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Barriers to blood pressure control in China in a large opportunistic screening

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Abstract

We investigated the prevalence, awareness, treatment, and control of hypertension in a large opportunistic screening study in China. Our study participants had to be ≥18 years of age and had ideally not taken blood pressure (BP) for ≥1 year. BP was measured three times consecutively in the sitting position with a 1-minute interval, using a validated electronic BP monitor or mercury sphygmomanometer. Trained volunteer investigators administered a questionnaire to collect information on medical history, lifestyle, and use of medications. The 364 000 participants (52.6% women, and mean age 53.4 years) had a mean systolic/diastolic BP of 124.2/76.4 mm Hg. The proportion of hypertension was 24.7%. In all hypertensive subjects (n = 89 925), the awareness, treatment, and control rates of hypertension were 60.1%, 42.5%, and 25.4%, respectively. In multiple stepwise logistic regression analyses, the odds for unawareness vs awareness of hypertension was higher in men and lower with age advancing, current smoking, and the presence of diabetes mellitus, coronary heart disease, and stroke or transient ischemic attack ($P < .0001$). The odds for uncontrolled vs controlled hypertension was higher with age advancing and current smoking, and lower with the presence of diabetes mellitus and coronary heart disease ($P \leq .03$) in 38 207 treated hypertensive patients, and it was also higher with the use of antihypertensive monotherapy (odds ratio 1.13, $P = .0003$) in 19 523 treated hypertensive patients with specific antihypertensive drugs. Our study identified several factors as barriers to BP control in China, such as male gender, younger age, current smoking, and the under-use of combination therapy.

1 | INTRODUCTION

According to the most recent China nationwide hypertension survey in 2012-2015, the crude prevalence of hypertension was 27.9%, and the awareness, treatment and control rates of hypertension were 46.9%, 40.7%, and 15.3%, respectively.[1] If this survey would be compared with the previous one in 2002,[2] the prevalence was substantially increased by an absolute percentage of 9.1% from 18.8%,

while the awareness, treatment, and control rate increased by an absolute percentage of 16.7%, 16.0%, and 9.2%, respectively. However, the awareness and control rate remains at low level. Untreated and uncontrolled hypertension remains a major cause of cardiovascular events and mortality in China.[3-5] It is, therefore, extremely important to make all efforts to raise awareness and control of hypertension in China.

As one of the China nationwide initiatives for improving the management of hypertension, we actively participated in the May Measurement Month (MMM) project,[6-8] organized by the International Society of Hypertension in collaboration with the World Hypertension League and the Lancet Commission on Hypertension.[9] The earlier collected data in 2017 in 125 236 participants were included in the pooled analysis of the worldwide project.[6,7] However, in the whole measurement period in 2017, a total of 364 000 study participants had their blood pressure measured and had sufficient quality of data. In the present study, we investigated the prevalence, awareness, treatment, and control of hypertension in this opportunistic screening in China.

2 | METHODS

2.1 | Study design and participants

The MMM China project strictly followed the international MMM 2017 protocol, which had been previously described in detail elsewhere.[6,7] The China project was conducted from May to September 2017 in 394 measurement sites across 22 of the 31 China mainland provinces. Measurement sites were mostly inside hospitals or community health centres, but usually located in a public area instead of doctors' offices for routine clinical service. The Ethics Committee of Ruijin Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China approved the study protocol. All participants provided written informed consent.

Eligible participants were volunteer adults aged ≥18 years, who had ideally not taken blood pressure for at least 1 year.

2.2 | Blood pressure measurement

Blood pressure was measured three times consecutively in the sitting position after at least 5 minutes rest with an 1-minute interval, using a validated automatic blood pressure monitor (Omron HEM-9200T Omron Healthcare or A&D TM2656) or a mercury sphygmomanometer. These three blood pressure readings were averaged for analysis. Hypertension was defined as a blood pressure of at least 140 mm Hg systolic or 90 mm Hg diastolic, or the use of antihypertensive medication. In treated hypertensive patients, control of hypertension was defined as a blood pressure below 140 mm Hg systolic and 90 mm Hg diastolic.

2.3 | Questionnaire and anthropometric measurements

Trained volunteer investigators administered a questionnaire to collect information on medical history, lifestyle, and use of medications. The trained investigators also measured body height, body weight, and waist and hip circumferences. Body mass index was calculated as the body weight in kilograms divided by the body height in meters squared. Overweight and obesity were defined as a body mass index of 24.0-27.9 and ≥28.0 kg/m^2, respectively.

2.4 | Statistical methods

Database management and statistical analyses were performed using the SAS software (SAS 9.2, SAS Institute). Means and proportions were compared using the student *t* test and chi-square test, respectively. We performed multiple stepwise logistic regression analyses with a *P* value for entry and stay in the model set at .10. We considered sex, age, body mass index, current smoking, and alcohol intake, the presence of diabetes mellitus, coronary heart disease, and stroke or transient ischemic attack (TIA), and the use of statins.

TABLE 1 Characteristics of the study participants

Characteristic	Men (n = 172 395)	Women (n = 191 605)	*P* value
Age, years	53.6 ± 17.7	53.2 ± 17.7	<.0001
Body height, cm	168.6 ± 6.7	159.1 ± 6.3	<.0001
Body weight, kg	67.4 ± 10.0	58.6 ± 9.0	<.0001
Body mass index, kg/m^2	23.7 ± 3.2	23.2 ± 3.4	<.0001
Waist circumference, cm	84.1 ± 9.1	79.3 ± 9.4	<.0001
Hip circumference, cm	94.6 ± 9.5	90.8 ± 9.1	<.0001
Waist-to-hip ratio	0.89 ± 0.08	0.88 ± 0.08	<.0001
Systolic blood pressure, mm Hg	125.9 ± 15.5	122.4 ± 16.7	<.0001
Diastolic blood pressure, mm Hg	77.8 ± 9.9	75.0 ± 9.4	<.0001
Use of antihypertensive drugs, %	10.5	10.5	.80
Current smoking, %	20.3	1.9	<.0001
Alcohol intake, %	15.0	1.5	<.0001
Diabetes mellitus, %	4.1	4.1	.83
Coronary heart disease, %	1.5	1.4	.21
Stroke or transient ischemic attack, %	1.1	1.1	.07
Use of lipid lowering drugs, %	3.0	3.0	.86

Note: Values are mean ± SD or percentage of the column total.

For control of hypertension, we additionally considered the use of combination antihypertensive therapy vs monotherapy.

3 | RESULTS

3.1 | Characteristics of the study participants

The 364 000 participants included 191 605 women (52.6%) and had a mean age of 53.4 (±17.7) years, and a mean body mass index of 23.4 (±3.3) kg/m^2. Men, compared with women, had a significantly (P < .0001) higher prevalence of overweight and obesity (45.0% vs 36.7%) and higher proportions of current smoking (20.3% vs 1.9%) and alcohol intake (15.0% vs 1.5%). However, they had similar (P ≥ .05) prevalence of diabetes mellitus (4.1%), coronary heart disease (1.5%), and stroke or TIA (1.1%), and similar use of statins (3.0%, Table 1).

Men, compared with women, had higher systolic/diastolic blood pressure (125.9/77.8 vs 122.4/75.0 mm Hg, P < .0001), especially in the younger age range (Figure 1). Overall, automatic electronic blood pressure monitors were used in 89.7% of the participants, and a mercury sphygmomanometer in 11.3% of the participants.

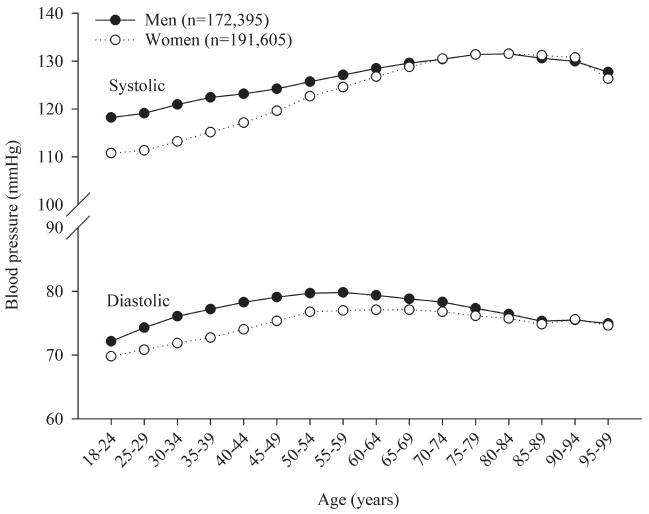

FIGURE 1 Systolic and diastolic blood pressure by age and gender. Values in dots or circles are mean in each group

3.2 | Prevalence of hypertension

The prevalence of hypertension was 24.7%, being higher in men than in women (27.2% vs 22.5%, Table 2). The gender-based difference was prominent in people less than 65 years of age (18.3% vs 39.0%, P < .0001) and became insignificant in people of 65 years or older (Figure 2).

In multiple stepwise logistic regression analyses, the prevalence of hypertension was significantly (P < .0001) higher in men (odds ratio [OR] 1.08, 95% confidence interval [CI] 1.06-1.10) and with age advancing (for each 10-year increase, OR 1.51, 95% CI 1.49-1.51), current smoking (OR 1.25, 95% CI 1.22-1.29), the presence of diabetes mellitus (OR 1.76, 95% CI 1.70-1.83), coronary heart disease (OR 1.38, 95% CI 1.30-1.47), and stroke or TIA (OR 1.43, 95% CI 1.33-1.54) and the use of statins (OR 1.55, 95% CI 1.49-1.62).

3.3 | Awareness and treatment of hypertension

In all hypertensive patients (n = 89 925), the awareness and treatment of hypertension was 60.1% and 42.5%, respectively (Table 2), being significantly (P < .0001) higher in women than in men (awareness: 63.5% vs 57.3%; treatment: 46.7% vs 38.6%).

In multiple stepwise logistic regression, the odds for unawareness vs awareness of hypertension was significantly (P < .0001) higher in men (OR 1.41, 95% CI 1.37-1.46) and lower with age advancing (for each 10-year increase, OR 0.71, 95% CI 0.70-0.71), current smoking (OR 0.53, 95% CI 0.48-0.59), the presence of diabetes mellitus (OR 0.39, 95% CI 0.36-0.42), coronary heart disease (OR 0.36, 95% CI 0.31-0.41), and stroke or TIA (OR 0.38, 95% CI 0.33-0.45), and the use of statins (OR 0.19, 95% CI 0.17-0.21, Figure 3).

In similar multiple stepwise logistic regression analyses, the odds for untreated vs treated hypertension was significantly (P ≤ .04)

TABLE 2 Prevalence, awareness, treatment, and control of hypertension

	All	Men	Women	*P* value
All participants	n = 364 000	n = 172 395	n = 191 605	
Prevalence, %	24.7	27.2	22.5	<.0001
Hypertensive patients	n = 89 925	n = 46 819	n = 43 106	
Awareness, %	60.1	57.3	63.5	<.0001
Treatment, %	42.5	38.6	46.7	<.0001
Control, %	25.4	22.9	28.1	<.0001
Treated hypertensive patients	n = 38 207	n = 18 075	n = 20 132	
Treated and controlled, %	59.8	59.3	60.3	.049

Note: Values are percentage of patients.

higher in men (OR 1.41, 95% CI 1.35-1.47) and current smokers (OR 1.07, 95% CI 1.01-1.14), and lower with age advancing (for each 10-year increase, OR 0.89, 95% CI 0.88-0.90), the presence of coronary heart disease (OR 0.58, 95% CI 0.51-0.65), and stroke or TIA (OR 0.88, 95% CI 0.78-0.99), and the use of statins (OR 0.83, 95% CI 0.77-0.90, Figure 4).

3.4 | Control of hypertension in treated hypertensive patients

The control rate of hypertension was 25.4% in all hypertensive patients (n = 89 925) and 59.8% in treated hypertensive patients (n = 38 207, Table 2), being significantly ($P \leq .049$) higher in women than in men (control: 28.1% vs 22.9%; treated and controlled: 60.3% vs 59.3%).

In multiple logistic regression analyses in treated hypertensive patients, the odds for uncontrolled vs controlled hypertension was ($P \leq .03$) higher with age advancing (for each 10-year increase, OR 1.02, 95% CI 1.00-1.04) and current smoking (OR 1.18, 95% CI 1.11-1.26), and lower with the presence of diabetes mellitus (OR 0.93, 95% CI 0.87-1.00) and coronary heart disease (OR 0.87, 95% CI 0.79-0.96), and the use of statins (OR 0.87, 95% CI 0.81-0.94, Figure 5).

In further analyses in treated hypertensive patients with specific antihypertensive drug information (n = 19 523, Table 3), the odds for uncontrolled vs controlled hypertension was additionally higher with the use of monotherapy (vs combination therapy, OR 1.13, 95% CI 1.06-1.21, $P = .0003$).

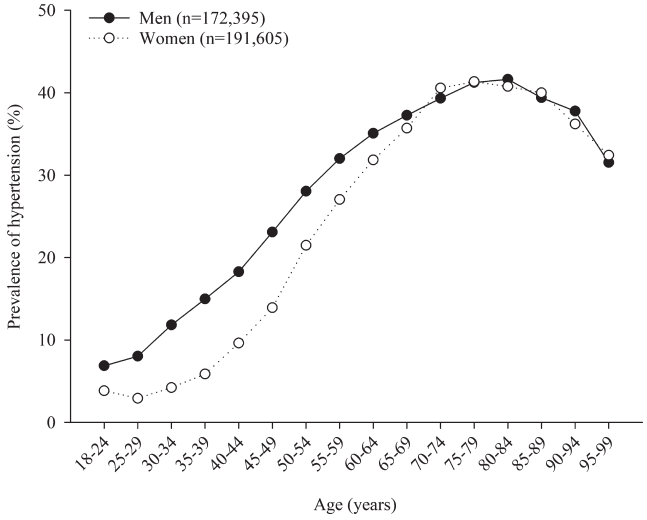

FIGURE 2 Prevalence of hypertension by age and gender. The number of men and women is given

4 | DISCUSSION

Our study showed that the awareness, treatment, and control rates of hypertension were consistently lower in men than women and higher in patients with comorbid diseases, such as diabetes mellitus, coronary heart disease, stroke or TIA, or the use of statins, than those without. Advancing age was positive for the awareness and treatment, but negative for the control of hypertension. Cigarette smoking was positive for the awareness, but negative for the treatment and control of hypertension. In addition, the use of monotherapy was also negative for the control of hypertension.

Our study identified current cigarette smoking as an important negative factor for the management of hypertension. Although cigarette smokers had higher awareness of hypertension than non-smokers, they had lower treatment and control rate of hypertension. The prevalence of cigarette smoking is high in men and increases substantially in women recently.[10] Cigarette smokers have a higher prevalence of hypertension,[11] including masked hypertension.[12,13] Smokers apparently are one of the major target populations for the management of hypertension.

Our study also identified the inadequate use of antihypertensive treatment as another modifiable risk factor for the management of hypertension. Indeed, combination antihypertensive therapy was under-used in the present study, in spite of the low control rate of

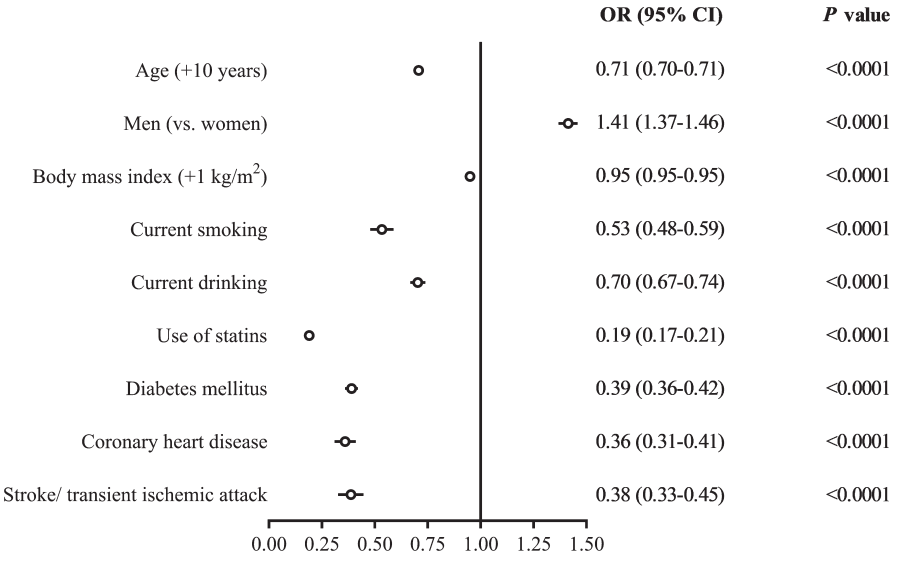

FIGURE 3 Odds (95% confidence intervals) for unawareness vs awareness of hypertension in hypertensive patients (n = 89 925). Symbols on the right side of the vertical unity (1) line indicate increased odds of unawareness

hypertension. Recent hypertension guidelines consistently recommended initial combination antihypertensive therapy for the management of hypertension.[14-17] With the increasing availability of single-pill combination antihypertensive drugs in China,[18] combination antihypertensive therapy would be a choice of approaches for improving control of hypertension.

Our study identified several non-modifiable factors for the worse management of hypertension, such as male gender and younger age. These observations are in keeping with the results of numerous previous studies.[19,20] We might have to build technological platforms to tackle the problems in these special populations. We are currently building a Web-based and WeChat-linked blood pressure measuring system in China mainly in public areas such as office buildings, shopping malls, airports, railway stations and so on, where younger people often walk around.[21] Hopefully, with these approaches, the awareness of hypertension will be improved in these populations.

We found that several comorbid diseases were significantly associated with a better management of hypertension. These observations are in line with the results of many previous studies.[22] When a patient sees a doctor for another disease, blood pressure may be measured, and hypertension may be diagnosed and treated. In addition, because of the comorbid diseases, the risk is high, and the patient may be more careful and mindful in the management of the diseases.

A major limitation of our study was the non-random sampling approach for the recruitment of the study participants. Nonetheless, the estimations on the awareness, treatment and control were similar to the results of the recent China nationwide hypertension survey.[1] In addition, we did not succeed in collecting detailed information on the use of antihypertensive drugs in all participants. Our analysis for this topic had to be restricted to a much smaller number of study participants.

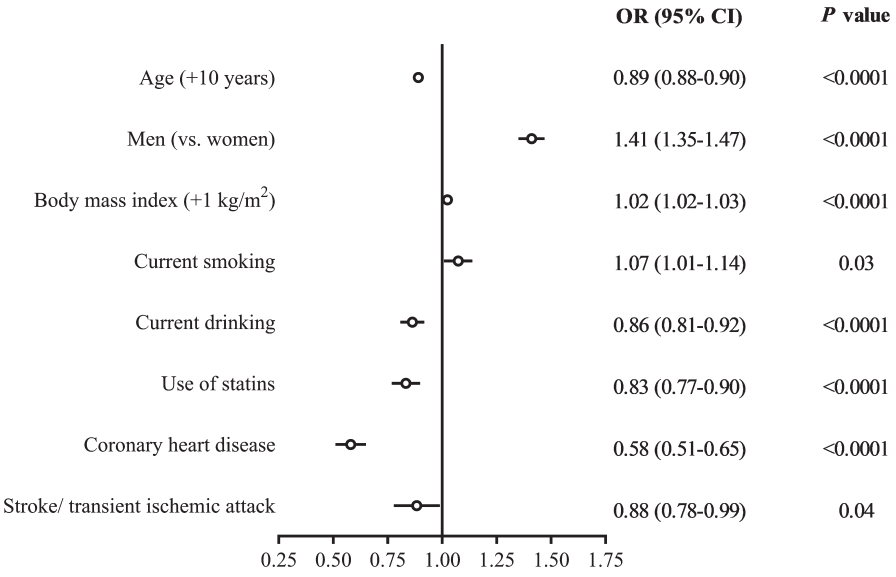

FIGURE 4 Odds (95% confidence intervals) for untreated vs treated hypertension in all hypertensive patients (n = 89 925). Symbols on the right side of the vertical unity (1) line indicate increased odds of untreated hypertension

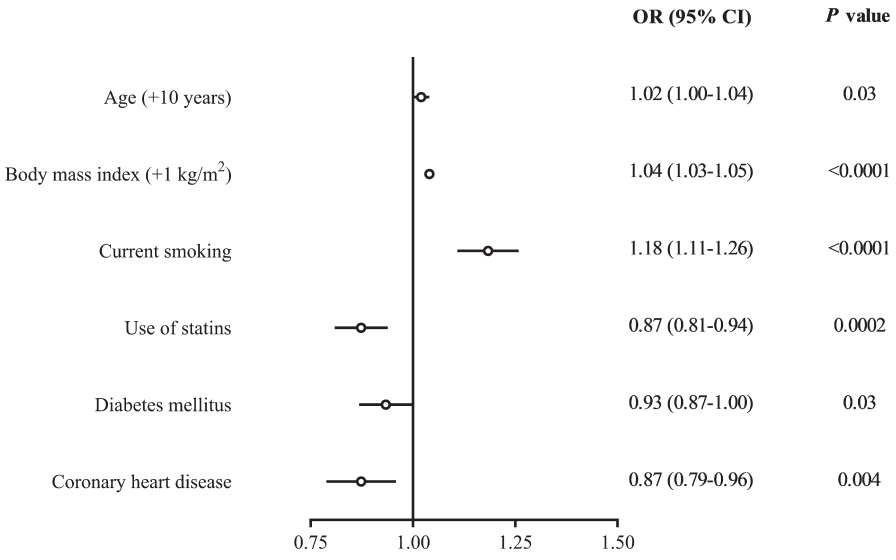

FIGURE 5 Odds (95% confidence intervals) for uncontrolled vs controlled hypertension in treated hypertensive patients (n = 38 207). Symbols on the right side of the vertical unity (1) line indicate increased odds of uncontrolled hypertension

TABLE 3 Use of antihypertensive drugs in 19 523 treated hypertensive patients who volunteered detailed information on the use of antihypertensive drugs

Antihypertensive treatment	Percentage of patients, %	Control rate, %
Monotherapy (n = 14 305)	73.3	60.6
Angiotensin-converting enzyme inhibitors	4.9	50.0
Angiotensin receptor blockers	17.1	68.2
Long-acting calcium channel blockers	37.2	60.9
Short-acting calcium channel blockers	7.2	51.1
Diuretics	2.7	49.4
β-blockers	2.7	68.2
Other[a]	1.4	51.6
Combination therapy (n = 5218)	26.7	63.1
Fixed-dose combination	8.5	58.1
An angiotensin-converting enzyme inhibitor or an angiotensin receptor blocker plus hydrochlorothiazide	4.5	71.6
Hydrochlorothiazide plus reserpine or clonidine	4.0	42.9
Free combination	18.2	65.4

Note: Values are percentage of patients.

[a]Including α-blockers, reserpine, clonidine, isosorbide mononitrate, and Chinese herbs.

In conclusion, our study identified several factors as barriers to blood pressure control in China, such as male gender, younger age, current smoking, and the under-use of combination therapy. A major implication of our study is that future initiatives in China might have to target these major barriers for the management of hypertension.

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CONFLICT OF INTEREST

None.

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