



A survey of national cardiology workforce in China

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Cardiologists provided specialized care for patients with various cardiac conditions. The qualification system of subspecialty as cardiologist is well established in developed countries. However, there is no standardized national training programmes and common board certification for cardiovascular professionals in China. We launched a survey of national cardiology workforce to assess general characteristics of cardiovascular care providers in China. This survey includes licensed physicians who are currently working as cardiovascular care givers in tertiary or secondary hospitals in mainland China (Taiwan, Hongkong, and Macau were not included). A total of 25 240 physicians from 31 provinces responded to survey, achieving an estimated response rate at 76.5%. Data on demographic information, work characteristics, educational background, and professional skills of the physicians were collected. Results showed that cardiologist to population ratio is 1.9 per 100 000 and the number of cardiologist per 100 000 population over age of 65 is 21.3. Average age of respondents is 38.22 ± 8.19 and average time of medical practice after receiving medical certification is 12.1 ± 8.5 years. By gender and educational background, 58.5% of subjects are male and 33.3% had postgraduate degree. 25.9% of surveyed cardiologists were actively practicing interventional cardiology, but only 39.4% of them were licensed with interventional cardiology certification. Proportion of cardiologists worked on cardiac pacing, ablation of arrhythmia, and interventional treatment of congenital heart disease is 24.2, 14.1, and 9%, respectively, accordingly only 17.4, 36.5, and 25.6% of them had received specialty certifications. Physicians in eastern and middle regions had better educational background and training opportunities than those in western regions. This current survey is the most comprehensive investigation on cardiology workforce in China. The comparative study indicated a scarcity of cardiologists in China. This survey also helps greatly to guide authorities on decision making to improve training and specialty certification system of Cardiologist in China.

Introduction

China, with its growing economic prosperity, has a rapid increase in major cardiovascular risk factors including hypertension, smoking, obesity, and diabetes mellitus. Cardiovascular disease (CVD), including coronary heart disease, stroke, heart failure, and hypertension, is the current leading cause of death in China.¹ The management of CVD has to be modified in response to the increasing

demand, allowing patients to benefit from the advances in cardiovascular care delivery. Previous studies suggested that patients with heart failure or acute myocardial infarction receive better and more consistent evidence-based care from cardiologists than from general physicians.^{2–5} Consequently, larger cardiology workforce is required for specialized care of such patients.

In USA and other developed countries, professional development in cardiology includes standardized fellowship training, internal medicine, and CVD license certification and sub-sub-speciality license certification (e.g. interventional cardiology, advanced heart failure) (see <http://www>.

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usmle.org and <http://www.abim.org>). But China only has national medical license certification and interventional cardiology license certification, of which the latter was initiated in 2010, which is a sub-sub-speciality license. But CVD license certification did not exist. So it became difficult and complicated to evaluate the competence of cardiovascular health-care providers. The Ministry of Health (MOH) in China planned to establish a qualification system with cardiology board certification. To better understand the demographics and characteristics of current cardiologists in China, the Chinese National Medical Examination Center and Chinese Medical Doctor Association launched the 2011 Chinese National Cardiology Workforce Survey, and assigned the Chinese College of Cardiovascular physicians to conduct this survey.

Methods

The surveys were undertaken from May 2011 to November 2011. All registered cardiovascular physicians in mainland China (Taiwan, Hong Kong, and Macau were excluded) were contacted by mails or emails, but only those licensed in internal medicine certification and currently working as adult cardiovascular care providers in tertiary or secondary hospitals were included in this survey. The Chinese MOH urged all eligible physicians to participate in this survey. Since the total number of cardiovascular physicians practicing in tertiary or secondary hospitals in China is not known, we made reasonable estimation according to the data from China health statistics 2012.⁶ By 2011, there were 447 758 and 554 434 licensed doctors in tertiary and secondary hospitals, respectively. With 22.8% physicians in 2011, numbers of physicians in tertiary or secondary hospitals were calculated to be ~220 000. The number of cardiovascular physicians in tertiary or secondary hospitals was estimated to be 33 000, indicating 15% of cardiovascular physicians in internal medicine.

Survey design

This survey was designed to collect data using a self-administered questionnaire. The official notifications of the survey were circulated to all eligible hospitals in mainland China. Data of eligible physicians were pooled together by trained survey assistants or the physicians were requested to complete the mail/online survey (www.nmec.org.cn or www.cmda.gov.cn or www.drheart.cn). The questionnaire was comprised of four sections: general demographic information, work characteristics, educational background, and professional skills.

Data analysis

Data were expressed as percentages or mean \pm SD. To estimate the cardiologist-to-population ratio, we calculated the ratio of cardiologists to elderly population (>65 years), since this age group comprised the majority of cardiac patients. Data from the Sixth National Population Census of China published in April 2011 was used.

Surveyed hospitals were divided into three groups based on the geographical location: eastern, middle, or western. The provinces/municipalities/autonomous regions in different groups are shown in *Table 1*. Twelve, nine, and ten provinces/municipalities/autonomous regions were included in eastern, middle, and western groups, respectively. The characteristics of physicians were compared between the different groups using χ^2 statistics and ANOVA. A two-sided *P*-value of <0.05 was considered to be statistically significant. All statistical analyses were performed using the SAS 9.1 statistical package.

Table 1 Provinces/municipalities/autonomous regions in different groups

Eastern <i>n</i> = 12	Middle (<i>n</i> = 9)	Western <i>n</i> = 10
Beijing	Shanxi	Sichuan
Tianjin	Inner Mongolia	Chongqing
Hebei	Jilin	Guizhou
Liaoning	Heilongjiang	Yunnan
Shanghai	Anhui	Xizang
Jiangsu	Jiangxi	Shaanxi
Zhejiang	Henan	Gansu
Fujian	Hubei	Ningxia
Shandong	Hunan	Qinghai
Guangdong		Xinjiang
Guangxi		
Hainan		

Results

Overview

A total of 25 240 physicians (henceforth referred to as cardiologists in this paper) responded to the survey, achieving an estimated response rate of 76.5%. The number of cardiologists in each administrative unit is listed in *Figure 1*. Cardiologist-to-population ratios in all provinces/municipalities/autonomous regions were calculated, and are shown in *Figure 2*. The average number of cardiologists per 100 000 population and per 100 000 population over 65 years of age was 1.9 and 21.3, respectively, with Beijing ranking highest in all surveyed administrative units.

General demographic information

58.5% of cardiologists were males. The average age of surveyed cardiologists was 38.22 ± 8.19 (range 21–87) years. Cardiologists who were 35 years or older comprised 42.5% and those over 55 years comprised 2.9%.

Characteristics of work and training

The average duration of medical practice after receiving Board certification in Internal Medicine was 12.07 ± 8.49 years (range 1–60). 20.8% of cardiologists had <5 years experience, 22.8% had 5–10 years, and 24.6% had 10–15 years. Cardiologists working in tertiary and secondary hospitals comprised 55.9 and 44.1%, respectively. 40.4% of surveyed cardiologists had senior professional titles.

The proportion of cardiologists who had masters or doctoral degrees was 33.3%. 30.4% cardiologists were trained with standardized residence training program step 1, while 10.2% were trained with standardized residence training program step 2. But these programs formulated by local competent authorities differed in different regions. 10.5% of cardiologists received additional training in interventional cardiology. 61.2% of cardiologists received domestic advanced education, while 26.8% completed overseas advanced education.

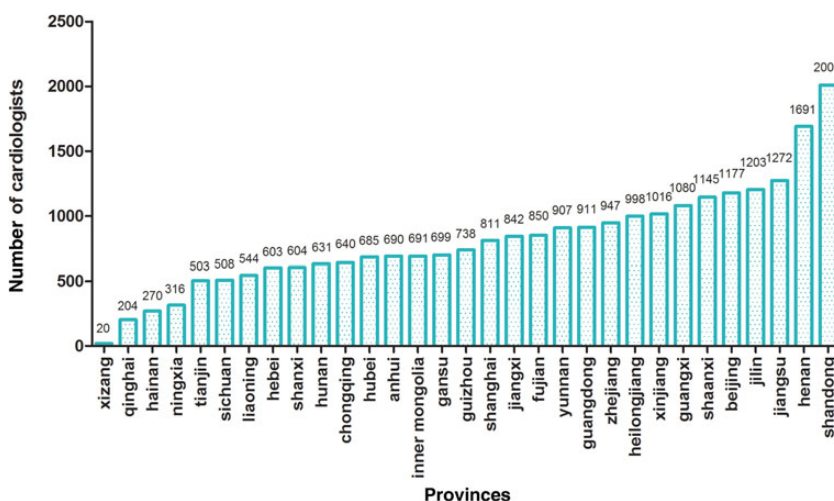


Figure 1 Distribution of cardiologists in different provinces.

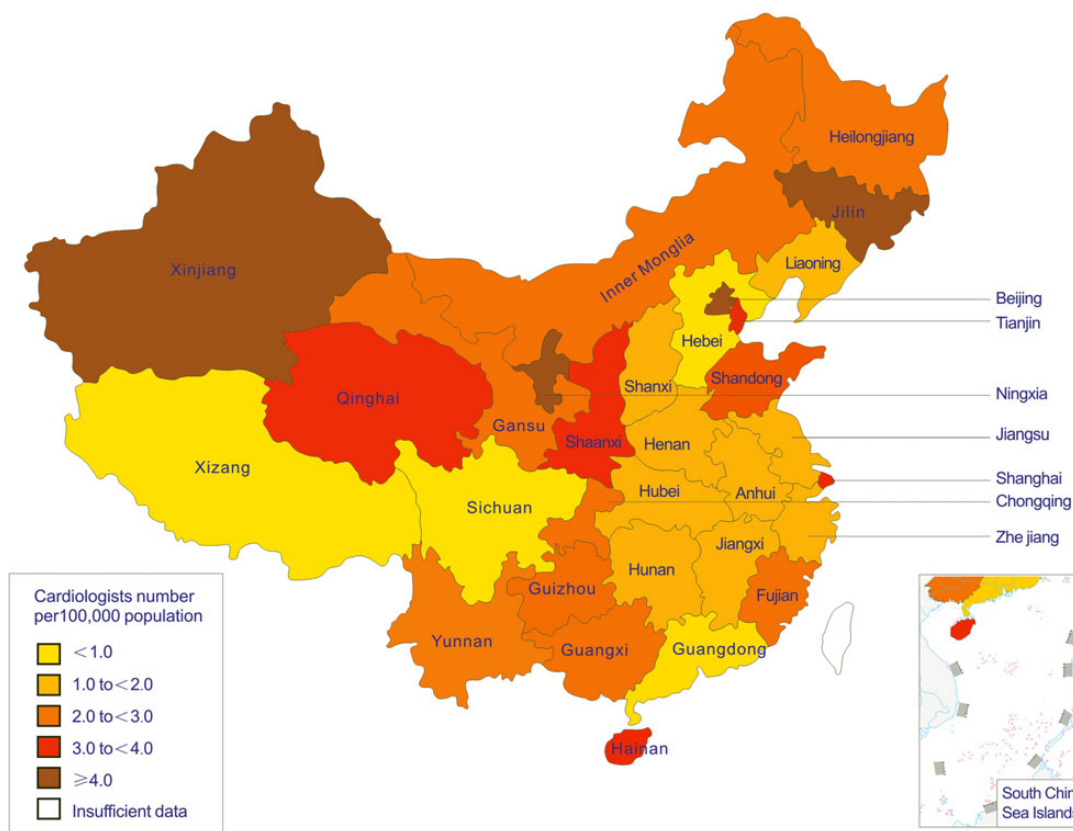


Figure 2 Cardiologists per 100 000 population. The sixth China national census data published in April 2011 was used for analysis.

Professional skills

Most physicians were practicing as general clinical cardiologists. As previously mentioned, interventional cardiology certification started in 2010. 25.9% of surveyed cardiologists were actively practicing interventional cardiology, but only 39.4% of them were licensed in interventional cardiology certification. 24.2, 14.1, and 9% of cardiologists worked on cardiac pacing, ablation of arrhythmia, and interventional treatment of congenital heart disease, respectively, although

only 17.4, 36.5, and 25.6% of them had received specialty certifications.

Geographical diversity of the cardiology workforce

Characteristics of physicians differed between the geographical groups, and are shown in *Table 2*. Physicians in eastern and middle groups had better educational background and more training opportunities.

Table 2 Difference in physicians' characteristics between geographical groups

	Eastern (n = 10 977)	Middle (n = 8035)	Western (n = 6193)	Statistics	P-value
Sex (male)	6596 (61.5%)	4511 (57.8%)	3268 (53.9%)	95.449	<0.00
Age	38.3 ± 8.3	38.5 ± 8.3	37.8 ± 7.9	8.8683	<0.00
Hospital level					
Tertiary	6489 (60.4%)	4270 (55.1%)	2996 (49.3%)	207.625	<0.00
Secondary	4256 (39.6%)	3486 (44.9%)	3085 (50.7%)		
Practice duration	12.2 ± 8.6	12.2 ± 8.6	11.8 ± 8.2	5.5518	<0.00
Professional title					
Senior	4420 (42.1%)	3220 (42.8%)	2075 (35.0%)	104.7779	<0.00
Junior	6082 (57.9%)	4305 (57.2%)	3856 (65.0%)		
Education degree					
Postgraduate	4335 (40.7%)	2314 (30.4%)	1459 (24.1%)	528.0488	<0.00
Bachelor	6316 (59.3%)	5299 (69.6%)	4593 (75.9%)		
Additional training of interventional cardiology	1225 (11.2%)	721 (9.0%)	696 (11.2%)	30.8503	<0.00
Domestic advanced education	6231 (56.8%)	5234 (65.1%)	3962 (64.0%)	165.6958	<0.00
Overseas advanced education	2898 (26.4%)	2491 (31.0%)	1357 (21.9%)	153.2683	<0.00

Discussion

Cardiovascular care has achieved dramatic success due to new diagnostic and therapeutic technology as well as increasing specialty. The American Board of Internal Medicine approved subspecialty of CVD and interventional cardiology in 1940s and 1999, respectively.⁷ To become a cardiologist (see <http://www.usmle.org> and <http://www.abim.org>), multiple licenses and certifications are required. It takes at least 6 years to complete the training. While in China, neither guidelines for cardiologist training program nor qualification system for certification of CVD are applied to evaluate the competence of cardiovascular healthcare providers. In a previous national survey, 837 physicians from cardiology departments in 35 tertiary hospitals in China were invited to complete a questionnaire on guidelines for secondary prevention of CHD, which showed that their knowledge was poor.⁸ It is urgent to initiate a qualification system for cardiologist certification and understand the current information of cardiovascular care providers.

A 2011 survey provided deep insights into the cardiovascular physician workforce in China. Overall, there are 25 240 cardiologists in mainland China and the ratio to population is 19 per million. When compared with 25 901 actively practicing cardiologists and 55.7 general cardiologists per million population in the USA according to the ACC 2009 cardiologist workforce survey, a scarcity of cardiologists was suggested in China. This survey showed that there are 21.3 cardiologists per 100 000 population of 65 years or older, which is close to the ratio in Canada reported in 2005.¹⁰

41.5% of cardiologists were females in our survey, only 12% of general cardiologists and <10% of interventional cardiologists and clinical cardiac electrophysiologists were females in the USA.⁹ To understand why the percentage of female cardiologists in China is much higher than in the USA, many factors have to be examined including specialty training duration, compensation, reimbursement, work-life balance, family responsibility. In the USA, training duration for a cardiologist to achieve clinical competence and required qualification is long. Occupational

exposure to radiation is a major concern for female cardiologists during the training period and the professional career.¹¹ Majority of female physicians tend to avoid fluoroscopic procedures during their pregnancy but those are mandatory requirements during cardiologist training for right-heart and left-heart catheterization, and diagnostic coronary angiography. In contrast, since there are no such requirements for cardiologists in China, female physicians who are not competent in diagnostic catheterization can work as cardiologists. This may partially explain the difference in percentage of female cardiologists between the two countries.

The average age of physicians was 38.22 ± 8.19 years, and only 2.9% were >55 years. 20.8% of physicians had short work experience (<5 years). In the USA, physicians are not eligible to qualify as cardiologists if their work experience is <6 years. The ACC survey indicated that >40% of general cardiologists are >55 years. The requirement of minimal working experience in the USA is the major reason for the difference in age distribution of cardiologists when compared with China.

More effort is required to become a cardiologist (which is also true for medical care providers in general) in the USA than in China, resulting in a gap in competence of physicians between the USA and China. To satisfy the growing demand for better healthcare, policy makers are seeking management procedures of knowledge and skill-based qualification system for physicians.¹² The improvements in competence of physicians lead to better overall healthcare safety and quality, which consequently offers a positive outcome for hospitals, doctors, and patients. Training programs and qualification system of board certification are urgently needed to standardize physician's performance in China.

The unequal geographical distribution of cardiologists in China is obvious. As the capital of China, Beijing had the highest doctor-to-population ratio. Physicians in eastern and middle groups (with relatively higher economic prosperity) had better educational background and more training opportunities. Unequal distribution of workforce is a much bigger problem than physician shortage. This

information-centred survey suggested that policy makers should solve the geographical imbalance in physician workforce for a better use of limited resources.

Cardiovascular specialists are urged to develop standardized procedures for appropriate cardiovascular care. Prevention strategies, the broad array of diagnostic services, additional specific therapies, and follow-up care for cardiovascular patients are also critical. Efforts have to be made to establish standardized training programmes and license system of cardiology certification to achieve these goals.

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