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Prevalence, awareness, treatment, and control of hypertension and associated risk factors among adults in Xi'an, China

A cross-sectional study

Meiqin Hu, MD[a,b], Yi Wan, PhD[c], Lifen Yu, MD[a,b], Jing Yuan, MD[b], Yonghong Ma, MD[b], Bin Hou, MD[a], Xun Jiang, PhD[d,*], Lei Shang, PhD[b,*]

Abstract

To investigate the prevalence, awareness, treatment, and control of hypertension, and the associated risk factors among adults in Xi'an, China.

From October to December 2013, participants in Xi'an, China were recruited for the study by using a multiple-stage sampling method. A self-developed questionnaire with an additional health examination was used to collect data on the history of hypertension diagnosis and antihypertensive medication. The status on prevalence, awareness, treatment, and control of hypertension were analyzed and related risk factors were identified by using logistic regression analysis.

A total of 8193 participants were included with an overall prevalence of hypertension of 20.4%. Among the hypertensive participants, 63.7% were aware of their conditions, 47.3% took antihypertensive medication, and 17.8% had their blood pressure (BP) controlled within 140/90 mm Hg. More complications and less frequent BP measurements were associated with hypertension. Older participants, non-drinkers, and those with more complications and more frequent BP measurements were more aware of their hypertension. Being older, living in an urban area, and having more frequent BP measurements were all factors for better treatment. Participants who were women, living in an urban area, with a higher educational level and who were not obese were more likely to have their hypertension controlled.

The prevalence of hypertension among adults in Xi'an is high with suboptimal low awareness, treatment, and control rates. Further comprehensive integrated strategies based on these risk factors should be taken into account in order to improve the prevention, awareness, treatment, and control of hypertension.

Abbreviations: BMI = body mass index, BP = blood pressure, CI = confidence interval, OR = odds ratio, WC = waist circumference.

Keywords: Awareness, Control, Cross-sectional study, Hypertension, Prevalence

1. Introduction

Hypertension is a serious public health problem which accounts for half of coronary heart disease and almost two-thirds of the cerebrovascular disease burden.[1] It has been identified as the second leading risk factor for total disease burden just after a composite of dietary factors, and accounts for 12.0% of disability adjusted life years and 24.6% of deaths in China.[2] It has been estimated that more than one quarter of adults worldwide had hypertension in 2000, and that this would increase to 29.2% by 2025, with almost three quarters of cases occurring in developing countries.[3] Danaei et al[4] reported a decreasing trend of hypertension in western countries, but an increasing trend in Southeast Asia and Oceania. In China, National Nutrition and Health Surveys indicate that the estimated number of adults with hypertension has increased dramatically during the last decade, from 153 million in 2002 to 330 million in 2010,[5–7] with the corresponding prevalence increasing from nearly 19% in 2002 to 33.5% in 2010.

Previous studies have investigated the prevalence, awareness, treatment, and control of hypertension from a national or regional level among Chinese adults. However, most of these studies were performed in northeastern, eastern, and southern China,[8–13] with diversity on the awareness, treatment, and control of hypertension. As the largest city in the northwest of China, Xi'an has distinct geographic characteristics, cultural behaviors, and lifestyles compared with coastal, eastern, and southern regions of China, which may affect the prevalence of hypertension. However, little information was available on the status of hypertension among adults in Xi'an. Therefore, this

Editor: Erika I. Boesen.

MH and YW have contributed equally to the study.

This study was supported by National Natural Science Funds (No. 81273175).

The authors declared no any conflict of interest.

[a] Xi'an Centre for Disease Control and Prevention, [b] Department of Health Statistics, [c] Department of Health Service, School of Public Health, [d] Department of Pediatrics, Tangdu Hospital, Fourth Military Medical University, Xi'an, Shaanxi, China.

[*] Correspondence: Lei Shang, Department of Health Statistics, School of Public Health, Fourth Military Medical University, No.169, Changle West Road, Xi'an 710032, Shaanxi, China (e-mail: shanglei@fmmu.edu.cn); Xun Jiang, Department of Pediatrics, Tangdu Hospital, Fourth Military Medical University, No.1, Xinsi Road, Xi'an 710038, Shaanxi, China (e-mail: jiangx@fmmu.edu.cn).

Medicine (2016) 95:34(e4709)

Received: 20 April 2016 / Received in final form: 3 August 2016 / Accepted: 4 August 2016

http://dx.doi.org/10.1097/MD.0000000000004709

study aimed to investigate the prevalence, awareness, treatment, and control of hypertension as well as associated factors among adults in Xi'an.

2. Methods

2.1. Participants

From October to December 2013, participants were recruited among adults in Xi'an for a cross-sectional, population-based survey. A multiple-stage sampling method was used to select a representative noninstitutionalized sample of the adult population from all 14 districts (urban) and counties (rural) in the city. In the first stage, four communities (urban) or townships (rural) from each district or county were randomly selected. In the second stage, three residential committees (urban) or villages (rural) were randomly selected from each selected community or township. The final stage of sampling was stratified by sex and by age distribution according to Xi'an 2010 census data. The probability proportional to size sampling method was used in the first two stages. All participants aged ≥18 years with more than 6 months in their current residence and who were willing to participate were included in the survey. Participants were excluded if they met any of the following criteria during the survey period: dementia, schizophrenia, serious illness, deaf, or dumb.

Ethical approval was obtained from the Ethics Committee of the Fourth Military Medical University and Xi'an Centre for Disease Control and Prevention. All participants signed informed consent forms prior to enrollment.

2.2. Data collection

A central survey site was set up in a community clinic or health center in the participants' residential area, and the participants were interviewed and received a health examination on-site. The investigators were medical researchers, physicians, nurses, and technicians. The health examination involved the measurement of height, weight, waist circumference (WC), blood pressure (BP), and fasting blood glucose. The questionnaire collected a wide range of information on socio-demographics and other factors including education, marital status, career, and lifestyle (such as smoking, alcohol drinking, and physical activity). For each participant, self-reported histories of diabetes and dyslipidemia were recorded.

Height, weight, and WC were measured according to the standard protocol.[14] Height was measured without shoes with a metal column height meter to the nearest 0.1 cm. Weight was measured in light indoor clothing and barefoot using balance beam scales placed on a firm, level surface to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight (kilograms) divided by height (meters) squared. WC was measured halfway between the lowest rib margin and the iliac crest using plastic tape to the nearest 1 cm. Systolic and diastolic blood pressure was measured with standardized mercury sphygmomanometers. Three consecutive measurements on the right arm at heart level were taken after the participants rested in a seated position for 5 minutes according to 1999 World Health Organization/International Society of Hypertension guidelines.[15] The mean of the latter two measurements was used for analysis. Fasting plasma glucose was measured using the glucose oxidase method.

2.3. Quality control

Stringent programs were implemented to ensure the validity and reliability of the study data. All investigators were trained before the survey on the use of standardized protocols and instruments for data collection and the data were recorded on the questionnaire by the investigators. At each survey site, investigators were required to check all information after each interview, and a key investigator was responsible for rechecking all the questionnaires for each survey site. If there was missing information or logic errors, a repeated interview or examination was required on site. All measuring instruments were corrected before measurement. All data were double entered into a database established by using Epidata 3.1 software (Epidata Association, Odense, Denmark) and then compared and checked for errors.

2.4. Definitions

Hypertension is defined according to the Chinese Guidelines on Prevention and Control of Hypertension[16] as an average BP ≥140/90 mm Hg, and/or a self-report of being previously diagnosed with hypertension and of taking antihypertensive medication in the last 2 weeks. Awareness of hypertension was defined as self-report of any previous diagnosis of hypertension by a healthcare professional before the survey. Treatment of hypertension was defined as the self-reported use of a prescription medication for the management of hypertension during the previous 2 weeks. Control of hypertension was defined as the pharmacological treatment of hypertension associated with an average BP < 140/90 mm Hg.

Diabetes was defined as a fasting plasma glucose level of ≥7.0 mmol/L (126 mg/dL), and/or a self-report of being previously diagnosed with diabetes and taking antidiabetic medication. Dyslipidemia was defined as a self-reported history of being previously diagnosed with dyslipidemia by a health professional before the survey. Smokers were defined as those participants who reported currently smoking or having smoked at least 100 cigarettes in his or her lifetime. Alcohol drinkers were defined as those participants who reported having one drink at least once per week over the last 12 months. Physical activity was assessed by the global physical activity questionnaire, which was classified into low, moderate and high physical activity levels according to criteria used in other studies.[17–18] Body size was grouped into underweight (BMI < 18.5 kg/m^2), normal (BMI ≥ 18.5 kg/m^2 and BMI < 24 kg/m^2), overweight (BMI ≥ 24 kg/m^2 and BMI < 28 kg/m^2), and obese (BMI ≥ 28 kg/m^2) according to the Chinese criteria.[19] WC was divided into two categories: normal (<85 cm for men and <80 cm for women) and central obese (≥85 cm for men and ≥80 cm for women).[19]

2.5. Statistical methods

Descriptive statistics were calculated and presented as the mean (standard deviation) for continuous data and the frequency (percentage) for categorical data. Inferential statistics were estimated by the Chi-square test for categorical variables. The strength of the associations between risk factors and the prevalence of hypertension, hypertension awareness, treatment, and control were assessed by multivariable logistic regression models that were performed by stepwise logistic regressions. For these analyses, awareness was strictly restricted to participants with hypertension, treatment of those who were aware of their hypertensive diagnosis, and control of those who were being treated. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All data were analyzed using the SAS software package, version 9.2 (SAS Institute, Cary, NC). All *P* values

were two-sided and $P < 0.05$ was considered statistically significant.

3. Results

A total of 8401 participants aged 18 years or above were recruited in the study. Eight thousand and two hundred twenty eight participants completed the questionnaire and health examination (149 individuals failed to attend the interview and 24 individuals did not complete the questionnaire). Finally, 8193 participants were included for analysis (35 individuals without a BP measurement were excluded from the analysis) with 4154 (50.7%) participants living in the urban area and 4077 (49.8%) participants being men. The mean age of the participants was 41.0 ± 16.1 years old.

3.1. Prevalence, awareness, treatment, and control of hypertension

Among the 8193 participants, 21.4% (n = 1754) had hypertension, with no significant difference between sex (22.0% in men, 20.9% in women, $P = 0.232$) and residential area (20.7% in urban, 22.2% in rural, $P = 0.092$). A higher level of education, a younger age, lower BMI, and fewer complications were associated with a reduced risk of hypertension. Furthermore, higher prevalence of hypertension was found among those who were divorced or widowed, had larger WC, were current or former smokers, were alcohol drinkers, had high physical activity, and had more frequent BP measurements than their counterparts (all $P < 0.05$) (Table 1). Further analysis showed that the prevalence of hypertension increased with age in both sexes and in both residential areas. It was significantly higher in men than in women under 55 years of age, however, no statistical significance was found between sexes with an age of over 55 years.

As shown in Table 1, participants who were older, women, divorced or widowed, non-smokers, non-drinkers, had a lower educational level, more complications, moderate physical activity, and more frequent BP measurements were more aware of their hypertension. Being older, living in an urban area, having a higher educational level, having more complications, being a former smoker, being a non-drinker, and having more frequent BP measurements were factors associated with better treatment. Only those living in an urban environment, having a higher educational level, being organization cadres, and those without obesity were more likely to have their hypertension controlled.

Among 1754 hypertension participants, 1118 (63.7%) were aware of their hypertensive condition, 829 (47.3%) took antihypertensive medication, and 312 (17.8%) had their BP at less than 140/90 mm Hg. The treatment rate was 74.2% among those who were aware of their hypertensive condition, and the optimal BP control rate was 37.6% among those who received treatment. Compared with those in rural areas, hypertension participants in urban areas were more likely to receive treatment either among all hypertension participants or among those who were aware of their hypertensive condition. A similar situation was observed for the control of hypertension. Men had lower rates of awareness, treatment, and control among all hypertension participants when compared with women. However, there was no significant difference between men and women in either the treatment among those who were aware of their hypertensive condition or the control among those who were treated (Table 2).

3.2. Risk factors associated with prevalence, awareness, treatment, and control of hypertension

After adjusting other variables, older age (35–44 years: Odds ratio [OR] = 2.88, 95% confidence interval [CI] = 2.21–3.74; 45–54 years: OR = 7.03, 95% CI = 5.46–9.04; 55–64 years: OR = 11.04, 95% CI = 8.50–14.35; 65 years and above: OR = 16.25, 95% CI = 12.26–21.52), higher BMI (overweight: OR = 1.70, 95% CI = 1.45–1.99; obesity: OR = 3.47, 95% CI = 2.81–4.27), larger WC (OR = 1.36, 95% CI = 1.16–1.58), more complications (diabetes and dyslipidemia: OR = 3.41, 95% CI = 2.29–5.08; diabetes only: OR = 1.40, 95% CI = 1.12–1.74; dyslipidemia only: OR = 2.16, 95% CI = 1.72–2.71) and more frequent BP measurements (<6 months: OR = 2.13, 95% CI = 1.80–2.52) were independently and significantly associated with an increased risk of hypertension. Furthermore, women (OR = 0.71, 95% CI = 0.62–0.81), of a higher educational level (junior school: OR = 0.70, 95% CI = 0.59–0.84; senior school: OR = 0.67, 95% CI = 0.55–0.82; college or higher: OR = 0.35, 95% CI = 0.27–0.45) and of single status (OR = 0.56, 95% CI = 0.39–0.81) were inversely associated with a prevalence of hypertension. When stratified by residential area, these associations were still significant except for being women and being single in a rural area. When stratified by sex, the associations between hypertension and being single and having a larger WC were attenuated to be negative among women (Table 3).

After adjustment, older age (45–54 years: OR = 0.54, 95% CI = 0.32–0.89; 55–64 years: OR = 0.33, 95% CI = 0.20–0.55; 65 years and above: OR = 0.32, 95% CI = 0.19–0.55), more complications (diabetes and dyslipidemia: OR = 0.36, 95% CI = 0.20–0.66; diabetes only: OR = 0.99, 95% CI = 0.70–1.38; dyslipidemia only: OR = 0.50, 95% CI = 0.34–0.72), and more frequent BP measurements (<6 months: OR = 0.05, 95% CI = 0.04–0.08; 6–12 months: OR = 0.19, 95% CI = 0.09–0.38) were associated with hypertensive awareness among all hypertension participants, whereas it was less likely for those who were alcohol drinkers (OR = 1.68, 95% CI = 1.21–2.33). Among those who were aware of their hypertensive condition, older age (45–54 years: OR = 0.32, 95% CI = 0.15–0.66; 55–64 years: OR = 0.24, 95% CI = 0.12–0.50; 65 years and above: OR = 0.22, 95% CI = 0.11–0.45), and more frequent BP measurements (<6 months: OR = 0.31, 95% CI = 0.14–0.69) were associated with a higher rate of hypertension treatment, while those who lived in rural areas were less likely to receive the treatment (OR = 1.80, 95% CI = 1.35–2.39). Among those who were treated, it was more likely to control the BP for women (OR = 0.71, 95% CI = 0.52–0.97) or those with a higher educational level (college or higher: OR = 0.37, 95% CI = 0.19–0.69), and it was less likely for those who lived in rural areas (OR = 1.83, 95% CI = 1.33–2.51) or those who were obese (OR = 1.77, 95% CI = 1.17–2.69).

4. Discussion

This population based study shows that the prevalence of hypertension among adults in Xi'an is 21.4%. Hypertension is associated with an older age, men, a lower educational level, being married, higher BMI, larger WC, more complications, and less frequent BP measurements. Among hypertension participants, 63.7% are aware of their condition, 47.3% take antihypertensive medication, and 17.8% have their BP controlled within 140/90 mm Hg. Older age, having more complications, non-drinkers, and having more frequent BP measurements are associated with hypertension awareness. Furthermore, older age,

Table 1

General characteristics of participants on hypertension prevalence, awareness, treatment, and BP control.

	N (%)	Prevalence	Awareness*	Treatment†	BP control‡
Age groups, y					
18–34	3390 (41.4)	107 (3.2)	37 (34.6)	16 (43.2)	9 (56.3)
35–44	1600 (19.5)	229 (14.3)	112 (48.9)	61 (54.5)	21 (34.4)
45–54	1339 (16.3)	447 (33.4)	266 (59.6)	196 (73.7)	68 (34.7)
55–64	1027 (12.5)	489 (47.6)	348 (71.2)	273 (78.4)	104 (38.1)
65∼	837 (10.2)	482 (57.6)§	355 (73.7)§	283 (79.7)§	110 (38.9)
P value		<0.001	<0.001	<0.001	0.469
Gender					
Males	4077 (49.8)	895 (22.0)	522 (58.3)	382 (73.2)	138 (36.1)
Females	4116 (50.2)	859 (20.9)	596 (69.5)§	447 (75.0)	174 (38.9)
P value		0.232	<0.001	0.488	0.407
Residential areas					
Urban	4154 (50.7)	858 (20.7)	563 (65.6)	448 (79.6)	204 (45.5)
Rural	4039 (49.3)	896 (22.2)	555 (62.0)	381 (68.6)§	108 (28.3)§
P value		0.092	0.109	<0.001	<0.001
Education					
≤Primary school	1183 (14.4)	520 (44.0)	354 (68.1)	271 (76.6)	85 (31.4)
Junior school	3374 (41.2)	718 (21.3)	432 (60.3)	306 (70.8)	106 (34.6)
Senior school	1934 (23.6)	389 (20.1)	262 (67.4)	192 (73.3)	85 (44.3)
≥College	1702 (20.8)	127 (7.5)§	70 (55.1)§	60 (85.7)§	36 (60.0)§
P value		<0.001	0.002	0.036	<0.001
Marital status					
Single	1571 (19.2)	41 (2.6)	18 (43.9)	10 (55.6)	3 (30.0)
Married	6322 (77.2)	1566 (24.8)	991 (63.3)	734 (74.1)	274 (37.3)
Divorced/widowed	300 (3.7)	147 (49.0)§	109 (74.1)§	85 (78.0)	35 (41.2)
P value		<0.001	0.001	0.13	0.694
Career					
Blue-collar workers	4133 (50.4)	895 (21.7)	550 (61.5)	399 (72.5)	126 (31.6)
Organization cadres	1927 (23.5)	209 (10.8)	115 (55.0)	80 (69.6)	38 (47.5)
Others	2133 (26.0)	650 (30.5)§	453 (69.7)§	350 (77.3)	148 (42.3)§
P value		<0.001	<0.001	0.117	0.002
BMI					
Underweight	415 (5.1)	22 (5.3)	16 (72.7)	9 (56.3)	4 (44.4)
Normal	4158 (50.8)	543 (13.1)	333 (61.3)	242 (72.7)	94 (38.8)
Overweight	2659 (32.5)	761 (28.6)	501 (65.8)	373 (74.5)	161 (43.2)
Obese	960 (11.7)	428 (44.6)§	268 (62.6)	205 (76.5)	53 (25.9)§
P value		<0.001	0.282	0.279	0.001
WC					
Normal	4171 (50.9)	494 (11.8)	304 (61.8)	222 (73.0)	91 (41.0)
Central obese	4022 (49.1)	1260 (31.3)§	814 (64.5)	607 (74.6)	221 (36.4)
P value		<0.001	0.230	0.600	0.228
Complication					
Diabetes and dyslipidemia	142 (1.7)	100 (70.4)	85 (85.0)	71 (83.5)	25 (35.2)
Diabetes only	502 (6.1)	228 (45.4)	155 (68.0)	127 (81.9)	44 (34.6)
Dyslipidemia only	437 (5.3)	227 (51.9)	180 (79.3)	132 (73.3)	60 (45.5)
None	7112 (86.8)	1199 (16.9)§	698 (58.3)§	499 (71.5)§	183 (36.7)
P value		<0.001	<0.001	0.01	0.231
Smoking					
Current smoker	2363 (28.8)	525 (22.2)	292 (55.6)	196 (67.1)	69 (35.2)
Former smoker	225 (2.7)	100 (44.4)	63 (63.0)	52 (82.5)	20 (38.5)
No smoking	5605 (68.4)	1129 (20.1)§	763 (67.6)§	581 (76.1)§	223 (38.4)
P value		0.007	<0.001	0.003	0.724
Alcohol drinking					
Yes	889 (10.9)	232 (26.1)	118 (50.9)	79 (66.9)	29 (36.7)
No	7304 (89.1)	1522 (20.8)§	1000 (65.7)§	750 (75.0)§	283 (37.7)
P value		<0.001	<0.001	0.059	0.858
Physical activity					
High	3343 (40.8)	797 (23.8)	482 (60.5)	349 (72.4)	139 (39.8)
Moderate	2972 (36.3)	603 (20.3)	418 (69.3)	323 (77.3)	120 (37.2)
Low	1878 (22.9)	354 (18.8)§	218 (61.6)§	157 (72.0)	53 (33.8)
P value		<0.001	0.002	0.182	0.416
Frequency of BP measurement, mo					
<6	4755 (58.0)	1452 (30.5)	1067 (73.5)	801 (75.1)	301 (37.6)

(*continued*)

Table 1

(continued).

	N (%)	Prevalence	Awareness*	Treatment†	BP control‡
6–12	555 (6.8)	56 (10.1)	23 (41.8)	14 (60.9)	5 (35.7)
Never/>12	2883 (35.2)	246 (8.5)§	28 (11.4)§	14 (50.0)§	6 (42.9)
P value		<0.001	<0.001	0.004	0.911

BP = blood pressure, WC = waist circumference.

* Self-reported previously diagnosed hypertensive conditions among those with hypertension.

† Antihypertensive medication among those who were aware of hypertensive conditions.

‡ BP control at an average <140/90 mm Hg among those who were treated. BMI = body mass index.

§ χ^2 test $P < 0.05$.

living in urban areas, and having more frequent BP measurements are associated with hypertension treatment. Only those women, living in urban areas, and having a higher educational level are associated with hypertension control, but this is less likely for those who are obese.

The prevalence of hypertension is high among adults in Xi'an with 1 in 5 adults aged 18 years or above suffering from hypertension. Accordingly, there are approximately 1.7 million people with hypertension in Xi'an. The prevalence of hypertension in the study is relatively lower than those reported in the northeastern, eastern, and central provinces of China, such as Beijing (35.5%),[11] Liaoning (28.7%),[12] Jilin (41.0%),[8] Henan (26.6%),[20] and Shandong (43.8%).[13] Compared with the national surveys conducted in China (33.5%)[7] and the USA (men: 30.5%, women: 28.5%),[21] it is also much lower. Furthermore, it is similar to those in southern China, such as Guangdong (20.5%).[10] The prevalence of hypertension varies geographically in China, and in the northwest region, it is close to the lowest prevalence in the southwest region, but is much lower than the severe high prevalence in the east and northeast regions.[22] Less economic development and relative slower urbanization could be one of the major reasons for such a big difference in prevalence. Another reason could be that residents living in the cold northeastern regions consume significantly more sodium than southerners, which could affect blood pressure.[23–25] Furthermore, it is possibly due to the different living styles and dietary habits in Xi'an where traditional Chinese food still dominates.

Older age and obesity are major risk factors for hypertension. The results of the study support the associations of hypertension with older age and being overweight or obese, which are consistent with previous epidemiological studies.[7–9,12] Interestingly, the prevalence of hypertension is broadly similar between men and women with an age above 55 years. This phenomenon is possibly due to hormonal factors, postmenopausal weight gain, and a different risk profile. Furthermore, the study shows that hypertension is associated with a lower educational level and men, which are also in accordance with previous studies.[9–11] In contrast to other studies, being married is associated with the risk of hypertension in Xi'an,[4] and similar findings were observed in a Macau study.[9] The results from this study also highlight the relationship between diabetes, dyslipidemia, and hypertension. Diabetes and dyslipidemia have an independent association with hypertension, and the association of hypertension is strengthened with the combination of diabetes and dyslipidemia. With respect to other factors, previous studies indicate smoking[8,11,26] and heavy drinking[27] as potential risk factors for hypertension. However, the results of this study did not show such associations.

Awareness, treatment, and control among participants with hypertension in this study were 63.8%, 47.5%, and 17.8% respectively, higher than the 44.6%, 35.2%, and 11.2% found in 2010[22] and those found in other studies in China.[8,10–13,20] The reasons for this discrepancy could be the normal control level in the northwest region in mainland of China[22] as well as the later survey time, as more and more multiple campaigns against hypertension have been launched. Another important potential factor is that all community health clinics or health centers in Xi'an, covering both urban and rural, had been involved in the management of hypertension after the release and implementation of Chinese guidelines for the management of hypertension.[16,28] Furthermore, these rates were much lower than the results found in Beijing,[29] Macau,[9] and the United States (the corresponding data in the 2009–2010 US National Health and Nutrition Examination Survey were 74.0%, 71.6%, and 46.5%, respectively).[21] Compared with the control rate of 64.9% among those who were treated in the United States, the control rate among those who were treated in Xi'an is around 40%, which indicates an urgency to call for improvements in hypertension treatment. BP control is crucial for those who are hypertensive. Therefore, hypertension participants are encouraged to receive normative treatment and improve compliance to achieve optimal BP for the early prevention and control of cardiocerebrovascular diseases and for decreasing disease burden.

In accordance with the low rate of awareness among hypertension participants in Xi'an, only 60.0% of men and

Table 2

The rate of hypertension awareness, treatment, and control among adults in Xi'an by residence areas and sex.

	Urban	Rural	*P* value	Males	Females	*P* value	Total
Awareness†	563 (65.6)	555 (61.9)	0.109	522 (58.3)	596 (69.4)	<0.001	1118 (63.7)
Treatment							
Among those with hypertension*,†	448 (52.2)	381 (42.5)	<0.001	382 (42.7)	447 (52.0)	<0.001	829 (47.3)
Among those aware of their hypertensive conditions*	448 (79.6)	381 (68.6)	<0.001	382 (73.2)	447 (75.0)	0.488	829 (74.2)
Control							
Among those with hypertension*,†	204 (23.8)	108 (12.1)	<0.001	138 (15.4)	174 (20.3)	0.008	312 (17.8)
Among those receiving medication*	204 (45.5)	108 (28.3)	<0.001	138 (36.1)	174 (38.9)	0.407	312 (37.6)

* Urban versus rural, $P < 0.05$.

† Males versus females, $P < 0.05$.

Table 3

Risk factors analyses on hypertension prevalence, awareness, treatment, and BP control[*] (OR, 95% CI).

	Prevalence	Awareness[†]	Treatment[‡]	BP control[§]
Age (ref: 18–34, y)				
35–44	2.88 (2.21, 3.74)	0.68 (0.39, 1.17)	0.70 (0.32, 1.52)	–
45–54	7.03 (5.46, 9.04)	0.54 (0.32, 0.89)	0.32 (0.15, 0.66)	–
55–64	11.04 (8.50, 14.35)	0.33 (0.20, 0.55)	0.24 (0.12, 0.50)	–
65∼	16.25 (12.26, 21.52)	0.32 (0.19, 0.55)	0.22 (0.11,0.45)	–
Gender (ref: males)				
Females	0.71 (0.62,0.81)	–	–	0.71 (0.52,0.97)
Residential areas (ref: urban)				
Rural	–	–	1.80 (1.35, 2.39)	1.83 (1.33,2.51)
Education (ref: primary school)				
Junior school	0.70 (0.59,0.84)	1.19 (0.89, 1.59)	–	0.93 (0.64,1.35)
Senior school	0.67 (0.55,0.82)	0.83 (0.59, 1.17)	–	0.71 (0.47,1.09)
College or higher	0.35 (0.27,0.45)	1.50 (0.94, 2.39)	–	0.37 (0.19,0.69)
Marital status (ref: married)				
Single	0.56 (0.39,0.81)	–	–	–
Divorced/widowed	1.17 (0.89,1.55)	–	–	–
BMI (ref: normal)				
Underweight	0.56 (0.34,0.92)	–	–	0.65 (0.17,2.56)
Overweight	1.70 (1.45,1.99)	–	–	0.85 (0.61,1.20)
Obese	3.47 (2.81,4.27)	–	–	1.77 (1.17,2.69)
WC (ref: normal)				
Central obese	1.36 (1.16,1.58)	–	–	–
Complication (ref: none)				
Diabetes and dyslipidemia	3.41 (2.29,5.08)	0.36 (0.20, 0.66)	–	–
Diabetes only	1.40 (1.12,1.74)	0.99 (0.70, 1.38)	–	–
Dyslipidemia only	2.16 (1.72,2.71)	0.50 (0.34, 0.72)	–	–
Alcohol drinking (ref: no)				
Yes	–	1.68 (1.21, 2.33)	–	–
Frequency of BP Measurement (ref: never/>12, mo)				
<6	2.13 (1.80,2.52)	0.05 (0.04,0.08)	0.31 (0.14,0.69)	–
6–12	0.87 (0.62,1.23)	0.19 (0.09,0.38)	0.58 (0.18,1.88)	–

BMI = body mass index, BP = blood pressure, CI = confidence interval, OR = odds ratio, WC = waist circumference.

[*] The stepwise logistic regression was used for analysis with odds ratios adjusted for all other variables in the table.

[†] Self-reported previously diagnosed hypertensive conditions among those with hypertension.

[‡] Antihypertensive medication among those who were aware of hypertensive conditions.

[§] BP control at an average <140/90 mm Hg among those who were treated.

69.5% of women measured their BP within the last 12 months, and the corresponding rates in urban and rural areas were 66.4%, 63.2%, respectively. As with Ma's study,[10] BP measurements were also found to be associated with both hypertension awareness and treatment in the study. Urban areas, where there is better access to health care and more qualified health professionals than rural areas, were found to be associated with hypertension treatment and control. These findings suggest that public health policy should focus more on the improvement of primary health care to encourage people to actively check their BP more regularly and receive treatment when diagnosed hypertensive, especially for men and those in rural areas. Older age is a non-modifiable risk factor independently influencing the awareness and treatment of hypertension, as is confirmed by the results of other studies.[29,30] In contrast, the findings in the current study do not support that old age is associated with hypertension control.

The study had some limitations. Firstly, it was a cross-sectional survey, which made it difficult to establish a cause-and-effect relationship between risk factors and prevalence, awareness, treatment, and control of hypertension. Secondly, family history of hypertension and dietary factors were not included in the study, which might be associated with the prevalence of hypertension and the low rate of adequate awareness, treatment, and control. Despite these limitations, the study presented representative data on the prevalence, awareness, treatment, and control of hypertension among adults in Xi'an, a city in the northwest of China with a large population of 8 million residents. It also provided evidence for further management and control of hypertension at a population level.

In conclusion, the prevalence of hypertension in Xi'an is high, with suboptimal low awareness, treatment, and control rates. The unprecedented high hypertension prevalence among adults highlights an urgent need for more aggressive public health strategies on the target population, such as older people, males, people with a lower educational level, those who are obese/central obese, or with diabetes and dyslipidemia. In addition, the low treatment and control level of hypertension, especially in rural areas, males, and young people, emphasize the importance of hypertension management.

Acknowledgments

The authors thank all the participants of this study and all the staff who participated in data collection.

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