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STATE-OF-THE-ART REVIEW

Hypertension and Related Cardiovascular Disease Burden in China

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Abstract

BACKGROUND With rapid economic development, urbanization, and an aging population, cardiovascular diseases (CVDs) have become the leading cause of death in China.

OBJECTIVES The aim of this study was to provide a comprehensive review on the prevalence, awareness, treatment, and control of hypertension (HTN) as well as blood pressure (BP)-related morbidity and mortality of CVD in Chinese adults over time.

FINDINGS The prevalence of HTN in China is high and increasing. Recent estimates are variable but indicate 33.6% (35.3% in men and 32% in women) or 335.8 million (178.6 million men and 157.2 million women) of the Chinese adult population had HTN in 2010, which represents a significant increase from previous surveys. BP-related CVD remains the leading cause of death in Chinese adults, with stroke being the predominant cause of cardiovascular deaths. Of those with HTN, 33.4% (30.4% in men and 36.7% in women) were aware of their condition, 23.9% (20.6% in men and 27.7% in women) were treated, and only 3.9% (3.5% in men and 4.3% in women) were controlled to the currently recommended target of BP $<$140/90 mm Hg. Awareness and treatment of HTN have improved over time, but HTN control has not. Geographic differences in the prevalence, awareness, treatment, and control of HTN are evident, both in terms of a north-south gradient and urban-rural disparity.

CONCLUSIONS The prevalence of HTN is high and increasing, while the control rate is low in Chinese adults. Combatting HTN and BP-related morbidity and mortality will require a comprehensive approach at national and local levels. The major challenge moving forward is to develop and implement effective, practical, and sustainable prevention and treatment strategies in China.

KEY WORDS hypertension, cardiovascular disease, mortality, prevalence, treatment, control, China

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INTRODUCTION

Hypertension (HTN) is the leading global preventable risk factor for cardiovascular disease (CVD) and premature death.[1,2] With 20% of the world's population, China represents a large portion of this burden, where HTN and blood pressure (BP)-related CVD are major public health challenges.[3,4] In the past few decades, China has undergone rapid economic development and demographic and epidemiologic transitions characterized by declines in fertility and child mortality and increases in life expectancy.[5] Consequently, major causes of morbidity and mortality in China have shifted

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from primarily infectious diseases to chronic, particularly cardiovascular, diseases.

HTN prevalence has risen in China in recent decades, resulting in an increase of BP-related morbidity and mortality. Since the 1950s, several national HTN surveys have been conducted in China to assess the prevalence and risk factors of this condition.[6-14] Data suggest that HTN and CVD have been serious health issues in China for decades and there are no signs of abatement.

The aim of the present study was to comprehensively review literature on the current prevalence, awareness, treatment, and control of HTN in the general adult population in China. We compared the secular trends of HTN burden and control in Chinese populations using data from several national surveys over several decades. Additionally, we examined BP-related morbidity and mortality burden in China.

PREVALENCE OF HYPERTENSION

Recently, several national surveys in China have reported the prevalence of HTN in the Chinese general population (Table 1). The 2007-2008 China National Diabetes and Metabolic Disorders Study, conducted with a nationally representative sample of 46,239 adults aged ≥20 years, showed that 26.6% of Chinese adults had HTN (29.2% in men and 24.1% women).[10] Similar estimates were obtained by the China National Survey of Chronic Kidney Disease, which reported an adjusted prevalence of 29.6% (31.2% in men and 28% in women) in a nationally representative sample of 50,171 adults aged ≥18 years conducted in 2009-2010.[11]

The most updated estimates of HTN prevalence are from the China Non-communicable Disease Surveillance 2010, which included a nationally representative sample of 98,658 Chinese adults aged ≥18 years from all 31 provinces, autonomous regions, and municipalities in mainland China.[12,13] Three BP measurements were obtained by trained observers using a calibrated automatic electronic device. Hypertension was defined as a mean systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥90 mm Hg and/or use of antihypertensive medications. An estimated 33.6% (35.3%

Table 1. Prevalence, Awareness, Treatment, and Control of Hypertension in China

	China National Diabetes and Metabolic Disorders Study[6]	China National Survey of Chronic Kidney Disease[7]	China Non-communicable Disease Surveillance 2010[4,5]
Year	2007–2008	2009–2010	2010
Sample size	46,239	50,171	98,658
Sampling methods	Multistage stratified sample from 14 provinces and municipalities	Multistage stratified sample from 13 provinces	Multistage stratified sample from 31 provinces and municipalities
Age range (y)	≥20	≥18	≥18
Blood pressure measurement	2 sitting readings using a standardized mercury sphygmomanometer	3 sitting readings using a standardized mercury sphygmomanometer	3 sitting readings using an automatic device (Omron HEM-7071)
Prevalence, %			
Total	26.6	29.6	33.6
Men	29.2	31.2	35.3
Women	24.1	28.0	32.0
Awareness, %			
Total	45.0	42.6	33.4
Men	42.5	35.1	30.4
Women	47.9	51.0	36.7
Treatment, %			
Total	36.2	34.1	23.9
Men	32.7	26.8	20.6
Women	40.2	42.3	27.7
Control*, %			
Total	11.1	9.3	3.9
Men	10.5	7.6	3.5
Women	11.8	11.3	4.3

* Among all hypertensive patients.

in men and 32% in women), or 335.8 million (178.6 million men and 157.2 million women), of the Chinese adult population had HTN. Additionally, an estimated 38.9% (43.8% in men and 34.1% in women), or 389.3 million (222 million men and 167.3 million women), of the Chinese adult population had prehypertension. Prevalence of HTN increased with age and men had a higher prevalence than women before age 50, whereas women had higher prevalence after age 50. For example, the age-specific prevalences of HTN for men and women were 14.9% and 7.6%, 26.1% and 15.7%, 36.4% and 31.6%, 49.1% and 51.1%, 61.5% and 66%, and 70.2% and 73.8%, respectively, among the general population aged 18-29, 30-39, 40-49, 50-59, 60-69, and ≥70 years old.[12,13]

A systematic pooled analysis of prevalence data from 65 studies in China conducted between 2003 and 2012 found that 265 million adults (145 million men and 120 million women) or 26.7% (28.9% among men and 24.5% among women) of the Chinese adult population had HTN.[14] These estimates are slightly lower than those from the China Noncommunicable Disease Surveillance 2010 because this analysis included data covering a period of 10 years. Nevertheless, this meta-analysis documents a high prevalence of HTN in China.

Studies in China have documented geographic variations in HTN and CVD, noting both north-south and urban-rural gradients characterized by higher prevalence in the north and urban areas.[6–8,15,16] The north-south gradient has been recognized since the Second National High Blood Pressure Survey conducted in 1979-1980.[7] More recently, in a cross-sectional survey conducted in 2000-2001, the InterASIA study found that the age-standardized prevalence was significantly higher among Chinese residents living in northern regions versus southern regions (33.8% in northern regions versus 23.3% in southern regions; $P < 0.001$).[16] A major contributing factor to the north-south gradient is likely a higher dietary sodium intake in the northern region.[17]

Urban-rural disparities have been more challenging to consistently identify. Opposed to earlier studies, the InterASIA study found no significant difference between urban and rural areas, likely due to a rapid increase in HTN in rural areas. Recent results from the PURE (Prospective Urban Rural Epidemiology) study with 45,108 adults age 35 to 70 years documented a higher prevalence among rural residents.[18]

SECULAR TRENDS OF HYPERTENSION PREVALENCE

The prevalence of HTN in China has been increasing steadily over the past several decades. In 1991, the Third National High Blood Pressure Survey was conducted to assess the prevalence of HTN in 950,356 Chinese people aged ≥15 years, finding that the age-adjusted prevalence of HTN, defined as SBP ≥140 mm Hg and/or DBP ≥90 mm Hg, and/or use of antihypertensive medication, was 11.3% (12.2% in men and 10.3% in women).[6] This represents an approximately 25% increase in the prevalence of HTN from the second nationwide survey in 1979-1980, after taking into account the difference in the definition of HTN.[7] In 2002, the China National Nutrition and Health Survey, conducted in a nationally representative sample of 141,892 Chinese adults aged ≥18 years, indicated that 18% of the adult population (20% in men and 17% in women) had HTN.[9] In 2010, the prevalence of HTN increased to 33.6% (35.3% in men and 32% in women) based on the China Noncommunicable Disease Surveillance 2010.[12,13] These surveys used the same sampling method to select a nationally representative sample covering major geographic areas of all 31 provinces, autonomous regions, and municipalities in mainland China. The prevalence of HTN increased in both men and women and in all age groups (Fig. 1).

A recent publication from the China Health and Nutrition Survey, which assessed 75,526 records from 24,410 adults aged ≥18 years, highlights the dynamic nature of HTN prevalence in China, providing trend analysis for 8 surveys over 10 years (1991-2011).[19] Significant trends were seen over time, indicating that the prevalence of HTN is increasing in both men and women. The most significant increase is seen in adults aged 40 to 59 years. In 2011, the age-adjusted prevalence of HTN among Chinese adults was 28.7% (30.8% in men and 26.8% in women) which is a significant increase from 23.4% in 1991 and 28% in 2000.

Although trends indicate an increasing prevalence of HTN across China, estimates by study vary considerably due to different factors (eg, age of included participants or sampling methods). A systematic review of 60 HTN studies in China likewise noted wide discrepancies in the prevalence of HTN by study.[20] Systematic collection of information on the prevalence and burden of HTN in China will be crucial moving forward.

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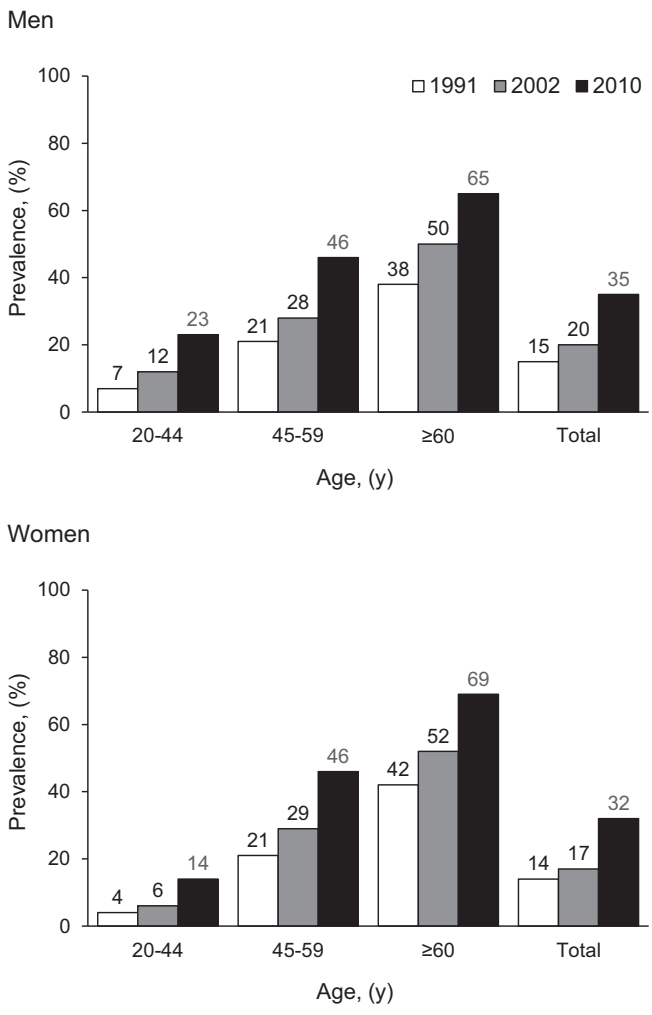

Figure 1. Age-specific prevalence of hypertension in Chinese adults aged ≥20 years, in 1991, 2002 and 2010. Hypertension was defined as a systolic blood pressure ≥140 mm Hg and/or a diastolic blood pressure ≥90 mm Hg, and/or self-reported use of antihypertensive medications within 2 weeks of the examination.

BP-RELATED CARDIOVASCULAR DISEASE

In recent years, the mortality burden attributable to HTN has increased. Estimates for 2005 suggested 2.33 million cardiovascular deaths were attributable to increased BP in China (2.11 million in those with HTN).[4] Of these deaths, 1,395,400 occurred in men and 935,100 in women. Additionally, 1.27 million premature cardiovascular deaths were attributable to increased BP (1.15 million in those with HTN).

Many studies identify cerebrovascular disease as the predominant CVD in China.[3,21-24] The Sino-MONICA study showed that stroke accounted for 3 times the number of deaths in Chinese adults compared with coronary heart disease (CHD) in 1987-1993.[21] More recently, analysis of a national survey follow-up showed that stroke accounted for 1,076,000 deaths in men and 786,100 deaths in women in 2005.[4] In contrast with stroke, CHD incidence and mortality are relatively low in China, accounting for 71,000 deaths in men and 43,600 deaths in women.

As China undergoes further economic and epidemiologic changes, the gap in incidence and mortality for CHD and stroke may decrease. The Sino-MONICA project was uniquely qualified to examine time trends in CVD incidence and mortality by collecting data yearly from 1984 to 2004. Stroke results from that study provide an interesting

picture of the transition in type of CVD occurring in China over that time period. From 1984 to 2004, the study documented declining incidence of stroke, reduced case fatality rates, increased onset age, and increased proportion of CVD due to CHD.[24]

Consistent with prevalence of HTN, studies suggest a north-south gradient in the incidence and mortality of CVDs in China.[24] A systematic review of stroke studies in China documented a north-south gradient in incidence and mortality of stroke, with incidence and mortality rates being consistently higher in northern regions versus southern regions.[23] Because HTN is a major risk factor for CVD in China, geographical variations in incidence and mortality may be mainly due to geographical variations in the prevalence of HTN.

The absolute burden of CVD in China is enormous and consistent among studies. As HTN is the most important risk factor for CHD and cerebrovascular disease, control of HTN is an extremely important task for Chinese health workers.[21,24] Data from the China National Hypertension Survey Epidemiology Follow-up Study show a strong, linear, and significant association between SBP and DBP and risk for CVD, CHD, and stroke, independent of other risk factors.[25] Thus, lowering BP is a crucial part of prevention of CVD.

TREATMENT AND CONTROL OF HYPERTENSION

Clinical trials conducted in a wide variety of populations, including in Chinese patients, have shown substantial benefits to antihypertensive treatment.[26-30] Results from these trials suggest that reduction in BP is the key mechanism behind risk reduction, with larger reductions in BP leading to larger reductions in risk, which is consistent with previous studies in other populations.[31] Wei and colleagues recently showed that treatment to an SBP target of <140 mm Hg using a variety of medications decreased total and cardiovascular mortality by 41.7% and 50.4%, respectively, in a population of Chinese patients >70 years.[32] Other recent results reported by the China Stroke Primary Prevention Trial suggest that addition of folic acid to antihypertensive treatment may afford further reduction in risk for stroke.[33]

Clinical trials have shown clear benefits to any antihypertensive treatment.[34] Current guidelines for the management of HTN in Chinese adults recommend all 5 classes of antihypertensive medication as possible treatments for HTN with a treatment goal of <140/90 mm Hg in general and <130/80 in certain high-risk groups.[35] Recently, SPRINT (Systolic Blood Pressure Intervention Trial) showed that intensive BP reduction to a target SBP of <120 mm significantly decreased risk for major cardiovascular events in patients without diabetes.[36] Effective management of HTN based on current and evolving knowledge from clinical trials and meta-analyses will be key in preventing its associated morbidity and mortality.

Although effective antihypertensive treatment is available, the control rate of HTN is low in Chinese adults. In the 2002 China National Nutrition and Health Survey, the proportion of patients with HTN who were aware, treated, and controlled were 24%, 19%, and 5%, respectively.[9] In the China Non-communicable Disease Surveillance 2010, the awareness, treatment, and control of HTN in Chinese adults were 33.4% (30.4% in men and 36.7% in women), 23.9% (20.6% in men and 27.7% in women), and 3.9% (3.5% in men and 4.3% in women), respectively.[12,13] The lack of adequate BP control documented in both studies is alarming, especially because these data showed that there is no improvement in HTN control. A systematic pooled analysis estimated that among hypertensives, only 44.6% were aware, 35.2% were treated, and 11.2% were controlled.[14] Although slight discrepancies among estimates are apparent, it is clear that much improvement is needed. These data document that underdiagnosis and undertreatment of HTN are major public health problems in China.

There is a striking disparity in levels of awareness, treatment, and control in urban versus rural areas with residents in urban areas exhibiting higher percentages compared with residents in rural areas.[8,9,11-13] It was noted that urban-rural disparities in awareness and treatment of HTN were present even after adjusting for socioeconomic and lifestyle variables. Poor HTN control in rural residents is troublesome because these individuals are facing a double burden of infectious and chronic diseases.

CONCLUSIONS AND FUTURE DIRECTIONS

HTN and associated CVD and mortality are major public health challenges in China. To reduce the CVD burden in the Chinese population, the prevention and treatment of HTN with a goal of reducing prevalence and substantially increasing awareness, treatment, and control should be a public health priority in China. Prevention efforts should

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focus on lifestyle modification programs and target several risk factors for both HTN and CVD, namely obesity, unhealthy diet, high sodium intake, physical inactivity, and smoking. Developing and implementing effective, practical, and sustainable antihypertensive intervention strategies is crucial in reducing BP-related morbidity and mortality. It has been suggested that treating all HTN in China could cost-effectively prevent about 800,000 CVD events annually.[37] However, low-cost essential antihypertensive medication programs need to be implemented and maintained. Additional benefits may be seen with simplification of HTN guidelines, reliable home measurement of BP, and improved identification of people with uncontrolled HTN.[35] Combating HTN and BP-related morbidity and mortality will require a comprehensive strategy at national and local levels.

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