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ORIGINAL ARTICLE

Prevalence, awareness, treatment and control of hypertension in elderly Chinese

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We studied the prevalence, awareness, treatment and control of hypertension in an elderly Chinese population. The study subjects (age ⩾60 years) were recruited from a suburban town of Shanghai from 2006 to 2008. We administered a standardized questionnaire to collect information on medical history, the use of medications and lifestyle. We measured blood pressure three times consecutively using a validated Omron 7051 oscillometric device (Kyoto, Japan) after the subjects had rested for at least 5 min in the sitting position. We defined hypertension as a blood pressure of at least 140 mm Hg systolic or 90 mm Hg diastolic or as the use of antihypertensive drugs. The 3949 participants (mean age of 68.3 years) included 2185 (55.3%) women, 182 (4.6%) obese subjects (body mass index ⩾30 kg m^{-2}) and 366 (9.3%) diabetic patients. The prevalence of hypertension was 59.4%. In the 2345 hypertensive patients, the awareness, treatment and control (<140/90 mm Hg) rates were 72.5%, 65.8% and 24.4%, respectively. In the 1542 treated hypertensive patients, 1196 (77.6%) used fixed-dose combinations of thiazide and reserpine or clonidine ($n=1157$, 75.0%) or of an angiotensin receptor blocker and hydrochlorothiazide ($n=1$) or free combinations ($n=38$, 2.5%), and 346 (22.4%) used a monotherapy of short-acting calcium channel blockers ($n=217$, 14.1%) or other classes of antihypertensive drugs ($n=129$, 8.3%). The corresponding control rates were 37.3% and 36.4%, respectively. In a stepwise logistic regression, the risk of uncontrolled hypertension was higher with older age (+10 years, odds ratio (OR) 1.19, $P=0.03$), female sex (OR 1.40, $P=0.01$), obesity (OR 2.35, $P=0.0002$) and heavy drinking (⩾300 g per week, OR 2.18, $P=0.0007$). In conclusion, in elderly Chinese, the prevalence of hypertension is high. In spite of reasonably high awareness and treatment rates, the control rate remains low, most likely due to an unhealthy lifestyle and the underuse and/or underdose of antihypertensive drugs.
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Keywords: awareness; elderly Chinese; prevalence; treatment

INTRODUCTION

Hypertension is an established modifiable risk factor for cardiovascular disease and mortality.[1,2] The prevalence of hypertension consistently increases with age worldwide[3,4] and is therefore high in the elderly. For various reasons, such as comorbid cardiovascular,[5] renal[6] and metabolic disorders,[7] the management of hypertension can be difficult, the control rate of hypertension is usually low and the risk of hypertension is high.

According to the 2002 National Nutrition and Health Survey (NNHS) in adult Chinese, the prevalence of hypertension in people of 60 years of age or older was 49.1%, and the rates of awareness, treatment and control were 37.6%, 32.2%, and 7.6%, respectively.[8] Uncontrolled hypertension in more than 90% of Chinese hypertensive patients is likely to be a major reason for the steady increase in the risk of mortality attributable to stroke and coronary heart disease over more than 20 years.[9] Hypertension is becoming a major public health problem in China.[10] With increasing longevity, rapid economic development and brisk urbanization, the problem of the management of hypertension, if not properly addressed, will become even worse in the next few years.

Not only does the pathophysiology of hypertension differ across populations, but the strategies for the management of hypertension can also be specific to populations.[3,11] Barriers to improving the management of hypertension have to be investigated and identified in specific populations. We recently conducted a study in an elderly Chinese population, which was more than half hypertensive, living in a suburb of Shanghai. In the present cross-sectional analysis, we studied the prevalence, awareness, treatment and control of hypertension, and investigated the risk factors for uncontrolled hypertension.

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METHODS

Study population

Our study was conducted in the framework of the Chronic Disease Detection and Management in the Elderly ($\geqslant$60 years of age) Program supported by the municipal government of Shanghai. In a newly urbanized suburban town 30 km from the city center, we invited all residents of 60 years of age or older to participate in comprehensive examinations of cardiovascular disease and risk. The Ethics Committee of Ruijin Hospital, Shanghai Jiaotong University School of Medicine, approved the study protocol. All subjects provided written informed consent.

In the period from 2006 to 2008, a total of 4080 subjects (participation rate of 90%) were enrolled. We excluded 131 subjects from this analysis because blood pressure measurements were not performed ($n=46$) or because of other missing information ($n=85$). Thus, the number of participants included in this analysis was 3949.

Field work

One experienced physician measured each participant's blood pressure three times consecutively using a validated Omron 7051 oscillometric blood pressure monitor (Omron, Kyoto, Japan) after the subjects had rested for at least 5 min in the sitting position. These three blood pressure readings were averaged for analysis. The same physician administered a standardized questionnaire to collect information on medical history, smoking habits, alcohol consumption and the use of medications. A trained technician performed anthropometric measurements, including body height and weight. The body mass index was the weight in kilograms divided by the height in square meters.

Hypertension was defined as a sitting blood pressure of at least 140 mm Hg systolic or 90 mm Hg diastolic or as the use of antihypertensive drugs. We defined awareness of hypertension as a self-reported previous medical diagnosis of hypertension, the treatment of hypertension via the current use of antihypertensive drugs intended to lower blood pressure and the control of hypertension to a blood pressure lower than 140 mm Hg systolic and 90 mm Hg diastolic in users of antihypertensive drugs. We defined moderate and heavy drinking as a weekly volume of alcohol consumption of 5–299 and $\geqslant$300 g, respectively.[12] We defined overweight and obesity as a body mass index of 25.0–29.9 and $\geqslant 30\,kg\,m^{-2}$, respectively.[13]

Blood biochemistry

Venous blood samples were drawn after overnight fasting for the measurement of plasma glucose concentration and serum concentrations of total cholesterol and triglycerides. Diabetes mellitus was defined as a plasma glucose level of at least $7.0\,mmol\,l^{-1}$ while fasting or $11.1\,mmol\,l^{-1}$ at any time or as the use of antidiabetic agents.

Statistical methods

For database management and statistical analysis, we used SAS software (version 9.13; SAS Institute, Cary, NC, USA). Mean values and proportions were compared by the Student's *t*-test and Fisher's exact test, respectively. Continuous measurements with a skewed distribution were normalized by logarithmic transformation and represented by geometric mean and 95% confidence interval (CI).

We studied determinants of uncontrolled hypertension using stepwise logistical regression, with the *P*-value set at 0.10 for independent variables to enter and stay in the model. We considered sex, age, obesity, current smoking, moderate and heavy alcohol consumption, diabetes mellitus, serum total cholesterol, the use of short-acting calcium channel blockers and the use of a combination of hydrochlorothiazide and reserpine or clonidine.

RESULTS

Characteristics of the participants

The 3949 participants (mean age of 68.3 years) included 2185 (55.3%) women, 1208 (30.6%) overweight subjects, 182 (4.6%) obese subjects and 366 (9.3%) diabetic patients. Men, compared with women, were slightly younger (-0.8 years, $P<0.0001$); had a lower body mass index ($-0.3\,kg\,m^{-2}$, $P=0.004$); reported significantly higher ($P<0.0001$) proportions of current smoking (55.7% *vs.* 2.4%) and alcohol intake (36.8% *vs.* 1.3%); and had a lower ($P<0.05$) prevalence of overweight (28.9% *vs.* 32.0%), obesity (3.9% *vs.* 5.2%), and diabetes mellitus (8.1% *vs.* 10.1%; Table 1).

Prevalence, awareness, treatment and control of hypertension

Table 2 details the prevalence, awareness, treatment and control of hypertension by sex and age group. Overall, the prevalence of hypertension was 59.4%. In the 2345 hypertensive subjects, 1701 (75.6%) were aware of their disease condition, 1542 (65.8%) were taking antihypertensive drugs and 572 (22.7%) had their blood pressure controlled to a level below 140/90 mm Hg. In the 1542 treated hypertensive patients, the control rate was 37.1%.

Men and women had a similar prevalence of hypertension (59.5% *vs.* 59.4%, $P=0.87$). However, men, compared with women, had slightly lower rates of awareness (71.2% *vs.* 74.6%, $P=0.07$) and treatment (63.3% *vs.* 67.7%, $P=0.03$) and had a slightly higher control rate of hypertension in both all (25.7% *vs.* 23.3%, $P=0.08$) and treated (40.6% *vs.* 34.4%, $P=0.01$) hypertensive patients.

In men as well as women, the prevalence, awareness and treatment rates of hypertension were higher with older age ($P\leqslant0.006$), whereas the control rate of hypertension slightly decreased with older age ($P\leqslant0.09$). In addition, the control rate of hypertension in treated hypertensive patients was lower ($P\leqslant0.03$) in obese (21.6%) than in overweight (36.7%) and normal-weight subjects (40.6%) and in heavy-drinking men (28.2%) than in their moderate-drinking or nondrinking (43.4%) counterparts (42.7%, Figure 1).

Table 1 Characteristics of the study population by sex

Characteristic	*Men* (n = *1764*)	*Women* (n = *2185*)	P-*value*
Age (years)	67.7 ± 7.1	68.7 ± 7.5	<0.0001
Body mass index ($kg\,m^{-2}$)	23.6 ± 3.4	23.9 ± 3.7	0.004
Current smoking, *n* (%)	973 (55.7)	52 (2.4)	<0.0001
Alcohol intake, n *(%)*	642 (36.8)	28 (1.3)	<0.0001
Moderate, *n* (%)	282 (16.4)	20 (0.9)	<0.0001
Heavy, *n* (%)	360 (20.4)	8 (0.4)	<0.0001
Blood pressure (mm Hg)			
Systolic	137.8 ± 19.6	138.7 ± 19.8	0.14
Diastolic	81.8 ± 10.8	80.5 ± 10.5	0.0001
Pulse rate ($beats\,min^{-1}$)	74.9 ± 12.0	78.0 ± 11.5	<0.0001
Biochemical measurements			
Plasma fasting glucose ($mmol\,l^{-1}$)	5.31 ± 1.12	5.47 ± 1.31	<0.0001
Serum total cholesterol ($mmol\,l^{-1}$)	5.51 ± 1.42	5.68 ± 1.41	0.0002
Serum triglycerides ($mmol\,l^{-1}$)	1.45 (1.42, 1.47)	1.57 (1.54, 1.59)	<0.0001
Diabetes mellitus, *n* (%)	142 (8.1)	224 (10.3)	0.02
Overweight, *n* (%)	509 (28.9)	699 (32.0)	0.03
Obesity, *n* (%)	68 (3.9)	114 (5.2)	0.04

Values are anthrometric (±s.d.) or geometric mean (95% confidence interval), or the number of subjects (%). *P*-values are for comparisons between men and women.
For definitions of moderate and heavy drinking, diabetes mellitus, overweight and obesity, see METHODS section.

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

	Men (n = *1764*)				*Women* (n = *2185*)				*All* (n = *3949*)			
	60–69 years	*70–79 years*	*⩾80 years*	*All*	*60–69 years*	*70–79 years*	*⩾80 years*	*All*	*60–69 years*	*70–79 years*	*⩾80 years*	*All*
All subjects	*n* = 1169	*n* = 472	*n* = 123	*n* = 1764	*n* = 1298	*n* = 684	*n* = 203	*n* = 2185	*n* = 2467	*n* = 1156	*n* = 326	*n* = 3949
Prevalence, *n* (%)	676 (57.8)	295 (62.5)	79 (64.2)	1050 (59.5)	733 (56.5)	416 (60.8)	146 (71.9)	1295 (59.3)	1409 (57.1)	711 (61.5)	225 (69.0)	2345 (59.4)
Hypertensive subjects												
Awareness, *n* (%)	464 (69.2)	215 (73.4)	64 (81.0)	743 (71.2)	524 (72.2)	328 (79.6)	106 (72.6)	958 (74.6)	988 (70.7)	543 (77.0)	170 (75.6)	1701 (75.6)
Treatment, *n* (%)	412 (61.0)	194 (65.7)	59 (74.7)	665 (63.3)	467 (63.7)	305 (73.3)	105 (71.9)	877 (67.7)	879 (62.4)	499 (70.2)	164 (72.9)	1542 (65.8)
Control of hypertension, *n* (%)	163 (24.1)	84 (28.5)	23 (29.1)	270 (25.7)	164 (22.4)	110 (26.4)	28 (19.2)	302 (23.3)	327 (23.2)	194 (27.3)	51 (22.7)	572 (24.4)
Treated hypertensive subjects												
Control of hypertension, *n* (%)	163 (39.6)	84 (43.3)	23 (39.0)	270 (40.6)	164 (35.1)	110 (36.1)	28 (26.7)	302 (34.4)	327 (37.2)	194 (38.9)	51 (31.1)	572 (37.1)

Values are number of subjects (%).

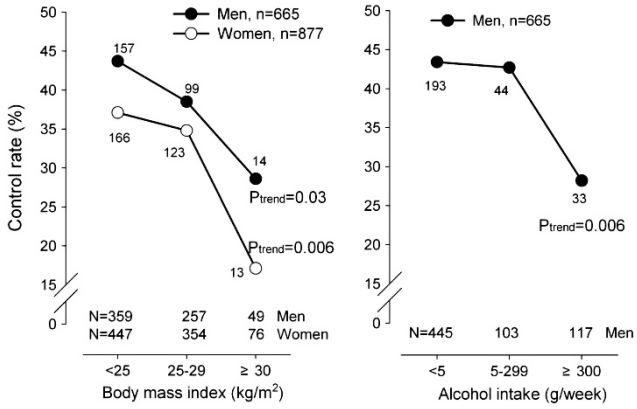

Figure 1 Control rate of hypertension in treated hypertensive patients by body mass index (left panel) and alcohol intake (right panel). The closed and open circles represent men and women, respectively. The number of treated hypertensive patients per group is given at the bottom, and the number of patients with controlled hypertension is given alongside the symbols.

Use of antihypertensive drugs and the control rate of hypertension

Table 3 shows the control rate of hypertension according to the use of antihypertensive drugs in the 1542 treated hypertensive patients. In men and women combined, 77.6% of treated hypertensive patients used fixed-dose combinations of hydrochlorothiazide (3.125–6.25 mg) and reserpine (0.032–0.1 mg) or clonidine (0.03 mg, 75.0%) or of an angiotensin receptor blocker and hydrochlorothiazide ($n = 1$), or free combinations (2.5%), and 22.4% used a monotherapy of calcium channel blockers (14.1%), diuretics (2.8%), angiotensin receptor blockers (2.1%), angiotensin-converting enzyme inhibitors (1.6%), β-blockers (0.9%) or other antihypertensive drugs (0.9%).

Men, compared with women, more frequently used a monotherapy of calcium channel blockers (16.2% *vs.* 12.4%, $P = 0.03$) and less frequently received a combination therapy of hydrochlorothiazide and reserpine or clonidine (64.5% *vs.* 71.0%, $P = 0.02$). However, the use of antihypertensive drugs was similar between obese subjects and overweight and normal-weight subjects ($P \geqslant 0.87$) and between heavy-drinking men and moderate-drinking and nondrinking men ($P \geqslant 0.61$).

Overall, the control rate of hypertension was similar across various classes of antihypertensive drugs ($P \geqslant 0.21$, Table 3). Increasing the frequency of the drug usage per day slightly but nonsignificantly ($P \geqslant 0.18$) increased the control rate of hypertension for a monotherapy of short-acting calcium channel blockers (from 35.4% once daily to 37.4% two times daily and 41.4% three times daily) and for a combination therapy of hydrochlorothiazide and reserpine or clonidine (from 34.5% once daily to 38.2% two times daily and 40.0% three times daily).

Risk factors for uncontrolled hypertension

For the treated hypertensive patients, we performed a stepwise logistical regression to investigate the determinants of uncontrolled hypertension. The risk of uncontrolled hypertension was higher with older age (+10 years, odds ratio (OR) 1.19, 95% CI: 1.02–1.38, $P = 0.03$), female sex (OR 1.40, 95% CI: 1.07–1.84, $P = 0.01$), obesity (OR 2.35, 95% CI: 1.50–3.69, $P = 0.0002$) and heavy drinking ($\geqslant 300$ g per week, OR 2.18, 95% CI: 1.39–3.44, $P = 0.0007$; Table 4).

In further gender-specific analyses, we found that the risk of uncontrolled hypertension was higher with obesity (OR 1.85, 95% CI: 0.97–3.52, $P = 0.06$) and heavy drinking (OR 1.98, 95%: CI 1.28–3.01,

Table 3 Classification of antihypertensive drugs

	Men (n = *665*)		*Women* (n = *877*)	
	Number of patients (%)	*Control rate (%)*	*Number of patients (%)*	*Control rate (%)*
Monotherapy	163 (24.5)	40.5	183 (20.1)	34.4
Diuretics	20 (3.0)	40.0	23 (2.6)	34.8
β-Blockers	6 (0.9)	50.3	8 (0.9)	37.5
Short-acting calcium channel blockers	108 (16.2)	38.9	109 (12.4)*	33.9
Once daily	58 (53.7)	36.2	55 (50.5)	32.7
Two times daily	44 (40.7)	40.9	45 (41.3)	35.6
⩾3 Times daily	6 (5.6)	50.0	9 (8.2)	33.3
Angiotensin-converting enzyme inhibitors	12 (1.8)	41.7	13 (1.5)	38.5
Angiotensin receptor blockers	13 (2.0)	46.2	20 (2.3)	35.0
Other antihypertensive drugs	4 (0.6)	50.0	10 (1.1)	30.0
Combination therapy	502 (75.5)	41.0	694 (79.1)	34.7*
Fixed-dose combinations of hydrochlorothiazide plus reserpine or clonidine	480 (72.2)	40.8	677 (77.2)	34.7*
Alone	429 (64.5)	41.5	623 (71.0)*	34.3*
Once daily	163 (38.0)	39.2	224 (36.0)	32.6
Two times daily	197 (45.9)	41.1	306 (49.1)	35.0
⩾3 Times daily	69 (16.1)	47.8	93 (14.9)	36.6
Plus others	51 (7.8)	35.3	54 (6.2)	38.9
Fixed-dose combination of angiotensin receptor blocker plus hydrochlorothiazide	1 (0.2)	—	0	—
Free combinations	21 (3.2)	47.6	17 (1.9)	35.3

Values are number of subjects with the percentage of column total within the parentheses or control rate of hypertension in patients on a specific antihypertensive regimen.
*$P \leqslant 0.05$ *vs.* men.

Table 4 Determinants of uncontrolled hypertension in stepwise logistic regression

	Odds ratio (95% confidence interval)	P-*value*
Age (+10 years)	1.19 (1.02–1.38)	0.03
Women (*vs.* men)	1.40 (1.07–1.84)	0.01
Obesity (⩾30 kg m^{-2})	2.35 (1.50–3.69)	0.0002
Heavy drinking (⩾300 g per week)	2.18 (1.39–3.44)	0.0007

In the analysis, we considered sex, age, obesity, current smoking, alcohol intake, diabetes mellitus, serum total cholesterol, the use of short-acting calcium channel blockers and the use of combination of hydrochlorothiazide plus reserpine or clonidine to enter and stay in the model with a *P*-value set at 0.10.

$P = 0.002$) in men and with obesity (OR 2.91, 95% CI: 1.57–5.41, $P = 0.0007$) in women.

DISCUSSION

Our study in an elderly Chinese population demonstrated that very few hypertensive patients used the guidelines recommended newer, long-acting antihypertensive drugs. This underuse or underdose might explain the low control rate of hypertension in treated hypertensive patients. In addition, several lifestyle factors, such as obesity and alcohol intake, also render hypertension difficult to control.

In comparison with the elderly (⩾60 years of age) subgroup of the 2002 NNHS,[8] the prevalence (59.4% *vs.* 49.1%), awareness (75.6% *vs.* 37.6%), treatment (65.8% *vs.* 32.2%) and control (22.7% *vs.* 7.6%) of hypertension were higher in our study. However, when we scrutinize the difference between our study and the national survey, the major distinction in the management of hypertension is the approximately onefold higher rate of awareness of hypertension in our study. This difference made substantial contributions to the higher rate of the treatment and control of hypertension in our study. Our study was a few years later than the national survey and was conducted in a single town near one of the most industrialized cities in China. Both the time and location factors may account for the difference between our study and the most recent national survey.[8]

In spite of the significant improvement in the management of hypertension in our study, there is still a large lag when compared with the National Health and Nutrition Examination Survey (NHANES) administered from 1999 to 2004 in the United States,[14] in which the prevalence, awareness, treatment and control of hypertension in the elderly (⩾60 years of age) subgroup were 66.3%, 81.0%, 73.4% and 36.7%, respectively. The results of our study suggest that the gap is mainly attributable to the inappropriate use of antihypertensive drugs. In our study, most patients used a combination therapy of underdosed hydrochlorothiazide and reserpine or clonidine or a monotherapy of short-acting antihypertensive drugs. These drugs should be taken multiple times per day, but in our elderly subjects, these drugs were often taken once daily. Both the 2005 and 2010 Chinese hypertension guidelines recommend using long-acting antihypertensive drugs.[15,16] The low-cost, generic forms of long-acting antihypertensive drugs have also been available on the Chinese market for decades. Most antihypertensive drugs are on the reimbursement list of the public health insurance in the geographical area of our study. The major reason for the inappropriate use of antihypertensive drugs is the lack of qualified physicians in suburban and rural areas. For this reason, the guideline recommendations have not yet been implemented.

In addition to the inappropriate use of antihypertensive drugs, obesity and heavy drinking could also be reasons for uncontrolled hypertension. These unhealthy lifestyle factors are known to cause hypertension and render hypertension resistant to antihypertensive

therapy.[17,18] Regarding the very low control rate of hypertension in obese people and heavy drinkers in our study, it is possible that hypertension is secondary to these risk factors and can only be controlled when these risk factors are properly modified.[19,20] To a certain extent, it is unexpected that diabetes mellitus was not associated with uncontrolled hypertension. In our study, the treatment rate was higher in diabetic patients than non-diabetic patients (57.4% *vs.* 37.2%, $P<0.0001$). We therefore speculate that hypertension might have been diagnosed and/or treated earlier and hence better controlled in diabetic than in non-diabetic subjects.

Our study should be interpreted within the context of its strengths and limitations. Our study was conducted in a newly urbanized population. China is now in a rapid urbanization period. In the past decades, a large number of rural people, such as our study subjects, immigrated to cities or were locally urbanized. In the coming decades, more people from rural areas will follow this path. Our study will therefore provide useful information on the disease and health status of newly urbanized people. In addition, our study had a high participation rate (90%) and a low exclusion rate (3%). Our study was conducted in a single town near the most industrialized Chinese city, Shanghai. Our study could be less representative of the Chinese population than a multicenter study, especially in terms of various rates of hypertension. However, this limitation in representation has little influence on the validity of our findings on the risk factors for uncontrolled hypertension. In addition, we measured blood pressure only during a single visit, which could cause overestimation.

In conclusion, in elderly Chinese, the prevalence of hypertension is high. In spite of a reasonably high awareness and treatment rate, the control rate remains low, most likely due to the underuse or underdose of antihypertensive drugs and an unhealthy lifestyle. Our ongoing and future research in this elderly population will monitor changes in the management of hypertension and investigate these changes' relevance to cardiovascular prevention.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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