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Prevalence of Hypertension Subtypes in 2011 and the Trends from 1991-2011 among Chinese Adults

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Abstract

Background: This study aims to estimate the current prevalence and trends of hypertension subtypes among Chinese adults from 1991 to 2011.

Methods: We analyzed the measurements of systolic and diastolic blood pressure among adults aged 18 years from the China Health and Nutrition Survey (CHNS) 1991–2011. The prevalence was age-adjusted to the 2010 census of Chinese adults.

Results: The adjusted prevalence in 2011 was 20.9% (95% CI, 20.2%–21.6%) of hypertension, 3.30% (95% CI, 2.99%–3.62%) of isolated systolic hypertension, 4.44% (95% CI, 4.08%–4.80%) of isolated diastolic hypertension, 4.11% (95% CI, 3.76%–4.46%) of systolic-diastolic hypertension and 9.01% (95% CI, 8.51%–9.51%) of current use of antihypertensive medication, respectively. Compared with 1991, the prevalence increased from 15.6% to 20.9% for hypertension ($P<0.001$) and from 3.04% to 3.30% for isolated systolic hypertension ($P<0.001$); However, the prevalence decreased from 4.77% to 4.44% for isolated diastolic hypertension ($P=0.023$) and from 5.27% to 4.11% for systolic-diastolic hypertension ($P<0.001$). Consistent with these findings, the percentage of current use of antihypertensive medication increased from 2.55% to 9.01%, which accounted for approximately 43.1% of the total number of

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Contributors

Qing-Bao Tian is the corresponding author and contributed to all aspects of the research and writing process and takes final responsibility for the paper. Su-Fen Qi contributed to the analysis and interpretation of data as well as drafting of the article. Bing Zhang and Hui-Jun Wang contributed to collecting and analysis the data. Jing Yan and Ying-Jun Mi assisted in the analysis, review and final approval of the article, Dian-Wu Liu revise and final approval of the article.

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Competing interests

None declared.

Ethics approval

Ethics permission was obtained from the Institute for Nutrition and Food Safety, the China Center for Disease Control (China CDC)

cases in 2011. Importantly, only 36.9% (equivalent to 17.5% of the total number of hypertensive people) of cases of current use of antihypertensive medication were adequately controlled.

Conclusions: Both the prevalence of hypertension and the percentage of current use of antihypertensive medication significantly increased from 1991 to 2011. Currently, about one-fifth Chinese adults are hypertensive; however, only 17.5% of hypertension is controlled.

Keywords

Chinese; hypertension; prevalence; control; trend

Introduction

Cardiovascular disease (CVD) is the leading cause of death worldwide, and accounts for 30% of deaths globally¹. In China, the burden of major CVDs has increased from 1990–2010², and CVD deaths resulted in a 4.79-year life expectancy loss in the Chinese population³. Hypertension, as a major modifiable risk factor for CVD, accounts for approximately 45% of global CVD morbidity and mortality⁴. Globally, the overall prevalence in adults 25 years of age was 40% in 2008, with the highest being 46% in Africa^{5, 6}. Previous studies in China have suggested that the prevalence of hypertension in adults was from 14.5% in 1991 to 34.0% in 2012^{7–10}. Because hypertension is associated with wide phenotypic variability, it can be divided into the following subtypes: isolated systolic hypertension (ISH), isolated diastolic hypertension (IDH), and systolic-diastolic hypertension (SDH)^{11, 12}. These subtypes may provide important information concerning the causation of hemodynamic and/or structural abnormalities that contribute to hypertension^{11–16}. ISH is associated with increased large artery stiffness^{13, 17}, which is more common in the elderly¹², and age, BMI and smoking are significant independent risk factors of ISH^{17–19}. However, the development of IDH and SDH is associated with increased peripheral vascular resistance^{13, 16}, which is more prevalent among young adults¹², and IDH mainly affected by body mass index (BMI)²⁰.

On the basis of data obtained from the China Health and Nutrition Survey (CHNS), the prevalence of hypertension has increased from 14.5% in 1991 to 21.4% in 2009²¹. However, the prevalence and trends of hypertension subtypes among Chinese adults are still unknown. To further understand these aspects of hypertension in Chinese adults, we present a comprehensive analysis of the trends of the prevalence and proportion of hypertension subtypes among the Chinese population using data obtained from CHNS 1991–2011. In addition, we calculated the crude prevalence of hypertension stratified by age and BMI to estimate the age-specific effect of BMI on hypertension in CHNS 2011.

Methods

Study design

The China Health and Nutrition Survey (CHNS) is an international collaborative project between the National Institute for Nutrition and Food Safety, the Chinese Center for Disease Control and Prevention, and the University of North Carolina at Chapel Hill and is currently the only large-scale longitudinal, household-based survey in China²². The first round of

CHNS was conducted in 1989, and was subsequently performed in 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011 (<http://www.cpc.unc.edu/projects/china>). The CHNS began with eight provinces and a ninth was added, Heilongjiang in 1997, with three largest municipalities including Beijing, Shanghai and Chongqing in 2011. These provinces account for approximately 56% of China's population, varying substantially in geography, economic development, public resources, and health indicators²³. A detailed description of the survey design and procedures has been published elsewhere^{22, 24, 25}.

Study Participants

Analysis was based on data obtained from the CHNS conducted in 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011, because the data were not collected for all age groups in the 1989 survey. This study focused on adults aged 18 years or older in each survey year and the data provided information on age, gender, the use of antihypertensive medications and detailed physical examinations, including systolic blood pressure (SBP), diastolic blood pressure (DBP), height and weight. To limit biases caused by pre-existing factors, participants who had been diagnosed with pregnancy or lactating and participants with missing information on SBP or DBP or extreme or implausible blood pressure (BP) values (SBP-DBP <10 mmHg) were excluded. In addition, to calculate the age-specific effect of BMI on the prevalence of hypertension in CHNS 2011, participants with missing information on height, weight, extreme or implausible height (<120.0 cm) or BMI (BMI <15.0 kg/m² or >40.0 kg/m²) values were excluded.

Anthropometric methods and definitions of hypertension

Blood pressure was based on the mean of three measurements collected after 10 minutes of seated rest and 30-s interval between cuff inflations by experienced physicians using standard mercury sphygmomanometers²⁶. In this process, regularly calibrated mercury sphygmomanometers with appropriate-sized cuffs were employed. SBP was measured at the first appearance of a pulse sound (Korotkoff phase I) and DBP at the disappearance of the pulse sound (Korotkoff phase V)²⁷. Three measurements of SBP or DBP were averaged as the corresponding BP values to reduce the effect of measurement errors. BMI was calculated as participants' weight in kilograms divided by their height in meters squared (kg/m²).

Consistent with the World Health Organization conventions (1999) and the seventh Joint National Commission guidelines (JNC7)²⁶, hypertension was defined as a SBP/DBP 140/90 mm Hg or current use of antihypertensive medication. The following hypertension subtypes were included in the analysis: 1) ISH, defined as SBP 140 mm Hg and DBP <90 mm Hg; 2) IDH, defined as SBP <140 mm Hg and DBP 90 mm Hg; 3) SDH, defined as SBP 140 mm Hg and DBP 90 mm Hg; and 4) current use of antihypertensive medication. However, we were unable to distinguish between ISH, IDH or SDH in hypertension cases of current use of antihypertensive medication because their original BP values were unknown²⁶.

Statistical Methods

Analyses were stratified by gender, age and BMI. On the basis of the patients' age at the interview in 1991–2011, the subjects were stratified into the following age groups: 18–39,

40–59 and 60 years and/or into the following BMI groups: <20, 20–21, 22–23, 24–25, 26–27 and 28 kg/m². Taking into account unequal probabilities of selection, the values of hypertension and subtypes were adjusted by direct method to the 2010 census of the Chinese adults using the corresponding age groups. The age-adjusted prevalence estimates of ISH, IDH and SDH together with the use of antihypertensive medication from the most recent data (the CHNS of 2011) were compared using the chi square test between males and females as well as a comparison of different age groups. Trends in the age-adjusted prevalence of hypertension and subtypes among participants and trends of the proportion of hypertension subtypes from 1991 to 2011 were assessed by using linear-by-linear trend testing.

Statistical analysis was performed using SPSS software for Windows version 13.0. The statistical significance was determined as a two-tailed $P < 0.05$.

Results

After excluding ineligible participants, a total of 74,887 participants aged 18 years old at baseline were included. The selection procedure of the participants in this study is summarized in Fig. 1.

The anthropometric characteristics of all of the participants in eight waves of the CHNS 1991–2011 are displayed in Table 1. The mean age of the participants increased from 41.2 (95% CI, 40.9–41.6) years old in 1991 to 46.9 (95% CI, 46.5–47.2) years old in 2011. The percentage of SBP 140 mm Hg among all participants increased from 9.26% in 1991 to 17.5% in 2011. A similar significant trend was observed in DBP 90 mm Hg.

Age-adjusted prevalence of hypertension and subtypes in CHNS 2011

According to CHNS 2011, 20.9% of the Chinese adults were hypertensive (Table 2). The subtype-specific prevalence of hypertension was 3.30% (95% CI, 2.99%–3.62%) of ISH, 4.44% (95% CI, 4.08%–4.80%) of IDH, 4.11% (95% CI, 3.76%–4.46%) of SDH and 9.01% (95% CI, 8.51%–9.51%) of the current use of antihypertensive medication.

The prevalence was significantly greater for males compared to females (23.4% versus 18.7%; $X^2=40.7$, $P<0.001$; Table 2). Similar significant differences were observed in the prevalence of IDH (6.23% versus 2.92%; $X^2=310$, $P<0.001$) and SDH (5.26% versus 3.09%; $X^2=310$, $P<0.001$) according to gender. However, there was no significant difference between males and females for the prevalence of ISH (3.44% versus 3.21%; $X^2=1.19$, $P=0.275$). In contrast, the prevalence of the use of antihypertensive medication was significantly greater for females compared to males (8.49% versus 9.52%, $X^2=59.2$, $P<0.001$).

The prevalence of hypertension in 2011 increased with age; with the highest prevalence being 47.8% (95% CI, 45.4%–50.1%) and 50.4% (95% CI, 48.1%–52.6%) in the age group of 60 years in males and females (eTable 1). Similar increasing trends were observed in the ISH and the use of antihypertensive medications. However, the highest prevalence of IDH was 8.42% (95% CI, 7.38%–9.45%) and 4.45% (95% CI, 3.72%–5.18%) in the age group of

40–59 years in males and females, respectively. Interestingly, the highest prevalence of SDH was 10.4% (95 %CI, 9.24%–11.5%) in males aged 40–59 years and 5.84% (95 %CI, 4.79%–6.88%) in females in the age group of 60 years.

Trend of age-adjusted prevalence of hypertension and subtypes

Secular changes in the age-adjusted prevalence of hypertension and subtypes among Chinese adults from 1991 to 2011 are presented in Table 2. Compared with 1991, the age-adjusted prevalence increased from 15.6% to 20.9% for hypertension ($P<0.001$); and 3.04% to 3.30% for ISH; however, the prevalence was decreased from 4.77% to 4.44% for IDH; and from 5.27% to 4.11% for SDH. Consistent with these findings, the prevalence of the current use of antihypertensive medication increased from 2.55% to 9.01% ($P<0.001$). Details of age- and gender-specific prevalence of hypertension and subtypes are shown in Table S1

Crude prevalence of hypertension stratified by age and BMI in 2011

To further clarify the effects of BMI on age-specific prevalence of hypertension, we calculated crude prevalence to estimate the age-specific effect of BMI in CHNS 2011 (Fig. 2). The BMI-specific prevalence increased sharply when BMI ≥ 24 kg/m² in groups of those aged 18–39 and 60, indicating that body weight has a strong effect on hypertension and optimal BMI should be lower than 24 in these two age groups. In contrast, the BMI-specific prevalence of hypertension increased gradually without platforms in the group of those aged 40–59. Interestingly, the prevalence in the group of those aged 18–39 and a BMI of 26–27 (13.1%, 95% CI, 9.39%–16.9%) was similar to the group of those aged 40–59 and a BMI of 20–21 (12.9%, 95% CI, 10.7%–15.1%) (Fig. 2), suggesting that the effect of increasing 6 kg/m² on the risk of hypertension was equivalent to that of increasing age by twenty years old. A similar pattern was observed in the group of those aged 40–59 and BMI of 26–27 (33.5%, 95% CI, 30.5%–36.5%) and the group of those aged 60 and BMI <20 (30.6%, 95% CI, 26.3%–34.9%). Taken together, our findings suggest that the effect of increasing 6–8 kg/m² on the risk of hypertension could be equivalent to that of increasing age by twenty years.

Trend of the proportion of hypertension subtypes from 1991 to 2011

In CHNS 2011, a total of 3501 individuals had hypertension. Among these cases, 593 (16.9%), 573 (16.4%), 667 (19.1%) and 1668 (47.6%) patients had ISH, IDH and SDH and currently used of antihypertensive medication (Fig. 3). In individuals who currently used of antihypertensive medication, 1053 (63.1%) patients were uncontrolled, including 394 (23.6%) with ISH, 137 (8.20%) with IDH and 522 (31.4%) with SDH. In contrast, only 615 (36.9%) patients (equivalent to 17.5% of the total number of hypertensive people) of cases taking medication were adequately controlled.

The trend of the proportion of hypertension subtypes from 1991 to 2011 is observed in Fig. 3. The proportion of individuals taking antihypertensive medication among hypertension cases was increased from 16.1% in 1991 to 47.6% in 2011 ($P<0.001$) (Fig. 3A). Consistent with these findings, the proportion of ISH, IDH and SDH decreased ($P<0.001$). Similarly, the proportion of individuals who were controlled into SBP ≤ 140 mm Hg and DBP ≤ 90 mm Hg among people who used antihypertensive medication increased from 18.5% in 1991 to

36.9% in 2011 ($P<0.001$) (Fig. 3B). The same increasing trend was observed in the proportion of ISH ($P<0.001$), where the trend of the proportion of IDH showed no significant change ($P=0.117$). Accordingly, the proportion of SDH among people who used antihypertensive medication decreased from 54.5% to 31.3% ($P<0.001$).

Period effect on prevalence of hypertension and subtypes in 1991–2011

To further clarify the period (1991–2011) effect on hypertension, the age-specific (40, 50 and 60 years) prevalence in different periods (1991–2000, 2000–2011 and 1991–2011) was analyzed (Fig. 4). The prevalence of hypertension increased from 9.84% in 1991 to 36.6% in 2011 males aged 50 years, which reflected the period effect on the age-specific prevalence of hypertension over the period of 1991–2011. However, we could not find a period effect in other age-groups (Fig. 4A). A similar period effect was found in the prevalence of ISH (Fig. 4B), which increased over the period of 1991–2011 in males aged 50 years and 60 years. There was no period effect on age-specific prevalence of IDH even when stratified by gender (Fig. 4C). The prevalence of SDH decreased from 17.4% to 9.33% in males and from 13.8% to 5.97% in females aged 60 years over the period of 1991–2011 (Fig. 4D). In contrast, the prevalence of using antihypertensive medication increased from 6.52% to 18.7% in males and from 6.90% to 20.9% in females aged 60 years over the same period (Fig. 4E).

Discussion

This study reported the recent prevalence and trends of hypertension subtypes as well as the use of antihypertensive medications among Chinese adults aged 18 years or older, based on the CHNS from 1991 through 2011. Compared with 1991, the prevalence increased from 15.6% to 20.9% for hypertension and from 3.04% to 3.30% for ISH; however, the prevalence decreased from 4.77% to 4.44% for IDH and from 5.27% to 4.11% for SDH. Consistent with these findings, the percentage of current use of antihypertensive medication increased from 2.55% to 9.01%, which accounted for approximately 43.1% of the number of cases in 2011. Importantly, only 36.9% (equivalent to 17.5% of the total number of hypertensive people) of cases taking medication were adequately controlled.

The present data showed a striking increase in the prevalence of hypertension from 1246 (15.6%) to 3501 (20.9%) in Chinese adults based on the CHNS 1991–2011, which is equivalent to 222 million individuals. A similar trend was observed in studies based on data obtained from the national survey data in China in 1991–2002^{7, 28} and CHNS 1991–2009²¹. The data taken together showed that the prevalence of hypertension in China has been increasing over the past 20 years.

The prevalence of hypertension was 22.9% in CHNS 2009 and 20.9% in CHNS 2011 in our study, which were lower than values reported by recent studies^{10, 29}. These discrepant findings resulted from the differential age of the participants. For example, we used one database of CHNS aged 18 years, whereas Li et al¹⁰ used integrated data obtained from 48 independent studies with subjects aged 20–79 years. However, this discrepancy could have resulted from a different population used for calculating the age-adjusted prevalence. For example, we used the 2010 census data with 22.9% in CHNS 2009, whereas Xi et al²¹ used the 2000 census of Chinese adults adjusting with 21.4% in CHNS 2009.

The percentage of the current use of antihypertensive medication was 9.01% in 2011, which accounted for approximately 43.1% among the total hypertensive people in 2011. Importantly, only 36.9% (equivalent to 17.5% among the total number of hypertensive people) of cases among patients taking medication were adequately controlled in our study, which was equivalent to 35.3 million individuals who were under controlled among the 95.7 million individuals using antihypertensive medication in CHNS 2011. These percentages were higher compared to the previous studies, in which treatment and control of the total number of the total hypertensive people, and control among patients taking medication were 34.1%, 9.3% and 27.4%, respectively, in 2009²⁹, and 35.2%, 11.2% and 31.8%, respectively, in 2010¹⁰. In a previous study on CHNS 2009, the treatment and control of hypertension in the total number of hypertensive people and of patients taking medication were 22.8%, 6.1%, and 33.1% in 2009²¹. These inconsistent data indicated the percentage of hypertension control in all hypertensive people and increased more rapidly in patients taking medication.

The results of the age-specific effect of BMI on the prevalence of hypertension indicated that body weight had a strong effect on hypertension and optimal BMI, which was lower than 24 in the group of those aged 18–39 and 60 years old; however, the BMI-specific prevalence of hypertension increased gradually without platforms in the group of those aged 40–59 in CHNS 2011. These above results suggested that overweight and obesity is associated with the prevalence of hypertension in Chinese adults.

Both the prevalence of hypertension and the percentage of the current use of antihypertensive medication increased significantly from 1991 to 2011. Currently, about one-fifth of Chinese adults were hypertensive; however, the overall treatment, and control of hypertension (in hypertensive individuals) increased over time, but are still unacceptably low. Taken together, our results suggest an urgent need for controlling modifiable risk factors (particularly those maintaining a BMI less than 24 kg/m² for life, which is important to control hypertension) and a national hypertension education program to improve the prevention, detection, treatment and control of hypertension in China, with the ultimate goal of lowering hypertension-related morbidity and mortality.

Study Limitations

Some limitations should be considered when interpreting our data. First, this study is limited due to its cross-sectional nature, thus cause and effect could not be established. Second, other social and environmental variables such as physical activity and diet as well as geographic regions, which may have impact on hypertension, were not considered. Third, although three BP measurements were obtained to estimate the average, all of which were obtained on a single visit, which may result in an overestimation of uncontrolled hypertension. However, this effect should be minimized for the within-sample comparison²¹. Despite these limitations, we had a large sample size and all BP measurements were performed at the study subjects' homes, which would minimize the white-coat hypertension effect. Finally, because the CHNS population is not a representative sample, caution should be taken when generalizing these results to the whole national population.

Conclusions and perspectives

Both the prevalence of hypertension and the percentage of the current use of antihypertensive medication increased significantly from 1991 to 2011. Currently, about one-fifth of Chinese adults were hypertensive; however, only 17.5% of hypertension was controlled. Taking into account the high prevalence of hypertension and low hypertension treatment and control rates, these data underscore the critical need to determine an effective way for hypertension prevention and control in China.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviation:

CVD	Cardiovascular disease
ISH	isolated systolic hypertension
IDH	isolated diastolic hypertension
SDH	systolic-diastolic hypertension
BMI	body mass index
CHNS	China Health and Nutrition Survey
SBP	systolic blood pressure
DBP	diastolic blood pressure
BP	blood pressure
CI	confidence interval

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What is already known on this subject?

The prevalence of hypertension has increased in the previous study. However, the prevalence and trends of hypertension subtypes among Chinese adults are still unknown. This study aims to estimate the current prevalence and trends of hypertension subtypes among Chinese adults from 1991 to 2011.

What this study adds?

This study showed the trends of hypertension subtypes among Chinese adults from 1991 to 2011.

FIGURE 1. Flow chart illustrating the sample selection procedure.

FIGURE 2. Crude prevalence of hypertension stratified by age and body mass index (BMI, kg/m²) in 2011

The prevalence of hypertension and 95% confidence intervals (P, 95% CI) of hypertension are shown. The bars indicate 95% CI.

FIGURE 3. Prevalence cases of hypertension and subtypes among Chinese aged 18 years in CHNS 2011.

Prevalence cases of hypertension in the total (A) number of males (C) and females (E); cases were controlled into systolic blood pressure 140 mm Hg and diastolic blood pressure 90 mm Hg among people taking antihypertensive medication in the total (B) number of males (D) and females (F).

ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic-diastolic hypertension; MED, currently taking antihypertensive medication; Controlled, hypertension was controlled into systolic blood pressure 140 mm Hg and diastolic blood pressure 90 mm Hg among people taking antihypertensive medication;

FIGURE 4.

Age-adjusted prevalence of hypertension and subtypes in males and females in 40-, 50- and 60-year-old age groups over the period of 1991–2000, 2000–2011 and 1991–2011 in China.

Table 1.

Characteristics of the Participants Aged 18 Years and Older: CHNS 1991–2011

Survey	1991	1993	1997	2000	2004	2006	2009	2011
All (n)	8567	8125	8565	9396	9138	9163	9474	12459
Age (y) *	41.2 (40.9–41.6)	42.3 (41.9–42.6)	43.7 (43.4–44.1)	45.3 (45.0–45.6)	48.2 (47.9–48.5)	49.4 (49.1–49.7)	50.6 (50.2–50.9)	51.0 (50.7–51.2)
SBP 140 mm Hg [†]	793 (9.26)	745 (9.17)	1091 (12.7)	1229 (13.1)	1391 (15.2)	1332 (14.5)	1827 (19.3)	2176 (17.5)
DBP 90mm Hg [†]	939 (11.0)	1025 (12.6)	1252 (14.6)	1464 (15.6)	1462 (16.0)	1408 (15.4)	1872 (19.8)	1899 (15.2)
BMI (kg/m ²) *	21.7 (21.7–21.8)	21.9 (21.8–21.9)	22.3 (22.3–22.4)	22.8 (22.8–22.9)	23.1 (23.0–23.1)	23.2 (23.1–23.3)	23.4 (23.3–23.4)	23.8 (23.7–23.8)
Ever smoking [‡]	35.5 (34.5–36.5)	34.4 (33.3–35.4)	32.7 (31.7–33.7)	31.8 (30.8–32.7)	32.9 (31.9–34.0)	32.0 (30.9–33.1)	31.6 (30.6–32.5)	31.0 (30.2–31.9)
Alcohol drinker [‡]	38.3 (37.3–39.3)	36.1 (35.0–37.1)	36.4 (35.3–37.4)	35.4 (34.4–36.4)	33.1 (32.0–34.1)	32.0 (31.0–33.0)	33.3 (32.3–34.3)	33.9 (33.0–34.7)
Urban resident [‡]	32.8 (31.8–33.8)	31.6 (30.6–32.6)	35.0 (34.0–36.0)	34.1 (33.2–35.1)	35.0 (34.0–36.0)	34.2 (33.2–35.2)	33.3 (32.3–34.2)	40.6 (39.8–41.5)
Male (n)	4148	3934	4207	4538	4376	4325	4523	5852
Age (y) *	40.9 (40.4–41.3)	41.9 (41.4–42.3)	43.1 (42.6–43.6)	44.8 (44.3–45.2)	47.8 (47.3–48.2)	49.0 (48.6–49.5)	50.2 (49.8–50.7)	51.0 (50.6–51.4)
SBP 140 mm Hg [†]	387 (9.33)	353 (8.97)	553 (13.1)	599 (13.2)	671 (15.3)	655 (15.1)	888 (19.6)	1060 (18.1)
DBP 90 mm Hg [†]	519 (12.5)	557 (14.2)	696 (16.5)	802 (17.7)	811 (18.5)	769 (17.8)	1039 (23.0)	1064 (18.2)
BMI (kg/m ²) *	21.5 (21.4–21.6)	21.7 (21.6–21.8)	22.2 (22.1–22.3)	22.7 (22.6–22.8)	23.0 (22.9–23.1)	23.1 (23.0–23.2)	23.4 (23.3–23.5)	23.8 (23.7–23.9)
Ever smoking [‡]	68.1 (66.6–69.5)	65.6 (64.1–67.1)	61.1 (59.6–62.6)	60.5 (59.1–61.9)	64.0 (62.3–65.7)	63.0 (61.3–64.8)	61.6 (60.0–63.1)	61.7 (60.4–63.0)
Alcohol drinker [‡]	64.9 (63.5–66.4)	61.7 (60.2–63.3)	62.8 (61.3–64.2)	61.9 (60.5–63.4)	59.4 (57.8–61.1)	58.5 (57.0–60.1)	59.5 (58.0–61.0)	59.5 (58.2–60.8)
Urban resident [‡]	32.0 (30.1–33.4)	31.6 (30.1–33.0)	34.4 (33.0–35.9)	33.7 (32.3–35.0)	34.9 (33.5–36.3)	34.2 (32.8–35.7)	32.9 (31.6–34.3)	40.5 (39.2–41.7)
Female (n)	4419	4191	4358	4858	4762	4838	4951	6607
Age (y) *	41.6 (41.1–42.1)	42.7 (42.2–43.2)	44.4 (43.9–44.9)	45.7 (45.3–46.2)	48.6 (48.2–49.0)	49.8 (49.4–50.2)	50.8 (50.4–51.3)	50.9 (50.6–51.3)
SBP 140 mm Hg [†]	406 (9.19)	392 (9.35)	538 (12.4)	630 (13.0)	720 (15.1)	677 (14.0)	939 (19.0)	1116 (16.9)
DBP 90 mm Hg [†]	420 (9.50)	468 (11.2)	556 (12.8)	662 (13.6)	651 (13.7)	639 (13.2)	833 (16.8)	835 (12.6)
BMI (kg/m ²) *	22.0 (21.9–22.1)	22.1 (22.0–22.2)	22.5 (22.4–22.6)	23.0 (22.9–23.1)	23.1 (23.0–23.3)	23.2 (23.1–23.3)	23.3 (23.2–23.4)	23.7 (23.6–23.8)
Ever smoking [‡]	4.89 (4.25–5.53)	4.83 (4.18–5.49)	4.75 (4.11–5.39)	4.66 (4.06–5.26)	4.39 (3.81–4.98)	4.30 (3.55–5.05)	4.16 (3.51–4.81)	3.81 (3.18–4.50)
Alcohol drinker [‡]	13.3 (12.3–14.3)	11.8 (10.8–12.7)	10.4 (9.52–11.4)	10.3 (9.41–11.5)	8.80 (7.92–9.69)	8.21 (7.43–8.98)	9.29 (8.35–10.2)	11.2 (10.5–12.0)

Survey	1991	1993	1997	2000	2004	2006	2009	2011
Urban resident [‡]	33.6 (32.2–35.0)	31.6 (30.2–33.0)	35.6 (34.14–37.0)	34.6 (33.2–35.9)	35.1 (33.8–36.5)	34.2 (32.9–35.5)	33.5 (32.2–34.8)	40.7 (39.6–41.9)

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

* Mean with 95% credibility interval (95% CI).

[‡] *n* (%), the number of cases (*n*) and percentage among participants (%).

[‡] Percentage with 95% credibility interval (95% CI).

Table 2

Trends in the Prevalence of Hypertension and Subtypes among Chinese Adults Aged 18 Years or Older: the CHNS 1991–2009 (% (95% CI))^{*}.

Subtypes	1991	1993	1997	2000	2004	2006	2009	2011	P for trend [†]
All									
HTN	15.6 (14.9,16.4)	16.2 (15.4,17.0)	19.2 (18.4,20.0)	19.5 (18.7,20.3)	20.1 (19.2,20.9)	18.6 (17.8,19.4)	22.9 (22.0,23.7)	20.9 (20.2,21.6)	<0.001
ISH	3.04 (2.68,3.40)	2.61 (2.27,2.96)	4.18 (3.76,4.61)	3.31 (2.95,3.67)	3.83 (3.44,4.22)	3.32 (2.95,3.68)	3.52 (3.15,3.89)	3.30 (2.99,3.62)	<0.001
IDH	4.77 (4.32,5.22)	6.25 (5.73,6.78)	6.38 (5.86,6.90)	6.25 (5.76,6.74)	5.95 (5.46,6.43)	5.56 (5.09,6.03)	6.39 (5.90,6.88)	4.44 (4.08,4.80)	0.023
SDH	5.27 (4.79,5.74)	4.67 (4.21,5.13)	5.98 (5.48,6.49)	5.60 (5.14,6.07)	5.18 (4.73,5.64)	4.08 (3.68,4.49)	5.89 (5.42,6.36)	4.11 (3.76,4.46)	<0.001
MED	2.55 (2.22,2.89)	2.71 (2.35,3.06)	2.66 (2.32,3.01)	4.30 (3.89,4.71)	5.10 (4.65,5.55)	5.60 (5.13,6.07)	7.09 (6.58,7.61)	9.01 (8.51,9.51)	<0.001
Male									
HTN	16.9 (15.8,18.0)	17.4 (16.2,18.6)	21.5 (20.2,22.7)	21.5 (20.3,22.7)	22.6 (21.4,23.9)	21.1 (19.9,22.3)	26.1 (24.8,27.4)	23.4 (22.3,24.5)	<0.001
ISH	2.93 (2.41,3.44)	2.26 (1.80,2.73)	4.30 (3.69,4.92)	3.35 (2.83,3.87)	4.06 (3.47,4.64)	3.39 (2.85,3.93)	3.56 (3.02,4.10)	3.44 (2.97,3.90)	<0.001
IDH	6.00 (5.27,6.72)	7.74 (6.90,8.57)	7.90 (7.09,8.72)	8.05 (7.26,8.84)	8.07 (7.26,8.87)	7.40 (6.62,8.18)	8.82 (7.99,9.64)	6.23 (5.61,6.84)	0.652
SDH	5.86 (5.15,6.58)	4.65 (3.99,5.31)	6.60 (5.85,7.35)	6.44 (5.73,7.16)	6.01 (5.31,6.72)	5.09 (4.43,5.74)	7.12 (6.37,7.87)	5.26 (4.69,5.83)	0.765
MED	2.09 (1.66,2.53)	2.78 (2.27,3.29)	2.68 (2.19,3.17)	3.69 (3.14,4.24)	4.50 (3.88,5.11)	5.21 (4.55,5.88)	6.60 (5.87,7.32)	8.49 (7.78,9.21)	<0.001
Female									
HTN	14.5 (13.4,15.5)	15.1 (14.0,16.2)	17.0 (15.9,18.1)	17.5 (16.5,18.6)	17.7 (16.6,18.8)	16.3 (15.3,17.3)	19.9 (18.8,21.0)	18.7 (17.8,19.7)	<0.001
ISH	3.15 (2.63,3.66)	2.96 (2.45,3.47)	4.04 (3.46,4.63)	3.27 (2.77,3.77)	3.62 (3.09,4.16)	3.25 (2.75,3.75)	3.47 (2.96,3.98)	3.21 (2.79,3.64)	<0.001
IDH	3.62 (3.07,4.17)	4.88 (4.22,5.53)	4.90 (4.26,5.55)	4.56 (3.97,5.15)	4.00 (3.44,4.55)	3.91 (3.36,4.45)	4.11 (3.56,4.67)	2.92 (2.52,3.33)	<0.001
SDH	4.71 (4.09,5.34)	4.67 (4.03,5.31)	5.39 (4.72,6.06)	4.83 (4.23,5.43)	4.42 (3.83,5.00)	3.18 (2.69,3.67)	4.75 (4.16,5.35)	3.09 (2.68,3.51)	<0.001
MED	2.99 (2.48,3.49)	2.62 (2.14,3.10)	2.65 (2.17,3.12)	4.86 (4.25,5.46)	5.67 (5.01,6.32)	5.96 (5.29,6.62)	7.56 (6.82,8.29)	9.52 (8.81,10.2)	<0.001

Abbreviations: HTN, hypertension; ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic-diastolic hypertension; MED, use of antihypertensive medication.

^{*} Age adjusted using the direct method to the year 2010 Census population

[†] Trends in the prevalence of hypertension and subtypes from 1991 to 2011 were assessed using the linear-by-linear trend test