

Prevalence, Awareness, Treatment, and Control of Hypertension in China

Data from the China National Nutrition and Health Survey 2002

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Background—The present article aims to provide accurate estimates of the prevalence, awareness, treatment, and control of hypertension in adults in China.

Methods and Results—Data were obtained from sphygmomanometer measurements and an administered questionnaire from 141 892 Chinese adults ≥ 18 years of age who participated in the 2002 China National Nutrition and Health Survey. In 2002, ≈ 153 million Chinese adults were hypertensive. The prevalence was higher among men than women (20% versus 17%; $P < 0.001$) and was higher in successive age groups. Overall, the prevalence of hypertension was higher in urban compared with rural areas in men (23% versus 18%; $P < 0.01$) and women (18% versus 16%; $P < 0.001$). Of the 24% affected individuals who were aware of their condition, 78% were treated and 19% were adequately controlled. Despite evidence to suggest improved levels of treatment in individuals with hypertension over the past decade, compared with estimates from 1991, the ratio of controlled to treated hypertension has remained largely unchanged at 1:4.

Conclusions—One in 6 Chinese adults is hypertensive, but only one quarter are aware of their condition. Despite increased rates of blood pressure-lowering treatment, few have their hypertension effectively controlled. National hypertension programs must focus on improving awareness in the wider community, as well as treatment and control, to prevent many tens of thousands of cardiovascular-related deaths. (*Circulation*. 2008;118:2679-2686.)

Key Words: awareness ■ China ■ hypertension ■ prevalence ■ prevention and control ■ therapeutics

Cardiovascular disease (CVD) is the leading cause of death worldwide, accounting for an estimated 30% and 10% of all deaths and disability, respectively, in 2005.^{1,2} Despite recent and substantial downward trends in the prevalence of CVD within many industrialized countries,^{2,3} the global burden of CVD is rising because of its increasing prevalence in lower- and middle-income countries where 80% of all global CVD-related deaths occur.⁴ In China, one third of all deaths were due to CVD in 2005,⁵ with numbers anticipated to double by 2020.^{1,2,6-8}

Blood pressure is the most important risk factor for CVD, accounting for $\approx 45\%$ of global CVD morbidity and mortality.⁹ As with other major chronic disease risk factors such as smoking, diabetes, and obesity, hypertension is an emerging epidemic in many lower- and middle-income countries,^{10,11} including China, where there is generally poor awareness,

treatment, and control of the condition. National survey data suggest that the prevalence of hypertension in the Chinese adult population has quadrupled from 5% in 1959¹² to nearly 19% in 2002.¹³

Current Chinese guidelines for the management of hypertension¹⁴ stipulate a blood pressure treatment goal of 140/90 mm Hg, but evidence from previous studies, including the 1991 National Survey¹⁵ and the more recent International Collaborative Study of Cardiovascular Disease in ASIA (InterASIA),¹⁶ suggests that only a small proportion of affected individuals receive adequate treatment or achieve effective blood pressure control. To explain the development of appropriate management and treatment strategies for hypertension in the Chinese population, we report here a comprehensive analysis of the prevalence, awareness, treatment, and control of hypertension among Chinese population subgroups using data from the

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nationally representative First China National Nutrition and Health Survey (NNHS) 2002.

Methods

Study Participants

The 2002 survey, conducted from August to December 2002, covered all 31 provinces, autonomous regions, and municipalities directly under the central government throughout China (except Taiwan, Hong Kong, and Macao). Participants were recruited by use of a stratified multistage cluster sampling design. The country was divided into 6 strata: large cities, small to medium cities, class 1 rural areas, class 2 rural areas, class 3 rural areas, and class 4 rural areas, according to their characteristics of economy and social development using data from the China National Bureau of Statistics and China Ministry of Health Statistics in which cities were divided mainly by population size and gross national product and rural class areas were classified mainly according to the gross national product, with the least economically advantaged areas graded as the most rural (class 4) regions.¹⁷ The first stage of sampling involved the random selection of 22 districts (urban) or counties (rural) from each of the 6 strata. The second stage involved the random selection of 3 neighborhoods (urban) or townships (rural) from each of the selected districts/counties. From each of the neighborhoods or townships, 2 residential committees (urban) or villages (rural) were randomly selected; 90 households were randomly sampled from each village. A total of 795 residential committees or villages and 68 828 families were sampled. The study participants were defined as permanent residents of the households with a record in the household registration. Ethics approval was obtained from the Ethics Committee of China Centre for Disease Control. All participants gave informed consent.

Survey Methods

All participants were assessed at a central survey site in their area. Surveys in the north were run earlier in the year and then finalized in the south in December to reduce variations in ambient temperature. The outside temperature was required to be between 18°C and 25°C for survey measurements to be performed. All adult participants completed a questionnaire-based interview, dietary assessment, and physical examination, and approximately one quarter of participants had a venous blood sample taken for subsequent biochemical analysis.

The physical examination involved the measurement of height, weight, waist circumference, and blood pressure. Only those methods pertaining to measurement of blood pressure are provided here. All participants >15 years of age had their blood pressure measured with standardized mercury sphygmomanometers that were purchased centrally. In this article, only data pertaining to the measurement of blood pressure in individuals ≥18 years of age were used to facilitate international comparisons. Investigators were trained in the measurement of blood pressure and in the questionnaire before the survey. Two consecutive readings of blood pressure were taken on the right arm according to 1999 World Health Organization/International Society of Hypertension guidelines on hypertension¹⁸ with the participant in a seated position after 5 minutes of rest; the mean of the 2 measures was used for analysis. The cuff size was selected on the basis of the upper arm circumference to ensure that the cuff did not overlap. Hypertension was defined according to the Chinese Guidelines on Prevention and Control of Hypertension¹⁴ and the Sixth Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure guidelines¹⁹ as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥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. 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 systolic blood pressure <140 mm Hg and an average diastolic blood pressure <90 mm Hg. Quality control of the data was ensured by national and provincial quality control teams, which reported that the percentage of agreement between observers for both systolic and diastolic blood pressures (difference in measurements <4 mm Hg) was >97% for both the national and provincial quality control teams.

Statistical Methods

A comparison with the year 2000 National Census conducted by the National Statistics Bureau indicated that there were age and sex differences in the distributions between the 2000 Census and the study population of the 2002 China NNHS ($P<0.05$). There was no difference between the study populations with respect to the following demographic indexes: number of dependents, size of family, or proportion of ethnic minorities. Not all sampled individuals agreed to participate.

Prevalence data were analyzed with SAS 9.3 for Windows (SAS Institute Inc, Cary, NC), allowing for the complex survey design and nonresponse in both estimates and corresponding SEs. Survey weights were derived from the 2000 Census and associated administrative data. PROC SURVEYFREQ was used to obtain the prevalence of hypertension overall and within subgroups. For comparisons of prevalence (and their SEs) between subgroups according to level of development, body mass index, waist circumference, and regions of China, age or age and sex standardization was performed with the China 2000 Census population as the standard population. Logistic regression, applied with PROC SURVEYLOGISTIC in SAS, was used to test for trends across age groups, levels of development, body mass index and waist circumference, and education with adjustment for potential confounding variables. The same procedure was used to estimate age-adjusted odds ratios for hypertension by level of education. Mean levels of systolic blood pressure were estimated in each of the 9 ordinal groups of body mass index with PROC SURVEYMEANS.

Among those with hypertension, the percentage aware of their condition, treated, and controlled was estimated in each age group for both sexes with PROC SURVEYFREQ. These percentages (and SEs) were then age standardized with the total sample of hypertensives in this survey used as the standard population. Differences between sexes were tested with PROC SURVEYLOGISTIC with adjustment for age.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

A total of 243 479 children, adolescents, and adults were selected for the survey. Of these, 218 920 (90%) were eligible (living at a registered home); 26 420 (12% of eligible sample) refused to participate or had missing data. All individuals ≥15 years of age ($n=152\ 437$) had blood pressure measurements taken. Estimates of current prevalence, treatment, and control of hypertension were based on data from study participants ≥18 years of age ($n=141\ 892$). The demographic characteristics of all participants and the prevalence of hypertension in both rural and urban areas and within each age and sex category are shown in Table 1.

Prevalence of Hypertension

According to the 1999 World Health Organization criteria,¹⁸ 18% of the adult Chinese population in 2002 were hypertensive, which equates to ≈153 million individuals. The overall prevalence of hypertension was significantly greater for men than women (20% versus 17%; Table 1) and was higher with each successive age group in both sexes and in all classes (Table 1). Among individuals ≤45

Table 1. Prevalence of Hypertension by Age, Sex, and Level of Economic and Social Development

Economic and Social Development	n	Men, % (SE)				Women, % (SE)				Overall Population†
		18–44 y	45–59 y	≥60 y	Total*	18–44 y	45–59 y	≥60 y	Total*	
Large cities	25 244	15 (1.8)	33 (2.9)	58 (1.7)	24 (0.5)	6 (0.9)	32 (2.8)	60 (2.1)	19 (0.3)	22 (0.3)
Small/medium cities	22 367	13 (2.2)	36 (4.3)	55 (3.7)	23 (0.5)	5 (0.6)	33 (1.9)	57 (2.2)	17 (0.3)	20 (0.3)
Class 1 rural areas	23 417	12 (1.3)	29 (2.4)	49 (3.2)	20 (0.4)	7 (0.9)	32 (2.1)	56 (3.1)	18 (0.4)	19 (0.3)
Class 2 rural areas	23 624	12 (1.3)	25 (2.6)	46 (2.5)	19 (0.4)	7 (0.7)	27 (2.1)	46 (2.6)	16 (0.3)	17 (0.3)
Class 3 rural areas	24 695	12 (0.9)	28 (2.1)	46 (2.4)	20 (0.4)	9 (0.6)	35 (1.7)	58 (2.4)	20 (0.4)	20 (0.3)
Class 4 rural areas	22 545	6 (0.6)	21 (1.3)	41 (2.7)	14 (0.3)	4 (0.4)	21 (1.7)	38 (2.5)	12 (0.3)	13 (0.2)
Overall population†	141 892	12 (0.9)	28 (1.8)	50 (1.6)	20 (0.2)	6 (0.3)	29 (1.1)	52 (1.4)	17 (0.1)	18 (0.1)

*Prevalences are standardized for age.

†Prevalences are standardized for age and sex.

Values for trend by age: men, $P < 0.0001$; women, $P < 0.0001$. Value between levels of development, $P < 0.0001$.

years of age, the prevalence of hypertension in men was almost double that of women (12% versus 6%), whereas in older individuals (>45 years of age), the prevalence was broadly similar between the sexes: In individuals 45 to 59 years of age, the prevalence was 28% in men and 29% in women; in those >60 years of age, the corresponding values were 50% and 52%. An additional 764 individuals (0.54% of the eligible survey population) had a normal blood pressure reading at the time of the survey but had previously been informed by a healthcare professional that they were hypertensive (but they were not on treatment in

the previous 2 weeks). Hence, these individuals were not considered hypertensive and were not included in the above prevalence estimate.

Prevalence of Hypertension by Level of Urbanization

The prevalence of hypertension varied by the level of urbanization, with populations living in the most rural areas typically being the least affected, particularly men (Table 1). In the most undeveloped rural areas (class 4 strata), the prevalence of hypertension among men was

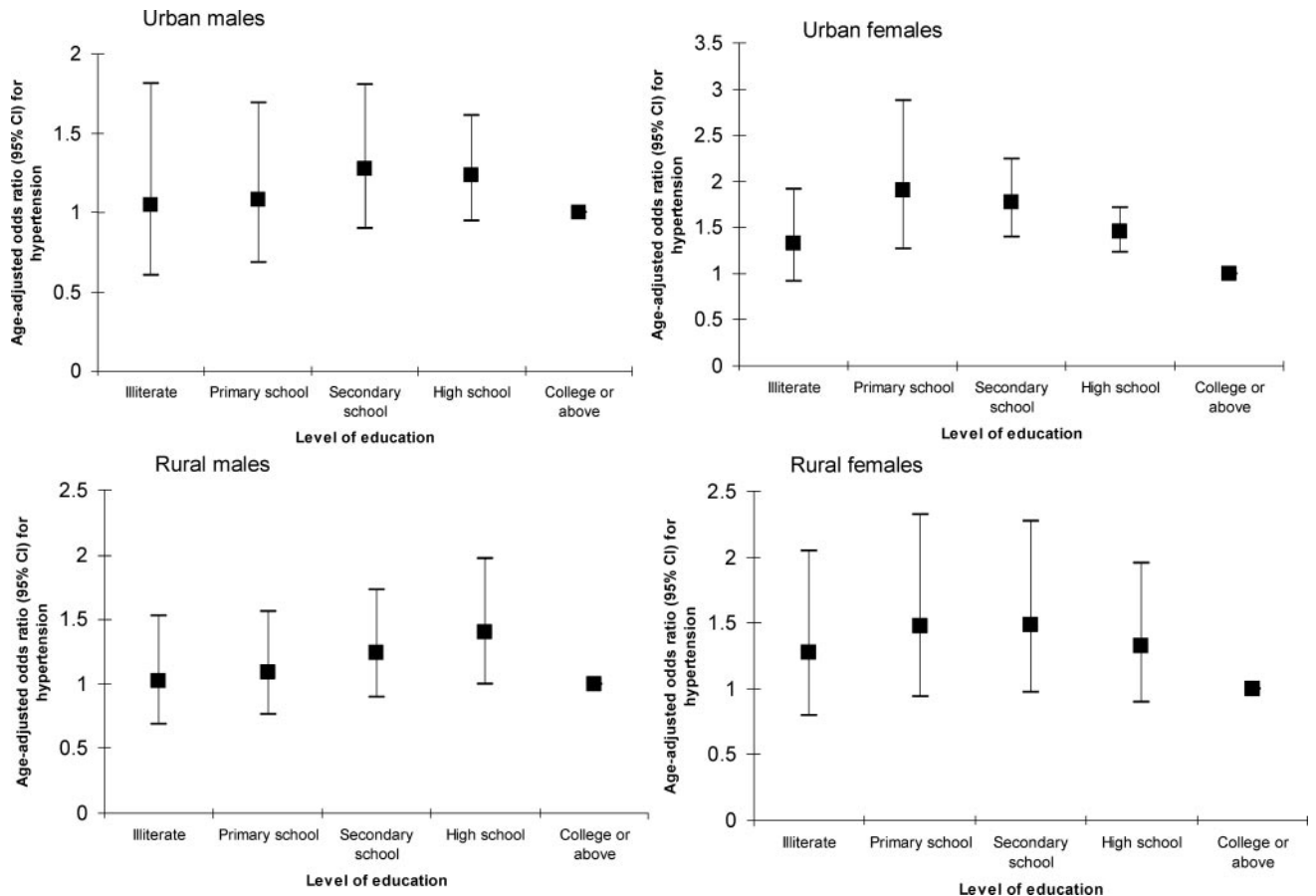


Figure 1. Age-adjusted odds ratio (OR) for hypertension (showing 95% CIs) by education status in urban and rural areas in men and women.

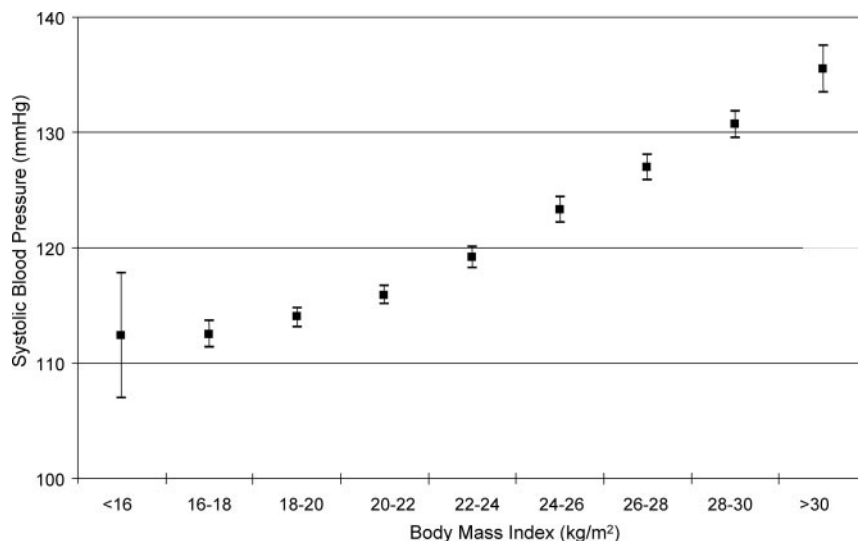


Figure 2. Mean systolic blood pressure (showing 95% CIs) vs body mass index.

14% compared with 24% in large cities. In women, the trend with urbanization was consistent with the above pattern: The prevalence of hypertension among class 4 women was 12% compared with 19% in the largest cities. The prevalence of hypertension was significantly higher in urban than rural areas (21% versus 17%; $P < 0.001$).

Relationship Between Education Status and Prevalence of Hypertension

There was no clear evidence to indicate that the risk of hypertension was associated with the level of education attained, with the possible exception of urban women, in whom there was evidence of a trend toward increasing level of education being associated with reduced risk of hypertension ($P < 0.0001$; Figure 1). This trend was not observed in rural women. In all men, the risk of hypertension in those who either were illiterate or had a primary-school level of education was comparable to that of men who had achieved the highest level of education (college or above).

Relationship Between Indexes of Body Size and Blood Pressure

There was a clear linear relationship between body mass index and systolic blood pressure in the overall study population across a wide range of values (Figure 2). When body size was categorized according to the Chinese-specific criteria for defining underweight (< 18.5 kg/m²; normal weight, 18.5 to < 24 kg/m²; overweight, 24 to 28 kg/m²; and obesity ≥ 28 kg/m²), the prevalence of hypertension was ≈ 3 times higher in obese individuals compared with those of normal weight in both sexes and in rural and urban areas (Table 2). A similar relationship was observed if waist circumference (as a marker of central obesity) was used instead: The prevalence of hypertension in individuals in the highest category of waist circumference (> 95 cm for men, > 90 cm for women) was ≈ 3 times higher than that in individuals in the lowest category (< 85 cm for men, < 80 cm for women; Table 2).

Geographic Area and Prevalence of Hypertension

There was substantial geographic variation in the prevalence of hypertension among the 6 regions of China (Figure 3). The northern region of China had more than twice the prevalence of hypertension compared with the southwest region of the country (27% versus 12%; Figure 3). The remaining regions of China had prevalence estimates that were intermediate to these levels.

Awareness, Treatment, and Control of Hypertension

Overall, of those individuals with hypertension, one quarter were aware of their condition. Awareness of hypertension was higher among women compared with men regardless of age group or level of urbanization: 25% versus 22%

Table 2. Age-Standardized Prevalence of Hypertension by Body Mass Index and Waist Circumference by Sex and Rural/Urban Region

	Urban		Rural	
	Men, % (SE)	Women, % (SE)	Men, % (SE)	Women, % (SE)
Body mass index, kg/m ²				
<18.5	14 (0.9)	10 (0.5)	9 (0.7)	9 (0.4)
18.5–<24	16 (0.4)	14 (0.2)	13 (0.3)	12 (0.2)
24–<28	30 (0.7)	30 (0.6)	21 (0.5)	22 (0.4)
≥ 28	45 (1.5)	47 (1.5)	36 (1.3)	37 (1.0)
<i>P</i> for trend	<0.0001	<0.0001	<0.0001	<0.0001
Waist circumference, cm				
<85 for men (<80 for women)	16 (0.3)	14 (0.2)	13 (0.3)	12 (0.2)
85–94 for men (80–89 for women)	31 (0.8)	29 (0.6)	23 (0.6)	23 (0.5)
≥ 95 for men (≥ 90 for women)	47 (1.4)	48 (1.4)	33 (1.5)	35 (1.0)
<i>P</i> for trend	<0.0001	<0.0001	<0.0001	<0.0001

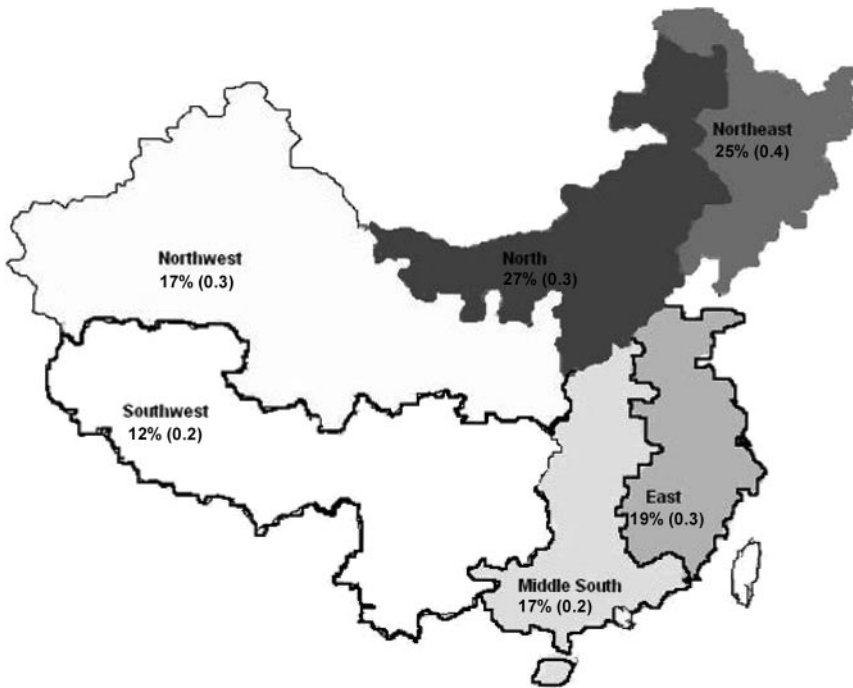


Figure 3. Map showing the estimated age- and sex-standardized prevalence of hypertension in each region of China.

of men ($P < 0.001$). Among all hypertensive individuals, one fifth were receiving prescribed antihypertensive medications (equivalent to nearly 80% of those aware of their condition). The proportion of treated individuals differed by area, with level of treatment twice as high in urban (23% in men, 26% in women) compared with rural (13% in men, 17% in women; P for difference in regions in both sexes < 0.001) areas. As with awareness, more women were treated than men regardless of age group (22% versus 17%; $P < 0.001$; Figure 4).

Among those individuals receiving treatment, adequate control of blood pressure (140/90 mm Hg) was achieved in 24%, with evidence of a strong urban-rural disparity: In men, the corresponding values were 28% in urban areas and 23% in rural areas ($P < 0.001$); in women, the corresponding values were 27% and 20%. Overall control was achieved in 5% of hypertensive patients (Figure 4), 6% in urban areas and 3% in rural areas ($P = 0.002$). In terms of absolute numbers, of the 153 million Chinese adults affected with hypertension, 38 million were aware of their condition, of whom 31 million were receiving treatment but < 7 million were adequately controlled.

Discussion

Findings from the 2002 NNHS indicate that $\approx 18\%$ of the Chinese adult population are hypertensive, which equates to 153 million affected individuals, the equivalent of 1 in 6 adults. Of these individuals, fewer than one quarter were aware of their condition. Although nearly 80% of individuals who were aware of their hypertensive status were receiving antihypertensive medication, blood pressure control was achieved in only ≈ 1 in 4 of these individuals. Compared with the 1991 China Hypertensive Survey (which is not directly comparable with the present study because of differences in study methodology), this represents little improvement in

either the prevalence or awareness of the condition. In 1991, 13.6% of the adult population were reported to be affected, and 27% were aware of their condition, estimates that are broadly similar to those observed more than a decade later. In contrast, the number of affected individuals who were both aware of their condition and on treatment nearly doubled from 44% in 1991 to 78% in 2002, although this did not translate into better control. In 1991, the ratio of controlled to treated individuals was 1:4; in 2002, this remained largely unaltered at 1:4.2. This estimate is similar to that of many other countries where fewer than one third of people with hypertension are adequately controlled.^{20–22} By comparison, in the United States, the ratio of those controlled to those treated is higher at 2:3.^{23,24}

Our present findings for the prevalence, awareness, treatment, and control of hypertension are lower than those reported by InterASIA, which was conducted in 1999 to 2000 by sampling 15 540 men and women 35 to 74 years of age in China^{16,25,26} and estimated the prevalence, awareness, treatment, and control of hypertension to be 27.4%, 45%, 28%, and 8%, respectively.¹⁶ A possible explanation for the discrepant findings between the 2 surveys may be the nonsampling of individuals 18 to 35 years in InterASIA; in contrast, the current national survey examined the prevalence of hypertension across all age groups > 18 years. Another possible explanation may be the very different sampling methods used. A total of 795 residential committees or villages were selected in the present study, but only several tens were selected in InterASIA. However, despite these differences, there is agreement between the previous and present findings that the prevalence of hypertension is increasing in China but the level of awareness, treatment and control of hypertension remains disproportionately and unacceptably low.

The high proportion of affected individuals on antihypertensive treatment in China differs compared with both lower-

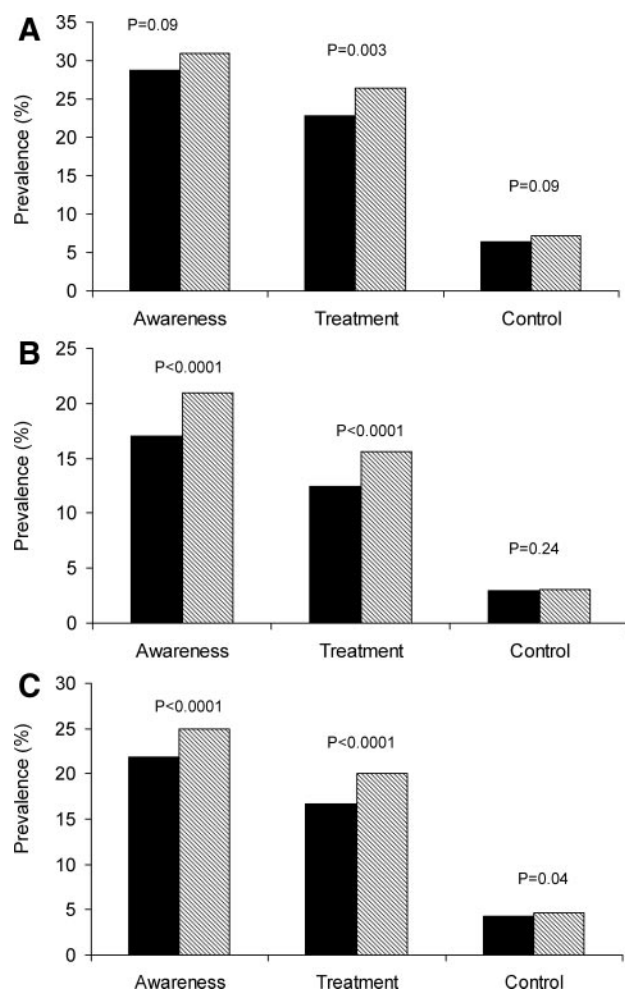


Figure 4. Age-standardized awareness, treatment, and control of hypertension in urban (A) and rural (B) areas of China and overall (C) in men (solid bars) and women (shaded bars) with hypertension.

and higher-income countries. In some lower- and middle-income countries (eg, India), the rule of halves is apparent; ie, half of the hypertensive population are aware of their condition, half of those aware are treated, and half of those treated are controlled.^{20,22,27} Whereas in some high-income countries such as the United States and the Netherlands, the rule of halves is more accurately described as the rule of two thirds as a result of increased awareness and control of hypertension.^{23,28–30} One explanation for the particularly high levels of treatment in China may be particularly aggressive marketing of antihypertensive drugs, combined with financial rewards to doctors for the prescription of certain medications. Marketing has been shown to influence the prescription of antihypertensive drugs by doctors in the United States.³¹

These data also highlight the increasing problem of hypertension in rural populations. In previous Chinese national surveys, there was a much greater disparity in the prevalence of hypertension between urban and rural areas; in the first hypertension survey of 1959, urban factory workers had 1.5 times the prevalence of hypertension than their rural counterparts.¹² By 2002, this disparity was diminished considerably; the prevalence of hypertension in rural areas (18%) is

closer to that found in towns and cities (21%). If this trend continues, the prevalence of hypertension will be greater in rural compared with urban areas within the next 5 to 10 years.

The increasing prevalence of hypertension in rural areas in recent years has been paralleled by similar trends in other risk factors for chronic disease such as obesity, the prevalence of which rose >40% between 1992 and 2002, with the greatest increase occurring in rural areas.³² Currently, 1 in 6 Chinese (≈ 215 million affected individuals) are overweight, with the highest prevalence of overweight and obesity observed in urban areas, where approximately one third of men and more than a quarter of women are affected. Numerous studies have indicated that body mass index is positively associated with blood pressure, and data from the NNHS 2002 clearly indicate the strong correlation between the 2 variables. It is therefore likely that the increasing prevalence of overweight and obesity in the Chinese adult population is a major contributing factor to the increased prevalence of hypertension over the past decade reported in the present study.

An increased prevalence of risk factors for chronic disease is often symptomatic of a country's increasing economic development and modernization, which are frequently accompanied by detrimental changes in diet and lifestyle. Increases in the prevalence of these risk factors are at first apparent within the most educated and wealthiest sectors of society. Over time, as the health hazards associated with poor diet and lifestyle become known (particularly among the most educated and economically advantaged), there is a downward shift in the mean level of these risk factors in these groups while they become simultaneously more prevalent in the least educated and more economically deprived population groups.^{2,33,34} This phenomenon may account in part for the north-south disparity in the prevalence of hypertension; the north and northeastern parts of China have, on average, a higher dietary intake of sodium, a higher prevalence of overweight and obesity, greater alcohol intake, and lower levels of physical activity compared with southern regions of the country, risk factors that are all determinants of blood pressure.^{35–38} These findings are consistent with those of InterASIA, which found that the odds ratio of hypertension awareness, treatment, and control increased with income.²⁶

Perspectives

It is apparent from these data that China is going to experience an enormous increase in the prevalence of cardiovascular-related morbidity and mortality attributable to blood pressure over the next few years. In high-income countries, public health measures and improved hypertensive therapy are credited for reducing the prevalence and improving the control of hypertension.³ Such measures have included mass education campaigns, diet and lifestyle interventions, and pharmacological treatment.^{3,23,39,40} In China, current strategies aimed at the prevention and control of hypertension are hospital based and are specifically targeted at the promotion of pharmaceutical treatments. But, as these data indicate, these strategies are ineffective at both reducing the prevalence and increasing

the control of hypertension in the Chinese population. The present findings also highlight the fact that elevated blood pressure is not restricted to particular subgroups of the Chinese population but is pervasive (although to differing extents) in young and elderly individuals, in men and women, and across all socioeconomic groups. Moreover, public health strategies that simply rely on treating those individuals who are aware of their condition will do little to reduce the burden of blood pressure-related disease in China. If China is to make any significant headway into reducing the burden of blood pressure-related disease, public health strategies that target the entire population and focus on both raising the awareness of the condition and enhancing the primary practitioner's capability of controlling hypertension (raise efficacy of treatment), including promoting healthier diets and lifestyles, are urgently required. Achieving this goal will require an unprecedented level of cooperation between China's policy makers, healthcare specialists, primary practitioners, and the general population.

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Disclosures

None.

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