

# Factors associated with awareness, treatment and control of hypertension among 3,579 hypertensive adults in China: data from the China Health and Nutrition Survey

junxiang Wei (✉ [junxiang.wei@xjtu.edu.cn](mailto:junxiang.wei@xjtu.edu.cn))

Xi'an Jiaotong University School of Medicine

**Bo Xin**

Shanxi University of Traditional Chinese Medicine

**Yan Li**

Icahn School of Medicine at Mount Sinai Department of Medicine

**Youfa Wang**

Xi'an Jiaotong University

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## Research article

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# Abstract

**Background:** Hypertension prevalence is high and rising in China, but it is inadequately controlled. This study investigated hypertension awareness, treatment, and control and their associated factors among Chinese adults.

**Methods:** Data collected from the 2011 China Health and Nutrition Survey (CHNS) from 12,991 Chinese adults were used. Hypertension was defined as systolic blood pressure  $\geq 140$  mm Hg, diastolic blood pressure  $\geq 90$  mm Hg, self-reported prior diagnosed hypertension, or taking antihypertensive medications. Hypertension awareness, treatment, and control were defined as a self-reported diagnosis of hypertension, current use of antihypertensive medication, and blood pressure  $< 140/90$  mm Hg, respectively. Multivariate logistic regression was performed to examine factors associated with hypertension awareness, treatment, and control.

**Results:** Overall, 3,579 (27.6%) of the CHNS adult participants had hypertension, of whom 55.7% were aware of their diagnosis, 46.5% were treated with antihypertensive medications, but only 20.3% had their blood pressure controlled. Higher hypertension treatment rate was associated with older age (OR, 2.57; 95%CI, 1.65-4.02), urban residence (1.50; 1.14-1.97), living in the Eastern region (1.52; 1.14-2.01), and having overweight/obesity (1.99; 1.39-2.84); Awareness rate showed the same association as treatment rate with an additional protect factor of being female (1.37, 1.12-1.66). Lower control rate was associated with obesity (0.56; 0.42-0.76) and minority ethnicity (0.52; 0.31-0.86).

**Conclusion:** Hypertension is a major public health burden in China. Rates of hypertension awareness, treatment, and control are still low despite efforts that have been made. More intensive screening and treatment intervention programs are needed in the future.

## Introduction

Hypertension is one of the most prevalent chronic diseases in many countries and is the most common modifiable risk factor for other health conditions such as heart disease, stroke, kidney disease, and subsequent morbidity and mortality.(1) It leads to 9.4 million deaths each year worldwide, with the condition particularly affecting low- and middle-income countries.(2, 3)

China has the largest population with hypertension in the world with an estimated number of 244.5 million (23.2%) adults with hypertension in 2015.(4) Recent population-based surveys estimated that almost one third of Chinese adults have hypertension.(5-7) As the society ages and continues an uncurbed trend of unhealthy lifestyles, such as high sodium consumption,(8) obesity/central obesity, physical inactivity, habitual drinking, chronic use of nonsteroidal anti-inflammatory drugs,(9) hypertension has become a major threat to the improvement of population health. To address this problem, effective prevention programs and timely treatment and control are critical.

Some recent studies showed that the awareness, treatment, and control rates of hypertension in China have increased significantly over the past two decades.(9, 10) This is mainly attributed to the increases in health insurance coverage and utilization of healthcare resources as well as a wider implementation of evidence-based blood pressure management programs.(11, 12) However, the awareness, treatment, and control rates of hypertension in China remain low compared to most developed countries.(7) This might be due to that large and diverse geography in China. With a rapid economic development, high hypertension prevalence and low control rates will exacerbate the entire population health and socioeconomic burdens. There is a need to study these issues further to alleviate the burden of hypertension and improve public health.

This study aimed to: (a) examine the status of hypertension awareness, treatment, and control among Chinese adults and by age, sex, region, and socioeconomic status; and (b) describe factors that associated with hypertension awareness, treatment, and control to help shed light on the implementation of policies and interventions in the future.

## Methods

### 1. Data source

We used data from the 2011 China Health and Nutrition Survey (CHNS), which is an ongoing, large-scale, population-based survey initiated in 1989. CHNS used a stratified multistage, random cluster sampling strategy to select participants from 288 communities across a large number of primary provinces/autonomous cities.(13) The CHNS 2011 was conducted across more than 10 provinces and autonomous cities, including Beijing, Chongqing, Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanghai, Yunnan, and Zhejiang. Our sample from the CHNS 2011 includes 5,884 households and 12,991 adults, which provides a large nationwide sample of the Chinese population in terms of major behavioral health and disease burden.

We restricted our analysis to those aged  $\geq 18$  years ( $n = 12,991$ ) and focused on those with hypertension ( $n = 3,645$ ) in 2011. Excluding missing values, 3,579 adults were included in the final dataset for analysis. Written informed consent was obtained from each participant before any data were collected. Note that newer CHNS data have not yet been released for use.

### 2. Measurement and definitions

We selected variables regarding knowledge about and medical history of hypertension, as well as demographics, socioeconomic status, and lifestyle behaviors from the adult household questionnaire in CHNS. We categorized geographic regions into three groups: Western China (Guangxi, Guizhou, and Chongqing), Eastern China (Shanghai, Beijing, Jiangsu, Liaoning, and Shandong) and Central China (Henan, Hubei, and Heilongjiang). Marital status was classified into currently married and single (i.e., never married, divorced, widowed, or separated). There were six a priori characteristics selected: residency (urban vs. rural), ethnicity (Han vs. minority), occupation (employed vs. unemployed), educational

attainment [elementary school ( $\leq 6$  years of education), middle school (6-9 years of education), high school or technical school (9-12 years of education), and college or above ( $>12$  years of education)]. Smoking status was defined as non-smoker (subjects who responded negatively to “have you ever smoked cigarettes?”), ex-smoker (subjects who responded positively to questions “have you ever smoked cigarettes?” , but negatively to “do you still smokes cigarettes?”; and current smoker (as subjects who responded both positive answers to questions “have you ever smoked cigarettes?” and “do you still smokes cigarettes?”). Alcohol consumption status was defined as drinker (subjects replied “yes” to “do you regularly drink alcohol since last year?” and non-drinker. Medical insurance status was classified as insured vs. not insured. The physical examination, including height and weight, were measured by health care professionals. Weight was measured in light closing to the nearest 0.1kg on a calibrated beam balance, while height was measured to the nearest 0.1cm using a portable stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by the height squared ( $m^2$ ). Overweight and obesity were defined as a BMI of at least  $24\text{kg}/m^2$  and  $28\text{kg}/m^2$ , respectively, based on the recommendations of the Working Group on Obesity in China.(14)

### **3. Assessment of hypertension and hypertension awareness, treatment, and control**

The measurement and definition of hypertension was reported according to the 7<sup>th</sup> Chinese Joint National Commission guidelines.(15) A standard mercury sphygmomanometer was used by well-trained physicians to measure SBP and DBP on the right arm in triplicate after a 10-minute seated rest. The mean of the three readings was calculated and used in all analysis. Hypertension was defined as having an average SBP  $\geq 140$  mm Hg and/or an average DBP  $\geq 90$  mm Hg, and/or a self-reported previous diagnosis of hypertension by a health care provider, and/or taking antihypertensive drugs currently. Awareness of hypertension was defined as a self-report of any previous diagnosis of hypertension by a health care provider. Treatment of hypertension was defined as a self-reported use of antihypertensive medications at present. Control of hypertension was defined as having an average SBP  $< 140$  mmHg and an average DBP  $< 90$  mmHg while under pharmacological treatment for hypertension.

In order to make comparisons with previous studies, we retrieved the data on hypertension prevalence, awareness, treatment, and control rates from China Health and Nutrition Survey 2011 (CHNS 2011) and the International Collaborative Study of Cardiovascular Disease in ASIA (InterASIA 2000-2001). Detailed information on these two studies have been reported previously. (16, 17) In brief, CHNS 2011 study was conducted in 31 provinces, autonomous regions and municipalities throughout China. Stratified multistage cluster sampling was used to recruit participants and 141,892 participants  $\geq 18$  were analyzed as the final sample size. In the InterASIA study, stratified sampling method was used to select a nationally representative sample of population aged 35-74 years in China during 2000-2001, and 14,989 subjects were included in the analysis.

### **4. Statistical analysis**

Data were presented as mean SD for continuous and percentages for categorical variables according to gender, respectively. Differences between groups were tested using two-sample student t-tests for continuous variables and the Chi-square test for categorical variables. Multivariable logistic regression models were fit to explore the associations between relevant risk factors and hypertension awareness and treatment.

We also investigated the adjusted associations between independent variables and taking antihypertensive drugs among subjects who were aware of hypertension. Finally, characteristics and proportions of subjects by age groups were analyzed to identify the subpopulations that were more likely to take antihypertensive medications (“adherence”) in the subsample of participants who took treatments for hypertension. All the analysis was done using Stata 15.0 (StataCorp., 2017). P values were 2-tailed and  $p < 0.05$  was considered to be statistically significant.

## Results

### 1. General characteristics

The mean age of participants with hypertension was 60 years. About half of them were men (50.4%) and 58.5% were from rural areas. **Table 1** presents their demographic characteristics, behavioral risk factors, and weight status. Rates of smoking and alcohol consumption were significantly higher in men than in women ( $p < 0.001$ ). Women had a higher obesity ( $\text{BMI} \geq 28\text{kg/m}^2$ ) prevalence (22.6% vs. 18.4%) than men ( $p = 0.01$ ).

// Table 1 here //

### 2. Awareness, treatment, and control of hypertension

Totally, 27.6% of Chinese adults had hypertension in the total sample, and the hypertension prevalence were 29.5% and 25.8% in men and women ( $p < 0.001$ ), respectively. Overall, the estimated awareness, treatment, and control rates were 55.7%, 46.5%, and 20.3% among Chinese adults with hypertension, respectively. The awareness and treatment rates were higher in women compared to men, but the blood pressure control rate was higher in men than in women though not significant (**Figure 1**).

// Figure 1 here // Of those who were aware of their hypertension, 83.0% ( $n = 1,664$ ) received antihypertensive treatment. In addition, 43.8% ( $n = 728$ ) of those who received treatment had their blood pressure controlled ( $\text{SBP/DBP} < 140/90$  mmHg).

**Table 2** presents the proportions of hypertension outcomes in various characteristic groups. Older adults ( $\geq 65$  yrs) had higher hypertension awareness and treatment rates compared to young adults (18-49 yrs). Hypertension awareness, treatment and control rates were higher in urban areas compared to rural areas and were higher in Eastern China compared to Central China. Participants who had a higher educational attainment (high school and above) were more likely to be aware of hypertension, and got treated and

controlled. In contrast, participants who were ethnic minorities and obese were less likely to have controlled hypertension.

// Table 2 here //

### 3. Hypertension prevalence, awareness, treatment in CHNS 2001 and InterASIA 2000-2001

Overall, hypertension prevalence, awareness, treatment, and control rates in CHNS 2001 were 18.0%, 24.0%, 20.0% and 4.5% among subjects with hypertension in China, respectively. Of these 24.0% individuals who were aware of their condition, 78% were treated and 19% were adequately controlled. The overall hypertension rates were 26.5%, 43.0%, 29.9%, and 7.7%, respectively, in InterASIA study. Of those who were aware of their hypertension, 61.5% received treatment, and 29.1% of those who received treatment had their blood pressure controlled (SBP/DBP < 140/90 mmHg). **(Table 3)**

// Table 3 here //

### 4. Factors associated with hypertension awareness and treatment

**Table 4** presents findings from multivariate logistic regression that identified factors associated with hypertension awareness, treatment, and control. Women were more likely to be aware of their hypertension than men, with an OR of 1.39 (95% CI, 1.14-1.70). Rural residency, minority ethnicity, and unemployment were negatively associated with hypertension awareness. Adults who were overweight and obese were more likely to be aware of their hypertension compared to those with normal weights. Factors associated with treatment of hypertension were similar to those related to hypertension awareness except for smoking status and drinking. Smoking status was not associated with treatment of hypertension. Current drinkers were less likely to receive antihypertensive medication (OR, 0.53; 95% CI, 0.39-0.72).

// Table 4 here //

### 5. Factors associated with hypertension control

Hypertension was better controlled in women (1.32, 1.04-1.68) compared with men, and in older ( $\geq 65$  years old) (1.84, 1.34-2.52) compared to young or mid-aged adults. People in urban areas (2.16; 1.79-2.60) and those from Eastern China (2.12; 1.72-2.63) were more likely to have controlled hypertension. In contrast, minority ethnicity (0.47; 0.31-0.73) and obese (0.77; 0.60-0.98) participants were less likely to have their hypertension controlled. Among participants taking medication for hypertension, those in an urban area, located in Eastern China, and with higher educational attainment had higher odds of hypertension control, whereas minorities (0.52; 0.31-0.86) and people with obesity (0.56; 0.42-0.76) were less likely to have their blood pressure controlled.

## Discussion

This study provides important evidence about the burden of hypertension in China. Over a quarter (27.6%) of Chinese adults had hypertension. Overall, among all these participants with hypertension only 55.7% were aware of their condition, 46.5% were taking antihypertensive medication to lower their blood pressure, and only 20.3% achieved blood pressure control. . Being female, of older age, living in urban area or Eastern region, having a high educational attainment, and not drinking alcohol and not currently smoking were associated with higher rates of hypertension awareness, treatment, and control.

Our findings on hypertension awareness, treatment, and control are consistent with previous similar studies.(18) We compared the prevalence, awareness, treatment, and control of hypertension among Chinese adults from two waves of CHNS (2001 and 2011) and from the International Collaborative Study of Cardiovascular Disease in ASIA (InterASIA 2000-2001). We would like to evidence what are the improvements in hypertension prevalence, awareness, treatment and control over ten years interval in the same survey and another coetaneous study which conducted in a representative sample in China. The hypertension awareness and treatment rates in the present study were more than two times greater than those seen a decade earlier(16) and the control rate was substantially higher than that reported in the InterASIA study.(17)

Despite the progress, hypertension awareness, treatment, and control rates in China were lower than the global average level of 46.5%, 87.5%, and 32.5% for hypertension awareness, treatment under awareness, and control under treated,(19, 20) and they were much worse than those in developed countries.(21, 22) According to a systematic review based on data from 35 countries, the hypertension awareness and control rates in China were even lower than the average level of many developing countries, such as Indonesia and India.(23)

Our multivariate logistic regression analysis identified several factors being associated with awareness, treatment, and control among all participants with hypertension. Consistent with other studies,(24-26) we found that women were more likely to be aware of their hypertension and achieving hypertension control than men. Older age ( $\geq 65$  years) and urban residence had higher hypertension awareness and control rates. A potential reason is that urban residents are more wary of their health, and so does the elderly population.(9, 27, 28) Participants in Eastern China had higher rates of hypertension awareness and control compared to those in Central China, which is likely due to the fact that Eastern China has an advantage in economic development and, thus, has more health care resources.(29, 30) Being ethnic minority was associated with lower rates of hypertension awareness, and control. This difference may be attributed to variations in genetics, culture, and lifestyles between ethnic minorities and the majority Han ethnicity.(31) Employed participants were less aware of their hypertensive condition than unemployed subjects. An education level of high school and above was found to be associated with a higher hypertension awareness and control rate. This result was consistent with a study based on data collected from adults in Southern China,(32) but was different from what was reported by the CHPSNE study.(33) The disparity may reflect differences in the study sample and treatment of hypertension in these studies. Being overweight and obesity were positively associated with higher rates of hypertension awareness, which was consistent with several other studies.(34, 35) However, only obesity was associated with a

lower control rate among all patients with hypertension. This could be explained by poor adherence to medical treatment among subjects with a suboptimal body weight.(36, 37) As we assumed that subjects with a suboptimal body weight would be less likely to pay attention to their health conditions, thus might had poor adherence to medical therapies prescribed by physicians. In addition, our study found that the awareness and control rates were greater among former smokers and lower among current smokers when compared with non-smokers. This could be explained that those who used to smoke were more aware of health conscious and may go for more health check-ups and be more adherent to their medication than non-smokers. (38) The reasons behind these associations require further investigation that is beyond the scope of this study.

The treatment rate was 83% among participants who were aware of their hypertension. And 43.8% of subjects who took antihypertensive medication treatment had their hypertension controlled. Regarding treatment among subjects who were aware of hypertension and control rate among those who received medication treatment, there was no difference between sexes. Older participants had higher treatment rate but not higher control rate than younger (<50 years) ones. Urban residence and participants in Eastern China had higher treatment and control rates than rural residence and participants in Central China, respectively. This could be explained by the facts that different socioeconomic status associates with unequal access to basic health care facilities and primary health care practitioners. Overweight and obesity were associated with higher treatment, and obese subjects had low control rate than subjects with normal weight. Educated people (middle school and above) who received treatment had high control rate. This mainly attribute to that subjects with higher educational level were more likely to seek medical care than others, and they could be more likely to adherent to instructions/medications that prescribed by primary health care practitioners.(39, 40)

Increased proportion of hypertension awareness, treatment, and control has been made during the past decades, but the control of hypertension remains at unacceptably low level. Our finding indicates that only one fifth (20.3%) of participants with hypertension had their blood pressure controlled. Some effective and feasible strategies could be carried out to improve hypertension control in China. For example, outpatient and community-based screening and monitoring efforts should be strengthened in primary health care service practices to increase hypertension awareness in people at risk. Second, programs of professional education on the use of appropriate antihypertensive alone or the correct combined therapy need to be implemented for primary care physicians in China who prescribe evidence-based medications. Finally, more standardized and comprehensive hypertension treatment guidelines, which includes health education, standardized management and treatment, follow-ups and prognosis records, must be released to improve the knowledge of both general population and healthcare providers to obtain the optimal control of hypertension management.

Our study has several limitations. First, cross-sectional data analysis does not support causal inferences between risk factors and hypertension outcomes. Second, blood pressure was not measured on separate occasions. Since the definition of hypertension was partly based on the blood pressure measurement, the absolute hypertension burden might be overestimated. Third, the CHNS did not capture

non-pharmacological treatment strategies such as healthy diet, adequate exercise, stress reduction, and sufficient amounts of potassium and magnesium. Fourth, our study is a secondary data analysis that used the dataset which is not designed for this aim. However, the large study sample and various risk factors that examined in analysis models stands the strength of this study.

## Conclusions

In conclusion, this study adds to the growing evidence that China suffers from a serious hypertension burden. Hypertension awareness, treatment, and control rates are still low compared to global averages and even compared to the average rates in many developing countries. The situation is worse among certain population groups, such as those who live in rural areas and underdeveloped regions. Substantial efforts and resources—such as strengthening/expanding blood pressure screening services, implementing effective education programs in primary health care providers, patients, and general population, launching standardized and comprehensive treatment guidelines—are needed to alleviate the burden and hypertension and, eventually, improve population health in China.

## List Of Abbreviations

OR, odds ratio;

95% CI, confidence interval;

SD, standard deviation;

BMI, body mass index;

SBP, systolic blood pressure;

DBP, diastolic blood pressure;

HTN, hypertension;

CHNS, China Health and Nutrition Survey;

## Declarations

### Ethics approval and consent to participate

Written informed consent for CHNS was approved by the institutional review committees of the University of North Carolina at Chapel Hill and the national institute of Nutritional and Food safety, China Centre for Disease Control and Prevention.

### Consent for publication

Not applicable

## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests:

The authors declared that they have no competing interests.

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## Author contributions

JW designed the overall study with contributions from YL. JW collected, analyzed data and drafted the manuscript. BX critically revised the manuscript. YL and YW interpreted the results and critically revised the manuscript. All authors approved the final manuscript.

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## Tables

**Table 1.** Demographic characteristics of Chinese adults with hypertension based on China Health and Nutrition Survey 2011

	All	Women	Men	P-value**
Sample size (N)	3,579	1,775	1,804	
Age (year, mean±SD)	60.0±12.4	61.6±11.7	58.5±12.9	< 0.001
BMI (kg/m <sup>2</sup> )	25.3±5.4	25.4±5.2	25.2±5.6	0.13
Residence (%)				
Urban	41.5	41.5	41.5	1.0
Rural	58.5	58.5	58.5	
Geographic region <sup>†</sup> (%)				0.33
Western China	20.1	21.1	19.1	
Eastern China	49.4	48.6	50.3	
Central China	30.5	30.3	30.6	
Marital status* (%)				< 0.001
Married	83.2	76.0	90.3	
Single	16.8	24.0	9.7	
Ethnicity				1.0
Han	92.0	92.0	90.0	
Minority	8.0	8.0	8.0	
Occupational status (%)				< 0.001
Employed	44.1	32.1	56.0	
Unemployed	55.9	67.9	44.0	
Health insurance (%)				
Insured	95.8	95.9	95.7	0.82
Not insured	4.2	4.1	4.3	
Education (%)				< 0.001
≤ Elementary school	48.2	60.8	35.7	
Middle school	27.4	22.4	32.4	
High school	17.1	13.0	21.1	
≥ College	7.3	3.8	10.8	
Smoking (%)				< 0.001

Non-smoker	65.9	94.3	38.0	
Ex-smoker	6.4	0.8	11.8	
Smoker	27.7	4.9	50.2	
Alcohol consumption (%)				< 0.001
Drinking	34.5	8.7	59.9	
Not drinking	65.5	91.3	40.1	
Weight status (%)				0.01
Normal weight (18.5≤BMI<24)	36.4	36.0	36.8	
Underweight (BMI<18.5)	2.2	2.3	2.0	
Overweight (24≤BMI<28)	41.0	39.1	42.8	
Obese (BMI≥28)	20.5	22.6	18.4	

Hypertension was defined as having an average systolic blood pressure BP  $\geq$  140 mmHg, diastolic blood pressure  $\geq$  90mmHg, self-reported being previously diagnosed as hypertension by a physician or taking antihypertension drugs currently;

Non-smoker was defined as subjects who responded negatively to “have you ever smoked cigarettes?”; ex-smoker was defined as subjects who responded positively to questions “have you ever smoked cigarettes?” but negatively to “do you still smokes cigarettes?”; current smoker was defined as subjects who responded both positive answers to questions “have you ever smoked cigarettes?” and “do you still smokes cigarettes?”; drinking refers to subject who regularly drink alcohol since last year.

\*Single includes never married, divorced, widowed and separated;

†Western China includes Guangxi, Guizhou and Chongqing; Eastern China includes Shanghai, Beijing, Jiangsu, Liaoning and Shandong; Central China includes Henan, Hubei, Henan and Heilongjiang;

\*\**p*-value was calculated from t-test for continuous variables and *chi*-square test for categorical variables.

**Table 2.** Proportion<sup>¶</sup> (%) of hypertension awareness, treatment, and control among Chinese adults with hypertension (HTN) based on CHNS 2011

	Awareness (1,993)	Treatment (1,664)		Control (728)	
		HTN	Awareness <sup>a</sup>	HTN	Treated <sup>b</sup>
Age group (years)					
18-49	36.2	25.9	71.7	12.7	49.0
50-64	58.1**	48.6**	83.6**	22.2**	45.7
65+	64.8**	56.8**	87.6**	22.8**	32.9
Residence					
Rural	48.0	38.4	80.0	13.5	35.2
Urban	66.6**	58.0**	87.0**	30.0**	51.7**
Geographic region <sup>†</sup>					
Central China	50.1	39.6	79.0	13.3	33.6
Western China	47.2	39.1	82.9	15.7	40.2
Eastern China	62.6**	53.8**	85.1**	26.6**	49.4**
Ethnicity					
Han	56.7	47.5	83.7	21.3	44.9
Minority	44.1**	35.0**	79.4	9.1**	26.0 <sup>‡</sup>
Marital status*					
Unmarried	58.9	49.8	84.5	19.6	39.5
Single	55.0	45.8	83.3	20.5	44.7
Occupational status					
Unemployed	64.5	56.4	87.4	24.4	43.3
Employed	44.6**	34.0**	76.3**	15.2**	44.7
Health insurance					
Not insured	51.3	42.0	81.8	19.3	46.0
Insured	55.9	46.7	83.6	20.4	43.7
Education					

≤ Elementary school	54.2	45.0	82.9	16.0	35.6
Middle school	52.9	43.8	82.9	21.2‡	48.4**
High school	60.0 <sup>§</sup>	51.6‡	86.1	27.1**	52.5**
≥ Collage	65.9**	54.8‡	83.1	29.9**	54.5**
Smoking					
Non-smoker	58.4	50.1	85.7	21.7	43.3
Ex-smoker	68.4‡	55.3	80.8	28.5 <sup>§</sup>	51.6
Smoker	46.3**	36.0**	77.8**	15.3**	42.6
Alcohol consumption					
Not drinking	58.7	50.9	86.8	21.5	42.1
Drinking	50.0**	38.1**	76.0**	18.2 <sup>§</sup>	47.9
Weight status					
Normal weight (BMI<24)	50.7	40.5	79.8	20.2	50.0
Overweight (24≤BMI<28)	58.6**	49.6**	84.8 <sup>§</sup>	21.8	43.8
Obese (BMI≥28)	59.4**	51.6**	83.5‡	17.7	34.4**

¶3,579 adults with hypertension;

Hypertension was defined as having an average systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥ 90 mmHg, self-reported being previously diagnosed as hypertension by a physician or taking antihypertension drugs currently;

Non-smoker was defined as subjects who responded negatively to “have you ever smoked cigarettes?”; ex-smoker was defined as subjects who responded positively to questions “have you ever smoked cigarettes?” but negatively to “do you still smokes cigarettes?”; current smoker was defined as subjects who responded both positive answers to questions “have you ever smoked cigarettes?” and “do you still smokes cigarettes?”; drinking refers to subject who regularly drink alcohol since last year.

Awareness of hypertension was defined as a self-report of hypertension diagnosed by a doctor before, or taking any antihypertensive drugs;

Control of hypertension was defined as blood pressure (SBP/DBP) < 140/90 mmHg;

<sup>a</sup> Treatment among subjects who were aware of their hypertension;

<sup>b</sup> Control among participant who took antihypertension medications;

\*Single includes never married, divorced, widowed and separated;

<sup>†</sup>Western China includes Guangxi, Guizhou and Chongqing; Eastern China includes Shanghai, Beijing, Jiangsu, Liaoning and Shandong; Central China includes Henan, Hubei, Henan and Heilongjiang;

- $p < 0.05$ , <sup>‡</sup> $p < 0.01$ , <sup>\*\*</sup> $p < 0.001$ .

**Table 3.** Comparison of average blood pressure, hypertension prevalence, awareness, treatment and control across China Health and Nutrition Survey (CHNS) 2011, CHNS 2001 and the International Collaborative Study of Cardiovascular Disease in ASIA (InterASIA 2000-2001) among Chinese adults

	CHNS 2011	CHNS 2001(16)	InterASiA (2000-2001)(17)
Blood pressure <sup>‡</sup>	SBP/DBP	SBP/DBP	SBP/DBP
All subjects	143/89	N/A	149/90
Those took treatment	143/87	N/A	148/89
Those did not take treatment	143/90	N/A	149/91
Hypertension profile (%)			
Prevalence	27.6	18.0	26.5
Awareness	55.7	24.0	43.0
Treatment <sup>‡</sup>	46.5	20.0	29.9
Treatment <sup>§</sup>	83.0	N/A	61.5
Control <sup>‡</sup>	20.3	4.5	7.7
Control <sup>¶</sup>	43.8	N/A	29.1

SBP systolic blood pressure, DPB diastolic blood pressure;

<sup>‡</sup>among subjects with hypertension;

- among subjects who were aware of their hypertension;

<sup>¶</sup>among subjects who took antihypertensive medications;

Control of hypertension was defined as SBP/DBP < 140/90 mm Hg among subjects receiving pharmacological treatment;

N/A indicated data not specified.

**Table 4.** Multivariable logistic regression analysis of factors associated with hypertension awareness, treatment and control among Chinese adults with hypertension (n=3,579) in CHNS 2011

	Awareness	Treatment <sup>¶</sup>	Control	Control <sup>‡</sup>
Women (vs. men)	1.37 (1.12 - 1.66)	0.94 (0.65 - 1.34)	1.32 (1.04 - 1.68)	1.17 (0.88 - 1.57)
Age group (years)				
18-49 (ref)				
50-64	2.34 (1.92 - 2.85)	1.87 (1.32 - 2.65)	1.87 (1.43 - 2.44)	1.33 (0.92 - 1.92)
65+	3.13 (2.45 - 3.99)	2.57 (1.65 - 4.02)	1.84 (1.34 - 2.52)	1.06 (0.70 - 1.62)
Residence				
Urban (vs. rural)	1.75 (1.50 - 2.04)	1.50 (1.14 - 1.97)	2.16 (1.79 - 2.60)	1.79 (1.43 - 2.24)
Geographic region <sup>†</sup>				
Central (ref)				
Western	0.92 (0.75 - 1.12)	1.35 (0.93 - 1.96)	1.33 (1.01 - 1.75)	1.33 (0.95 - 1.88)
Eastern	1.50 (1.27 - 1.77)	1.52 (1.14 - 2.01)	2.12 (1.72 - 2.63)	1.78 (1.37 - 2.31)
Ethnicity (vs. Han)				
Minority	0.74 (0.57 - 0.96)	0.78 (0.49 - 1.26)	0.47 (0.31 - 0.73)	0.52 (0.31 - 0.86)
Occupational status (vs. unemployed)				
Employed	0.78 (0.66 - 0.93)	0.74 (0.54 - 1.00)	0.92 (0.74 - 1.15)	0.96 (0.72 - 1.26)
Marital status* (vs. single)				
Married	1.09 (0.89 - 1.34)	1.27 (0.89 - 1.83)	1.11 (0.87 - 1.43)	1.16 (0.86 - 1.57)
Health insurance (vs. not				

insured)				
Insured	1.32 (0.93 - 1.87)	1.44 (0.77 - 2.68)	1.08 (0.70 - 1.66)	0.90 (0.52 - 1.55)
Weight status				
Normal weight ((BMI<24) (ref))				
Overweight (24≤BMI<28)	1.41 (1.20 - 1.66)	1.52 (1.15 - 2.01)	0.96 (0.79 - 1.16)	0.83 (0.65 - 1.05)
Obese (BMI≥28)	1.57 (1.29 - 1.92)	1.99 (1.39 - 2.84)	0.77 (0.60 - 0.98)	0.56 (0.42 - 0.76)
Education				
≤ Elementary school (ref)				
Middle school	1.11 (0.92 - 1.33)	1.08 (0.78 - 1.50)	1.39 (1.11 - 1.74)	1.57 (1.20 - 2.06)
High school	1.34 (1.07 - 1.67)	1.42 (0.97 - 2.08)	1.65 (1.28 - 2.12)	1.53 (1.13 - 2.07)
≥ College	1.69 (1.23 - 2.32)	1.04 (0.64 - 1.71)	1.77 (1.26 - 2.48)	1.80 (1.20 - 2.70)
Smoking status				
Non-smoker (ref)				
Ex-smoker	1.62 (1.16 - 2.24)	0.75 (0.46 - 1.23)	1.47 (1.04 - 2.09)	1.23 (0.80 - 1.88)
Smoker	0.86 (0.70 - 1.04)	0.83 (0.59 - 1.18)	0.81 (0.63 - 1.05)	0.83 (0.61 - 1.14)
Alcohol consumption				
Drinking (vs. not drinking)	0.95 (0.79 - 1.13)	0.53 (0.39 - 0.72)	0.96 (0.77 - 1.19)	1.03 (0.78 - 1.35)

<sup>¶</sup>Treatment among subjects who were aware of their hypertension;

‡control among participant who took antihypertension medications;

Hypertension was defined as having an average systolic blood pressure  $\geq 140$  mmHg, diastolic blood pressure  $\geq 90$ mmHg, self-reported being previously diagnosed as hypertension by a physician or taking antihypertension drugs currently;

Non-smoker was defined as subjects who responded negatively to “have you ever smoked cigarettes?”; ex-smoker was defined as subjects who responded positively to questions “have you ever smoked cigarettes?” but negatively to “do you still smokes cigarettes?”; current smoker was defined as subjects who responded both positive answers to questions “have you ever smoked cigarettes?” and “do you still smokes cigarettes?”; drinking refers to subject who regularly drink alcohol since last year.

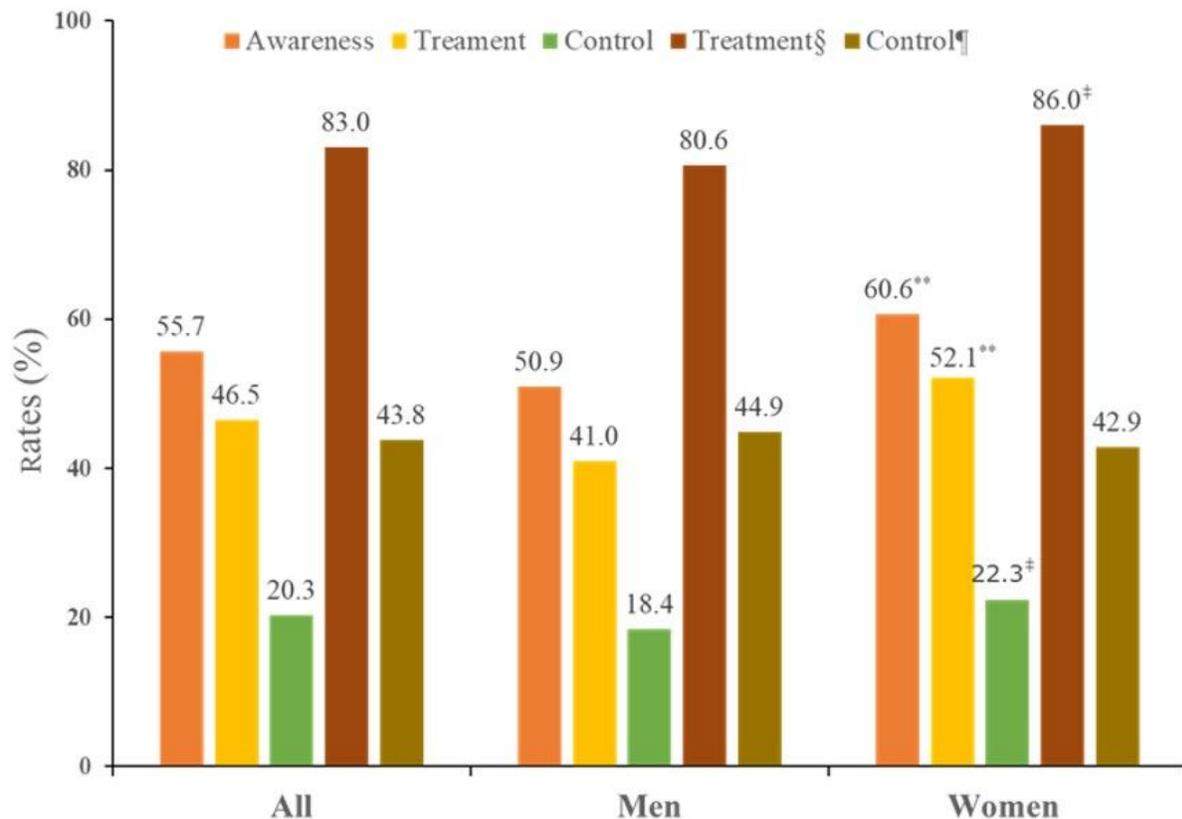
Awareness of hypertension was defined as a self-report of hypertension diagnosed by a Physician before, or taking any antihypertensive drugs;

Control of hypertension was defined as blood pressure (SBP/DBP)  $< 140/90$  mmHg;

\*Single includes never married, divorced, widowed and separated;

†Western China includes Guangxi, Guizhou and Chongqing; Eastern China includes Shanghai, Beijing, Jiangsu, Liaoning and Shandong; Central China includes Henan, Hubei, Henan and Heilongjiang.

## Figures



**Figure 1**

Rates of hypertension awareness, treatment, and control among Chinese adults with hypertension (n=3,579) by sex based on CHNS 2011. Hypertension awareness, treatment, and control were defined as a self-reported diagnosis of hypertension, current use of antihypertensive medication, and blood pressure (SBP/DBP) < 140/90 mmHg, respectively §treatment among subjects who were aware of their hypertension; ¶control among subjects who took antihypertensive medications; \*\*p<0.001, ‡p<0.01, female versus male

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Supplementaltable1.docx](#)