Hypertension Subtype and Risk of Cardiovascular Disease in Chinese Adults

Tanika N. Kelly, MPH; Dongfeng Gu, MD, PhD; Jing Chen, MD, MSc; Jian-feng Huang, MD; Ji-chun Chen, MD; Xiufang Duan, MD; Xigui Wu, MD; C. Lillian Yau, PhD; Paul K. Whelton, MD, MSc; Jiang He, MD, PhD

Background—We examined the relationship between hypertension subtype and cardiovascular disease incidence and mortality in Chinese adults.

Methods and Results—We conducted a prospective cohort study in a nationally representative sample of 169 871 Chinese men and women aged ≥40 years. Data on systolic (SBP) and diastolic blood pressure (DBP) and other variables were obtained at a baseline examination in 1991 with the use of standard protocols. Follow-up evaluation was conducted in 1999–2000, with a response rate of 93.4%. Hypertension subtypes were defined as combined systolic and diastolic hypertension (SBP ≥140 and DBP ≥90 mm Hg), isolated systolic hypertension (SBP ≥140 and DBP <90 mm Hg), isolated diastolic hypertension (SBP <140 and DBP ≥90 mm Hg), and 2 categories of treated hypertension (SBP <140 and DBP <90 mm Hg or SBP ≥140 and/or DBP ≥90 mm Hg). After participants with missing BP values were excluded, 169 577 adults were included in the analyses. Compared with normotensives, relative risks (95% CIs) of cardiovascular disease incidence and mortality were 2.73 (2.60 to 2.86) and 2.53 (2.39 to 2.68) for combined systolic and diastolic hypertension, 1.78 (1.69 to 1.87) and 1.68 (1.58 to 1.78) for isolated systolic hypertension, 1.59 (1.43 to 1.76) and 1.45 (1.27 to 1.65) for isolated diastolic hypertension, 2.01 (1.64 to 2.48) and 1.61 (1.28 to 2.03) for treated hypertension with SBP <140 and DBP <90 mm Hg, and 3.37 (3.07 to 3.69) and 2.88 (2.60 to 3.19) for treated hypertension with SBP ≥140 and/or DBP ≥90 mm Hg, respectively, after adjustment for important covariates.

Conclusions—Our results indicate that all hypertension subtypes are associated with significantly increased risk of cardiovascular disease in Chinese adults. Primary prevention of hypertension should be a public health priority in the Chinese population. (Circulation. 2008;118:1558-1566.)

Key Words: cardiovascular diseases ■ Chinese ■ hypertension ■ relative risk

Cardiovascular disease (CVD) has become the leading cause of death among Chinese adults, with a heart disease mortality (per 100 000 person) of 319.1 in men and 268.5 in women and stroke mortality of 310.5 in men and 7.7% were taking antihypertensive medication.5

Clinical Perspective 1566

In recent years, the common paradigm of hypertension research has shifted from diastolic (DBP) to systolic BP (SBP) as the most important determinant of CVD risk.6–8 Researchers have investigated the singular and combined effects of elevations in SBP and DBP, with a growing awareness that hypertension subtypes may reflect unique biological processes, perhaps with distinct clinical implications.9–11 SDH arises from a combination of increased arterial stiffness along with a rise in arteriolar resistance; ISH reflects increased arterial stiffness alone and is most common in the elderly, and IDH is a consequence of an increase in only arteriolar resistance and is more frequent in young and middle-aged persons.10–12 A clear understanding of how each

Received June 23, 2007; accepted December 28, 2007.

From the Departments of Epidemiology (T.N.K., J.C., J.H.) and Biostatistics (C.L.Y.), Tulane University School of Public Health and Tropical Medicine, and Department of Medicine (J.C., J.H.), Tulane University School of Medicine, New Orleans, La; Cardiovascular Institute and Fuwai Hospital of the Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China (D.G., J.-f.H., J.-c.C., X.D., X.W.); and President’s Office, Loyola University Medical Center, Maywood, Ill (P.K.W.).

Correspondence to Jiang He, MD, PhD, Department of Epidemiology, Tulane University School of Public Health and Tropical Medicine, 1430 Tulane Ave SL18, New Orleans, LA 70112 (e-mail jhe@tulane.edu); or Dongfeng Gu, MD, MSc, Division of Population Genetics and Prevention, Cardiovascular Institute and Fu Wai Hospital, 167 Beilishi Rd, Beijing 100037, China (e-mail gudongfeng@vip.sina.com).

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Circulation is available at http://circ.ahajournals.org

DOI: 10.1161/CIRCULATIONAHA.107.723593
of these pathophysiological mechanisms influences CVD risk is crucial for establishing appropriate treatment recommendations and guidelines. Whereas several studies have been conducted in Western populations examining this association, very few have been conducted in Asian populations, and none have been conducted in a nationally representative cohort of Chinese adults.12–14

The purpose of this study was to quantify the risk of CVD, coronary heart disease (CHD), and stroke incidence and mortality associated with hypertension subtype in a prospective, nationally representative Chinese cohort. In addition, gender- and age-specific effects of hypertension subtype on CVD risk were examined.

**Methods**

**Study Population**

In 1991, the third China National Hypertension Survey was performed in all 27 provinces and 3 municipalities of mainland China with the use of a multistage random cluster sampling design to select a nationally representative sample of the Chinese population aged ≥15 years.15 In 1999–2000, investigators from each province were invited to participate in the Chinese National Hypertension Epidemiology Follow-up study. Of the 30 provinces or autonomous regions, 13 were not included in the follow-up study because study participants’ contact information was not available (Figure 1). However, the sampling process was conducted independently within each province in the 1991 China National Hypertension Survey, and the 17 provinces that were included in the follow-up study were evenly distributed in different geographic regions representing various economic developing statuses in China. Participants from included provinces did not differ with respect to baseline characteristics compared with those from excluded provinces. Overall, 83,533 men and 86,338 women aged ≥40 years at their baseline examination were eligible to participate in the follow-up study. From this population, a total of 158,666 study participants (93.4%) (or their proxies) were identified and agreed to be interviewed as part of the follow-up study. In this report, study participants with missing BP values (n=283) and prevalent CVD (n=4412), CHD (n=2253), or stroke (n=2303) were excluded from related analyses, respectively. Figure 2 shows the sample size of participants and exclusion reasons in our study.

![Figure 1. Map of China with participating provinces highlighted.](image)

**Figure 1.** Map of China with participating provinces highlighted.

![Figure 2. Flow chart of participant recruitment and derivation of the population used in the final analysis.](image)

**Figure 2.** Flow chart of participant recruitment and derivation of the population used in the final analysis.
Baseline Examination
Baseline data were collected at a single clinic visit by specially trained physicians and nurses using standardized methods with stringent levels of quality control.\textsuperscript{15} Data on demographic characteristics, medical history (including physician’s diagnosis of hypertension and other CVD as well as use of antihypertensive medication), and lifestyle risk factors were obtained with the use of a standard questionnaire administered by trained staff. Work-related physical activity was assessed because leisure-time physical activity was uncommon. Cigarette smokers were defined as having smoked at least 1 cigarette per day for \geq 1 year. Alcohol consumption was defined as drinking alcohol at least 12 times during the last year. Body weight and height were measured in light indoor clothing without shoes according to a standardized protocol. Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters. Three BP measurements were obtained by a trained observer using a standard mercury sphygmomanometer according to a standard protocol after the study participant had been seated quietly for 5 minutes.\textsuperscript{16} The first and fifth Korotkoff sounds were recorded for SBP and DBP, respectively. Participants were instructed not to eat; drink alcohol, coffee, or tea; smoke; or exercise for at least 30 minutes before their BP measurement. The mean of 3 BP measures was used in all analyses. There was no evidence of digit preference on BP readings.

Follow-Up Data Collection
The follow-up examination, which was conducted in 1999–2000, included tracking study participants or their proxies to a current address, performing in-depth interviews to ascertain disease status and vital information, and obtaining hospital records and death certificates. If a study participant reported a hospitalization or emergency department overnight stay because of a study outcome including acute myocardial infarction or stroke during the in-person interview, the participant’s hospital records, including medical history, physical examination findings, laboratory test results, and discharge diagnosis, were abstracted by trained staff using a standard form. In addition, photocopies of selected sections of the participant’s inpatient record, discharge summary, ECG, and pathology reports were obtained. All deaths reported during the in-person interview were verified by obtaining death certificates from the local public health department or police department. If death occurred during a hospitalization, the participant’s hospital records and autopsy results were also abstracted by trained staff using a standard form. An end point assessment committee within each province reviewed all data abstraction forms to ensure the completeness of medical information.

A studywide end point assessment committee, consisting of cardiologists, neurologists, and a clinical epidemiologist at the Chinese Academy of Medical Sciences in Beijing, China, reviewed all hospital records and death certificates and determined the final diagnosis of event or underlying cause of death according to preestablished criteria.\textsuperscript{17} Two committee members independently verified the diagnosis, and discrepancies were adjudicated by discussion involving additional committee members. All members of the local and studywide end point assessment committees were blinded to the study participant’s baseline risk factor information. Causes of death were coded according to the \textit{International Classification of Diseases, Ninth Revision (ICD-9)}.\textsuperscript{18}

For this analysis, CVD was defined as a confirmed diagnosis of acute myocardial infarction or stroke during the follow-up period or mortality with a cardiovascular event (\textit{ICD-9} 390.0 to 398.9, 401.0 to 429.9, and 430.0 to 438.9) listed as an underlying cause of death. CHD was defined as a confirmed diagnosis of acute myocardial infarction during the follow-up period or CHD listed as an underlying cause of death (\textit{ICD-9} 410.0 to 414.9). Finally, stroke was defined as a confirmed diagnosis of stroke during the follow-up period or stroke listed as an underlying cause of death (\textit{ICD-9} 430.0 to 438.9).

This study was approved by the Tulane University Health Sciences Center Institutional Review Board and the Cardiovascular Institute and Fu Wai Hospital Ethics Committee. Written informed consent was obtained from all study participants who agreed to participate in the follow-up study.

Statistical Analysis
Hypertension subtype was determined by average baseline SBP and DBP and use of antihypertensive medications. Treated hypertensives, defined as receiving antihypertensive medication within the past 2 weeks, were further categorized into 1 of 2 groups, SBP <140 and DBP <90 mm Hg or SBP \geq 140 and/or DBP \geq 90 mm Hg. Untreated hypertensive participants were grouped according to SBP and DBP as follows: SDH (SBP \geq 140 mm Hg and DBP \geq 90 mm Hg), ISH (SBP \geq 140 mm Hg and DBP <90 mm Hg), or IDH (SBP <140 mm Hg and DBP \geq 90 mm Hg). Participants with a SBP <140 mm Hg and DBP <90 mm Hg were classified into the normotensive group.

Baseline characteristics were compared between each hypertension subtype and the normotensive group with the use of \chi² tests for categorical variables and ANOVA for continuous variables. Person-years of follow-up were calculated from the date of baseline examination until the date of cardiovascular event, death, or follow-up interview for each study participant. Age-standardized incidence and mortality were calculated with the 5-year age-specific incidence and mortality and the age distribution of the Chinese population from year 2000 census data.

To examine the association between hypertension subtype and CVD incidence and mortality, Cox proportional hazards regression models were used to adjust for baseline age, sex, education, cigarette smoking, alcohol consumption, physical inactivity, BMI, geographic region (north versus south), urbanization (rural versus urban), and diabetes as a time-dependent covariate. The onset time and diagnosis of diabetes were self-reported. Multivariable-adjusted relative risks (RRs) were calculated with normotensives used as the reference category. Subgroup analyses by gender and age (<60 or \geq 60 years) were conducted. The proportional hazards assumption was assessed visually with plots of the Schoenfeld residuals versus time for each covariate modeled. Methods to estimate variances that take into account sample clustering, by province, were used in Cox proportional hazards models.\textsuperscript{18} Statistical analyses were conducted with the use of SAS statistical software (version 9.1; SAS Institute Inc, Cary, NC).

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

Results
Baseline characteristics of the study participants by normotensive status and hypertension subtype are presented in Table 1. Overall, SDH was the most common hypertension subtype (10.8%), followed by ISH (10.5%) and IDH (3.6%). Only 2.8% of study participants were taking antihypertensive medication, with a SBP <140 and DBP <90 mm Hg attained in 24.0% of those treated. The average age of study participants ranged from 52.9 years among those with IDH to 64.6 years among those with ISH. Compared with the normotensive group, all hypertension subtypes had a higher mean BMI, SBP, and DBP. Moreover, hypertensive participants were more likely to be physically inactive, diabetic, and living in urban regions compared with normotensive participants. With the exception of those with ISH, hypertensive participants were also more likely to be living in north China. High school education, cigarette smoking, and alcohol consumption varied between groups, with the highest percentage among those with IDH.

During an average follow-up of 8.3 years, there were a total of 11 543 cardiovascular events (8745 fatal), including 1907 CHD events (1300 fatal) and 7151 strokes (4249 fatal). The treated hypertensives with a SBP \geq 140 and/or DBP \geq 90 mm Hg had the highest RR of all cardiovascular events
compared with normotensive participants (Table 2). The treated hypertensives with a SBP <140 and/or DBP <90 mm Hg were also at an increased risk of CVD, CHD, and stroke incidence and mortality compared with normotensive participants. Among untreated hypertensives, those with SDH had the highest RR of all cardiovascular events. Both ISH and IDH conferred similar increased risks of CVD, CHD, and stroke incidence and mortality compared with the normotensive group.

The association between hypertension subtype and CVD incidence and mortality was consistent between genders (Table 3). Similarly, the multivariable-adjusted RRs (95% CI) of stroke incidence in men and women were 3.68 (3.41 to 3.98) and 3.84 (3.49 to 4.21) for SDH, 2.09 (1.91 to 2.30) and 2.33 (2.11 to 2.57) for ISH, 1.70 (1.46 to 1.98) and 2.21 (1.78 to 2.74) for IDH, 2.20 (1.55 to 3.13) and 2.76 (1.94 to 3.93) for treated hypertensives with a SBP <140 and DBP <90 mm Hg, and 4.17 (3.56 to 4.87) and 4.87 (4.16 to 5.70) for treated hypertensive with a SBP ≥140 and/or DBP ≥90 mm Hg, respectively. The multivariable-adjusted RRs (95% CI) of stroke mortality in men and women were 4.18 (3.77 to 4.62) and 4.21 (3.71 to 4.77) for SDH, 2.13 (1.89 to 2.39) and 2.40 (2.11 to 2.72) for ISH, 1.72 (1.36 to 2.17) and 2.29 (1.66 to 3.15) for IDH, 2.32 (1.57 to 3.42) and 2.22 (1.38 to 3.57) for treated hypertensives with a SBP <140 and DBP <90 mm Hg, and 4.23 (3.54 to 5.06) and 4.40 (3.61 to 5.37) for treated hypertensives with a SBP ≥140 and/or DBP ≥90 mm Hg, respectively. Because of the small number of CHD events and deaths in women, the multivariable-adjusted RR estimates by gender were unstable (data not shown).

Table 1. Baseline Characteristics of Study Participants by Hypertension Subtype

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normotensives</th>
<th>SDH</th>
<th>ISH</th>
<th>IDH</th>
<th>Treated Hypertensives</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participants</td>
<td>122,612</td>
<td>18,310</td>
<td>17,849</td>
<td>6,140</td>
<td>1121</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>54.1 (10.1)</td>
<td>59.2 (10.4)‡</td>
<td>64.6 (10.6)‡</td>
<td>52.9 (9.3)‡</td>
<td>58.9 (9.5)‡</td>
</tr>
<tr>
<td>Men, No. (%)</td>
<td>60,538 (49.4)</td>
<td>9326 (50.9)‡</td>
<td>7333 (41.1)‡</td>
<td>4002 (65.2)‡</td>
<td>510 (45.8)‡</td>
</tr>
<tr>
<td>≥High school education, No. (%)</td>
<td>26,839 (24.3)</td>
<td>4352 (25.1)*</td>
<td>2614 (16.0)‡</td>
<td>2053 (25.3)‡</td>
<td>332 (22.1)‡</td>
</tr>
<tr>
<td>Cigarette smokers, No. (%)</td>
<td>42,784 (38.4)</td>
<td>6434 (37.0)‡</td>
<td>5628 (34.2)§</td>
<td>2465 (42.3)‡</td>
<td>317 (30.7)‡</td>
</tr>
<tr>
<td>Alcohol consumption, No. (%)</td>
<td>21,819 (19.6)</td>
<td>3810 (21.9)‖</td>
<td>2776 (16.9)§</td>
<td>1645 (28.2)‡</td>
<td>155 (15.0)‖</td>
</tr>
<tr>
<td>Physical inactivity, No. (%)</td>
<td>37,553 (33.5)</td>
<td>7515 (42.9)‡</td>
<td>7414 (44.8)‡</td>
<td>2196 (37.3)‡</td>
<td>697 (67.4)‡</td>
</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>22.1 (3.4)</td>
<td>24.3 (4.1)†</td>
<td>22.8 (4.0)†</td>
<td>24.1 (3.6)‡</td>
<td>24.8 (3.8)‡</td>
</tr>
<tr>
<td>Diabetes, No. (%)</td>
<td>1597 (1.4)</td>
<td>548 (3.3)‡</td>
<td>422 (2.6)‡</td>
<td>153 (2.7)‡</td>
<td>53 (5.2)‡</td>
</tr>
<tr>
<td>SBP, mean (SD), mm Hg</td>
<td>116.0 (12.4)</td>
<td>163.0 (19.5)‡</td>
<td>152.9 (13.4)‡</td>
<td>130.3 (6.8)‡</td>
<td>126.0 (9.4)§</td>
</tr>
<tr>
<td>DBP, mean (SD), mm Hg</td>
<td>72.7 (8.5)</td>
<td>98.4 (8.5)‡</td>
<td>79.7 (7.4)§</td>
<td>92.4 (3.5)‡</td>
<td>77.6 (7.9)§</td>
</tr>
<tr>
<td>North, No. (%)</td>
<td>70,973 (57.9)</td>
<td>13,516 (73.8)§</td>
<td>10,450 (58.6)</td>
<td>4749 (77.4)§</td>
<td>693 (61.8)*</td>
</tr>
<tr>
<td>Urban, No. (%)</td>
<td>67,829 (55.3)</td>
<td>12,224 (66.8)‖</td>
<td>10,752 (60.2)‡</td>
<td>4386 (71.4)‖</td>
<td>912 (81.4)‡</td>
</tr>
</tbody>
</table>

*P<0.05, †P<0.001, ‡P<0.0001 for χ² test or ANOVA, compared with normotensive group.

Discussion

Although elevated BP has long been established as an important risk factor for CVD, the risk conferred by hypertension subtype has not been well examined. Our analysis indicates that among untreated hypertensives, participants with SDH were at the highest risk for any cardiovascular event, whereas both ISH and IDH increased the risk of CVD compared with their normotensive counterparts. We found that treated hypertensives, including those with a SBP <140 and DBP <90 mm Hg, were at an increased risk of CVD compared with normotensives, whereas treated participants with a SBP ≥140 and/or DBP ≥90 mm Hg had the highest risk among all hypertension subtypes studied. An increased risk of CVD associated with hypertension subtype was observed in both genders and age groups. The present results emphasize the importance of hypertension subtype in predicting CVD risk and highlight the need for a public health response focusing on primary prevention of hypertension in the general Chinese population.

The present study is the only prospective cohort in which the association between hypertension subtype and CVD risk was evaluated. Although a very high follow-up rate of 93.4% was achieved, there were no losses to follow-up. The use of antihypertensive medication was also a limitation. BP measurements and information on the use of antihypertensive medication were collected only at the baseline examination, and therefore the impact of changes in these measurements on CVD risk cannot be assessed.
be assessed. In addition, because the original survey was not conducted with the current follow-up study in mind, important covariables including serum lipids, glucose, diet, and leisure-time physical activity were not obtained, and information on lifestyle risk factors and medical history was self-reported. Lack of or underadjustment for these variables might have resulted in a slight overestimation of the RR of CVD. Furthermore, study outcomes were identified by self-
reported events retrospectively, and only 1 underlying cause of death was recorded for each participant, which might underascertain events. Finally, no information on stroke subtype was available, and although associations between BP and both ischemic and hemorrhagic strokes have been observed, the precise effects of hypertension subtype on differing stroke types may vary because of the distinct etiologies of these conditions.14,19,20

In general, we observed lower CHD and higher stroke rates for any given BP level compared with studies conducted in Western populations.21,22 A lower serum lipid level in the Chinese population may help to explain the lower rates of CHD.23 Similarly, population differences in CVD risk factors may explain the higher stroke rates. For example, hemorrhagic strokes are more common in the Chinese population than in Western populations.24,25 Low serum cholesterol level and cigarette smoking are important risk factors for hemorrhagic stroke.

ISH has been associated with a higher risk of CVD compared with SDH in some large, prospective studies.26–28 In contrast, our results and findings from other studies suggest that SDH confers a higher CVD risk compared with ISH.12,14 Discrepancies may be due to heterogeneity between the study populations regarding age and other CVD risk factors.

The present study also showed that IDH was a significant predictor of CVD in the general Chinese population. Some studies have indicated no relationship between IDH and CVD risk,25–27 but others have reported results similar to our findings.14 A recent study by Fang et al14 examining the effects of hypertension subtype in a Chinese cohort reported a 2.2-fold increased risk of stroke incidence associated with IDH, which was similar to our observation. Again, population heterogeneity may have contributed to these discrepant findings in the relationship between IDH and CVD risk.

An important finding of this study is that treated hypertensives, including those with a SBP <140 and DBP

### Table 3. RR of CVD by Hypertension Subtype and Gender

<table>
<thead>
<tr>
<th></th>
<th>Normotensives</th>
<th>Untreated Hypertensives</th>
<th>Treated Hypertensives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SDH</td>
<td>ISH</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVD incidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person-years of follow-up</td>
<td>440 334</td>
<td>56 581</td>
<td>45 445</td>
</tr>
<tr>
<td>No. of events</td>
<td>3182</td>
<td>1567</td>
<td>1143</td>
</tr>
<tr>
<td>Age-standardized rate, per 100 000 person-years</td>
<td>668.8</td>
<td>1895.6</td>
<td>1172.5</td>
</tr>
<tr>
<td>Age- and sex-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.67 (2.51–2.85)</td>
<td>1.74 (1.62–1.86)</td>
</tr>
<tr>
<td>Multivariable-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.72 (2.56–2.90)</td>
<td>1.76 (1.64–1.89)</td>
</tr>
<tr>
<td>CVD mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person-years of follow-up</td>
<td>449 693</td>
<td>63 290</td>
<td>48 990</td>
</tr>
<tr>
<td>No. of events</td>
<td>2297</td>
<td>1242</td>
<td>930</td>
</tr>
<tr>
<td>Age-standardized rate, per 100 000 person-years</td>
<td>474.1</td>
<td>1227.9</td>
<td>741.8</td>
</tr>
<tr>
<td>Age- and sex-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.56 (2.39–2.75)</td>
<td>1.59 (1.47–1.72)</td>
</tr>
<tr>
<td>Multivariable-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.54 (2.36–2.74)</td>
<td>1.63 (1.51–1.77)</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVD incidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person-years of follow-up</td>
<td>455 726</td>
<td>56 514</td>
<td>67 981</td>
</tr>
<tr>
<td>No. of events</td>
<td>2222</td>
<td>1153</td>
<td>1246</td>
</tr>
<tr>
<td>Age-standardized rate, per 100 000 person-years</td>
<td>502.5</td>
<td>1531.3</td>
<td>923.5</td>
</tr>
<tr>
<td>Age- and sex-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.70 (2.51–2.91)</td>
<td>1.79 (1.66–1.93)</td>
</tr>
<tr>
<td>Multivariable-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.75 (2.55–2.96)</td>
<td>1.81 (1.68–1.95)</td>
</tr>
<tr>
<td>CVD mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person-years of follow-up</td>
<td>463 624</td>
<td>62 321</td>
<td>71 777</td>
</tr>
<tr>
<td>No. of events</td>
<td>1585</td>
<td>892</td>
<td>1008</td>
</tr>
<tr>
<td>Age-standardized rate, per 100 000 person-years</td>
<td>368.0</td>
<td>1018.2</td>
<td>598.3</td>
</tr>
<tr>
<td>Age- and sex-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.55 (2.35–2.78)</td>
<td>1.67 (1.54–1.82)</td>
</tr>
<tr>
<td>Multivariable-adjusted RR (95% CI)</td>
<td>1.0</td>
<td>2.53 (2.32–2.76)</td>
<td>1.72 (1.59–1.87)</td>
</tr>
</tbody>
</table>

*Adjusted for baseline age, sex, education, cigarette smoking, alcohol consumption, physical inactivity, BMI, geographic region (north vs south), urbanization (rural vs urban), and diabetes as a time-dependent covariate.
<90 mm Hg, were at an increased risk of all cardiovascular events compared with participants with a normal BP. To date, many clinical trials have shown that antihypertensive treatment results in a reduction of cardiovascular events, but few studies have compared treated hypertensives to normotensives in a prospective cohort.\textsuperscript{14,29–33} A recent study by Almgren et al\textsuperscript{33} indicated that treated hypertensive men had an elevated risk of CHD and stroke compared with men with normal BP, which is confirmed by the findings of this study. The high risk of CVD conferred by inadequate treatment of hypertension emphasizes the need for more aggressive antihypertensive treatment in this population. The potential benefits of BP-lowering treatment are reflected in the lower risks experienced by treated participants with a SBP <140 and DBP <90 mm Hg. Despite adequate treatment of BP based on current guidelines, these participants still experienced higher rates of cardiovascular events compared with participants with normal BP. As a matter of fact, mean BP levels in this group were significantly higher than those in normotensive participants. These findings illustrate that BP treatment to the “controlled” range based on the current guideline still translates into higher CVD-related morbidity and mortality. Future studies are warranted to examine the benefit of lowering BP to normal levels, ie, SBP <120 and DBP <80 mm Hg, on CVD risk. Our results also underscore the need for an increased focus on primary prevention of hypertension to reduce the societal burden of CVD in the Chinese population.

Increased risks of CVD incidence and mortality associated with all hypertension subtypes were observed among men and women and among those aged ≥60 and <60 years. The relationships between each subtype and CVD risk were
consistent across genders. Although similar patterns of association were seen between age groups, the risk of CVD conferred by hypertension subtype was attenuated among participants aged ≥60 years compared with participants aged <60 years. These results are similar to findings reported elsewhere, and, overall, they highlight the importance of hypertension prevention and treatment in both genders and all age groups.

In conclusion, our study identified a significantly increased risk of CVD associated with ISH, IDH, and SDH elevations in BP. Most importantly, this analysis indicated that treated hypertensives are at a significantly increased risk of CVD, including those with a SBP <140 and DBP <90 mm Hg. Therefore, although more aggressive secondary prevention efforts may help to decrease CVD risk among those already affected with inadequately treated or untreated hypertension, the primary prevention of hypertension may be most effective and should be considered the first choice for curbing the rising CVD epidemic in this population. A national program emphasizing lifestyle modification for the primary prevention of hypertension should be established in China.

Sources of Funding
This study was supported by a national Grant-in-Aid (9750612N) from the American Heart Association, Dallas, Tex, and partially supported by a grant (R01 HL68057) from the National Heart, Lung, and Blood Institute of the National Institutes of Health, Bethesda, Md, and by a grant (1990-272) from the Chinese Ministry of Health, Beijing, China, and by the Chinese Academy of Medical Sciences, Beijing, China.

Disclosures
None.

References
We examined the relationship between hypertension subtype and cardiovascular disease (CVD) incidence and mortality in a prospective cohort study of 169,871 Chinese men and women aged ≥40 years. Hypertension subtypes were defined as combined systolic and diastolic hypertension (systolic blood pressure [SBP] ≥140 and diastolic BP [DBP] ≥90 mm Hg), isolated systolic hypertension (SBP ≥140 and DBP <90 mm Hg), isolated diastolic hypertension (SBP <140 and DBP ≥90 mm Hg), and 2 categories of treated hypertension (SBP <140 and DBP <90 mm Hg or SBP ≥140 and/or DBP ≥90 mm Hg). All hypertension subtypes were associated with an increased risk of CVD compared with participants with normal BP. Compared with normotensives, combined systolic and diastolic hypertension was associated with 2.73- and 2.53-fold increased risk of CVD incidence and mortality; isolated systolic hypertension was associated with 1.78- and 1.68-fold increased risk of CVD incidence and mortality; isolated diastolic hypertension was associated with 1.59- and 1.45-fold increased risk of CVD incidence and mortality; treated hypertension with SBP <140 and DBP <90 mm Hg was associated with 2.01- and 1.61-fold increased risk of CVD incidence and mortality; and treated hypertension with SBP ≥140 and/or DBP ≥90 mm Hg was associated with 3.37- and 2.88-fold increased risk of CVD incidence and mortality, respectively, after adjustment for important covariables. These findings suggest that more aggressive antihypertensive treatment efforts may help to decrease CVD risk among those already affected with inadequately treated or untreated hypertension, whereas the primary prevention of hypertension may be most effective and should be considered the first choice for curbing the rising CVD epidemic in the Chinese population.
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Circulation. 2008;118:1558-1566; originally published online September 22, 2008; doi: 10.1161/CIRCULATIONAHA.107.723593
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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