The burden and management competency of cardiomyopathies in China: a nationwide survey study

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Summary

Background The public health burden of cardiomyopathies and competency in their management by health agencies in China are not well understood.

Methods This study adopted a multi-stage sampling method for hospital selection. In the first stage, nationwide tertiary hospital recruitment was performed. As a result, 88 hospitals with the consent of the director of cardiology and access to an established electronic medical records system, were recruited. In the second stage, we sampled 66 hospitals within each geographic-economic stratification through a random sampling process. Data on (1) the outpatient and inpatient visits for cardiomyopathies between 2017 and 2021 and (2) the competency in the management of patients with cardiomyopathies, were collected. The competency of a hospital to provide cardiomyopathy care was evaluated using a specifically devised scale.

Findings The outpatient and inpatient visits for cardiomyopathies increased between 2017 and 2021 by 38.6% and 33.0%, respectively. Most hospitals had basic facilities for cardiomyopathy assessment. However, access to more complex procedures was limited, and the integrated management pathway needs improvement. Only 4 (6.1%) of the 66 participating hospitals met the criteria for being designated as a comprehensive cardiomyopathy center, and only 29 (43.9%) could be classified as a primary cardiomyopathy center. There were significant variations in competency between hospitals with different administrative and economic levels.

Interpretation The health burden of cardiomyopathies has increased significantly between 2017 and 2021 in China. Although most tertiary hospitals in China can offer basic cardiomyopathy care, more advanced facilities are not yet universally available. Moreover, inconsistencies in the management of cardiomyopathies across hospitals due to differing administrative and economic levels warrants a review of the nation allocation of medical resources.

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Keywords: Cardiomyopathy; Public health burden; Competency

Introduction

Cardiomyopathies represent a considerable global health burden, potentially resulting in sudden cardiac death (SCD) and leading to heart failure in many cases.[1–4] Precision diagnostics, multimodal assessment, and evidence-based treatment have become core concepts in the modern management of these disorders.[5]

Studies commissioned by the Cardiomyopathy Registry of the EURObservational Research Programme (Europe) and the Technical Agency for Information on Hospitalization (France) have assessed the public health burden of cardiomyopathies in terms of hospitalizations.[6,7] However, to data, no nationwide studies of the competency in cardiomyopathy management by health agencies have been conducted in China.

In 2004, we conducted an epidemiological study of hypertrophic cardiomyopathy (HCM) in China.[8] However, despite these efforts, the overall landscape of cardiomyopathies in China, including the competency of hospitals to respond to these conditions, remains poorly understood. To address these issues, in 2022, the National Center for Cardiovascular Diseases (NCCD) established the Cardiomyopathy Specialty Alliance of the National Center for Cardiovascular Diseases

Research in context

Evidence before this study

We searched PubMed, China National Knowledge Internet, and Wanfang Data for original research on the characteristics of patients with cardiomyopathies and their management by health agencies published up to August 31, 2023 in English and Chinese. Although previous studies have assessed the public health burden of cardiomyopathies in terms of hospitalization in Europe, these data are not available for many Asian countries. To date, no nationwide studies of competency in the management of cardiomyopathies by health agencies have been conducted in China.

Added value of this study

In this study, we assessed the characteristics of outpatients and inpatients with any of the five most common cardiomyopathies in mainland China between 2017 and 2021, as well as the ability of hospitals to manage these conditions. We found that the number of outpatient and inpatient visits for cardiomyopathies increased during the assessment period, and the majority of patients attending these visits were middle-aged or older men. Although most tertiary hospitals were adequately equipped with basic facilities required for cardiomyopathy assessment, more sophisticated procedures were not widely implemented. Moreover, significant variations were observed across hospitals in the level of cardiomyopathy care provided, which were related to their administrative and economic levels.

Implications of all the available evidence

The number of visits for cardiomyopathies grew rapidly in mainland China between 2017 and 2021. Although most of the hospital surveyed were able to provide adequate levels of basic cardiomyopathy care, improvements in the quality of cardiomyopathy management provided and a review of medical resource allocation in China are urgently needed.

(CSA-NCCD). This initiative aims to improve the management of cardiomyopathies throughout China.

This nationwide survey-based study was performed by the CSA-NCCD to assess the characteristics of outpatient and inpatient visits for cardiomyopathies between 2017 and 2021, and evaluate the competency of management of these conditions by tertiary hospitals in various geographic-economic regions in mainland China.

Methods

Study design and hospital recruitment

We recruited study hospitals to reflect diverse care of cardiomyopathies in mainland China. Given that hospital volumes and clinical capacities differ according to the geography and economy of a given region, we surveyed hospitals in different geographic-economic regions. The geographic regions included Eastern China, Central China, and Western China based on the China Census definitions.[9] The provinces of each geographic region were divided into those with low, medium, and high economic levels according to the tertile of the gross domestic product per capita (Tables S1 and S2). There are a total of 1651 tertiary hospitals in mainland China, which were the target population of this study. In each geographic-economic stratification, 4% of the tertiary hospitals were designed to be recruited for this study, with 66 hospitals in total (Table S1). This study adopted a multi-stage sampling method for hospital selection. The first stage involved nationwide tertiary hospitals recruitment, which led to the recruitment of 88 hospitals with the consent of the director of cardiology and the established electronic medical records system. In the second stage, 66 of the 88 hospitals were selected using a random sampling process within each geographic-economic stratification according to the design. The list of 66 hospitals is shown in Table S2.

Data collection

The report form was designed by the study investigators (Table S3) to collect the following data elements: (1) the total number of outpatient and inpatient visits for cardiomyopathies (stratified by patient age and sex) for each year between 2017 and 2021, and (2) the hospital-based competency in performing cardiomyopathy-related diagnosis and assessment procedures, treatment, and integrated patient management.

The most common types of cardiomyopathy are HCM, dilated cardiomyopathy (DCM), arrhythmogenic cardiomyopathy (ACM), restrictive cardiomyopathy (RCM), and left ventricular noncompaction (LVNC). Only data from patients with these five most common types of cardiomyopathy were included in this study; patients with any other type of cardiomyopathy were excluded. The International Statistical Classification of Diseases and Related Health Problems (Tenth Revision) was used to identify patients with a principal discharge diagnosis of cardiomyopathy. Patients with a "likely" or "probable" diagnosis of cardiomyopathy were excluded.

Data from patient visits were collected by trained clinicians at the participating hospitals by searching through the electronic medical records. Hospital-based competency was assessed on the basis of the responses provided by trained clinicians, which were scored as 1 or 0, according to whether or not the aforementioned procedures were available at their hospitals, respectively.

Quality control

The following quality control protocols were adopted: (1) training sessions were held before the beginning of the

Levels of competency in the management of cardiomyopathies	Comprehensive cardiomyopathy center	Primary cardiomyopathy center
Diagnosis and assessment procedures		
Echocardiography	√	√
Stress echocardiography	√	√
Holter electrocardiography	√	√
Cardiopulmonary exercise testing	√	√
Cardiac CT	√	√
CT angiography	√	√
CMR	√	√
Late gadolinium enhanced-CMR	√	√
^{99}mTc-MIBI SPECT/CT	√	
^{99}mTc-PYP	√	
^{18}F-FDG PET/CT	√	
Coronary arteriography	√	√
Left ventricular angiography	√	
Invasive cardiac electrophysiology	√	
Endomyocardial biopsy	√	
Pathological examination	√	
Genetic testing	√	√
Alpha-galactosidase A enzyme activity test	√	√
Alpha-glucosidase enzyme activity test	√	√
Monoclonal protein screening for light chain amyloidosis	√	√
Treatment procedures		
Single/dual-chamber pacemaker	√	√
Implantable cardioverter-defibrillator	√	√
Cardiac resynchronization therapy	√	
Left ventricular assist device	√	
Interventional septal reduction therapy	√	
Surgical septal reduction therapy	√	
Heart transplantation	√	
Exercise prescription	√	
Education	√	
Psychological interventions	√	
Integrated patient management		
Specialized cardiomyopathy unit	√	
Multidisciplinary consultation system	√	
Routine follow-up	√	

CT, computed tomography; CMR, cardiac magnetic resonance; TC, technetium; MIBI, methoxyisobutylisonitrile; SPECT, single-photon emission computed tomography; PYP, pyrophosphate; ^{18}F-FDG, F-18 fluoro-2-deoxyglucose; PET, positron emission tomography. The specific criteria included in the scale to assess hospital competency in the management of cardiomyopathies are provided in Panel 1.

Table 1: **The scale of competency in the management of cardiomyopathies.**

study with item-by-item explanations of all the data elements; (2) all the recruited hospitals had full access to an electronic medical record system, and the system could automatically count the number of visits for cardiomyopathies; (3) the report forms were completed by experienced clinicians, and signed off and submitted by the Principal Investigator of each hospital; (4) all the report forms were edit checked, and any queries found were sent back to each hospital for confirmation and revision.

Evaluation of hospital-based competency in the management of cardiomyopathies

Two hospital grouping strategies were used to assess how competently the cardiomyopathies were managed by the various participating hospitals: (1) provincial and municipal, according to the administrative level of a participating hospital; and (2) economically developed and undeveloped, according to the economic status of the city where the participating hospital was located (referring to the Ranking of Cities' Business Attractiveness in China [Table S2]).

A scale was developed to assess the levels of competency in the management of cardiomyopathies at each hospital (Table 1). The items on this scale were drawn from the American Heart Association and European Society of Cardiology guidelines.[5,10] A hospital was then considered to be a comprehensive cardiomyopathy center, a primary cardiomyopathy center, or neither, based on whether it met the corresponding competency requirements (denoted with a "√"). A primary cardiomyopathy center had the competency for basic diagnosis, risk assessment and treatment decisions for cardiomyopathies. A comprehensive cardiomyopathy center had demonstrated levels of expertise and resources specific for the management of cardiomyopathies (e.g., additional advanced diagnostic procedures such as nuclear imaging, sophisticated invasive treatment strategies, rehabilitation therapy, and individualized management). The specific criteria included in the scale to assess hospital competency in the management of cardiomyopathies are provided in Panel 1 in supplementary.

Statistical analysis

A descriptive analysis was used to report the characteristics of the outpatient and inpatient visits for cardiomyopathies. Categorical variables, including age group, sex, and the level of competency in the management of cardiomyopathies were reported as percentages. The statistical analysis was performed using R (version 4.1.1; The R Foundation for Statistical Computing, Vienna, Austria). A standardized mean difference (SMD) > 0.1 was considered as a measure of statistical significance.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Characteristics of outpatient and inpatient visits for cardiomyopathies and the trends observed between 2017 and 2021

Overall, the numbers of outpatient and inpatient visits for cardiomyopathies in the 66 hospitals increased between 2017 and 2021 (Fig. 1). The outpatient visits increased from 109,112 in 2017 to 151,262 in 2021,

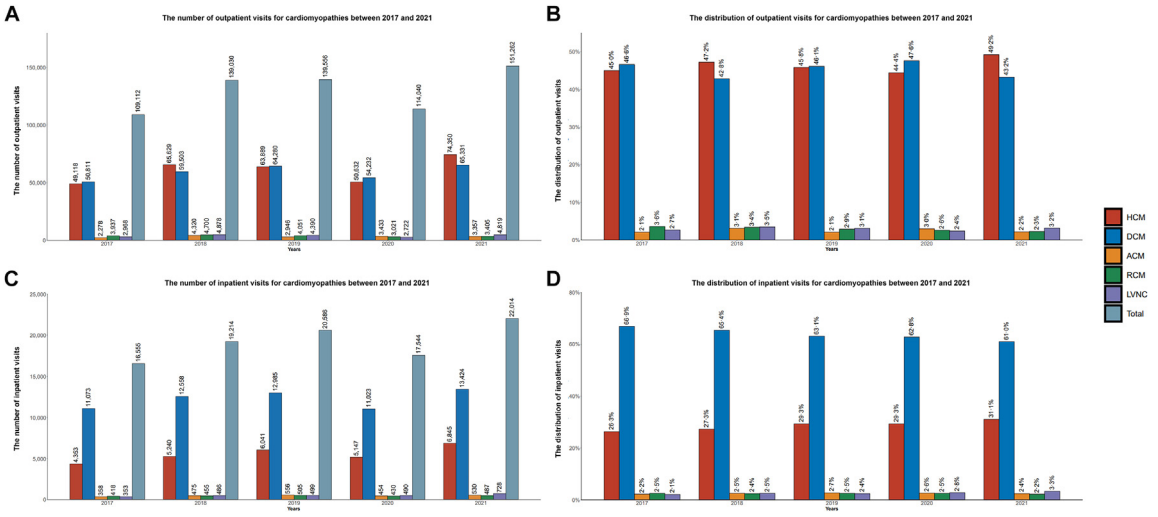

***Fig. 1:* Trends in the number of visits for cardiomyopathies between 2017 and 2021**. The numbers of outpatient (A) and inpatient (B) visits for cardiomyopathies between 2017 and 2021. The distribution of outpatient (C) and inpatient (D) visits for cardiomyopathies between 2017 and 2021. HCM, hypertrophic cardiomyopathy; DCM, dilated cardiomyopathy; ACM, arrhythmogenic cardiomyopathy; RCM, restrictive cardiomyopathy; LVNC, left ventricular noncompaction.

which corresponded to a 38.6% increase (95% confidence interval [CI] 38.3%–38.9%]). Meanwhile, the inpatient visits increased from 16,555 in 2017 to 22,014 in 2021, which corresponded to a 33.0% increase (95% CI 32.3%–33.7%). Owing to the impact of the COVID-19 pandemic, the number of visits for cardiomyopathies showed a year-to-year decline in 2020 but returned to the trend of increase in 2021.

DCM and HCM were the most common cardiomyopathies encountered during hospital visits, accounting for more than 90% of outpatient and inpatient cases. The proportions of outpatient and inpatient visits for ACM, RCM, and LVNC were all in the range of 2.1%–3.6%. The proportions of outpatient visits for HCM and DCM were almost the same, while the proportion of inpatient visits for DCM was approximately twice that of inpatient visits for HCM. Notably, the proportion of inpatient visits for HCM showed a stepwise increase from 26.3% in 2017 to 31.1% in 2021 (Fig. 1).

Most of the outpatient and inpatient visits for cardiomyopathies were middle-aged (aged 41–60 years) and older (aged >60 years) adults. There was a preponderance of men among both outpatient visits (66.3% in 2017, 65.8% in 2021) and inpatient visits (68.2% in 2017, 67.6% in 2021) (Fig. 2).

Hospital competency in the management of cardiomyopathies

Assessment of the cardiomyopathy-related services offered by the participating hospitals

Echocardiography, Holter electrocardiography, and computed tomography (CT) coronary angiography were available for non-invasive cardiomyopathy assessment in all the hospitals surveyed. Stress echocardiography, cardiopulmonary exercise testing (CPET), cardiac magnetic resonance (CMR), late gadolinium-enhanced (LGE)-CMR, and cardiac CT were available in 80.3%, 83.3%, 90.9%, 87.9%, and 92.4% of the hospitals, respectively. Meanwhile, nuclear imaging was less accessible, with ^{99}m-technetium (^{99}mTc)-methoxyisobutylisonitrile-single-photon emission computed tomography/CT, ^{99}mTc-pyrophosphate (PYP), and F-18 fluoro-2-deoxyglucose positron emission tomography/CT being available in only 72.7%, 60.6%, and 53.0% of the hospitals, respectively. Coronary arteriography, left heart ventricular angiography, and invasive cardiac electrophysiology were available for invasive cardiomyopathy assessment in all hospitals. Histological examination for cardiomyopathies included endomyocardial biopsy (EMB) followed by pathological examination. However, although pathological examination for cardiomyopathies was available in 83.3% of the hospitals, EMB was only available in 51.5% of the hospitals. Molecular diagnostic techniques are helpful for confirming a diagnosis or obtaining a differential diagnosis; we found that genetic testing (in-house or third-party), alpha-galactosidase (α-Gal) A enzyme activity testing, alpha-glucosidase (GAA) enzyme activity testing, and monoclonal protein screening for light chain amyloidosis, were available in 93.9%, 80.3%, 75.8%, and 84.8% of the hospitals, respectively (Table 2).

More than 90% of the hospitals were equipped with single/dual-chamber pacemakers and implantable cardioverter-defibrillators (ICDs), and were able to provide cardiac resynchronization therapy. Septal reduction

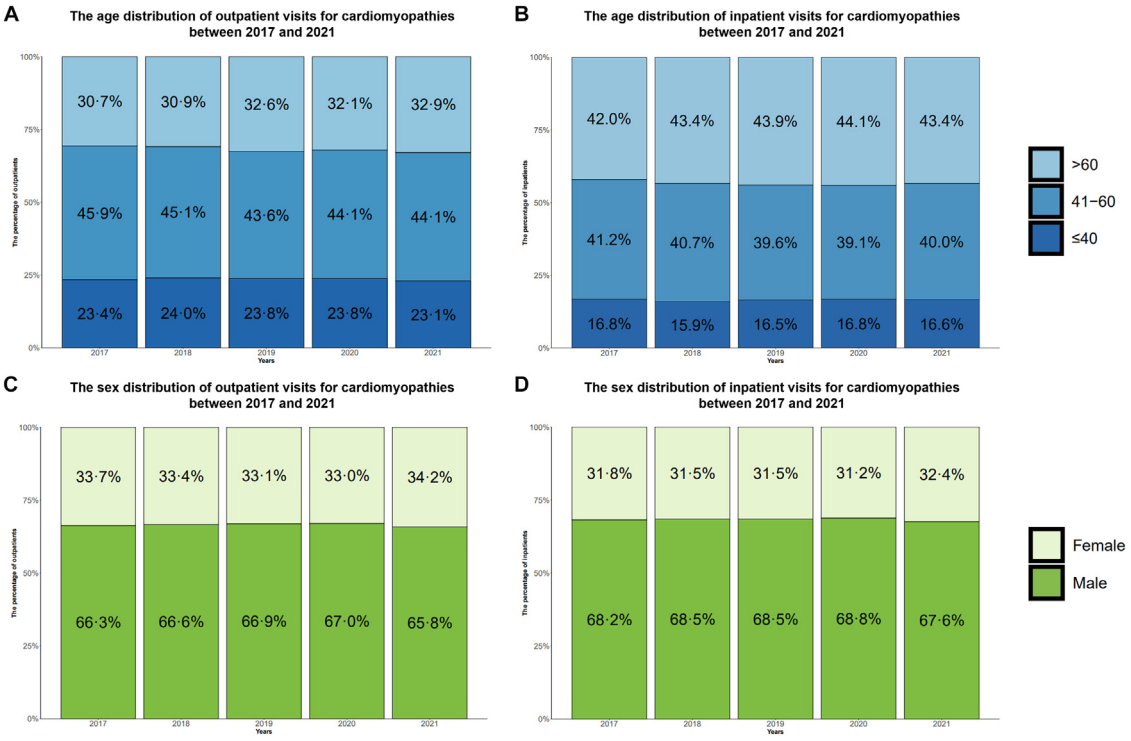

***Fig. 2:* Number of outpatient and inpatient visits for cardiomyopathies, stratified by age and sex, between 2017 and 2021**. Number of outpatient (A) and inpatient (B) visits for cardiomyopathies, stratified by age. Number of outpatient (C) and inpatient (D) visits for cardiomyopathies, stratified by sex.

therapy (SRT), which is HCM-specific, could be performed in 69.7% of the hospitals using interventional methods and in 62.1% of the hospitals via surgery. Therapies for severe heart failure, namely, left ventricular assist device (LVAD) implantation and heart transplantation, could be performed in 45.5% and 30.3% of the hospitals, respectively. Cardiac rehabilitation therapies, including exercise prescription, education, and psychological intervention, were provided in 72.7%, 62.1%, and 62.1% of the hospitals, respectively (Table 2).

One-third of the hospitals surveyed had established specialized cardiomyopathy units; meanwhile, a multidisciplinary consultation system was available in 75.8% of the hospitals. Moreover, 77.3% of the hospitals were able to perform routine patient follow-up (Table 2).

The heterogeneity of the competency by administrative and economical levels

Forty-one of the participating institutions were provincial hospitals and 25 were municipal hospitals (grouped by administrative level); 32 hospitals were located in economically developed cities and 34 in economically undeveloped cities (grouped by economic level). Competency of the participating hospitals in the management of cardiomyopathies varied significantly across the administrative levels and across the cities in which the hospitals were located (Table 2, Fig. 3).

Individual procedures for the management of cardiomyopathies were more readily available in provincial hospitals and hospitals in economically developed cities than in municipal hospitals and hospitals in economically undeveloped cities (Table 2). Large variations were observed in some specific aspects of cardiomyopathy management. For example, the provision of nuclear imaging, EMB, and some advanced treatments (e.g., SRT, LVAD implantation, and heart transplantation) was very low in municipal hospitals and hospitals in economically undeveloped cities (Fig. 3).

According to our scale score, only 4 (6.1%) of the 66 hospitals fulfilled the criteria for being designated a comprehensive cardiomyopathy center, while 29 (43.9%) of the hospitals could be classified as primary cardiomyopathy centers (Table 2). Provincial hospitals and hospitals located in economically developed cities were more likely to be classified as a comprehensive or primary cardiomyopathy center than the municipal hospitals and hospitals in economically undeveloped cities (both SMD >0.1). Of note, all four of the

Stratified by	Total (n = 66)	Administrative levels			Economic levels		
		Provincial (n = 41)	Municipal (n = 25)	SMD	Economically developed (n = 32)	Economically undeveloped (n = 34)	SMD
Diagnosis and assessment procedures							
Echocardiography	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
Stress echocardiography	80.3%	40 (97.6%)	13 (52.0%)	1.232	30 (93.8%)	23 (67.6%)	0.701
Holter electrocardiography	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
Cardiopulmonary exercise testing	83.3%	37 (90.2%)	18 (72.0%)	0.479	29 (90.6%)	26 (76.5%)	0.389
Cardiac CT	92.4%	40 (97.6%)	21 (84.0%)	0.482	32 (100.0%)	29 (85.3%)	0.587
CT angiography	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
CMR	90.9%	41 (100.0%)	19 (76.0%)	0.795	32 (100.0%)	28 (82.4%)	0.655
Late gadolinium enhanced-CMR	87.9%	41 (100.0%)	17 (68.0%)	0.97	32 (100.0%)	26 (76.5%)	0.784
^{99}mTc-MIBI SPECT/CT	72.7%	36 (87.8%)	12 (48.0%)	0.943	27 (84.4%)	21 (61.8%)	0.527
^{99}mTc-PYP	60.6%	35 (85.4%)	5 (20.0%)	1.732	23 (71.9%)	17 (50.0%)	0.460
^{18}F-FDG PET/CT	53.0%	30 (73.2%)	5 (20.0%)	1.260	23 (71.9%)	12 (35.3%)	0.788
Coronary arteriography	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
Left ventricular angiography	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
Invasive cardiac electrophysiology	100.0%	41 (100.0%)	25 (100.0%)	<0.001	32 (100.0%)	34 (100.0%)	<0.001
Endomyocardial biopsy	51.5%	26 (63.4%)	8 (32.0%)	0.663	25 (78.1%)	9 (26.5%)	1.208
Pathological examination	83.3%	36 (87.8%)	19 (76.0%)	0.310	32 (100.0%)	23 (67.6%)	0.978
Genetic testing	93.9%	40 (97.6%)	22 (88.0%)	0.376	32 (100.0%)	30 (88.2%)	0.516
Alpha-galactosidase A enzyme activity test	80.3%	37 (90.2%)	16 (64.0%)	0.658	28 (87.5%)	25 (73.5%)	0.358
Alpha-glucosidase enzyme activity test	75.8%	35 (85.4%)	15 (60.0%)	0.594	27 (84.4%)	23 (67.6%)	0.399
Monoclonal protein screening for light chain amyloidosis	84.8%	39 (95.1%)	17 (68.0%)	0.747	30 (93.8%)	26 (76.5%)	0.500
Treatment procedures							
Single/dual-chamber pacemaker	97.0%	40 (97.6%)	24 (96.0%)	0.089	31 (96.9%)	33 (97.1%)	0.011
Implantable cardioverter-defibrillator	90.9%	39 (95.1%)	21 (84.0%)	0.370	31 (96.9%)	29 (85.3%)	0.415
Cardiac resynchronization therapy	90.9%	40 (97.6%)	20 (80.0%)	0.579	31 (96.9%)	29 (85.3%)	0.415
Left ventricular assist device	45.5%	25 (61.0%)	5 (20.0%)	0.919	20 (62.5%)	10 (29.4%)	0.704
Interventional septal reduction therapy	69.7%	36 (87.8%)	10 (40.0%)	1.148	26 (81.2%)	20 (58.8%)	0.505
Surgical septal reduction therapy	62.1%	33 (80.5%)	8 (32.0%)	1.120	26 (81.2%)	15 (44.1%)	0.831
Heart transplantation	30.3%	19 (46.3%)	1 (4.0%)	1.118	15 (46.9%)	5 (14.7%)	0.743
Exercise prescription	72.7%	30 (73.2%)	18 (72.0%)	0.026	26 (81.2%)	22 (64.7%)	0.379
Education	62.1%	28 (68.3%)	13 (52.0%)	0.337	21 (65.6%)	20 (58.8%)	0.141
Psychological interventions	62.1%	28 (68.3%)	13 (52.0%)	0.337	23 (71.9%)	18 (52.9%)	0.399
Integrated patient management							
Specialized cardiomyopathy unit	30.3%	15 (36.6%)	5 (20.0%)	0.375	15 (46.9%)	5 (14.7%)	0.743
Multidisciplinary consultation system	75.8%	33 (80.5%)	17 (68.0%)	0.289	27 (84.4%)	23 (67.6%)	0.399
Routine follow-up	77.3%	34 (82.9%)	17 (68.0%)	0.352	27 (84.4%)	24 (70.6%)	0.335
Levels of competency in management of cardiomyopathies							
Comprehensive cardiomyopathy center	4 (6.1%)	4 (9.8%)	0 (0.0%)	1.348	4 (12.5%)	0 (0.0%)	0.762
Primary cardiomyopathy center	29 (43.9%)	25 (61.0%)	4 (16.0%)		17 (53.1%)	12 (35.3%)	
Not meet the criteria for a primary cardiomyopathy center	33 (50.0%)	12 (29.3%)	21 (84.0%)		11 (34.4%)	22 (64.7%)	

CT, computed tomography; CMR, cardiac magnetic resonance; TC, technetium; MIBI, methoxyisobutylisonitrile; SPECT, single-photon emission computed tomography; PYP, pyrophosphate; ^{18}F-FDG, F-18 fluoro-2-deoxyglucose; PET, positron emission tomography; SMD, standardized mean difference.

Table 2: **Competency in management of cardiomyopathies among recruited hospitals.**

comprehensive cardiomyopathy centers were provincial hospitals located in economically developed cities.

Discussion

According to contemporary epidemiological metrics, there are at least 7 million patients with DCM and HCM in China.[5,8] Providing high-quality care to all these individuals is challenging, especially as China has a large population and inconsistent levels of economic development across regions.

This study was the first multicenter, real-world, nationwide investigation to assess the characteristics of outpatient and inpatient visits for any of the five most

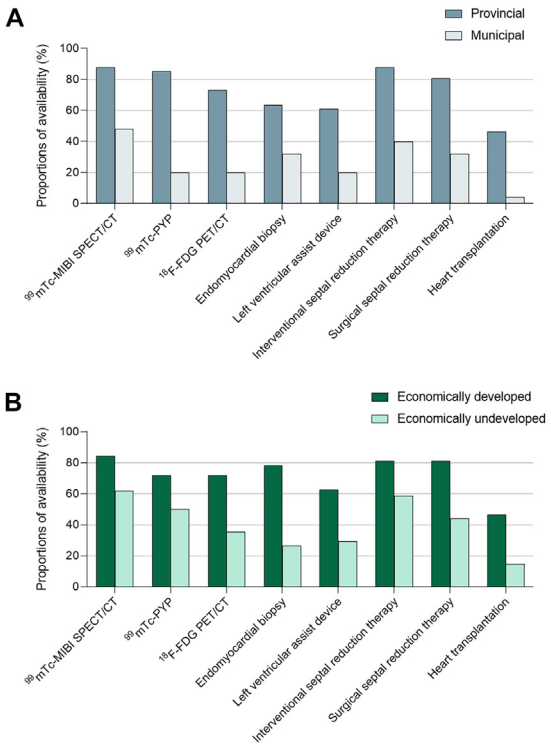

***Fig.* 3: Variations of competency in the management of cardiomyopathies**. Large variations were observed in how competently the patients with cardiomyopathies were managed by hospitals with different administrative (A) and economic (B) levels. ^{99}mTc-MIBI SPECT/CT, ^{99}m-technetium-methoxyisobutylisonitrile-single-photon emission computed tomography/computed tomography; ^{99}mTc-PYP, ^{99}m-technetium-pyrophosphate; ^{18}F-FDG PET/CT, F-18 fluoro-2-deoxyglucose positron emission tomography/computed tomography.

common cardiomyopathies and their trends between 2017 and 2021 as well as hospital-based competency in the management of cardiomyopathies in mainland China. These findings can serve as a basis to guide efforts for improvement in the quality of cardiomyopathy care and allocation of the nation's resources.

The year-over-year increase in the number of inpatient visits for cardiomyopathies in 2021 (25.5%) surpassed that of inpatient visits for coronary heart disease (20.7%) but was still lower than that of inpatient visits for hypertension (64.8%), reflecting improved awareness and competency in management of cardiomyopathies in mainland China. DCM and HCM are the two most prevalent types of cardiomyopathy. Our outpatient data showed that the proportions of these two diseases were very similar but that DCM was overwhelmingly more common in hospitalized patients, which may reflect the more severe symptoms of patients with DCM and their more urgent need for treatment.[11] Another important finding was the increase in the proportion of inpatients with HCM, suggesting that the rate of HCM detection has improved with the development of more effective diagnostic and assessment techniques. The proportions of patients with ACM, RCM, and LVNC were much lower than those with DCM and HCM, which was attributed to the low prevalence of these three cardiomyopathies, as well as challenges associated with their diagnosis and screening.[12–15]

Consistent with previous reports, we found that more men than women visited the hospital and were hospitalized for cardiomyopathy.[6,16] Possible explanations for these sex-related differences may be that the cardiomyopathy phenotype occurs later in women than men[17] and that women are still less able to access healthcare services in China.[18] This may be especially true for HCM, which impacts women more severely than men.[19]

Our investigation of hospital competency in the management of cardiomyopathies showed that echocardiography, Holter electrocardiography, CT coronary angiography, coronary arteriography, left ventricular angiography, and invasive cardiac electrophysiology were available in all hospitals. There finding indicate that most tertiary hospitals in mainland China are well equipped with the basic facilities needed to assess cardiomyopathies. It is worth noting that although important advanced procedures (e.g., stress echocardiography, CPET, and CMR) had a relatively high application rate (80.3%–90.9%), they have not been fully popularized even in the tertiary hospitals we surveyed.

Histopathology remains the gold standard for diagnosing cardiomyopathies.[20] However, we found that although the overall pathological examination rate exceeded 80%, the EMB rate was much lower. Given that EMB is not more difficult to operate compared to other invasive techniques (e.g., coronary angiography), its low rate of implementation is largely related to poor recognition of the value of EMB in the differential diagnosis of cardiomyopathy, the unavailability of suitable instruments (e.g., biopsy forceps), and low patient adherence. The mismatch between the ease of EMB implementation and its actual adoption in hospitals suggests that EMB is a restricting factor for the clinical acquisition of histological evidence.

The approval of ^{99}mTc-PYP use for the non-invasive assessment of transthyretin cardiac amyloidosis has greatly enhanced the application of nuclear medicine in the diagnosis of cardiomyopathies in China.[21] Although ^{99}mTc-PYP was first implemented in China as recently as 2019, we found that 60.6% of the tertiary hospitals had successfully adopted this technique. Although there is still considerable scope for improvement, nuclear medicine has considerably facilitated the diagnosis (including differential diagnosis) of cardiomyopathies in China.

The cardiomyopathy molecular diagnosis rate reported by the participating hospitals were encouraging. Most (93.9%) of the tertiary hospitals in mainland China were able to perform genetic tests, and the rates of α-Gal

A and GAA enzyme activity testing and monoclonal protein screening for light chain amyloidosis had reached approximately 80%, which is significantly higher than the rate of other differential diagnostic elements. The high rates of molecular testing reported reflect the growing understanding of the molecular mechanisms of cardiomyopathies. The emergence of targeted therapies for Fabry disease, cardiac amyloidosis, and glycogen storage diseases have also promoted the development of molecular diagnosis to some extent.[22,23]

Prevention of SCD is the cornerstone for cardiomyopathy management.[5] In accordance, we found that >90% of the hospitals surveyed offered ICD implantation. Appropriate recommendations for ICD implantation require adequate risk stratification for SCD. Combined with the aforementioned risk stratification methods, such as LGE-CMR and genetic testing, the corresponding implementation rates indicate that primary and secondary prevention of SCD can be implemented in most tertiary hospitals in China. However, a previous report indicates that few patients actually underwent ICD implantation in China.[24] Possibly reasons may be the lack of insurance cover for ICD devices and the low rate of patient acceptance of such an invasive treatment. SRT provides effective mechanical relief for patients who are highly symptomatic or refractory to maximum medical therapy.[25] Both interventional and surgical methods are highly dependent on the experience of the clinical team, which limits their implementation (69.7% and 62.1%, respectively, in all hospitals). Similarly, heart transplantation is limited by the number of donors and the availability of multidisciplinary teams[5]; as such, it was only available in 30.3% of the hospitals surveyed. However, the increasing availability of LVAD (45.5%), which has been shown to prolong the survival of patients with cardiomyopathies should offer some reassurance.[26]

Cardiac rehabilitation therapies play an important role in the secondary prevention of cardiomyopathies.[27] Underuse of cardiac rehabilitation therapies (exercise prescription, 72.7%; education, 62.1%; and psychological interventions, 62.1%) is related to the lack of suitably qualified professionals and low patient participation. Thus, the implementation of suitable staff training and patient education programs should be further explored.

To deliver optimal care to patients and any at-risk family members, integrated management should not only comprise specialist input but also the support of a multidisciplinary team.[5] Our study found that only one-third of the tertiary hospitals had a routinely operating specialist cardiomyopathy unit. Given that three-quarters of tertiary hospitals already had multidisciplinary consultation systems in place, setting up specialized cardiomyopathy units has great potential to prompt establishment of multidisciplinary cardiomyopathy teams, train cardiomyopathy specialists, and strengthen personalized and comprehensive management of cardiomyopathies. Furthermore, we found that only 77.3% of the hospitals currently offer routine follow-up for cardiomyopathy. This figure is suboptimal and suggests a need for the improved whole course management of cardiomyopathies in China.

In an effort to understand the significant imbalances in the abovementioned competency in the management of cardiomyopathies, we further explored the administrative and economic levels of the participating hospitals. We found that provincial hospitals and hospitals in economically developed cities were able to provide more advanced levels of care for cardiomyopathies than municipal hospitals and hospitals in economically undeveloped cities. In particular, all four comprehensive cardiomyopathy centers identified in this study were provincial hospitals located in economically developed cities. This imbalance is attributed mainly to differences in regional economic status, financial support provided to the hospital, and the allocation of health care resources. Further research is also needed to determine whether the insufficient competency in the management of cardiomyopathies is a dominant factor in the referral of patients to centers with higher levels of care. Particularly concerning was that only 6.1% and 43.9% of the participating hospitals could be classified as comprehensive cardiomyopathy centers and primary cardiomyopathy centers, respectively. These figures suggest that, at present, cardiomyopathies are not adequately managed in China and that urgent improvements are needed. Support from policy makers, investment in basic hospital equipment, and training of personnel would collectively help address the issues identified. Panel 2 in supplementary outlines the specific policy recommendations informed by our findings.

This study has some limitations. First, the hospitals analyzed in this study were selected following a multistage sampling method, which was not an entirely random sampling process. Moreover, the hospital catchment areas were not considered due to the lack of existing data. Second, we only investigated tertiary hospitals in mainland China, and the situation in less specialized health care facilities is unknown. Third, as the study data were collected using a survey, there could be variations between our statistics and the national actual situation.

Conclusions

In this study, we found that the numbers of visits for cardiomyopathies rapidly increased from 2017 to 2021. Investigations of competency in the management of cardiomyopathies showed that most tertiary hospitals in mainland China were adequately equipped with basic facilities for assessing patients with cardiomyopathies. However, more complicated procedures are still not widely available, and the integrated management pathway for cardiomyopathies needs improvement. We

also identified that half of the tertiary hospitals in China did not meet the criteria to be classified even as a primary cardiomyopathy center and that administrative level and economic status were major factors in determining how competently a hospital managed cardiomyopathies. We envisage that our findings will help guide future work to improve the care of patients with cardiomyopathies.

Contributors

Y.Zhang., M.L. and P.L. contributed equally as the co-first authors. L.W., H.Xiao, L.L., Y.Zou. and L.S. contributed equally as the corresponding authors.

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Analysis of data and drafting of the manuscript: Y.Zhang., M.L. and P.L.

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Data sharing statement

Data are available from the corresponding authors upon reasonable request.

Declaration of interests

The authors have no potential conflicts of interest to disclose.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2024.101062.

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