

ORIGINAL RESEARCH

The differences among educational background, certification characteristics, and professional subgroups of cardiologists in China: a cross-sectional survey

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Aim: To explore the gender, educational background, and choice of subspecialty characteristics of doctors working in the department of cardiology at four tertiary hospitals (Shanghai, Nanjing, Xuzhou, and Hangzhou, named Hospital A, B, C, and D, respectively) selected from four representative cities in China.

Methods: A total of 201 physicians from four tertiary hospitals in four cities in East China completed the questionnaire. Survey questions include physicians' educational background, professional title, specialty, and post-graduate education. These hospitals were in cities with diverse sizes and affiliated with different organizations.

Results: Most cardiologists working in the invasive subspecialty have a senior title (59.29%), especially in Hospital D (100%). Hospital D has the highest proportion of cardiologists with a domestic post-graduate education (56.25%); however, Hospital A has the highest proportion of cardiologists with an international post-graduate education (46.67%). Compared with male doctors, there are fewer female doctors (20.59 vs. 79.41%, $p < 0.001$) and fewer female doctors have a senior title and post-graduate education ($p < 0.005$). Most female doctors choose the non-invasive subspecialty (86.67 vs. 13.33%, $p < 0.001$).

Conclusion: Differences including age, sex, professional title, post-graduate education experience, and choice of subspecialty exist in the cardiologists from four representative hospitals in China. The extent to which these differences would affect the diagnosis, treatment, and prognosis of cardiovascular diseases deserves further research.

Keywords: medical education, cardiology, interventional cardiology, survey, gender differences

Introduction

Today, most cardiovascular diseases (CVDs)-related deaths come from undeveloped countries (1). This situation has brought about new requirements for physicians in the field of cardiology and has increased pressure on cardiologists during their work. In America, Japan, and most European countries, medical students must undergo strict internship, training, assessment, and promotion systems before becoming cardiologists, even after graduation

from medical school (2). A gender imbalance was also found within cardiology internationally that may affect patient care, education, and workplace culture, and this gender imbalance has caused wide concern in several countries (3–5).

In China, hospitals of different levels or in different locations have various requirements for doctors' educational background, ranging from undergraduate to doctoral degrees, and the diagnosis and treatment measures and techniques are also different. Obvious differences

exist in post-graduate education among hospitals from different areas. In this study, we analyzed the professional characteristics of cardiologists from four hospitals located in Shanghai (Hospital A), Nanjing (Hospital B), Xuzhou (Hospital C), and Hangzhou (Hospital D), China, representing different economic, educational, and regional characteristics. Our primary goal was to identify the factors involved in decision-making, and strategies used for improved quality of care, therapy, and the prognosis of patients with CVDs.

Research elaborations

We conducted this survey at four tertiary hospitals in four cities, with Hospitals A, B, C, and D affiliated with medical colleges. We have a strict examination for professional qualifications and divide the cardiology subspecialties into non-invasive and invasive. Post-graduate education includes domestic advanced study and international advanced study. Approval of the ethics requirements waiving was obtained from our hospital before the start of the work. An analyst conducted the analysis without knowing the grouping information and the respondents' origins. The Student unpaired *t*-test and the chi-square test were used appropriately.

Results or finding

A total of 201 doctors from four hospitals responded to the survey. Of these, 135 (67.16%) were male and most participants (186, 92.54%) had a master's or doctorate degree. Thirty-five (17.41%) participants had the primary title (resident), 64 (31.84%) the intermediate title (attending), and 102 (50.75%) the senior title (associate- or chief physician). Approximately 140 (70%) cardiologists chose the invasive subspecialty, and 89 (44.28%) of these chose coronary interventions. Eight cardiologists chose two invasive subspecialties as their sub-group, also only one chose three invasive subspecialties. Compared with doctors from other cities, doctors at Hospital C have more early-career titles, and fewer have primary titles; most cardiologists with the senior title are at Hospital D. The highest percentage of cardiologists with post-graduate education are at Hospital A (Table 1).

Characteristics of cardiologists with invasive subspecialty

Of the 201 survey participants, 140 (69.65%) had selected invasive subspecialty. Those choosing invasive subspecialty included a higher proportion of cardiologists with the senior

title (83 of 140; 59.29%) and fewer cardiologists with the primary title (15 of 140; 10.71%). Hospital D had the highest percentage of cardiologists with the senior title in the field of invasive subspecialty (14 of 16; 93.33%). In Hospital C, more invasive cardiologists have the primary title (10 of 56; 27.78%). Coronary intervention was the most popular choice in the invasive subspecialty (89 of 140; 63.57%); fewer participants practiced interventional therapy for congenital heart disease (13 of 140; 9.29%; Table 2).

Post-graduate education experience

In the field of domestic advanced study, participants in Hospital A had more training experience than participants in Hospitals B and C. However, participants in Hospital D had the highest percentage of doctors with domestic advanced study (9 of 16; 56.25%). Fewer participants with the primary title had experience with domestic advanced study. And a larger proportion of participants with the senior title had domestic advanced study than those with the intermediate title (see Table 3). Furthermore, Table 4 lists more participants with international advanced study in Hospital A (28 of 60; 46.67%). Most participants who had experience with international advanced study were cardiologists with the senior title (37 of 44; 84.09%). The highest proportion of participants with both domestic and international advanced studies in the invasive subspecialty practiced coronary interventions, and the second highest proportion practiced interventional cardiac electrophysiology (Tables 3, 4).

The gender gap

Overall, among those doctors working in the department of cardiology, the proportion of females (66 of 201; 32.84%) and females with the senior title (21 of 102; 20.59%) was lower. In Hospitals A and B, this gender disparity was remarkable (Table 5): more male doctors undergo interventional work (male/female: 130/20, $P < 0.001$), and more female doctors had majors in interventional cardiac electrophysiology (Table 6). In the field of post-graduate education, male doctors had more opportunities to participate in the fellowship training program, regardless of whether their education was domestic advanced or international. This difference was prominent in Hospital A (Table 7).

Discussion

Compared with hospitals in a megalopolis and large cities, in Hospital A in a super megacity, more cardiologists with the

TABLE 1 | Overall characteristics of respondents.

	Total n = 201	Hospital A n = 60	Hospital B n = 69	Hospital C n = 56	Hospital D n = 16	p
Men(n/%)	135/67.16	41/68.33	49/71.01	34/60.71	11/68.75	0.667
Age(year)	41.0 ± 8.23	42.30 ± 7.17	41.39 ± 8.04	37.84 ± 8.71 ^{ab}	45.56 ± 7.94 ^c	0.313
Doctor rank (n/%)						
Primary	35/17.41	9/15.0	6/8.70	20/35.71 ^{ab}	0/0 ^c	0.000
Intermediate	64/31.84	24/40.0	24/34.78	15/26.79	1/6.25 ^{ab}	0.056
Senior	102/50.75	27/45.0	39/56.52	21/37.50	15/93.75 ^{abc}	0.001
Education degree (n/%)						
Bachelor	15/7.46	2/3.33	4/5.80	3/5.36	6/37.50 ^{abc}	0.000
Master or doctor	186/92.54	58/96.67	65/94.20	53/94.64	10/62.50 ^{abc}	0.000
Cardiology sub-group (n/%)						
Non-invasive	61/30.35	17/28.33	23/33.33	20/35.71	1/6.25 ^{bc}	0.136
Coronary interventions	89/44.28	28/46.67	22/31.88	28/50.0	11/68.75 ^b	0.029
Cardiac electrophysiology	48/23.89	16/26.67	18/26.09	7/12.5	7/42.75 ^c	0.049
Intervention in structural heart disease	13/6.47	5/8.33	6/8.70	1/1.79	1/6.25	0.403
Post-graduate education (n/%)						
Domestic	44/1.89	25/41.67	3/4.35 ^a	7/8.93 ^a	9/56.25 ^{bc}	0.000
International	42/20.90	28/46.67	7/10.14 ^a	5/12.50 ^a	2/12.5 ^a	0.000

$p < 0.05$.

^acompared with Hospital A.

^bcompared with Hospital B.

^ccompared with Hospital C.

TABLE 2 | Characteristics of cardiologists in the invasive subspecialty.

	Total n = 201	Hospital A n = 60	Hospital B n = 69	Hospital C n = 56	Hospital D n = 16	p
Invasive subspecialty(n)	140	43	46	36	15	
Primary (n/%)	15/10.71	4/9.30	1/2.17	10/27.78 ^{ab}	0/0 ^c	0.001
Intermediate (n/%)	42/30.0	16/37.21	16/34.78	9/25.0	1/6.67 ^{ab}	0.120
Senior (n/%)	83/59.29	23/53.49	29/63.04	17/47.22	14/93.33 ^{abc}	0.017
Coronary interventions(n)	89	28	22	28	11	
Primary (n/%)	10/12.20	2/7.14	0/0	8/28.57 ^b	0/0	0.005
Intermediate (n/%)	28/34.15	12/42.86	8/36.36	8/28.57	0/0 ^{ab}	0.072
Senior (n/%)	51/57.3%	14/50.0	14/63.64	12/42.86	11/100 ^{abc}	0.010
Cardiac electrophysiology (n)	48	16	18	7	7	
Primary (n/%)	5/10.42	2/12.50	1/5.56	2/28.57	0/0	0.291
Intermediate (n/%)	14/29.17	4/25.0	8/44.44	1/14.29	1/14.29	0.309
Senior (n/%)	29/60.42	10/62.50	9/50.0	4/57.14	6/85.71	0.441
Intervention in structural heart disease (n)	13	5	6	1	1	
Primary (n/%)	0/0	0/0	0/0	0/0	0/0	
Intermediate (n/%)	0/0	0/0	0/0	0/0	0/0	
Senior (n/%)s	13/100	5/100	6/100	1/100	1/100	

$p < 0.05$.

^acompared with Hospital A.

^bcompared with Hospital B.

^ccompared with Hospital C.

primary title engaged in the invasive subspecialty, especially coronary interventions, and had undergone international advanced education. In the field of invasive subspecialty,

coronary interventions accounted for the largest proportion. However, compared with male cardiologists, fewer female cardiologists had the senior title and post-graduate education

TABLE 3 | The experience of domestic advanced study.

	Total n = 201	Hospital A n = 60	Hospital B n = 69	Hospital C n = 56	Hospital D n = 16	p
Post-graduate education (n/%)	42/20.90	25/41.67	3/4.35 ^a	5/8.93 ^a	9/56.25 ^{bc}	0.000
Primary	1/2.38	1/4.0	0/0	0/0	0/0	0.878
Intermediate	15/35.71	10/40.0	1/33.33	3/60	1/11.11	0.287
Senior	26/61.91	14/56.0	2/66.67	2/40	8/88.89	0.251
Invasive subspecialty (n,%)	39/65.0	23/38.33	2/2.90 ^a	5/8.93 ^a	9/56.25 ^{bc}	0.000
Coronary interventions	29/63.04	17/62.96	1/50	5/100	6/46.15	0.173
Cardiac electrophysiology	13/28.26	7/25.93	0/0	0/0	6/46.15	0.184
Intervention in congenital heart disease	5/10.87	3/11.11	1/50	0/0	1/7.69	0.505

$p < 0.05$.

^acompared with Hospital A.

^bcompared with Hospital B.

^ccompared with Hospital C.

TABLE 4 | The experience of international advanced study.

	Total n = 201	Hospital A n = 60	Hospital B n = 69	Hospital C n = 56	Hospital D n = 16	p
Post-graduate education (n/%)	44/21.89	28/46.67	7/10.14 ^a	7/12.50 ^a	2/12.50 ^a	0.000
Primary	0/0	0/0	0/0	0/0	0/0	1.000
Intermediate	7/15.91	7/25.0	0/0	0/0	0/0	0.094
Senior	37/84.09	21/75.0	7/100 ^a	7/100 ^a	2/100 ^a	0.199
Invasive subspecialty (n/%)	41/20.40	27/45.0	7/10.14 ^a	5/8.93 ^a	2/12.50 ^a	0.000
Coronary interventions	25/51.02	18/54.55	2/28.57	3/60	2/50.0	0.636
Interventional cardiac electrophysiology	15/30.61	10/30.30	2/28.57	2/40	1/25.0	0.964
Interventional therapy for structural heart disease	9/18.36	5/15.15	3/42.86	0/0	1/25.0	0.242

$p < 0.05$.

^acompared with Hospital A.

experience, and female doctors were more likely to practice general cardiology.

The gender ratio, academic background, professional title distribution, clinical subspecialty, and advanced learning affect more with regard to diagnosis and CVD treatment (6, 7). Tertiary hospitals and hospitals affiliated with medical universities have relatively higher standards for physicians' academic qualifications. Hospital D is not a teaching hospital, and residents are required to study in each subspecialty of internal medicine in the first few years. This may partially explain why fewer cardiologists have a higher academic background or junior title. Therefore, in tertiary hospitals in China, especially in teaching hospitals, the quality of the diagnosis and therapy, scientific research abilities, and clinical teaching level are all higher.

Our study found that cardiologists involved in interventional therapy were mostly those with the senior title and older than 40 years of age. In addition, we found a higher proportion of cardiologists conducting coronary interventions. This was consistent with the epidemiology of CVD and the development of coronary percutaneous intervention in China (8, 9). Data from the United States show that surgeons' age but not sex impacts patients'

TABLE 5 | The doctor rank structure of male cardiologists.

	Primary	Intermediate	Senior	P
Total (n/%)	15/42.86	39/60.94	81/79.41 ^{ab}	0.000
Hospital A (n/%)	4/44.44	15/62.50	22/81.48 ^a	0.090
Hospital B (n/%)	1/16.67	16/66.67	32/82.05 ^a	0.004
Hospital C (n/%)	10/50.0	8/53.33	16/76.19	0.187
Hospital D (n//%)	0/0	0/0	11/73.33	0.138

$p < 0.05$.

^acompared with Primary.

^bcompared with Intermediate.

mortality: the older the surgeons are, the lower mortality the patients have (10). Fewer doctors participate in the interventional treatment of structural or congenital heart disease. This might be due to the current immature development and popularity of adult congenital heart disease interventional treatment.

Literature has shown that female cardiologists differ from male cardiologists in terms of career development and selection of a clinical subspecialty (11–13). Female cardiologists more often choose a non-invasive subspecialty

TABLE 6 | Distribution of male cardiologists with the invasive subspecialty.

	Invasive subspecialty	Coronary interventions	Cardiac electrophysiology	Interventions in structural heart disease	p
Total (n/%)	130/86.67	83/93.26	34/70.83 ^a	13/100	0.000
Hospital A (n/%)	44/89.80	26/92.86	13/81.25	5/100	0.352
Hospital B (n/%)	53/94.64	22/100	15/83.33	6/100	0.087
Hospital C (n/%)	29/80.56	25/89.29	3/42.86 ^a	1/100	0.021
Hospital D (n/%)	13/72.22	10/90.91	3/42.86 ^a	1/100	0.075

$p < 0.05$.

^acompared with coronary interventions.

^bcompared with cardiac electrophysiology.

TABLE 7 | The gender gap in post-graduate education.

	Domestic			International		
	Male	Female	P	Male	Female	P
Total (n/%)	35/83.33	7/16.67	0.004	38/86.36	6/13.64	0.001
Hospital A (n/%)	22/88.0	3/12.0	0.005	24/85.71	4/14.29	0.007
Hospital B (n/%)	3/100	0/0	0.551	7/100	0/0	0.098
Hospital C (n/%)	4/80.0	1/20.0	0.638	5/71.43	2/28.57	0.692
Hospital D (n/%)	5/71.43	2/28.57	0.838	2/100	0/0	0.542

(14). At the same time, the proportion of women with senior titles or leadership roles is significantly lower than that of males. This phenomenon may be related to children raising, family life, physical ability, social environment, and work stress (15). Our study also found a significant decline in the proportion of female cardiologists with the senior title, and fewer females involved in domestic or international advanced studies. Physical fitness and the ability to work under pressure were also factors that might influence women's career development and career choices (4), and taking the physician's perspective into consideration is not redundant (16).

Conclusion

Differences exist in the professional aspects of cardiologists at four representative hospitals from four cities in China, which include the professional title, level of post-graduate education, subspecialty choice, and gender gap. More effective strategies should be implemented to ultimately monitor the gap, overcome the potential deficiencies, and improve the quality of CVD diagnosis and treatment.

Author contributions

ZC conceived the study. LZ collected and analyzed the data and wrote the draft. ZC made critical revisions to the

current version. All authors agree to be accountable for the content of the work.

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