participants to be permanent residents of the city. A wide media campaign was conducted to achieve a high level of participation. The standardized questionnaire was administered via door-to-door interviews by trained health professionals who collected and stored the data using a personal computer within 24 h of the interview. The questionnaire solicited self-reported information about age, gender, education, working hours, physical activity, smoking habits, family history of heart attack, hypertension and diabetes mellitus, alcohol consumption, awareness of hypertension and anti-hypertensive drug intake. The health professionals also obtained two measurements of systolic and diastolic blood pressure (BP) from each participant.

Measurement of BP. BP was measured three times by trained health professionals who were either undergraduate students or physicians of the First Hospital of Jilin University. Each participant was required to rest for 5 min before measurement of BP in a sitting position using a mercury

[1]Department of Cardiology, First Hospital, Jilin University, Changchun, China; [2]Department of Geriatrics, First Hospital, Jilin University, Changchun, China; [3]Department of Clinical Laboratory, First Hospital, Jilin University, Changchun, China; [4]Department of Electrical Diagnosis, Changchun University of Chinese Medicine, Changchun, China; [5]School of Public Health, Jilin University, Changchun, China and [6]Department of Hepatology, First Hospital, Jilin University, Changchun, China. Correspondence: Professor J Niu, Department of Hepatology, First Hospital, Jilin University, No.71 of Xinmin Street, Changchun 130021, China.
E-mail: junqiniu@yahoo.com.cn
[7]These authors contributed equally to this work.
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sphygmomanometer (Jiangsu Yuyue medical equipment and supply Co., Ltd., Danyang City, China). Health professionals were trained to take accurate BP measurements by reading the mercury column of the BP unit while listening to the first and fifth Korotkoff sounds using a teaching stethoscope (Jiangsu Yuyue medical equipment and supply Co., Ltd). BP estimates were based on the mean of the three measurements.

Definitions and preferred cutoff values. World Health Organization (WHO) criteria were used to classify hypertension. Participants were classified as hypertensive if two of their results of systolic BP were $\geqslant$140 mm Hg or diastolic BP were $\geqslant$90 mm Hg or if they were currently taking anti-hypertensive medications. Controlled hypertension was defined as BP $<$140/80 mm Hg in people who were taking anti-hypertensive medications.

Covariates included cigarette smoking (non-smokers; light smokers 1–20 cigarettes day^{-1}; and heavy smokers $>$20 cigarettes day^{-1}), education level (no formal education; grades 1–9; senior school; college), monthly income ($<$799 yuan; $\geqslant$800 yuan), occupation (white collar, including teachers, government officials and managers; blue collar, including farmer, factory worker and vendors), alcohol consumption (none; low, $<$ 40 g per day; moderate, 40–79 g per day; heavy, $>$ 80 g per day) and salt consumption (low intake $\leqslant$6 g day^{-1}; high intake $>$6 g day^{-1}). Body mass index (BMI) was computed as weight (kg)/height (m^2) and classified according to the World Health Organization's Asian criteria[5] as overweight (BMI$\geqslant$23 kg m^{-2}) and obese (BMI$\geqslant$25 kg m^{-2}). Central obesity was defined as a waist circumference $\geqslant$90 cm in men and waist circumference $\geqslant$80 cm in women.

The levels of fasting blood glucose, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density cholesterol lipoprotein (LDL-C) and were measured with a Synchron LX20 auto analyzer (Beckman Coulter, Brea, CA, USA). According to the Chinese guidelines on prevention and treatment of dyslipidemia in adults,[6] hypercholesterolemia was defined as TC$\geqslant$5.18 mmol l^{-1}; high LDL-C as LDL-C$\geqslant$3.37 mmol l^{-1}; hypertriglyceridemia as triglycerides$\geqslant$1.70 mmol l^{-1} and low HDL-C as HDL-C$<$1.04 mmol l^{-1}. Dyslipidemia was defined as the presence of one or more abnormal serum lipid concentrations. A ratio of TC to HDL-C (TC/HDL-C)$\geqslant$4.50 was considered abnormal.

Statistical analyses

Descriptive statistics were calculated for all continuous variables (for example, age, weight, BMI, BP) and categorical variables (physical activity, alcohol consumption, dietary fat intake, cigarette smoking, family history of hypertension, educational level and occupation). Bivariate analyses using Pearson's χ^2 tests and rank sum tests were used to identify those variables associated with hypertension. Multivariable logistic regression models were used to explore risk factors for hypertension. Probability values of $P<0.05$ were considered statistically significant.

RESULTS

Table 1 shows the anthropometric characteristics of the study sample stratified by sex. There were no statistically significant differences between males and females in mean age or LDL-C levels. All of the remaining parameters were significantly higher in males than in females, except for HDL which was higher in females.

As the age of men increased, their average BP also increased up to 55 years before decreasing thereafter. After 66 years, the average BP in men tended to increase again. For women, as their age increased their average BP increased up to 55 years and then remained stable after 66 years. The prevalence of hypertension stratified by age group is shown in Table 2. The overall prevalence of hypertension was 41.00%, and among those with hypertension, the awareness, treatment and control of the disease was 21.80, 15.60 and 1.10%, respectively.

Table 3 shows the prevalence, awareness, treatment and control of hypertension in different groups. The prevalence of hypertension differed significantly between age groups ($P<0.01$), but there was no difference between age groups in the control of hypertension. Urban residents had a higher prevalence of hypertension compared with rural residents. By occupation, farmers had the lowest prevalence of hypertension, but there were no statistically significant differences between occupations in the awareness, treatment and control of the disease. High dietary salt intake was associated with a significantly higher prevalence of hypertension ($P<0.001$), but salt intake was not associated with awareness, treatment or control of the disease.

Table 1. Anthropometric characteristics of the study sample stratified by sex

Characteristic	*Male (n = 1787)*	*Female (n = 1991)*	P-*value*
Age (years)	45.68 ± 12.94	46.53 ± 11.66	NS
Height (cm)	167.93 ± 7.13	158.10 ± 40.95	$P<0.001$
Weight (kg)	68.93 ± 18.92	59.44 ± 16.00	$P<0.001$
BMI (kg m^{-2})	24.20 ± 3.59	23.91 ± 3.73	$P<0.05$
WC (cm)	83.78 ± 10.83	79.21 ± 10.44	$P<0.001$
SBP (mm Hg)	130.52 ± 20.34	128.34 ± 22.17	$P<0.001$
DBP (mm Hg)	85.00 ± 12.99	81.73 ± 12.80	$P<0.001$
FBG (mmol l^{-1})	5.24 ± 1.35	4.96 ± 1.31	$P<0.001$
CHOL (mmol l^{-1})	4.41 ± 0.96	4.32 ± 0.94	$P<0.001$
LDL (mmol l^{-1})	3.04 ± 0.88	3.00 ± 0.80	NS
TG (mmol l^{-1})	1.75 ± 1.76	1.50 ± 1.25	$P<0.001$
HDL (mmol l^{-1})	1.37 ± 0.46	1.43 ± 0.41	$P<0.001$

Abbreviations: BMI, body mass index; CHOL, cholesterol; DBP, diastolic blood pressure; FBG, fast blood glucose; HDL, high-density lipoprotein-cholesterol; LDL, low-density lipoprotein-cholesterol; NS, not statically significant ($P>0.05$); SBP, systolic blood pressure; TG, triglycerides; WC, waist circumference. Data are presented as mean ± s.d.

Table 4 shows results from the logistic regression analyses on the relationship between hypertension and various risk factors stratified by urban vs rural residence. Age, male, dyslipidemia, central obesity, family history of hypertension, alcohol consumption and dietary salt intake were significantly associated with hypertension in both urban and rural residents. We found cigarette smoking to be a risk factor for hypertension only in rural residents ($P>0.05$) and diabetes mellitus to be a risk factor only in urban residents ($P>0.05$); however, these data were not significant at the multi-variate level.

DISCUSSION

Hypertension is a primary risk factor for CVD in both developed and developing countries. CVD has been shown to be the leading cause of mortality worldwide and is estimated to account for 14.3 million premature deaths in developing countries.[7,8] The prevalence of hypertension in China has increased from 20.20% to 40.20% in men and from 19.10% to 35.00% in women[9–11] and is now similar to that of developed countries[12–14] while being higher than other developing countries.[15–17]

In the present study, we found the prevalence of hypertension in Dehui City of Jilin Province in China to be 41.00%, higher than previous reports of this condition in the Chinese population. We found an age-specific prevalence of hypertension in the following age groups: 18$\sim$44 years (19.30%), 45$\sim$59 years (39.80%), and 60$\sim$78 years age group (62.10%). In 2002, the International Cooperation of Cardiovascular Disease in Asia revealed that the age-specific prevalence of hypertension in the 35$\sim$ 44 years, 45$\sim$54 years, 55$\sim$64 years and 65$\sim$74 year age groups was 17.40, 28.20, 40.70 and 47.30%, respectively, for males and 10.70, 26.80, 38.90 and 50.20%, respectively, for females in China.[16] For subjects aged $>$60 years, the prevalence of hypertension that we found is higher than in the Subei district (57.50%)[18] and similar to Beijing (62.46%).[19] However, awareness, treatment and control of the conditions are far lower than developed countries[20] and in some developing countries.[21]

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Table 2. Prevalence, awareness, treatment, and control of hypertension by age group

Age group (years)	n	*Hypertensive* n *(%)*	*Aware*[a] n *(%)*	*Treated*[a] n *(%)*	*Control*[a] n *(%)*
18–24	149	19 (12.75)	0	1 (5.26)	1 (5.26)
25–30	312	58 (18.59)	4 (6.90)	2 (3.45)	0
31–36	433	99 (22.86)	15 (15.15)	10 (10.10)	2 (2.02)
37–42	607	191 (31.47)	23 (12.04)	11 (5.76)	0
43–48	612	262 (42.81)	54 (20.61)	39 (2.52)	3 (1.15)
49–54	624	290 (46.47)	71 (24.48)	51 (14.89)	2 (3.45)
55–60	586	345 (58.87)	95 (27.54)	62 (17.97)	2 (0.69)
61–66	261	154 (59.00)	42 (27.27)	40 (25.97)	5 (3.25)
67–78	194	131 (67.53)	34 (25.95)	25 (19.08)	2 (1.53)
Total	3778	1549 (41.00)	338 (21.82)	241 (15.56)	17 (1.10)
Pearson's χ^2		$P<0.001$	$P<0.001$	$P<0.001$	0.08

[a]Percentage is of total hypertension.

Table 3. Prevalence, awareness, treatment and control of hypertension in different groups

	n	*Prevalence*	*Awareness*	*Treatment*	*Control*
Age, years					
18–44	819	19.29%** (158)	11.39%** (18)	6.96%* (11)	1.27% (2)
45–59	2004	39.82%$^{\#}$ (798)	20.80% (166)	14.04%$^{\#}$ (112)	1.00% (8)
60–78	955	62.10% (593)	25.97% (154)	19.90% (118)	1.18% (7)
Total	3778	41.00% (1549)	21.82% (338)	15.56% (241)	1.10% (17)
P-value		$P<0.001$	$P<0.001$	$P<0.001$	$P=0.930$
Urban vs rural area					
Urban area	2175	44.46% (967)	22.34% (216)	16.65% (161)	0.83% (8)
Rural area	1603	36.30% (582)	20.96% (122)	13.75% (80)	1.55% (9)
P-value		$P<0.001$	$P=0.568$	$P=0.146$	$P=0.287$
Occupation					
Farmers	1821	37.45%†*** (682)	21.85% (149)	14.37% (98)	1.47% (10)
Factory worker	537	47.30% (254)	23.23% (59)	18.90% (48)	0.79% (2)
Officials	282	44.32% (125)	24.80% (31)	16.00% (20)	0
Teachers	86	43.02% (37)	21.62% (8)	10.81% (4)	0
Vendors	1052	42.87% (451)	20.18% (91)	15.74% (71)	1.11 (5)
P-value		$P<0.001$	$P=0.798$	$P=0.470$	$P=0.578$
Salt intake					
Low-salt intake	969	28.48% (276)	23.91% (66)	13.41% (37)	2.17% (6)
High-salt intake	2809	45.32% (1273)	21.37% (272)	16.03% (204)	0.86% (11)
P-value		$P<0.001$	$P=0.353$	$P=0.319$	$P=0.115$

Value = %(*n*). **$P<0.01$, compared with the 45–59 and 60–78 age group. *$P<0.05$, compared with the 45–59 age group. $^{\#}P<0.01$, compared with the 60–78 age group. $^{\dagger}P<0.001$, compared with worker. ***$P<0.05$, compared with officials and self-employer.

The overall prevalence of hypertension in Korea[22] according to the Korean National Health and Nutrition Survey of 2001 was estimated as 22.90% (male: 26.90%; female: 20.50%), but the awareness, treatment and control of hypertension in individuals was 30.20, 22.90 and 10.70%, respectively. The National Health and Nutrition Examination Survey[20] in the USA reported in 2010 that the prevalence, awareness, treatment and control of hypertension was 29.00, 80.70, 72.50 and 50.10%, respectively. In Turkey,[23] such measurements of hypertension were 31.80, 40.70, 31.10 and 8.10%, respectively. In 2007, Guang-hui Dong[24] reported that the prevalence, awareness, treatment and control in Liaoning Province of China was 36.20, 27.00, 19.80 and 0.90%, respectively. Their reported prevalence was lower than that reported in our study, but the rate of awareness, treatment and control is higher than reported here.

There are several possible reasons for the elevated prevalence of hypertension and lower awareness, treatment and control of the disease in Dehui city of Jilin Province of China compared with Korea, United States, Turkey and other areas of China. First, economic development and educational levels are lower in Jilin Province compared with these other regions. Medical organizations in China have generated less public awareness of the risks and burden to society of hypertension. Although the standard of living has improved in China, the new anti-hypertensive agents continue to be expensive and unaffordable for many people. Second, dietary salt intake is very high in Jilin Province. The Ministry of Health of China reported that people residing in the North-East of China have been shown to consume an average of 18–19 g day^{-1} of salt as compared with only 6–7 g day^{-1} in Guangdong, 8–9 g day^{-1} in Shanghai, and 14–15 g day^{-1} in Beijing. A Japanese study showed a dose–response relationship between diastolic BP and salt consumption,[25] and as would be expected, we found a higher prevalence of hypertension in those who reported a high salt intake compared with those with a low

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Table 4. Results from logistic regression analyses assessing differences between urban and rural residents for hypertension

	Rural area		*Urban area*	
	OR	*95% CI*	*OR*	*95% CI*
Age	1.06	1.05–1.07	1.06	1.05–1.07
Sex				
Male vs female	1.81	1.40–2.33	1.42	1.17–1.73
Disease				
Diabetes mellitus	2.74	0.70–10.67 ($P>0.05$)	1.50	1.06–2.11
Dyslipidemia	1.65	1.30–2.10	1.59	1.30–1.93
Central obesity	2.15	1.66–2.78	2.56	2.10–3.12
Family history of hypertension				
Yes vs no	2.10	1.46–3.03	1.82	1.35–2.45
Type of work				
White collar vs blue collar	1.01	0.98–1.08	1.23	1.07–1.35
Number of cigarettes per day				
$\leqslant$20 per day vs no smoking	2.49	1.45–4.25	1.93	0.92–4.08 ($P>0.05$)
>20 per day vs no smoking	1.95	1.14–3.32	1.58	0.75–3.32 ($P>0.05$)
Alcohol consumption				
Yes vs no	1.18	1.03–1.62	1.24	1.09–1.83
Monthly income				
High level vs low level	0.78	0.56–1.22	0.62	0.57–1.18
Salt intake				
High level vs low level	7.29	4.98–10.66	1.25	1.01–1.55
Education				
Low level vs high level	1.06	0.94–1.18	1.34	1.21–1.78

Abbreviations: CI, confidence interval; OR, odds ratio.

salt intake (45.30% vs 28.50%, $P<.001$). The recommended daily consumption of salt for humans is 3–6 g day^{-1}.[26] Finally, Jilin Province has a longer winter season, which can prevent people from taking part in as much outdoor sports and physical activities as people in other regions.

As would be expected, we found other diseases associated with the metabolic syndrome to be risk factors for hypertension. Central obesity, diabetes mellitus and dyslipidemia were associated with significantly increased odds of having hypertension. Insulin resistance is the most likely mechanism that links this cluster of disorders.[27] Insulin resistance, especially hepatic insulin resistance, has been shown to have a critical role in the development of atherosclerosis.[28] Elevated plasma insulin concentrations have also been shown to enhance very-low-density lipoprotein synthesis, contributing to hypertriglyceridemia.

We found low educational level to be significantly associated with hypertension prevalence. Our results corresponded with previous findings from Liaoning Province in China that showed high levels of education to be protective against hypertension.[24] Lower levels of education could result in less awareness of the risk and protective factors for hypertension, and therefore individuals may be more likely to engage in unhealthy lifestyles. We also found alcohol consumption, type of work and sex to be significantly associated with hypertension prevalence.

Interestingly, we found diabetes mellitus to be associated with hypertension prevalence only in urban residents and cigarette smoking to be associated with hypertension prevalence only in rural residents. Type of work and educational level were associated with hypertension prevalence only in urban residents. Differences in economic development and educational levels between urban and rural residents could help to explain the differences for diabetes and cigarette smoking, but further research is necessary to confirm this.

Our results pointed to white collar workers being at increased odds of having hypertension. Our findings corroborate the data of Trudel *et al.*[29] Trudel *et al.* found that among the white collar worker, the incidence of masked hypertension is high in males compared with females, especially for the managers. Stress levels at work have been shown to have an impact on BP among women, with work settings and occupations that require manual labor such as agriculture being associated with particularly high levels of stress.[30]

The cross-sectional nature of our study precludes us from determining cause–effect relationships. Another limitation is the fact that our data were obtained from a few villages and towns in Dehui city of Jilin Province, so our results may not be generalizable to other localities. A potential concern is the fact that we measured height, weight, waist circumference, fasting blood glucose, CHOL, triglycerides, HDL-C and LDL-C only once, which might have led to random error.

CONCLUSION

We believe that the prevalence of hypertension in Dehui City of Jilin Province is higher than in other areas of China. In addition, rates of awareness and treatment are much lower than in other populations, and the control rate of hypertension is only 1.10%. The study demonstrated that hypertension is closely associated with age, male gender, central obesity, dyslipidemia, daily cigarette consumption, alcohol consumption and low education

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levels. In particular, subjects with central obesity, family history of hypertension and smoking of >20 cigarettes per day should be screened for BP. Public health educational interventions devoted to lifestyle change and adherence to hypertension treatment should help improve awareness, treatment and control of the disease.

What is known about this topic

- Hypertension is a primary risk factor for CVD, which is the leading cause of mortality worldwide.
- In China, the prevalence of hypertension has increased from 20.20% to 40.20% in men and from 19.10% to 35.00% in women from 1991 to 2002.
- There is little data about the epidemiology of hypertension in Jilin province in China, especially for the awareness, treatment and control of hypertension.

What this study adds

- The study reflected a higher prevalence of hypertension in Dehui city of Jilin province than other areas of China but with little awareness, poor treatment and control of hypertension.
- This study showed a new situation that the awareness, treatment and control of hypertension are not associated with areas, occupations and daily salt intake.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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