


BMJ Open Factors associated with treatment and control of hypertension among elderly adults in Shenzhen, China: a large-scale cross-sectional study

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ABSTRACT

Objective Hypertension has become the leading cause of death worldwide. Data on hypertension management among Shenzhen elderly are sparse. Our study aims to investigate treated and controlled hypertension in Shenzhen elderly, and identify relevant predictors.

Design A cross-sectional study.

Setting Communities in Shenzhen, Guangdong, China.

Participants A cross-sectional study was conducted. We employed a convenience sampling method to select participants; 124 007 participants aged 65 years and older were recruited from January to December 2018 at local community health centres in Shenzhen.

Main outcome measures Data on treatment, control and influencing factors of hypertension were obtained from a standard questionnaire, physical measurements and biochemical analyses.

Results Prevalence of hypertension was 55.8% among the sample population. Among this group of hypertensive patients, those undergoing hypertension treatment and those with hypertension under control were 54.4% and 32.3%, respectively. Employing multivariate analysis, significant associations were found between treatment and older age, junior high school education and above (OR=1.25, $p < 0.05$), being widowed rather than being married or cohabiting (OR=1.28, $p < 0.05$), engaging in physical activity (OR=1.14, $p < 0.05$), ex-smoker (OR=1.19, $p < 0.05$), habitual drinker (OR=0.72, $p < 0.05$), history of cardiovascular disease (CVD) (OR=2.20, $p < 0.05$) and comorbidities, with a higher probability for those with obesity (OR=1.89, $p < 0.05$), central obesity (OR=1.10, $p < 0.05$), diabetes (OR=1.49, $p < 0.05$) or dyslipidaemia (OR=1.20, $p < 0.05$). Male sex (OR=0.91, $p < 0.05$), junior high school education and above (OR=1.28, $p < 0.05$), engaging in physical activity (OR=1.06, $p < 0.05$), history of CVD (OR=1.82, $p < 0.05$) and individuals who had diabetes (OR=1.52, $p < 0.05$) or dyslipidaemia (OR=1.05, $p < 0.05$) were associated with increased likelihood of control. Aged 80 years and older (OR=0.93, $p < 0.05$), habitual drinker (OR=0.73, $p < 0.05$) and central obesity (OR=0.94, $p < 0.05$) were negatively associated with control of hypertension.

Conclusions We found a high prevalence of hypertension, but a low prevalence of treatment and control among Shenzhen elderly.

Strengths and limitations of this study

- This study is the first to evaluate the prevalence, treatment and control of hypertension in a population sample aged 65 years and older from local communities in Shenzhen.
- Convenience sampling was used to enrol the population sample.
- No data were collected on diet or family history of hypertension, which may play a role in the treatment and control of hypertension.

INTRODUCTION

Hypertension is a global public health challenge and a major risk factor leading to stroke, myocardial infarction and heart failure.¹ As is the case for many conditions, hypertension increases with age, with prevalence increasing from 27% in patients aged under 60 years to 74% in those aged over 80 years.² The Framingham Heart Study³ showed that more than 90% of participants with normal blood pressure at age 55 years eventually develop hypertension in later years. By the year 2020, the projected number of people living in China aged 60 years or older will comprise 17.8%.⁴ With this rapidly ageing population, the prevalence of hypertension can only be expected to rise. Therefore, it is crucial to understand the current status of management of hypertension in elderly adults.

The management of hypertension in the elderly has many challenges, including agreement on threshold and target blood pressure levels, and the balancing of adverse effects and potential benefits of treatment.⁵ While extensive studies have been undertaken to identify risk factors for hypertension in predominantly middle-aged populations, there exist gaps in our understanding of the risk profiles and management of hypertension among the older population. A better

understanding of the factors impacting treatment and control of hypertension in older adults is critical to the development of interventions to manage high blood pressure in this growing sector of the population. Therefore, the aim of our study was to investigate the treatment and control rate of hypertension among the elderly population in Shenzhen, China, and identify associated risk factors to provide evidence for disease prevention and control, and improve the quality of life of older hypertension patients. Strategies to target hypertension in the elderly population are additionally proposed.

MATERIAL AND METHODS

Study population

We used convenience sampling to select our population sample by recruiting people aged 65 years and older from the lists of all residents registered at local community health centres in Shenzhen, China, from January 2018 to December 2018. Recruitment activities include pasting posters or placing foldings in local community health centres and other public places. Electronic posters also be distributed via all the open WeChat groups of local community health centres' staff, to make the survey available to the close contacts easily. Moreover, the staff of the local community health centres recruited the elderly adults in their service community to participate in the survey by telephone. The eligibility criteria of participants were as follows: (1) having lived in Shenzhen for more than 6 months and (2) able to participate in the study and give informed consent. We excluded residents living in prisons. Initially, 141 684 were recruited into the study, accounting for 36.9% (141 684/383 700) of the resident population of elderly adults in Shenzhen based on the data from the 2015 population census. Data were collected in medical examination rooms at local community health centres in the participants' residential areas. We asked the participants to complete a questionnaire, provide a fasting blood sample and attend physical examinations. Participants excluded from the study, 17 677, were those who did not complete the questionnaire, provide a fasting blood sample or were unable to attend physical examinations. Finally, 124 007 participants (87.5%) were included in the final data analysis.

Questionnaire survey

Before the survey began, all investigators completed a training programme on the methods and process of the study. A manual of procedures was distributed, and detailed instructions for administration of the questionnaires, the taking of blood pressure and anthropometric measurements, and biological specimen collection and processing were provided.

Data were obtained during face-to-face interview in person 1 hour after blood collection. All participants completed a standardised questionnaire including sociodemographic status such as date of birth, sex, educational level and marital status; medical history

such as history of previous diseases, operation history and history of trauma; family health history such as incidence of hypertension, diabetes, coronary heart disease, malignant tumour and stroke; lifestyle habits such as smoking status, amount of physical activity and alcohol consumption; and medication use under the supervision of trained general practitioners and nurses. Educational level was categorised into three groups according to the number of years of education: illiterate, no education; primary education, 1–6 years of education and junior high school education and above, 7 or more years of education.

In this study, we define the term 'moderate to vigorous physical activity' to refer to at least some sweating and shortness of breath caused by engaging in physical activity, and the term 'light physical activity' to refer to no sweating or shortness of breath caused by engaging in physical activity.⁶ In addition, moderate to vigorous physical activity at least once a week was classified as 'yes' for physical activity status. For alcohol consumption status, participants reported themselves as habitual drinker (drinking at least once a day), non-habitual drinker (drinking six times a week to once a month) or non-drinker (almost never).⁷ For smoking status, we categorised participants as current smoker, ex-smoker and never-smoker, as described elsewhere.⁸

Physical examination

Anthropometric examinations were taken in the morning on participants who had fasted overnight, following which body measurements were taken by trained examiners based on a standardised protocol. Height and weight were measured using analogue scales with the participants wearing light clothing without footwear. Waist circumference (WC) was measured at the end of normal expiration at the midpoint level of the midaxillary line between the 12th rib head and the superior anterior iliac spine. Body mass index (BMI) was calculated by dividing body weight (in kilograms) by the square of height (in m). Blood pressure were measured in both arms and recorded the higher one. Calibrated electronic sphygmomanometers were used to measure blood pressure on the arm supported at heart level with sitting position, carried out twice. The average of the two measurements was used for the statistical analysis. To obtain accurate readings, the participants were asked to rest for at least 5 min before the measurement, or, if having engaged in excessive exercise prior to the visit, for at least 30 min before the measurement. Untreated subjects with a blood pressure of at least 140/90 mm Hg were seen again at a second visit within 2 weeks, and if still ≥ 140 and/or 90 mm Hg, they were seen a third time again within two further weeks. Those with high blood pressure at the first visit and who had normal blood pressure for both systolic blood pressure (SBP) (< 140 mm Hg) and diastolic blood pressure (DBP) (< 90 mm Hg) at the second or third visit were considered normotensive.

Blood sample collection and biochemical analyses

Participant venous blood samples were taken after at least 8 hours of overnight fasting. All blood samples were analysed at the clinical laboratories of grade 2 hospitals to which the community health centres were directly affiliated. All the laboratories involved had successfully completed a standardisation and competency programme. Fasting venous blood was drawn from subjects for the measurements of levels of total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) by automatic biochemistry analyser. TC and TG were estimated using enzymatic methods with commercially available reagents, while HDL and LDL were measured using a timed-endpoint colorimetric method. Fasting blood samples were biochemically analysed within a maximum of 4 hours after being drawn. Glucose oxidase measurements were used to ascertain the fasting blood glucose (FBG) level.

Definitions

A diagnosis of hypertension was considered when three consecutive high readings (≥ 140 SBP and/or ≥ 90 mm Hg DBP) with 2-week intervals were registered or treatment with antihypertensive medication within the previous 2 weeks was self-reported.⁹ Participants were considered to be undergoing treatment for hypertension if they answered 'yes' to the question 'Because of your high blood pressure/hypertension, are you now taking prescribed medicine?' Controlled hypertension was defined as SBP < 140 mm Hg and DBP < 90 mm Hg, and reported use of antihypertensive medication during the survey period.^{9 10} Participants were regarded as diabetic if one of the following three conditions was met: (1) previous diagnosis by professional doctors; (2) FBG ≥ 7.0 mmol/L; or (3) 2-hour plasma glucose level ≥ 11.1 mmol/L.¹¹ TC, LDL-C, HDL-C and TG levels were classified on the basis of the 2016 Chinese Guideline for the Management of Dyslipidemia in Adults.¹² It defines high TC as ≥ 6.22 mmol/L, high LDL-C as ≥ 4.14 mmol/L, low HDL-C as < 1.04 mmol/L and high TG as ≥ 2.26 mmol/L. In the present study, we defined dyslipidaemia as the presence of one or more abnormal serum lipid concentrations or use of antidyslipidaemia medications in the previous 2 weeks.

Based on the criteria of weight for adults released by the Ministry of Health of China (WS/T 428–2013), individuals were categorised into four groups: BMI < 18.5 kg/m², low weight; 18.5 kg/m² \leq BMI < 24.0 kg/m², normal weight; 24.0 kg/m² \leq BMI < 28.0 kg/m², overweight and BMI ≥ 28.0 kg/m², obese. Men with WC ≥ 90 cm and women with WC ≥ 85 cm were defined as having central obesity.

Statistical analyses

We collected descriptive statistics for all the variables, including continuous variables, expressed as means and SD, and categorical variables, expressed as numbers and

percentages. Categorical variables between groups were compared using a χ^2 test. Multivariate logistic regression analysis was performed to explore the association between treatment and control of hypertension, and associated risk factors. In the multivariate logistic regression model, the treatment or control of hypertension was defined as the dependent variable, and age, sex, education level, marital status, smoking status, alcohol consumption, physical activity status, BMI, central obesity, diabetes, diagnosis of dyslipidaemia and history of cardiovascular disease (CVD) were defined as the independent variables. SAS software V.9.4 (SAS Institute) was used to perform all statistical analyses. Tests were two sided, and $p < 0.05$ was considered to be statistically significant.

Participants and public involvement

Neither the study participants nor the public were involved in the design, recruitment or conduct of the study. All the participants had the option of receiving a health check and biochemical results when they visited the local community health centres.

Written informed consent was received by all participants before the collection of data and conducting of the research. Where participants were illiterate, we obtained written informed consent from their proxies.

RESULTS

Sociodemographic and other characteristics of participants

Of the 124 007 participants, 44.1% ($n=54 649$) were male and 55.9% ($n=69 358$) were female, the mean age was 71.3 ± 5.6 , 56.3% had attained a junior school education or above, 96.2% were married or cohabiting, 76.9% reported engaging in regular physical activities and 4.2% reported having the history of CVD (table 1). Current smokers accounted for 8.2%, and habitual drinkers accounted for 6.4% (table 1). In terms of anthropometric measurements, the means of average BMI, SBP, DBP, WC, FBG, TC, TG, LDL-C and HDL-C levels for all 124 007 participants were 23.8 ± 3.2 kg/m², 134.7 ± 17.7 mm Hg, 77.2 ± 10.3 mm Hg, 85.1 ± 8.8 cm, 6.0 ± 1.9 mmol/L, 5.2 ± 2.1 mmol/L, 1.6 ± 1.1 mmol/L, 3.1 ± 1.1 mmol/L and 1.4 ± 0.5 mmol/L, respectively (table 1).

Treatment and control rates in subgroups

The prevalence of hypertension was 55.8%. Of those individuals with hypertension, 54.4% were receiving treatment, and 32.3% had blood pressure under control. Table 2 lists the treatment and control of hypertension by sociodemographic grouping, lifestyle, clinical and anthropometric characteristics. The treatment rate demonstrated no difference between males and females. However, males had a significantly higher rate of control than females. Higher treatment and control rates were also found among those who had attained junior school education or above, engaged in regular physical activity, were ex-smokers and had history of CVD, or diabetes or dyslipidaemia. Participants who were single had the

Table 1 Sociodemographic, anthropometric, lifestyle and clinical characteristics of older adults living in Shenzhen (n=124 007)

Characteristics	General (N=124 007)	Characteristics	General (N=124 007)
Age (years)	71.3±5.6	Physical activity, n (%)	
BMI (kg/m ²)	23.8±3.2	Yes	95 338 (76.9)
SBP (mm Hg)	134.7±17.7	No	28 669 (23.1)
DBP (mm Hg)	77.2±10.3	History of cardiovascular disease, n (%)	
WC (cm)	85.1±8.8	Yes	5192 (4.2)
FBG (mmol/L)	6.0±1.9	No	118 815 (95.8)
TC (mmol/L)	5.2±2.1	Smoking status, n (%)	
TG (mmol/L)	1.6±1.1	Current smoker	10 163 (8.2)
LDL-C (mmol/L)	3.1±1.1	Ex-smoker	7662 (6.2)
HDL-C (mmol/L)	1.4±0.5	Never-smoker	106 182 (85.6)
Sex, n (%)		Drinking habit, n (%)	
Male	54 649 (44.1)	Non-drinker	103 388 (83.4)
Female	69 358 (55.9)	Non-habitual drinker	12 737 (10.2)
Education level, n (%)		Habitual drinker	7882 (6.4)
Illiterate	10 054 (8.1)		
Primary education	44 096 (35.6)		
Junior school education and above	69 857 (56.3)		
Marital status, n (%)			
Married or cohabiting	119 314 (96.2)		
Widowed	3623 (2.9)		
Divorced	565 (0.5)		
Single	505 (0.4)		

BMI, body mass index; DBP, diastolic blood pressure; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides; WC, waist circumference.

lowest treatment rates when compared with their non-treated counterparts. Participants aged 65–69 years had the lowest treatment rates compared with older participants. Habitual drinkers had the lowest treatment and control rates. Participants with obesity or central obesity had higher treatment rates and lower control rates.

Results of multivariate analysis of factors associated with treatment and control of hypertension

The results of multivariate logistic regression of hypertension treatment and control according to selected sociodemographic and other potential factors are presented in table 3. Participants with the highest educational attainment (OR=1.25, 95% CI 1.18 to 1.32) were more likely to be receiving treatment for hypertension compared with participants of low educational level. Being widowed (OR=1.28, 95% CI=1.17 to 1.40) was a protective factor for treatment of hypertension while being single (OR=0.58, 95% CI=0.45 to 0.74) was negatively associated with hypertension treatment. Older age, engaging in physical activity (OR=1.14, 95% CI=1.10 to 1.18), being an ex-smoker (OR=1.19, 95% CI=1.11 to 1.27) and history of CVD (OR=2.20, 95% CI=2.04 to 2.37) were associated with higher likelihood of receiving

treatment for hypertension, while non-habitual drinker (OR=0.89, 95% CI=0.85 to 0.94) or habitual drinker (OR=0.72, 95% CI=0.68 to 0.77) was associated with lower likelihood of receiving treatment for hypertension. Compared with individuals without comorbidities, having comorbidities was also associated with higher rate of treatment: overweight (OR=1.64, 95% CI=1.48 to 1.82), obesity (OR=1.89, 95% CI=1.68 to 2.11), central obesity (OR=1.10, 95% CI=1.06 to 1.14), diabetes (OR=1.49, 95% CI=1.44 to 1.54) and dyslipidaemia (OR=1.20, 95% CI=1.16 to 1.24). For those with hypertension, junior school education and above (OR=1.28, 95% CI=1.20 to 1.36), engaging in physical activity (OR=1.06, 95% CI=1.02 to 1.10) and history of CVD (OR=1.82, 95% CI=1.71 to 1.96), diabetes (OR=1.52, 95% CI=1.47 to 1.58) or dyslipidaemia (OR=1.05, 95% CI=1.03 to 1.09) were positively associated with the control of hypertension. In contrast, female sex (OR=0.91, 95% CI=0.88 to 0.95), aged 80 or above (OR=0.93, 95% CI=0.88 to 0.98), non-habitual drinker (OR=0.92, 95% CI=0.87 to 0.97), habitual drinker (OR=0.73, 95% CI=0.68 to 0.79) and central obesity (OR=0.94, 95% CI=0.91 to 0.98) were negatively associated with the control of hypertension.

Table 2 Treatment and control of hypertension in older adults diagnosed with hypertension living in Shenzhen, according to sociodemographic, lifestyle, clinical and anthropometric characteristics (n=69 207)

Characteristics	No of hypertension patients	Treatment n(%)	χ^2 value	P value	Control n(%)	χ^2 value	P value
Total	69 207	37 669 (54.4)			22 366 (32.3)		
Sex			0.16	0.69		56.07	<0.01
Male	29 919	16 311 (54.5)			10 126 (33.8)		
Female	39 288	21 358 (54.4)			12 240 (31.2)		
Education level			183.73	<0.01		242.41	<0.01
Illiterate	5 751	2 992 (52.0)			1 671 (29.1)		
Primary education	24 083	12 369 (51.4)			7 022 (29.2)		
Junior school education and above	39 373	22 308 (56.7)			13 673 (34.7)		
Marital status			63.50	<0.01		7.83	0.05
Married or cohabiting	66 220	35 915 (54.2)			21 352 (32.2)		
Widowed	2 356	1 436 (60.9)			810 (34.4)		
Divorced	377	216 (57.3)			132 (35.0)		
Single	254	102 (40.2)			72 (28.4)		
Age group			172.39	<0.01		2.12	0.55
65	30 727	15 965 (51.9)			9 932 (32.3)		
70	18 976	10 412 (54.9)			6 151 (32.4)		
75	10 774	6 208 (57.6)			3 516 (32.6)		
80	8 730	5 084 (58.2)			2 767 (31.7)		
Physical activity			51.09	<0.01		20.13	<0.01
Yes	53 528	29 527 (55.2)			17 530 (32.8)		
No	15 679	8 142 (51.9)			4 836 (30.8)		
Smoking status			28.06	<0.01		18.01	<0.01
Current smoker	5 071	2 659 (52.4)			1 678 (33.1)		
Ex-smoker	4 427	2 557 (57.8)			1 550 (35.0)		
Never-smoker	59 709	32 453 (54.4)			19 138 (32.1)		
Drinking habit			82.92	<0.01		49.09	<0.01
Non-drinker	57 976	31 854 (54.9)			18 885 (32.6)		
Non-habitual drinker	6 838	3 713 (54.3)			2 257 (33.0)		
Habitual drinker	4 393	2 102 (47.9)			1 224 (27.9)		
History of cardiovascular disease			545.61	<0.01		373.78	<0.01
Yes	3 804	2 768 (72.8)			1 772 (46.6)		
No	65 403	34 901 (53.4)			20 594 (31.5)		
BMI			381.72	<0.01		35.24	<0.01
Low weight	1 712	712 (41.6)			531 (31.0)		
Normal weight	31 104	16 056 (51.6)			10 352 (33.3)		
Overweight	28 142	15 923 (56.6)			9 004 (31.9)		
Obesity	8 249	4 978 (60.4)			2 479 (30.1)		
Central obesity			253.08	<0.01		24.23	<0.01
Yes	32 094	18 508 (57.7)			10 070 (31.4)		

Continued

Table 2 Continued

Characteristics	No of hypertension patients	Treatment n(%)	χ^2 value	P value	Control n(%)	χ^2 value	P value
No	37 113	19 161 (51.6)			12 296 (33.1)		
Diabetes			688.03	<0.01		603.08	<0.01
Yes	19 263	12 025 (62.4)			7580 (39.4)		
No	49 944	25 644 (51.4)			14 786 (29.6)		
Dyslipidaemia			243.60	<0.01		30.36	<0.01
Yes	33 416	19 210 (57.5)			11 138 (33.3)		
No	35 791	18 459 (51.6)			11 228 (31.4)		

Definition: A diagnosis of hypertension was considered when three consecutive high readings (≥ 140 systolic and/or ≥ 90 mm Hg diastolic) with 2-week intervals were registered or treatment with antihypertensive medication within the previous 2 weeks was self-reported. Participants were considered to be undergoing treatment if they answered 'yes' to the question 'Because of your high blood pressure/hypertension, are you now taking prescribed medicine?' Controlled hypertension was defined as SBP < 140 mm Hg and DBP < 90 mm Hg, and reported use of antihypertensive medication during the survey. BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.

DISCUSSION

Hypertension is the leading modifiable risk factor for CVD, which is the leading cause of death in China.^{13 14} The burden of hypertension and CVD on the healthcare system in China is increasing along with urbanisation, rising incomes and the ageing of the population.¹⁵ China has made substantial improvements in hypertension treatment indicators such as blood pressure lowering medication use and blood pressure control over the past decades.^{16 17} However, despite these improvements nearly half of the elderly hypertensive participants in our study were not undergoing treatment with antihypertensive medication. In addition, nearly seven in ten of hypertensives who had previously been diagnosed had blood pressure that was uncontrolled.

Several previous epidemiological studies have reported on the treatment of hypertension in Chinese elderly populations.^{18 19} One of those studies, the China Health and Retirement Longitudinal Study, measured the treatment of hypertension in a nationally representative sample of 9357 Chinese aged 45 years or above, which provided the best comparison data for our study.¹⁸ When compared with the findings from that study, the treatment of hypertension in this study indicated higher incidence, 51.0% vs 54.4%, respectively.¹⁸ Other regional studies have also previously examined the treatment of hypertension in local elderly residents. Cao *et al*¹⁹ revealed that the rate of treatment of hypertension in Hebei province was 38.2%, while Du *et al*²⁰ found that rate in Zhejiang province was 45.4%, both lower than in our study in Shenzhen. This could be because Shenzhen has established a people-centred integrated care model comprising local community health centres.²¹ Under the strong leadership of the district government, comprehensive strategies have been adopted to strengthen primary care and care coordination, improve the quality and efficiency of healthcare delivery, and promote population health.²¹

Even so, the treatment rate of hypertension in the elderly population in Shenzhen was still far below that of elderly in other countries such as the USA, Australia, Germany and Colombia.^{22–24}

Similar to other studies, we found that the treatment of hypertension was significantly higher among older, ex-smokers, non-drinkers, higher education level and those engaging in physical activity.^{9 19 24 25} Participants engaged in physical activity may generally pay more attention to their health. Unsurprisingly, therefore, the group with the highest level of physical activity had a higher likelihood of being aware of their hypertension and receiving medication.

Our study revealed a higher level of treatment in individuals with comorbidities such as overweight, obesity, central obesity, diabetes and dyslipidaemia, which are common comorbidities with hypertension.^{19 23} Moreover, in our study, history of CVD was highly correlated with receiving antihypertensive treatment. Other researchers have confirmed that having another medical condition, for example, diabetes or dyslipidaemia, is associated with greater awareness and treatment of hypertension.^{26 27} This causes people to go to health centres, and consequently be diagnosed with hypertension sooner, obtaining earlier treatment. Therefore, often patients with comorbid diseases have higher perception of the risk factors and their condition. An alternate theory to explain the higher rates of no treatment in individuals with fewer comorbidities is that physicians may be wary of the consequences of initiating medication and quality of life by 'medicalising' an otherwise healthy person.²²

Compared with previous epidemiological data of hypertension in China, the control rate in our study was significantly higher than the control rate of hypertension among elderly in Hebei province investigated in 2015.¹⁹ This could be due to the fact that Shenzhen is a relatively well-developed economy with higher levels of education, better community medical facilities and

Table 3 Risk factor analysis on the treatment and control of hypertension in older adults living in Shenzhen

Characteristics	Treatment*		Control†	
	OR (95% CI)	P value	OR (95% CI)	P value
Sex				
Male	–	–	1.00 (Reference)	
Female	–	–	0.91 (0.88 to 0.95)	<0.01
Education level				
Illiterate	1.00 (Reference)		1.00 (Reference)	
Primary education	1.00 (0.95 to 1.07)	0.90	0.99 (0.93 to 1.06)	0.84
Junior school education and above	1.25 (1.18 to 1.32)	<0.01	1.28 (1.20 to 1.36)	<0.01
Marital status				
Married or cohabiting	1.00 (Reference)		–	–
Widowed	1.28 (1.17 to 1.40)	<0.01	–	–
Divorced	1.07 (0.87 to 1.31)	0.54	–	–
Single	0.58 (0.45 to 0.74)	<0.01	–	–
Age group				
65~	1.00 (Reference)		1.00 (Reference)	
70~	1.11 (1.07 to 1.15)	<0.01	0.98 (0.94 to 1.02)	0.23
75~	1.24 (1.18 to 1.30)	<0.01	0.96 (0.92 to 1.01)	0.13
80~	1.32 (1.25 to 1.38)	<0.01	0.93 (0.88 to 0.98)	<0.01
Physical activity				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.14 (1.10 to 1.18)	<0.01	1.06 (1.02 to 1.10)	<0.01
Smoking status				
Never-smoker	1.00 (Reference)		–	–
Current smoker	1.06 (1.00 to 1.13)	0.06	–	–
Ex-smoker	1.19 (1.11 to 1.27)	<0.01	–	–
Drinking habit				
Non-drinker	1.00 (Reference)		1.00 (Reference)	
Non-habitual drinker	0.89 (0.85 to 0.94)	<0.01	0.92 (0.87 to 0.97)	<0.01
Habitual drinker	0.72 (0.68 to 0.77)	<0.01	0.73 (0.68 to 0.79)	<0.01
History of cardiovascular disease				
No	1.00 (Reference)		1.00 (Reference)	
Yes	2.20 (2.04 to 2.37)	<0.01	1.82 (1.71 to 1.96)	<0.01
BMI				
Low weight	1.00 (Reference)		–	–
Normal weight	1.42 (1.28 to 1.57)	<0.01	–	–
Overweight	1.64 (1.48 to 1.82)	<0.01	–	–
Obesity	1.89 (1.68 to 2.11)	<0.01	–	–
Central obesity				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.10 (1.06 to 1.14)	<0.01	0.94 (0.91 to 0.98)	<0.01
Diabetes				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.49 (1.44 to 1.54)	<0.01	1.52 (1.47 to 1.58)	<0.01
Dyslipidaemia				
No	1.00 (Reference)		1.00 (Reference)	

Continued

Table 3 Continued

Characteristics	Treatment*		Control†	
	OR (95% CI)	P value	OR (95% CI)	P value
Yes	1.20 (1.16 to 1.24)	<0.01	1.05 (1.03 to 1.09)	<0.01

Definition: A diagnosis of hypertension was considered when three consecutive high readings (≥ 140 systolic and/or ≥ 90 mm Hg diastolic) with 2-week intervals were registered, or treatment with antihypertensive medication within the previous 2 weeks was self-reported. Participants were considered to be treated if they answered 'yes' to the question 'Because of your high blood pressure/hypertension, are you now taking prescribed medicine?' Controlled hypertension was defined as SBP <140 mm Hg and DBP <90 mm Hg, and reported use of antihypertensive medication during the survey.

*Adjusted for sex.

†Adjusted for marital status, smoking status and BMI.

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.

equipment, and relatively high levels of diagnosis and treatment for hypertension compared with the national average. However, the control rate of hypertension in Shenzhen elderly were much lower than those reported in developed countries.^{22 23} Possible reasons include the following: (1) Shenzhen medical institutions are not doing a good job of screening for hypertension;²⁸ (2) Hypertensive individuals often cease taking antihypertensive agents when blood pressure control has been achieved, which may result in uncontrolled hypertension when checked later unless there is regular monitoring;²⁹ (3) Primary care physicians in the China might have been less knowledgeable or experienced in diagnosing and treating hypertension compared with those in developed countries;²⁹ (4) China's doctors might have become entrenched in traditional prescription practice and lack knowledge or willingness to follow new guidelines due to obstacles in information exchange and²⁹ (5) There was a lower rate of out-of-office blood pressure monitoring among hypertensive patients in China than that in developed countries, in spite of recommendations in multiple guidelines.^{30 31}

Previous studies have revealed that being female had a statistically significant association with the control of hypertension.^{24 25} On the contrary, our findings suggested that being female was a negative indicator of hypertension control, strongly indicating that it deserves further study. Our study revealed that participants with high educational attainment had more than 1.28-fold higher probability of being in control of their hypertension status than those with low educational level. Education is a well-elucidated determinant of health disparity, and such disparities have been shown to be more pronounced in later life phases.³² In the present study, hypertension control decreased with age. Literature shows consistency in the association between age and control of hypertension.³³ Older people often have hypertension accompanied by multiple diseases, as well as cognitive decline and low medication compliance, which are all related to the lower control rate of hypertension.³⁴ Previous studies have found that older age was independently associated with greater hypertension awareness and treatment but poorer

hypertension control, which is in accordance with the current report.^{35 36}

Alcohol consumption and physical inactivity have also been correlated with inferior hypertension control. As Gooding *et al*³⁷ reported that patients with more unhealthy behaviours care less about subjective well-being. This may have led to a generally lower control rate. In addition, the control of hypertension was lower with higher WC in our study, consistent with some previous studies.^{19 38} Greater WC is correlated with higher levels of fat mass, an increase in salt retention and insulin resistance, which cause increased high blood pressure.³⁹

In our study, patients who had diabetes or dyslipidaemia had higher probability of having controlled blood pressure, consistent with other studies.^{25 40} An explanation might be that when people have diabetes or dyslipidaemia, they become more focused on their health, and therefore may be more likely to engage in and comply with blood pressure-lowering drugs or lifestyle intervention for hypertension. Our study additionally showed that history of CVD is a positive factor for effective blood pressure control. Physicians use more ACE inhibitors, angiotensin receptor blockers or even aldosterone receptor blockers to treat participants with CVD, which all contribute to effective blood pressure reduction.⁴¹

Our study had some limitations. First, given the cross-sectional nature of the study design, only associations, rather than causality, could be inferred. Second, our research enrolled the elderly population by convenience sampling. This is a major factor preventing true extrapolation of the results to the general population. Third, patient previous experience of medications for other conditions could have contributed to their current adherence to treatment. Further studies are needed to evaluate the correlation between patient previous experience of taking medication and current hypertension treatment. Fourth, the impact of white coat hypertension and masked hypertension could not be excluded as factors affecting the findings in our research.

CONCLUSION

In conclusion, we found a high prevalence of hypertension but a low prevalence of treatment and control among Shenzhen elderly, a group at high risk for future CVD events. This study represents a warning for cardiovascular health management in Shenzhen elderly. Improvement in hypertension treatment and control should be a public health priority to reduce the disproportionate burden of CVD in this growing population. Out-of-office blood pressure monitoring is one measure that could be introduced to identify hypertensive patients earlier so as to start treatment more promptly to reduce CVD incidence in this high-risk group.

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