# Prevalence, Awareness, Treatment and Control of Hypertension in Macau: Results From a Cross-Sectional Epidemiological Study in Macau, China

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# BACKGROUND

Awareness of hypertension, as well as its prevalence, treatment, and control status, has not been comprehensively investigated in Macau Special Administrative Region (SAR), China.

# METHODS

A survey was conducted on a randomly sampled population of 1,410 participants (n = 638 men) aged 18–93 years in 2012. Blood pressure was individually measured twice. Awareness, treatment, and control of hypertension were assessed by interview-administered questionnaire.

#### RESULTS

Prevalence of hypertension was 34% in Macau, similar to the United States (30%) and United Kingdom (31%). Among hypertensives, 69% were aware of their condition, 59% were treated, and 30% were adequately controlled. Older age ( $\geq$ 50 years; odds ratio (OR) = 5.3; 95% confidence interval (CI) = 4.6–6.1), being of the male sex (OR = 2.2; 95% CI = 1.9–2.5), having retired (OR = 2.0; 95% CI = 1.8–2.3), being married (OR = 1.5; 95% CI = 1.3–1.9), having a low level of education in women (OR = 1.5; 95% CI = 1.1–2.1), P<sub>interaction</sub> = 0.01), and lack of salt

Despite recent downward trends in cardiovascular disease (CVD) mortality rates,<sup>1</sup> CVD deaths still represent 50% of noncommunicable disease deaths worldwide,<sup>2</sup> and there has been an exponential increase in CVD incidence in lowerand middle-income countries.<sup>3</sup> In China, one-third of all deaths were due to CVD in 2005,<sup>4</sup> with numbers anticipated to increase by 50% by 2025, compared with15% for economically developed countries.<sup>1</sup>

Hypertension is one of the primary modifiable risk factors for CVD. A survey in 2006 of the population of Macau (n = 3,120) reported an adjusted hypertension prevalence rate of 28%.<sup>5</sup> This survey did not collect data on participants' awareness,

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awareness (OR = 1.1; 95% CI = 1.0–1.3) were associated with hypertension. Older age, having retired, and being married were also associated with higher awareness and treatment rates. Those who were older and married were better controlled. These demographic factors differed by sex. Those who had some knowledge of salt intake were more likely to have higher hypertension awareness, treatment, and control rates.

#### CONCLUSIONS

The prevalence of hypertension in Macau in 2012 has increased compared with 2006 (28%) and is comparable with prevalence rates in developed countries. Specific health promotion campaigns related to knowledge of risk factors such as salt intake and smoking may be useful for hypertension prevention and to improve hypertension awareness, treatment, and control rates.

*Keywords:* blood pressure; China; demography; epidemiology; hypertension; hypertension awareness; hypertension control; hypertension prevalence; hypertension treatment; Macau.

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treatment, or control status of hypertension, all factors that are very important for future development of community-wide prevention strategies. Thus, in 2012 a large, representative survey was conducted to investigate all aspects of hypertension.

# METHODS

A cross-sectional, population-based study was conducted in Macau from August to September 2012. A household-based simple random sampling design was used. Based on an estimated hypertension prevalence of 28%,<sup>5</sup> a sample size of 1,488 was predicted. With an estimated 50% response rate, 2,400

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households (approximately 2.5 members per household) were randomly selected by the Macau Statistics and Census Service from a register of 170,000 households. Thus the reference population constituted permanent residents of Macau aged  $\geq$ 18; all household members aged  $\geq$ 18 were recruited. Ethics approval was obtained from both the University of Sydney, Australia, and Sun Yet-Sen University China.

Sixty-five percent of the eligible participants completed an interviewer- administered questionnaire, and systolic and diastolic blood pressure (SBP and DBP, respectively) were measured with an automatic OMRON sphygmomanometer (OMRON HEALTHCARE, Ltd, Muko, Japan). Two consecutive measures were taken on seated participants after 5 minutes of rest on the right arm at heart level.

Hypertension was defined according to the Chinese Guidelines on Prevention and Control of Hypertension<sup>6</sup> as average SBP  $\geq$ 140 mm Hg, average DBP  $\geq$ 90 mm Hg, and/or self-reported treatment of hypertension with antihypertensive medication in the last 2 weeks.

Awareness of hypertension was defined as self-report of any previous diagnosis of hypertension by a healthcare professional before the present survey.

Treatment of hypertension was defined as self-reported use of a prescription medication for management of hypertension during the previous 2 weeks.

Control of hypertension was defined as pharmacological treatment of hypertension associated with an average SBP <140 mm Hg and an average DBP <90 mm Hg.

Salt awareness was defined as those who had any knowledge of the World Health Organization recommended optimal salt intake (6g) per person per day.

#### Statistical methods

Survey data were weighted, and age and sex standardization was performed based on the population distribution from the Macau 2011 census. Descriptive data were presented as percentages and means, also stratified by sex. Inferential statistics were estimated by  $\chi^2$  test for categorical variables or by linear regression for continuous variables. Subsequently, associations between demographic factors and the risk of hypertension, hypertension awareness, treatment, and control were assessed by multivariable logistic regression models. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated. All data were analyzed with SPSS 21 statistical package (IBM, Armonk, NY).

## RESULTS

A total of 1,410 study participants from 2,174 eligible participants were enrolled. The sex ratio was the same between responders and nonresponders. However, nonresponders were significantly younger than the responders, probably because of their work habits in such a busy city as Macau  $(39 \pm 16$  years vs.  $47 \pm 17$  years; P < 0.001).

#### Demographics and hypertension prevalence

Of the 1,410 study participants (44% men) with a mean  $\pm$  SD age of 47 $\pm$ 17 years (range = 18–97 years), 34% were hypertensive (42% men, 27% women) (equivalent to n = 130,000) (Figure 1). This prevalence was significantly higher than the result reported from the last regional household random sampling survey with standard hypertension definition in 2006 (28%; *P* < 0.001). Hypertension increased with age, as did SBP (male  $\beta$  = 0.336; female  $\beta$  = 0.523; *P* < 0.001) and DBP (male  $\beta$  = 0.118; female  $\beta$  = 0.189; *P* < 0.001) (Figure 2). Table 1 presents the distribution of demographic factors by hypertension rates, awareness, treatment, and control. We have previously reported that body mass index (BMI), smoking, physical



Figure 1. Prevalence of hypertension among Macau population by sex and age groups, 2012.



Figure 2. Mean systolic and diastolic blood pressure by sex and age.

activity, and alcohol are associated with hypertension in this population.<sup>7</sup> Older age, being of the male sex, having retired, being married, having a lower educational level, and having some salt awareness were significantly associated with hypertension prevalence. Table 2 presents these associations as ORs, both unadjusted and adjusted. After adjustment, older age ( $\geq$ 50 years; OR = 5.3; 95% CI = 4.6–6.1), being of male sex (OR = 2.2; 95% CI = 1.9–2.5), having retired (OR = 2.0; 95% CI = 1.8–2.3), being married (OR = 1.5; 95% CI = 1.3–1.9), and having a low education level in women (adjusted OR = 1.5; 95% CI = 1.1–2.1;  $P_{\text{interaction}} = 0.01$ ) were independently associated with hypertension. Those who had no knowledge of salt intake (OR = 1.1; 95% CI = 1.0–1.3) were at higher risk of hypertension compared with their counterparts.

#### **Hypertension** awareness

Of those individuals who had hypertension, 67% were aware of their condition (62% men; 72% women) (Table 3). As with hypertension prevalence rates, awareness of hypertension differed demographically, with those subjects aged  $\geq$ 50 years, having retired, being married, those with lower educational levels, those with some salt intake knowledge were more aware of their hypertension (Table 1). Again, on multivariable categorical analysis these differences were reflected as positive ORs (Table 2). When investigating the association between smoking and BMI in these data, those who had higher BMI were more likely to be aware of their hypertension status. This was not the case between smoking and awareness of hypertension (data not shown).

## Hypertension treatment

Among those individuals who had hypertension, 59% were receiving prescribed antihypertensive medications (55% men; 65% women). This treatment rate was equivalent to 83% of those who were aware of their condition (Table 3). Demographically, being aged  $\geq$ 50 years, having retired, being married, having a lower educational level, and having some knowledge of salt intake were factors associated with better treatment. These differences were also reflected in positive ORs adjusted for confounding (Table 2). When these factors were adjusted for awareness, all factors remained except for marriage, where a risk of 5 became null. Again, as with awareness rates, those who had a high BMI were more likely to be treated, but this was not the case for smoking (data not shown).

#### Hypertension control

Among those individuals who received treatment, 49% achieved blood pressure control (140/90 mm Hg) with no sex differences. Overall, 30% of the hypertensive population was adequately controlled (28% men; 33% women) (Table 3). Only those of older age, those who were married, and those with some awareness of salt intake guidelines were more likely to have their hypertension controlled (Table 1). These differences were also reflected in positive ORs adjusted for confounding (Table 2). When these factors were adjusted for awareness, all factors remained except for marriage, where a risk of 3 became nonsignificant. Again, as with awareness rates, those who had a high BMI were more likely to be treated, but this was not the case for smoking (data not shown).

Demographic factors	Total (%) (n = 1,410)	Hypertension prevalence (%) (n = 1,410)	Awareness prevalence (%)ª (n = 478)	Treatment prevalence (%)ª (n = 478)	Control prevalence (%)ª (n = 478)
Age groups, y					
<50	54	14	37	23	10
≥50	46	56*	76*	70*	36*
Sex					
Male	44	42	62	55	28
Female	56	27*	72	65	33
Retired					
No	44	25	54	43	24
Yes	56	45*	76*	70*	34
Marital status					
Single	23	14	22	15	8
Married	77	40*	72*	64*	33*
Education level					
College/ university	23	20	46	36	19
Lower	77	38*	70*	63*	32
Salt awareness					
Yes	35	30	74	68	38
No	65	35*	64*	55*	27*
Body mass index					
Normal	62	25	61	54	31
Overweight	28	43	74	65	31
Obese	10	60	66	59	24
Physical activity levels					
Vigorous	30	34	61	54	29
Moderate	47	33	72	66	31
Low	23	35	65	54	31
Smoking					
No	80	31	68	61	31
Yes	20	42	62	54	28

Table 1.	Distribution of	demographic	factors and	hypertension	status in	residents of	Macau	2012
	Distribution of	uciniographic	lactors and	hypertension	status m	1031001113 01	macau	2012

<sup>a</sup>Among those with hypertension.

 $^{*}\chi^{2}P < 0.05.$ 

## DISCUSSION

The prevalence of hypertension reported in this study, 34%, is much higher than that reported from urban cities in Guangdong province  $(25\%)^8$  and from a Chinese national survey  $(20\%-22\%).^9$ 

A hypertension prevalence trend analysis<sup>10</sup> has reported a consistent increasing urban hypertension prevalence in China from 2002 (12%) to 2010 (16%), and it appears that the level of rapid economic development may be the reason for such a big difference in prevalence between large cities in mainland China and Macau and Hong Kong. We hypothesize that the Westernization of lifestyles in Macau may be the reason for prevalence rates approaching those of industrialized countries such as the United Kingdom and United States.<sup>1,3</sup>

The associations found in this study between hypertension and older age and being of the male sex are consistent with previous hypertension epidemiological studies.<sup>11,12</sup> The findings of an association of hypertension with lower education, especially in female subjects, and with retirement are also consistent with previous studies.<sup>13,14</sup> In contrast with other studies,<sup>15,16</sup> in the Macau data, being married was associated with risk of hypertension. Further investigation into this interesting phenomenon could be warranted because previous studies have been exclusively in male subjects and in subjects from European cultures, none from Asia.<sup>15,16</sup>

	Hypertens	ion prevalence	Hypertension among th hyperte	n awareness Iose with ension	Hyperter those	าsion treatment a ะ with hypertensi	nong	Hype	rtension control se with hyperte	among Ision
Demographic factors <sup>9</sup>	6 (95% CI)	Adjusted <sup>a</sup> OR (95% CI)	Crude OR (95% CI)	Adjusted <sup>a</sup> OR (95% CI)	Crude OR (95% CI)	Adjusted <sup>a</sup> OR (95% CI)	Adjusted <sup>b</sup> OR (95% CI)	Crude OR (95% CI)	Adjusted <sup>a</sup> OR (95% CI)	Adjusted <sup>b</sup> OR (95% CI)
Age										
<50 55	4 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
≥50 4	6 7.8 (6.9–8.7	) 5.3 (4.6–6.1)	5.3 (4.3–6.8)	3.1 (2.5–4.0)	8.1 (6.4–10.1)	5.0 (3.9–6.5)	6.6 (4.3–9.9)	5.0 (3.7-6.7)	3.6 (2.6–5.0)	2.5 (1.8–3.6)
Sex										
5 5	6 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Male 4	4 1.9 (1.7–2.1	) 2.2 (1.9–2.5)	0.6 (0.5–0.8)	1.0 (0.8–1.2)	0.6 (0.5–0.8)	1.0 (0.8–1.2)	1.0 (0.7–1.4)	0.8 (0.7–1.0)	0.9 (0.8–1.2)	0.9 (0.7–1.2)
Retired										
No	6 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Yes 4	4 2.4 (2.2–2.7	') 2.0 (1.8–2.3)	2.7 (2.3–3.2)	1.9 (1.5–2.4)	3.1 (2.6–3.7)	2.1 (1.7–2.6)	1.9 (1.3–2.8)	1.7 (1.4–2.0)	1.0 (0.8–1.3)	0.8 (0.6–1.0)
Marital status										
Single 2	3 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Married 7	7 4.1 (3.5–4.8	) 1.5 (1.3–1.9)	9.3 (6.6–12.9)	5.0 (3.4–7.3)	10.4 (7.1–15.3)	5.1 (3.3–7.9)	1.1 (0.5–2.4)	5.8 (3.5–9.6)	3.2 (1.9–5.4)	1.1 (0.6–2.1)
Education										
College/university 1	4 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lower 8	6 2.4 (2.1–2.7	) 1.0 (0.9–1.2)	2.7 (2.1–3.5)	1.1 (1.0–1.2)	3.1 (2.4–3.9)	1.7 (1.3–2.3)	1.8 (1.1–2.9)	2.0 (1.5–2.8)	1.3 (0.9–1.8)	1.1 (0.7–1.5)
Salt knowledge										
Yes 3	5 1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
No	5 1.3 (1.1–1.4	:) 1.1 (1.0–1.3)	0.6 (0.5–0.8)	0.6 (0.5–0.7)	0.6 (0.5–0.7)	0.5 (0.4–0.6)	0.5 (0.3–0.7)	0.6 (0.5–0.7)	0.6 (0.5–0.7)	0.7 (0.6–0.9)
Abbreviations: Cl, coi	ifidence interval;	; OR, odds ratio.								

<sup>a</sup>Adjusted for body mass index + physical activity + smoking and age, sex, retirement status, marital status, education, and salt knowledge where appropriate. <sup>b</sup>Adjusted as in footnote a plus awareness of hypertension status.

		Total (%)			Men (%)				Women (%)			
		Age	groups,	у		Age	groups,	у		Ag	e groups	s, y
Factors	Total	18–44	45–64	≥65	Total	18–44	45–64	≥65	Total	18–44	45–64	≥65
Awareness	67	29	68	79	62	27	68	76	72	41	69	82
Treatment												
Among those with hypertension		16	60	75	55	14	57	73	65	24	62	77
Among those aware of their hypertensive condition		46	79	95	83	44	79	96	84	59	80	93
Control												
Among those with hypertension		6	33	35	28	6	33	35	33	9	33	36
Among those receiving treatment		33	53	45	45	36	52	46	49	21	53	44

Table 3. Prevalence of hypertension awareness, treatment, and control among Macau population by sex and age groups, 2012

Compared with studies from southern China<sup>8</sup> and mainland China,<sup>9</sup> the prevalence of awareness, treatment, and control among hypertensive patients in Macau was much higher (67%, 59%, and 30% in Macau; 43%, 38%, and 14% in urban southern China; 23%, 25%, and 6% in mainland China) and close to prevalence rates in the United States (74%, 71%, 47%).<sup>1</sup>

The reason for the difference between Macau and other Chinese cities may be because Macau has a free-of-charge public primary healthcare benefit scheme that covers the entire population. Children aged <18 years, teachers in public schools, public servants, pregnant women, those aged  $\geq$ 65 years, and other "at-risk" subgroups are treated for free. For the remaining local population, 30% of the medication charge from the public specialist hospital is subsidized by the local government. We believe these implemented policies explain the demographic associations we have found in our data between retirement and greater age. The findings from our study of an association between age, being married, and being retired and of lower education and hypertension treatment were consistent with data from Singapore<sup>17</sup> and also from Mainland China.<sup>18</sup>

In our study, lack of knowledge of salt intake guidelines was associated with increased hypertension. Knowledge of such guidelines was also significantly associated with more awareness, control, and treatment of hypertension, even after mutual adjustment. A recent Institute of Medicine review has summarized the present lack of evidence about salt intake and mortality and morbidity from chronic diseases but does confirm the consistent relationship between salt and hypertension risk.<sup>19</sup> Thus, from our data, it appears salt-related public health strategies may be useful for hypertension prevalence, awareness, treatment, and control.

Because Macau has well-funded healthcare resources and a well-established public healthcare system, we believe that there needs to be planning for long-term strategies with respect to hypertension: for example, establishing goals for subpopulations (those with lower educational levels, those not married, those of the female sex, those who are retired) and thus enhancing compliance of nonmedication hypertension therapies (physical activity, BMI, smoking) along with existing drug treatments.

The hypertension treatment rate in Macau among those who were aware of their condition was similar to that of

previous studies<sup>8,9</sup> from China (Macau: 83%; Guang Dong Province: 88%; mainland China: 80%); however, treatment rate among hypertension patients was much higher in Macau (59%) than in urban southern China (38%) and overall mainland China (20%). One possible explanation for this may be attributed to different pharmaceutical marketing behavior between mainland China (where it is intensive)<sup>20</sup> and Macau (where it is controlled). In addition, hypertension control rates among the hypertensive population (30%) and among those who are aware of their condition (49%) were found to be much better in Macau than in southern China (14% and 36%, respectively)<sup>8</sup> and overall mainland China (6% and 24%, respectively).9 However, when compared with the United States (control rates: 46% among hypertensive population and 65% among those who are aware of their condition),<sup>1</sup> there is still room for improvement in Macau. Local healthcare policy and the primary healthcare system should be taken into account for such hypertension control achievement.

This study had multiple strengths. This was a large, epidemiological survey conducted in a systematic random manner from the whole Macau population. All blood pressure data were measured individually twice by trained and qualified senior nursing students during a household interview. Most known confounding variables associated with hypertension have been measured and used in these analyses.

This study had some limitations. Because our study was cross-sectional, there is no ability to either infer causation or to assess trends. Also, given the fact that our response rate was 65%, selection bias could not be ruled out. Because the responders were older, this may, in part, explain the high hypertension rates in our data.

Prevalence of hypertension in Macau SAR was higher than reported in mainland China and was comparable with that reported in Hong Kong, the United States, and Europe. We believe there is an urgent need for long-term public health strategies targeted at "at-risk" demographic groups. In addition, more specific health promotion campaigns for hypertension prevention related to knowledge of risk factors such as salt intake and smoking may be useful.

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## DISCLOSURE

The authors declared no conflict of interest.

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