Perception and self-management of hypertension in Chinese cardiologists (CCHS): a multicenter, large-scale cross-sectional study

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ABSTRACT

Objectives To determine the frequency of risk factors for hypertension among Chinese cardiologists using a nationwide survey.

Design Multicenter, cross-sectional observational study.

Setting 2441 hospitals across China were surveyed between September 2016 and August 2017.

Participants All in-service cardiologists were surveyed (n=28 924).

Interventions WeChat-based electronic data capture system, a social application in China (Tencent, Nanshan, China), was used for data acquisition. Physician subscribed to the WeChat official account of the China Cardiologist Heart Study, and filled out an online questionnaire that included age, gender, level of in-service hospital, professional title, academic degree, area of expertise and cardiovascular risk factors. All information was required.

Primary and secondary outcome measures The primary outcome was the presence of cardiovascular risk factors. The secondary outcome was the impact of the risk factors on the occurrence of hypertension.

Results Among 28 924 Chinese cardiologists who completed the questionnaire, 57.6% had blood pressure of 130–139/80–89 mm Hg (5.3% were taking antihypertensive drugs) and 22.0% had blood pressure >140/>90 mm Hg (36.5% were taking antihypertensive drugs). The multivariable analysis showed that age, gender, academic degree, hospital level, body mass index (BMI), smoking and comorbidities were independently associated with hypertension among cardiologists (all p<0.05). Age, female gender, BMI, smoking, family history of cardiovascular diseases (CVDs) and comorbidities were independently associated with taking antihypertensive drugs among hypertensive cardiologists (all p<0.05). Age, hospital level, professional title, BMI, family history of CVDs and comorbidities were independently associated with reaching target blood pressure among hypertensive cardiologists taking antihypertensive drugs.

Conclusion Chinese cardiologists do not recognise and pay attention to their own blood pressure. Their rate of antihypertensive treatment was low. The identified risk factors could be used to identify cardiologists at higher risk for hypertension and for implementing preventive interventions.

Strengths and limitations of this study

- The strength of the present study lies in its large sample size (>26 000 participants) from all across China.
- Because of funding and logistics, data had to be collected using a self-filled survey, which could introduce bias compared with a formal epidemiological study.
- The medical system in China and the formation required to work in cardiology are different from that of other countries, limiting the generalisability of the data.
- The geographical distribution of the cardiologists across China was not taken into account.

INTRODUCTION

Cardiologists are exposed to threats to their health, resulting in an important incidence of orthopaedic problems.12 In addition, there is a risk of radiation-related diseases.2 3 Besides those obvious occupational hazards, cardiologists are exposed to stress, work overload and bad lifestyle habits that may increase their cardiovascular risk,4 5 and this is observed in Chinese cardiologists.6 7 A study from Italy showed that the cardiovascular profile of Italian cardiologists was far from ideal and that the perception of their own risk factors was low.8 9 The understanding and awareness of cardiologists’ perception of their own health are not only important for maintaining individual health and the manpower of the national medical healthcare system, but also directly affect their understanding and behaviours toward the patients, eventually having some impact on the prevention and treatment of cardiovascular diseases (CVDs). Indeed, for many patients, cardiologists are role models for behavioural changes.9–11 Cardiologists’ knowledge about CVD risk factors and their perception of how they treat...
their patients with CVD risk factors have an impact on their perception of their own risk factors.12

Chinese physicians face a large number of patients and are at risk of job turnover.13 A survey of Chinese cardiologists found that there were only 1.9 cardiologists per 100 000 people,9 compared with 8.1 per 100 000 people in the USA in 2009.7 Hence, cardiologists in China have heavy responsibilities and high work burden. Faced with such a disparity in the proportion of cardiologists and patients, the working time of Chinese doctors usually exceeds the standard working time.14 All those factors may lead to an increase in the incidence of cardiovascular risk factors and diseases among Chinese cardiologists. Indeed, comparing the Physicians’ Health Study from the USA with the Chinese Cardiovascular Risk Evaluation (CARE) study,15 16 it was found that the prevalence of cardiovascular risk factors among Chinese cardiologists was higher than among American physicians, and that Chinese cardiologists had a poor perception of their own cardiovascular risk factors. Hypertension is a major risk factor for CVDs and death in China,17 as well as in the world in general.18 19 Hypertension may arise due to adverse lifestyle habits (tobacco, alcohol, caffeine and salty foods),20 but also due to chronic stress, work pressure and lack of sleep.21–25

A recent anecdotal observation is that sudden death was observed in many young Chinese cardiologists, prompting the hypothesis that Chinese cardiologists may neglect their own health. In addition, as stated above, Chinese cardiologists are likely to display risk factors of hypertension, which will have a certain impact on their health. Nevertheless, the factors for poor cardiovascular factors among cardiologists must first be identified and understood before interventions can be implemented. Therefore, the present study aimed to examine the risk factors for hypertension among Chinese cardiologists using a nation-wide survey.

SUBJECTS AND METHODS

Participants

This was a national, multicenter, cross-sectional observational study. Cardiologists from 2441 hospitals across China were surveyed between September 2016 and August 2017. All in-service cardiologists were eligible. If a hospital did not have a department of cardiology and only had a department of internal medicine, then the internists working in the cardiovascular field were included. Physicians who were unwilling to participate in this survey were excluded.

Sampling method

Due to the study funding and lack of manpower, it was difficult to design a sampling frame according to the economic and hospital levels and randomly select hospitals nation-wide. Hence, the study used a two-stage sampling process. In the first stage, hospitals were selected using non-random stratification according to regional economic and hospital levels. In the second stage, a random proportional sample from authoritative lists was created, and all the cardiologists in this sample of hospitals were invited to participate in the study.

Questionnaire

The study was carried out and coordinated under the guidance of a scientific advisory board. Data quality was monitored by the study coordinators throughout the study.

WeChat-based electronic data capture system, a social application in China (Tencent, Nanshan, China), was used for data acquisition. Physician subscribed to the WeChat official account of the China Cardiologist Heart Study (Wuxi Boyankang Technology Development Co. was responsible for platform construction and data management), and filled out an online questionnaire that included age, gender, level of hospital, professional title (general physicians were those with a bachelor degree; healers were those with a junior college degree or below), academic degree, area of expertise, height, body weight, blood pressure, heart rate, fasting blood glucose, total cholesterol (TC), low density lipoprotein-cholesterol (LDL-C), high density lipoprotein-cholesterol (HDL-C), triglyceride (TG), current diseases, medication status, smoking history and family history. The questions about area of expertise and current diseases had multiple choices. All information was required. Questionnaires with incomplete information could not be submitted. There were logically possible upper and lower limits for the content to be filled in. If the limit was exceeded, it could indicate that the data were incorrect. The staff of the project team would remind the physician to check. The questionnaire is shown in online supplementary appendix 1.

Data collection

Demographic variables and risk factors for CVD were assessed according to standardised study protocols. Age was automatically generated based on the birth date. Blood pressure and heart rate were the average levels over the past 2 weeks. Fasting blood glucose and blood lipids were reviewed by the physician for the most recent results within a year. Body mass index (BMI) was calculated based on weight and height as kg/m². Hypertension was defined as systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg or taking anti-hypertensive drugs. Reaching the target blood pressure was defined as systolic blood pressure <140 mm Hg and diastolic blood pressure <90 mm Hg. Smoking history was defined as at least one cigarette/day in the past 3 months (yes, no, never smoking). Family history was defined as first-degree male relative with a CVD at <55 years of age or a first-degree female relative with a CVD at <65 years of age.

Statistical analysis

All data were analysed using SPSS V.22.0 (IBM). Continuous variables that followed the normal distribution were...
expressed as means±SD, and skewed continuous variables were summarised as medians (IQR). Categorical variables were expressed as frequencies (percentage) and χ² tests were used for comparison between groups. Univariable and multivariable logistic regression analyses were used to analyse the factors influencing the prevalence of hypertension, rate of medicine taking and rate of reaching the target blood pressure. For the multivariable analysis, comorbidity was defined as the presence of any other disease, or taking antidiabetic or lipid-lowering drugs. Two-sided p<0.05 was considered as statistically significant.

**Patient and public involvement statement**

Patients were not involved in the study design and implementation.

**RESULTS**

**Characteristics of the participants**

A total of 30 000 cardiologists across China were invited to participate in this survey, and 28 924 completed the questionnaire, for a response rate of 96.4%. Tables 1 and 2 and online supplementary table S1 present their characteristics. Most (42.7%) were 30–39 years old, male (54.5%), with a bachelor degree (43.9%), working at a tertiary hospital (60.1%), and were attending physicians (46.5%). Their main areas of expertise were: hypertension (63.9%), atherosclerosis and coronary artery diseases (51.1%), blood lipids and metabolism (35.1%) and heart failure (31.4%). Most had a BMI of 18.5–23.9 kg/m² (66.7%), fasting blood glucose <6.1 mmol/L (90.0%), LDL-C <2.60 mmol/L (44.6%), HDL-C ≥1.0 mmol/L (93.5%), TC <5.2 mmol/L (86.3%) and TG <1.7 mmol/L (53.8%). Among them, 57.6% had blood pressure of 130–139/80–89 mm Hg (5.3% were taking antihypertensive drugs) and 22.0% had blood pressure ≥140/≥90 mm Hg (36.5% were taking antihypertensive drugs). Among all cardiologists, 37.0% never smoked, 78.2% had a family history of CVDs, 25.3% had hypertension and 8.0% were taking antihypertensive drugs.

**Gender differences in the prevalence of hypertension in Chinese cardiologists**

Hypertension was more prevalent in male cardiologists than in females (p<0.001) (table 3). More male cardiologists were taking antihypertensive drugs (33.5% vs 28.8%, p<0.001), but more female cardiologists achieved the target blood pressure (44.3% vs 39.8%, p=0.036).

**Age differences in the prevalence of hypertension in Chinese cardiologists**

Table 4 shows that hypertension was more prevalent in the older age groups (p<0.001). The highest proportions of cardiologists taking antihypertensive drugs were found in the 50–59 (42.0%) and 60–69 (48.8%) years age groups. The highest proportions of cardiologists reaching the target blood pressure were found in the

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**Table 1** Demographic characteristics, current disease and medication of the participants

| Variable                              | Total (n=28924) |
|---------------------------------------|----------------|
| Age (years)                           | 37.82±9.27     |
| 20–29                                 | 5308 (18.35)   |
| 30–39                                 | 12338 (42.66)  |
| 40–49                                 | 8019 (27.72)   |
| 50–59                                 | 2674 (9.24)    |
| 60–69                                 | 584 (2.02)     |
| ≥70                                   | 1 (0.00)       |
| Gender                                |                |
| Male                                  | 15749 (54.45)  |
| Female                                | 13175 (45.55)  |
| Academic degree                       |                |
| Junior college                        | 225 (0.78)     |
| Bachelor                              | 12704 (43.92)  |
| Master                                | 10580 (36.58)  |
| Doctor                                | 2905 (10.04)   |
| Post-doctor                           | 412 (1.42)     |
| Others                                | 2098 (7.25)    |
| Hospital level                        |                |
| Primary                               | 381 (1.32)     |
| Secondary                             | 10823 (37.42)  |
| Tertiary                              | 17375 (60.07)  |
| Others                                | 345 (1.19)     |
| Professional title                    |                |
| General physician                     | 4230 (14.62)   |
| Healer                                | 540 (1.87)     |
| Resident physician                    | 966 (3.34)     |
| Attending physician                   | 13448 (46.49)  |
| Associate chief physician             | 4674 (16.16)   |
| Chief physician                       | 2279 (7.88)    |
| Others                                | 2787 (9.64)    |
| BMI (kg/m²)                           |                |
| <18.5                                 | 1475 (5.10)    |
| 18.5–23.9                             | 19304 (66.74)  |
| ≥24                                   | 8145 (28.16)   |
| Current disease                       |                |
| Coronary heart disease                | 1760 (6.08)    |
| Heart failure                         | 554 (1.92)     |
| Diabetes                              | 598 (2.07)     |
| Stroke/transient ischaemic attack     | 167 (0.58)     |
| Chronic kidney disease                | 409 (1.41)     |
| Peripheral vascular disease           | 431 (1.49)     |
| Hypertension                          | 7319 (25.30)   |

Continued
Data are expressed as mean±SD or n (%). BMI, body mass index.

Hospital level differences in the prevalence of hypertension in Chinese cardiologists

Table 5 shows that the prevalence of hypertension was higher in cardiologists working at primary hospitals (35.7%) compared with secondary (24.9%) and tertiary (25.4%) hospitals (p<0.001). The proportions of cardiologists taking antihypertensive drugs and reaching the target blood pressure were higher in secondary and tertiary hospitals (both p<0.05). Similar patterns could be observed when analysing male and female cardiologists (online supplementary tables S4 and S5).

Professional title differences in the prevalence of hypertension in Chinese cardiologists

Hypertension was more prevalent in associate chief physicians and chief physicians (p<0.001), with a correspondingly higher proportion of cardiologists taking antihypertensive drugs (p<0.001). Residents, healers and attending physicians had the highest proportions of cardiologists achieving the target blood pressure (p<0.001) (online supplementary table S6). Globally, similar patterns were observed when analysing the data by male and female cardiologists (online supplementary tables S7 and S8).

Factors associated with hypertension among cardiologists

Online supplementary table 9 presents the univariable and multivariable analyses of the factors associated with hypertension among Chinese cardiologists. Age (50–59 years: OR=1.397, 95% CI: 1.164 to 1.678, p<0.001; >60 years: OR=1.949, 95% CI: 1.534 to 2.476, p<0.001 vs 20–29 years), female gender (OR=0.866, 95% CI: 0.813 to 0.924, p<0.001 vs male), academic degree (bachelor: OR=0.629, 95% CI: 0.461 to 0.859, p=0.004; master: OR=0.722, 95% CI: 0.528 to 0.988, p=0.04 vs junior college), hospital level (secondary: OR=0.582, 95% CI: 0.464 to 0.728, p<0.001; tertiary: OR=0.579, 95% CI: 0.463 to 0.724, p<0.001 vs primary), BMI (>24 kg/m²: OR=1.314, 95% CI: 1.233 to 1.400, p<0.001 vs 18.5–23.9 kg/m²), smoking (infrequent: OR=0.568, 95% CI: 0.525 to 0.613, p<0.001; never: OR=0.469, 95% CI: 0.341 to 0.509, p<0.001 vs frequent) and comorbidities (OR=3.158, 95% CI: 2.924 to 3.407, p<0.001) were all independent predictors of hypertension in cardiologists.
to 3.410, p<0.001) were independently associated with hypertension among cardiologists.

Factors associated with taking antihypertensive drugs among hypertensive cardiologists

Online supplementary table 10 presents the univariable and multivariable analyses of the factors associated with taking antihypertensive drugs among hypertensive cardiologists. Age (30–39 years: OR=1.433, 95% CI: 1.055 to 1.945, p=0.02; 40–49 years: OR=1.989, 95% CI: 1.428 to 2.771, p<0.001; 50–59 years: OR=2.282, 95% CI: 1.599 to 3.257, p<0.001; >60 years: OR=2.677, 95% CI: 1.754 to 4.086, p<0.001 vs 20–29 years), female gender (OR=1.200, 95% CI: 1.059 to 1.359, p=0.004 vs male), BMI (>24 kg/m²: OR=0.657, 95% CI: 0.548 to 0.787, p<0.001 vs 18.5–23.9 kg/m²), smoking (infrequent: OR=0.502, 95% CI: 0.440 to 0.572, p<0.001; never: OR=0.374, 95% CI: 0.322 to 0.434, p<0.001 vs frequent), family history of CVDs (OR=0.746, 95% CI: 0.624 to 0.891, p=0.001) and comorbidities (OR=0.811, 95% CI: 0.679 to 0.970, p=0.02) were independently associated with reaching target blood pressure among hypertensive cardiologists taking antihypertensive drugs.

Factors associated with reaching target blood pressure among hypertensive cardiologists taking antihypertensive drugs

Online supplementary table 11 presents the univariable and multivariable analyses of the factors associated with reaching target blood pressure among hypertensive cardiologists taking antihypertensive drugs. Age (30–39 years: OR=1.433, 95% CI: 1.055 to 1.945, p=0.02 vs general physicians), BMI (≥24 kg/m²: OR=0.657, 95% CI: 0.548 to 0.787, p<0.001 vs 18.5–23.9 kg/m²), family history of CVDs (OR=0.746, 95% CI: 0.624 to 0.891, p=0.001) and comorbidities (OR=0.811, 95% CI: 0.679 to 0.970, p=0.02) were independently associated with reaching target blood pressure among hypertensive cardiologists taking antihypertensive drugs.

**DISCUSSION**

Chinese cardiologists have a poor knowledge of their own cardiovascular risk factors. The present study aimed to examine the risk factors for hypertension among Chinese cardiologists using a nation-wide survey. The results suggest that Chinese cardiologists do not recognise and pay attention to their own blood pressure. Their rate of taking antihypertensive drugs was low. The identified risk factors could be used to identify cardiologists at higher risk for hypertension and for implementing preventive interventions.

In China, the prevalence of hypertension is around 24%,26–28 leading to a significant cardiovascular burden.29 In the present study, the prevalence of hypertension was 25.3%, similar to the prevalence in the general Chinese population. A previous survey of cardiologists conducted in 2011 revealed participants’ characteristics that were similar to those of the present study,6 further supporting the representativeness of our sample. Of course, there is a certain overlap between the samples of the two studies, but the exact extent of this overlap cannot be confirmed.

In the present study, 57.6% of the cardiologists had borderline or at-risk blood pressure (130–139/80–89 mm Hg) and only 5.3% were taking antihypertensive drugs. In addition, 22.0% had blood pressure ≥140/≥90 mm Hg, but only 36.5% were taking antihypertensive drugs. Despite the expected health knowledge in physicians compared with the general population, this rate of treatment was surprisingly not better than in the general Chinese population.30 31 The SOCRATES (the Survey on Cardiac Risk Profile and Lifestyle Habits in a Cohort of Italian Cardiologists) study showed that the rate of using lipid-lowering, antihypertensive and cardiovascular drugs was low among Italian cardiologists,8 supporting the present study. Data from the Chinese (CHARLS: China Health and Retirement Longitudinal Study) and the American (NHANES: US National Health and Nutrition Examination Survey) studies were similar to those of the present study,6 further supporting the representativeness of our sample.

**Table 2**

| Variable | Total (n=28924) | Male (n=15749) | Female (n=13175) | P value |
|----------|----------------|---------------|-----------------|---------|
| Hypertension | 7319 (25.30) | 4574 (29.00) | 2745 (20.83) | <0.001 |
| Taking antihypertensive drugs | 2323 (31.74) | 1333 (33.52) | 790 (28.78) | <0.001 |
| Reaching the target blood pressure | 960 (31.33) | 610 (39.79) | 350 (44.30) | 0.36 |

Data are expressed as n (%).

**Table 3**

| Variable | Total (n=28924) | Male (n=15749) | Female (n=13175) | P value |
|----------|----------------|---------------|-----------------|---------|
| Hypertension | 7319 (25.30) | 4574 (29.00) | 2745 (20.83) | <0.001 |
| Taking antihypertensive drugs | 2323 (31.74) | 1333 (33.52) | 790 (28.78) | <0.001 |
| Reaching the target blood pressure | 960 (31.33) | 610 (39.79) | 350 (44.30) | 0.36 |

Data are expressed as n (%).
Examination Survey) general populations indicate that China had lower rates of hypertension treatment than the USA.27 This is also supported by the CARE study, which showed that physicians had suboptimal awareness of their own cardiovascular risk, as well as suboptimal use of prophylaxis,15 16 and by the SOCRATES study, which showed that physicians had suboptimal awareness and management of smoking cessation strategies among smoking French cardiologists were low.6 On the other hand, Abuissa et al22 showed that American cardiologists had generally good lifestyle habits.

Age, gender, BMI, smoking, family history of CVDs and comorbidities are well-known risk factors for hypertension, compliance to treatment and/or achieving target blood pressure.33–35 Aboyans et al41 showed that the awareness and management of smoking cessation strategies among smoking French cardiologists were low. In the present study, age, gender, BMI, smoking and family history of CVDs were associated with the risk of having hypertension, with the risk of not taking the proper antihypertensive medication and with the risk of not achieving the target blood pressure. Even if age, gender and comorbidities are non-modifiable risk factors, they could help identify cardiologists in need of more efforts for seeking the proper cardiovascular treatments. This is supported by previous studies in various populations.30 36 37

Great efforts are necessary to become a cardiologist in Western countries, but because of differences in the Chinese medical system, it takes less efforts to become a cardiologist in China than in Western countries, a situation that is currently being corrected.38–40 The present study suggests that having a bachelor or master degree lead to lower risk of hypertension compared with junior college level. This could be due to the fact that people with more advanced training possess more skills and knowledge, leading to less stress in their work. In addition, they have higher income, decreasing the need for working long and stressful hours. This is supported by a study that showed that physicians with a low education level had poor quality of life in China.14 As more experienced physicians can have access to more advanced hospitals, we observed that cardiologists working in secondary and tertiary hospitals had a lower risk of having hypertension. This could be due to a better awareness of health knowledge in general, but also due to the better material and human resources in more advanced hospitals, thereby lowering stress and workload.14 41 Workload was not directly collected in the present study, but previous studies reported that it is higher in China than in the USA, with 1.9 vs 8.1 cardiologists per 100000 people.6 7 Considering the large sample size in the present study, it is probable that our study population follows the national trend. One study showed that the working hours of American physicians were decreasing over the years.42 It has been shown that working long hours was associated with an increased cardiovascular risk.43 Better knowledge and lower stress/workload can also be associated with being properly treated or not for hypertension and taking the proper steps, both on the medical and lifestyle points of view, to achieve the blood pressure targets, as observed in the present study. This is supported by a number of studies in the Chinese general population.30 31 44 45

The strength of the present study lies in its large sample size (>26000 participants) from all across China. On the other hand, because of funding and logistics, data had to

| Table 4 Prevalence of hypertension, rate of antihypertensive drugs taking and rate of reaching the target blood pressure in cardiologists with different age |
| Variable | Total | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | ≥70 | P value |
|----------|-------|-------|-------|-------|-------|-------|-----|-------|
| Hypertension | 7319 (25.3) | 1276 (24.04) | 2680 (21.72) | 2158 (26.91) | 946 (35.38) | 258 (44.18) | 1 (100) | <0.001 |
| Taking antihypertensive drugs | 2323 (31.74) | 256 (20.06) | 738 (27.54) | 806 (37.35) | 397 (41.97) | 126 (48.84) | 0 | <0.001 |
| Reaching the target blood pressure | 960 (41.33) | 124 (48.44) | 322 (43.63) | 336 (41.69) | 130 (32.75) | 48 (38.10) | – | 0.001 |

Data are expressed as n (%).

| Table 5 Prevalence of hypertension, rate of antihypertensive drugs taking and rate of reaching the target blood pressure in cardiologists with different hospital level |
| Variable | Total | Primary | Secondary | Tertiary | Others | P value |
|----------|-------|--------|-----------|----------|-------|-------|
| Hypertension | 7319 (25.30) | 136 (35.70) | 2695 (24.90) | 4413 (25.40) | 75 (21.74) | <0.001 |
| Taking antihypertensive drugs | 2323 (31.74) | 38 (27.94) | 904 (33.43) | 1354 (30.68) | 27 (36.00) | 0.049 |
| Reaching the target blood pressure | 960 (41.33) | 8 (21.05) | 390 (43.14) | 551 (40.69) | 11 (40.74) | 0.048 |

Data are expressed as n (%).
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