Understanding the Functional Needs of Chinese Cardiovascular Patients for Nursing Robots: A Kano Model Analysis

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Abstract

Background: With the intensification of population aging and the increase in chronic diseases, the number of CVD patients in China is rapidly growing. Nursing robots have been recognized as an effective method to alleviate the workload on nurses. However, in China, the true demand of CVD patients for nursing robots remains unclear.

Objective: Based on the Kano model, this study analyses cardiovascular disease patients' attitudes and demand priority levels towards functional areas of nursing robots. On this basis, it provides suggestions for optimizing the functions of Chinese nursing robots and promotes the broader adoption of nursing robots in China.

Methods: A self-designed questionnaire was used to survey 156 cardiovascular disease patients at Wuhan Asia Heart Hospital from July 2023 to June 2024, using the convenience sampling method—the survey aimed to gather information about the patient's understanding of nursing robots and their functional requirements.

Results: Among the 15 functional attributes surveyed, the Kano model classified ‘Accompany care’, ‘Consulting education’, ‘Information management’, and ‘Monitoring and warning’ as must-be attributes; ‘Activity management’, ‘Rehabilitation physiotherapy’, ‘Drug management’, ‘Security management’, and ‘Logistics transfer’ were classified as one-dimensional attributes; ‘Infection management’, ‘First aid skills’, and ‘Nutritional care’ were classified as attractive attributes; the remaining three items, ‘Sampling operation’, ‘Personal hygiene management’, and ‘Excretory care’, were indifferent demands.

Conclusions: Our study reveals that patients with cardiovascular disease generally have a positive attitude towards nursing robots. However, their demand for the functions of nursing robots varies. Research shows they prefer delegating tasks that enhance self-management skills to nursing robots. In the future, medical institutions are expected to introduce nursing robots based on users' functional requirements. Clinical Trial: This study is a nonrandomized controlled trial and does not require trial registration.

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Keywords: Artificial intelligence; Kano model; Demand analysis; Robot; Health services research

Introduction

Globally, cardiovascular disease (CVD) has emerged as one of the primary risk factors adversely affecting public health [1]. According to a global statistical report by the American Heart Association, by 2021, there were over 19.91 million deaths attributed to cardiovascular disease worldwide [2]. Over the past few decades, both the incidence and mortality rates of cardiovascular disease in China have exhibited a significant upward trend. The number of patients with cardiovascular disease in China alone amounts to 330 million [3]. Given the substantial population in China with risk factors for cardiovascular disease, the incidence and mortality rates of CVD continue to rise, posing significant challenges to the Chinese healthcare system. Additionally, the trend of an aging population in China is intensifying, resulting in an increased reliance on care services [4]. However, Chinese nurses face more arduous tasks compared to their counterparts in developed countries such as those in Europe and the United States, indicating that Chinese nurses bear a heavier workload [5]. Fortunately, the advent of intelligent nursing robots presents new opportunities to alleviate the stress burden on clinical nurses. These robots can undertake repetitive and simple tasks, thereby allowing nursing staff to concentrate more on professional and complex clinical work [Error: Reference source not found]. Specifically, in the field of cardiovascular specialty nursing, intelligent nursing robots demonstrate unique advantages in enhancing patient satisfaction, facilitating medical data extraction and clinical risk prediction, and reducing healthcare costs. This advancement will render future cardiovascular care more personalized, precise, and effective [6-8].

Despite the growing interest in nursing robots among professionals, their actual application in clinical environments faces challenges due to low sustained usage rates [9]. A report indicates that among early adopters of AI strategies, only about 3% of healthcare institutions continue to utilize service robots. This low figure highlights the difficult situation that nursing robots encounter in clinical applications [10]. Researchers such as Liu have investigated the factors influencing patients' willingness to continue using nursing robots in hospitals and have suggested that managers or practitioners could survey the usage intentions of specific user groups to inform the implementation of new technologies, thereby reducing costs for healthcare institutions [9]. Although previous studies have examined the positive role of nursing robots in improving care for patients with cardiovascular disease, few investigations have focused on the usage intentions and functional needs of this patient population regarding nursing robots. Therefore, we propose employing the KANO model to explore the usage intentions and functional preferences of cardiovascular disease user groups towards nursing robots. The aim is to identify the functionalities of nursing robots that are most urgently needed in today's clinical environment. By doing so, we seek to enhance the design of nursing robot products while maximizing the sustained usage rate of smart assistive devices.

Methods

Study design

A cross-sectional study design was adopted. During the collection of questionnaires, an online survey program was used to create and distribute the questionnaires. Prior to completing the questionnaire, each participant was accompanied by a trained researcher who provided a comprehensive introduction to the survey's content, objectives, and filling requirements. The researcher also clarified any aspects of the survey that participants found unclear, thereby ensuring the accuracy of the results. The minimum required sample size for the questionnaire was calculated using the following formula:

$$N=\frac{Z^2\sigma^2}{d^2}$$

Based on these parameters, the minimum sample size was 68. In order to minimize errors and eliminate the impact of invalid responses, and after considering the actual circumstances, it was ultimately decided to increase the number of distributed questionnaires to 200. This quantity sufficiently balances the sample size while taking into account the constraints of time and resources, thereby achieving reliable research results.

Participants

Convenience sampling was employed to select cardiovascular disease patients who visited Wuhan Asia Heart Hospital from July 2023 to June 2024 as the primary study participants. Inclusion criteria were: (1) adults aged 18 years and older, regardless of gender; (2) patients with a precise diagnosis of cardiovascular disease (any type); (3) voluntary participation in the study.

Exclusion criteria included: (1) failure to provide valid informed consent or incomplete questionnaires; (2) individuals with significant cognitive impairment (a Mini-Mental State Examination score<27; (3) those with decreased vision or hearing impairments, making it impossible to read text or engage in conversation; (4) participants with critical acute conditions or those in end-stage disease are excluded. The specific process of this study is shown in Figure 1.

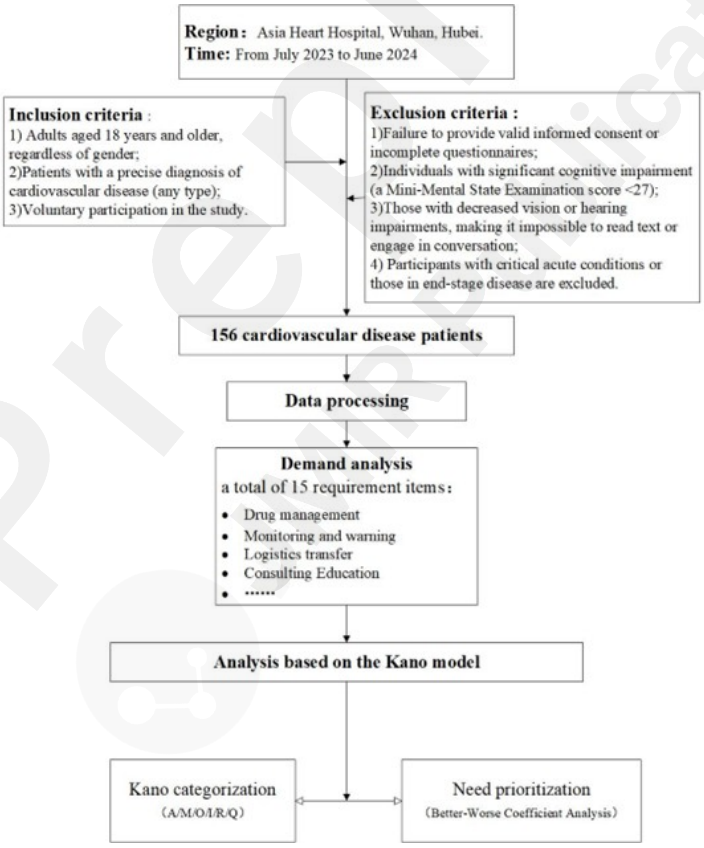


Figure 1 Flow diagram of the study.

Research tools

The survey tool comprises an online questionnaire designed with two sections. The first section is a general information survey that includes nine questions related to participants' gender, marital status, age, education level, type of cardiovascular disease, duration of illness, previous experience with nursing robots, receipt of robot services, and methods of interaction with robots. The second part features the Kano survey scale, which addresses the functional needs of nursing robots. Based on a preliminary literature analysis, we identified and analyzed tasks in nursing that could potentially be replaced by robots, classifying them into 15 demand items [11-12] using card sorting methods (see Table 1). The Kano demand survey questionnaire was developed based on these items. Following the completion of the questionnaire design, we invited five experts—three specializing in cardiovascular disease nursing and two in artificial intelligence and communication technology—to evaluate our designed Kano demand scale. They assessed the relevance of the questions using Likert scales. The item-level content validity index (I-CVI) for the Kano demand questionnaire ranged from 0.71 to 1.0, while the scale-level content validity index (S-CVI) was 0.8. We assessed the effectiveness of the questionnaire using the Cronbach alpha coefficient, which was found to be 0.929. Additionally, internal consistency was evaluated through the retest coefficient, which yielded a value of 0.940. These results indicate that the effectiveness and reliability of the questionnaire are acceptable.

Table 1 Classification of Functional Areas of Nursing Robots

Category	Application scenario
1. Drug management	Intravenous dispensing
	Drug distribution
	Medication Reminder
2. Monitoring and warning	Physiological indicators measurement and early warning
	Ward patrol
	Vital signs monitoring
3. Logistics transfer	Transfer patients
	Goods transfer
4. Consulting Education	Medical information query
	Drug guidance
	Disease-related knowledge guidance
	Prevention of knowledge propaganda and education
5. Security management	Prevent falls and other accidental injuries
	Disaster prevention
6. Nutritional care	Diet and nutrition guidance
	Feed the meal
7. Activity management	Postural transition
	Bed chair transfer
	Auxiliary walking
8. Excretory care	Assist with toileting
9. Personal hygiene management	Organizing and Changing Bed Linens
	Taking a shower
	Grooming (including brushing teeth, washing face, shaving)
	Dressing/Undressing

10. Accompany care	Interpersonal Interaction
	Accompany for check-up
	Cognitive training
11. Infection management	Ward cleaning, disinfection, and sterilization
	Wound disinfection and dressing
12. Rehabilitation physiotherapy	Rehabilitation knowledge guidance
	Development and adjustment of the rehabilitation plan
	Assessment of rehabilitation effect
13. First aid skills	Assisted CPR
	Oxygen and sputum absorption
14. Information management	Personal electronic medical information storage and record
15. Sampling operation	Venous blood sampling
	Collecting nasal/pharyngeal swabs

Kano Model Demand Assessment

KANO Demand Attributes

The Kano model, a quality management tool proposed by Professor Noriaki Kano from Japan in 1984, aims to elucidate the relationship between customer needs and product features. It has been widely utilized in demand analysis within the healthcare industry [13]. In our developed Kano demand scale, we included 15 items, each designed to assess participants’ attitudes and preferences regarding specific functional areas of AI nursing robots through both positive and negative questions [14]. For instance, one question asks, "How do you feel if the nursing robot has/does not have a medication management function?" Each question encompasses five evaluation dimensions: Like it, Must-be, Neutral, Accept it, and Dislike. Consequently, participants’ evaluations of a single item can yield 25 possible results (5x5), with each result corresponding to a specific attribute category (see Table 2).

Table 2. Kano evaluation table.

Question type		**Negatively worded item**: How would you feel if the nursing robot does not have *X* functions?				
		Like it	Must-be	Neutral	Accept it	Dislike
Positively worded item: How would you feel if the nursing robot has *X* functions?	Like it	Q	A	A	A	O
	Must-be	R	I	I	I	M
	Neutral	R	I	I	I	M
	Accept it	R	I	I	I	M
	Dislike	R	R	R	R	Q

In Table 2, M denotes Must-be Attribute, O signifies One-dimensional Attribute, I represents Indifferent Attribute, A indicates Attractive Attribute, R stands for Reverse Attribute, and Q refers to Suspicious results [15]. Following this, we calculated the frequency of each attribute category, with the category exhibiting the highest frequency determining the demand attribute category for that functional area [Error: Reference source not found]. It is important to note that significant differences exist in the relationship between various attribute categories and product user satisfaction (see Table 3). Consequently, the typical priority order for product functional demand attributes is as follows: M, O, A, I, R. During product development and design, it is advisable to prioritize functions that possess M, O, and A attributes. As for I and R attributes, these may be appropriately discarded after taking into account market demand, user feedback, resource constraints, and competitive environmental factors [16].

Table 3 Characteristic table of Kano attributes

Attribute	Characteristics
Attractive Attribute (A)	Attractive attributes can greatly enhance satisfaction, but customers will not feel dissatisfied if these attributes are absent.
One-dimensional Attribute (O)	One-dimensional attribute directly impacts user satisfaction. The presence of these attributes increases both product satisfaction and acceptance, while their absence leads to a decline in satisfaction and acceptance.
Must-be Attribute (M)	When optimizing M requirement, user satisfaction will not improve; however, when this requirement is not provided, user satisfaction will significantly decrease.
Indifferent Attribute (I)	Whether the I attribute exists or not, it will not affect the level of user satisfaction.
Reverse Attribute (R)	Without a reverse Attribute, satisfaction would be higher.
Suspicious results(Q)	The user does not understand a question or answer it correctly.

Better-Worse Coefficient Analysis

To compare the significance of various demands within the same attribute, we employed the Better-Worse coefficient analysis method to prioritize the items in the questionnaire. This approach offers clearer insights into the influence of a specific functional area on the respondents [18]. The analysis is grounded in the number of each Kano attribute category obtained, allowing for the calculation of the Better and Worse coefficients for each item. The formulas for calculating these coefficients are as follows:

$$Better\ coefficient=\frac{A+O}{A+O+M+I},Worse\ cofficient=\frac{O+M}{A+O+M+I}$$

The absolute value of the coefficient, which ranges from 0 to 1, reflects the degree of satisfaction or dissatisfaction with the presence or absence of a service [19]. Specifically, the closer the Better value is to 1, the more satisfied patients are when the target attribute is provided. Conversely, the closer the absolute value of Worse is to 1, the greater the degree of dissatisfaction among patients when the target attribute is not available. A quadrant diagram is established with the Better coefficient on the vertical axis and the absolute value of the Worse coefficient on the horizontal axis. Attributes located in the first quadrant (upper right area), where both the Better coefficient and the absolute value of the Worse coefficient exceed the mean, represent O requirements. Attributes characterized by a high Better coefficient and a low absolute value of the Worse coefficient are situated in the second quadrant (upper left area), denoting A requirements. Attributes found in the fourth quadrant (lower right area), where the Better coefficient is low and the absolute value of the Worse coefficient is high, represent M attributes. O, A, and M requirements are prioritized, warranting greater attention and consideration for provision. Finally, attributes located in the third quadrant (lower left area), where both the Better coefficient and the absolute value of the Worse coefficient are low, represent I requirements, which are deemed unimportant to patients and may not require provision or improvement [14].

Data Collection and Analysis

Subjects were enrolled at Wuhan Asian Heart Hospital from July 2023 to June 2024. Initially, researchers conducted surveys on a departmental basis with the assistance of the head nurse. These surveys were completed face-to-face and took approximately 15-30 minutes, immediately after which the data was collected. To ensure the accuracy of data collection, data was checked and verified for logical errors by two nursing graduate students using Excel 2019 software. SPSS 26.0 software was used for data analysis. Finally, Prism 10 was used for data graphing.

Ethical Considerations

The Ethics Committee of Wuhan University of Science and Technology (Ethics No.: 2024-096-02) approved this study, which adheres to the ethical standards outlined in the Declaration of Helsinki. Participation in this survey is voluntary and anonymous, and the participants have obtained informed consent. Participants can refuse or withdraw at any time, and the information collected will be used solely for academic research purposes and not for commercial gain.

Results

Basic Information of Survey Participants and Their Understanding of Nursing Robots

The survey participants were primarily from Wuhan, Hubei Province, with 156 individuals participating. Their ages ranged from 18 to 82 years. Among them, 48.08%（75/156） had used nursing robots, and 68.59%(107/156) expressed high interest and willingness to try nursing robots. The findings suggest that CVD patients are aware of the potential benefits and value of nursing robots and are willing to embrace this new technology in clinical care settings. In terms of interaction methods, patients prefer text input, images, and videos. Table 4 provides us with detailed information.

Table 4 Basic Information Statistics table

Categories	Option	Value（%）
Sex	Male	118（75.64）
	Female	38（24.36）
Marital status	Married	111（71.15）
	Unmarried	45（28.85）
Age	18-25 Years old	37（23.72）
	26-30 Years old	4（2.56）
	31-40 Years old	36（16.67）
	41-50 Years old	15（9.62）
	51-60 Years old	3（1.92）
	Over 60 years old	71（45.51）
Educational background	Primary school and below	19（12.18）
	Junior middle school	31（19.87）
	High school/Technical Secondary School Diploma	24（15.38）
	Undergraduate/Junior college	73（46.79）
	Master's degree or above	9（5.77）
Cardiovascular disease type	Atherosclerotic cardiovascular disease	44（28.21）
	Hypertensive cardiovascular disease	19（12.18）
	Valvular heart disease	29（18.60）
	Arrhythmia	46（29.48）
	Cardiomyopathy	11（7.05）
	Pericardial disease	5（3.2）
	Other	2（1.28）
Duration of disease	Less than 10 years	92（58.97）
	10 to 20 years	36（23.08）
	more than 20 years	28（17.95）
Previous use of nursing robots	Yes	75（48.08）
	No	81（51.92）
Receive robot services	Yes	107（68.59）
	No	49（31.41）
Methods of interaction with robots	Text Input	47（30.13）
	Images and Videos	71（45.51）
	Speech Recognition	29（18.59）
	Other	9（5.77）

Demand Analysis

Demand Attributes

Through the Kano model, we analyzed the requirements for nursing robots for patients with cardiovascular diseases across 15 functional areas. As shown in Table 5, based on the final survey results, we identified three items as M attributes: Monitoring and Warning, Consulting Education, and Information Management. Drug Management and Rehabilitation Physiotherapy were categorized as O attributes. A attributes included five items: Security Management, Logistics Transfer, Nutritional Care, Infection Management, and First Aid Skills. The presence of these functional areas would make the robot more acceptable to patients. The remaining five items were categorized as I attributes, which are not important to patients. These were Excretory Care, Personal Hygiene Management, Accompany Care, Activity Management, and Sampling Operation.

In Figure 2, among the top ten functional areas, Drug Management, Rehabilitation Physiotherapy, Nutritional Care, First Aid Skills, Infection Management, Security Management, and Logistics Transfer had relatively high Satisfaction Index (SI) values ranging from 0.5 to 0.8. This indicates that when the nursing robot possesses these functions, it will achieve high levels of satisfaction and acceptance. The other three functions (Consulting Education, Information Management, and Monitoring and Warning), although having lower SI values, exhibited high absolute value of the Dissatisfaction Index (DSI) levels. This suggests that if these requirements are not met, users will be highly dissatisfied, regardless of how well other functions are performed, leading to a lack of increased favorability towards the product.

Table 5 Classification of Structural Attributes of Functional Requirements for Caregiving Robots in Patients with Cardiovascular Diseases (n=156)

	M (%)	O (%)	A (%)	I (%)	R (%)	Q (%)	Better (%)	Worse (%)	Attribute
g management	2.56	35.9	26.28	17.95	16.03	1.28	75.19	-46.51	O
nitoring and warning	39.1	10.26	16.03	25	8.33	1.28	29.08	-54.61	M
istics transfer	24.36	17.31	28.21	19.87	8.33	1.92	50.71	-46.43	A
sulting Education	28.21	12.18	26.28	20.51	11.54	1.28	44.12	-46.32	M
urity management	13.46	28.21	30.13	19.87	7.69	0.64	63.64	-45.45	A
ritional care	5.77	12.82	50.64	21.15	8.33	1.28	70.21	-20.57	A
ivity management	5.41	26.35	24.32	37.16	6.08	0.68	54.35	-34.06	I
retory care	3.85	5.13	15.38	66.03	7.69	1.92	22.7	-9.93	I
sonal hygiene management	3.85	7.05	14.1	67.31	7.05	0.64	22.92	-11.81	I
company care	26.28	13.46	14.74	34.62	9.63	1.28	31.65	-44.6	I
fection management	4.49	6.41	53.85	27.56	7.05	0.64	65.28	-11.81	A
habilitation physiotherapy	3.21	35.9	19.87	30.77	8.97	1.28	62.14	-43.57	O
st aid skills	5.13	11.54	47.44	24.36	8.97	2.56	66.67	-18.84	A
formation management	37.82	9.62	24.36	17.95	8.97	1.28	37.86	-52.86	M
mpling operation	7.69	7.69	22.44	52.56	8.97	0.64	33.33	-17.02	I

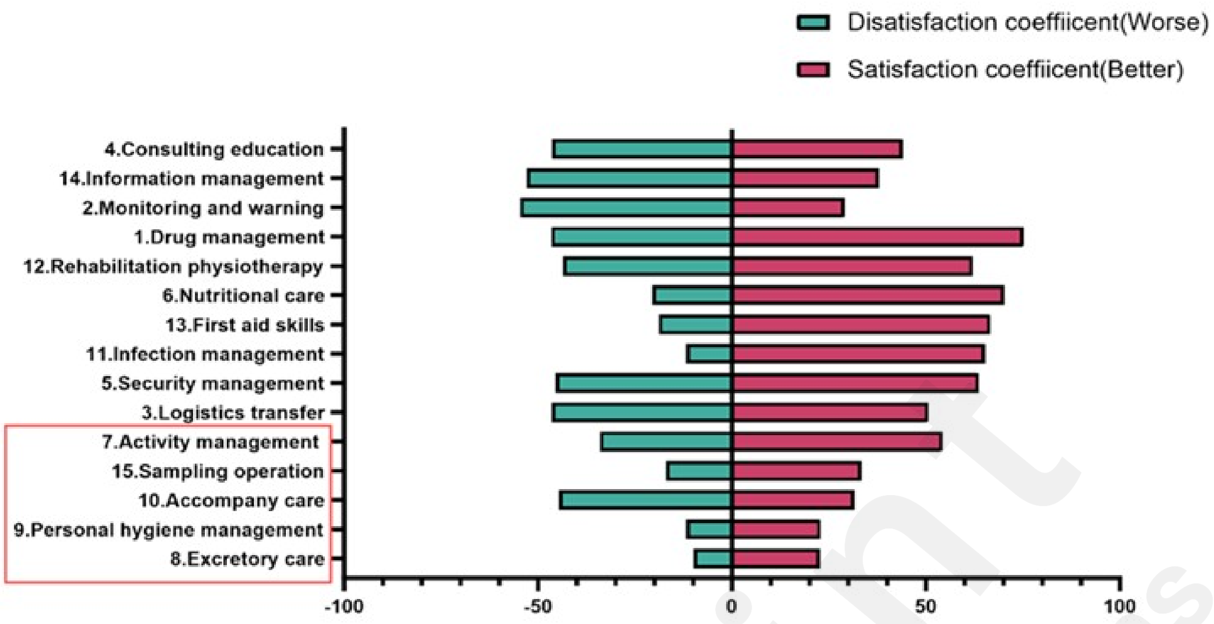
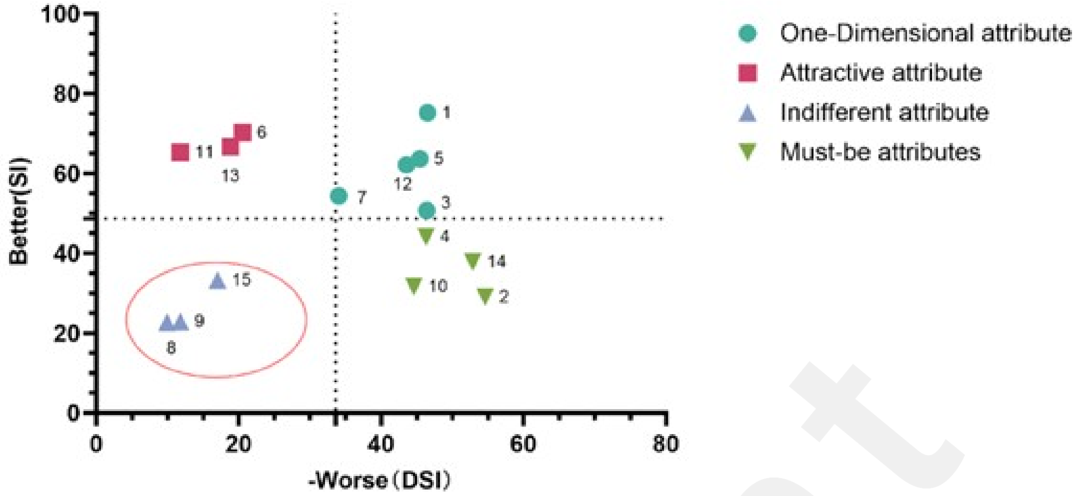


Figure 2 SI and DSI of Functional Requirements for Nursing Robots by Patients with CVD

Better-Worse Coefficient Analysis

To enhance the intuitiveness of prioritizing the 15 functional areas, we plotted a Kano demand quadrant diagram (Figure 3) utilizing the Better-Worse coefficients. The results indicated that four items were categorized within the Must-be attribute quadrant: Monitoring and Warning, Consulting Education, Accompany Care, and Information Management. Five items were classified in the One-dimensional attribute quadrant: Drug Management, Security Management, Logistics Transfer, Activity Management, and Rehabilitation Physiotherapy. The Attractive attribute quadrant included three items: Nutritional Care, Infection Management, and First Aid Skills. The remaining three items were placed in the Indifferent attribute quadrant: Excretory Care, Personal Hygiene Management, and Sampling Operation. Compared to the straightforward classification of needs presented in Figure 2, Figure 3 offers a more nuanced prioritization of each functional area, resulting in more precise outcomes. The findings illustrated in Figure 3 further corroborate that the functional areas of Sampling Operation, Excretory Care, and Personal Hygiene Management possess relatively low



priority.

Figure 2 Kano quadrant diagram of cardiovascular disease patients' demands for nursing robot functions

Discussion

Acceptance of nursing robots among CVD patients in China.

China's intelligent medical field has experienced rapid development in recent years, initially yielding results primarily in economically developed cities. In our study, 48.08% (75/156) of participants reported having already utilized care robot services, marking a significant breakthrough from zero to one. However, in comparison to the development strategy targets outlined in the 'China’s New Generation Artificial Intelligence Development Plan (2015-2030)' [20], this usage rate requires improvement. Furthermore, our research indicated that 68.59% (107/156) of participants expressed a willingness to try using care robots, suggesting substantial market potential for these technologies in the management of CVD patients. Nonetheless, there exists a notable gap between patients' willingness to use robots and the actual usage rates. This disparity, characterized by high intention yet low application, may be attributed to factors such as the high cost of AI implementation, insufficient policy support, and various medical ethical concerns [21]. Therefore, it is essential to thoroughly understand the strengths and weaknesses of AI robots in practice, continuously enhance AI technology, and develop appropriate legal frameworks related to AI. Increasing opportunities for individuals to engage with high-tech solutions in their daily lives can facilitate adoption in the medical sector. Additionally, conducting science popularization activities in clinical settings can help raise CVD patients' awareness and acceptance of intelligent robots.

Structural Analysis of CVD Patients' Functional Needs for Nursing Robots Based on the Kano Model

Through the Kano model, we identified 12 functional areas (attributes of M, O, A in the quadrant chart) that cardiovascular disease patients believe nursing robots should possess, including activity management, rehabilitation physiotherapy, drug management, security management, logistics transfer, accompany care, consulting education, information management, monitoring and warning, infection management, first aid skills, and nutritional care. Numerous studies have demonstrated that a healthy lifestyle not only prevents the onset of cardiovascular diseases but also effectively manages and controls existing conditions, thereby reducing the incidence of complications [22-23]. Diet and exercise play a crucial role in the rehabilitation process for cardiovascular diseases [24]. For instance, a diet rich in fruits, vegetables, whole grains, fish, and lean meats can reduce the risk of cardiovascular diseases; conversely, a low-salt, low-fat diet can help control hypertension and hyperlipidemia, thereby protecting the cardiovascular system. In contrast, a diet high in oil, fat, and sugar increases the likelihood of severe complications [25]. Similarly, moderate aerobic exercises such as brisk walking and jogging can significantly enhance cardiac function [26]. Therefore, dietary guidance tailored to the disease, activity management, educational consulting, and rehabilitation guidance have become key concerns for cardiovascular disease patients and are essential aspects of their daily lives [27].

Recent advancements in the promotion of knowledge regarding cardiovascular diseases in China have resulted in participants of this survey demonstrating a strong inclination towards self-management and disease prevention. They expressed a significant demand for medication management, monitoring and warning systems, as well as first aid skills. This proactive approach to health management can enhance their ability to control their condition and mitigate the risk of sudden health events [28]. Furthermore, research indicates that prolonged loneliness and psychological anxiety may elevate the incidence of cardiovascular diseases and extend the recovery period for affected patients [29]. Despite this, the psychological state and emotional needs of cardiovascular disease patients are frequently overlooked in the fast-paced clinical environment. To address this gap, the integration of companion robots in clinical settings could fulfill the psychological needs of these patients. For example, the robot Pepper has been demonstrated by Betriana to facilitate effective communication and companionship for both individuals with mental health issues and those who are healthy [30].

In our study, areas such as sample operation, personal hygiene management, and excretion care were categorized as indifferent needs. This suggests that patients, at this stage, do not desire care robots to perform these services. However, this low demand may be attributed to two main factors: 1) privacy concerns, as tasks related to personal hygiene management and excretion care are typically private and involve sensitive information, which heightens patients' resistance to robots in these domains and subsequently impacts their acceptance of the technology. This viewpoint is supported by Christoforou’s research [31]. 2) Many patients believe that care robots lack adequate operational capabilities, leading to skepticism regarding functions that may potentially cause harm.

Development Strategies to Promote the Clinical Application of Nursing Robots

Artificial intelligence has long been a prominent trend across various industries, and the emergence of COVID-19 has accelerated the large-scale adoption and application of this technology [32-33]. Given the diverse demands for nursing robot functionalities revealed in this survey, it is recommended that future research on nursing robots not only concentrate on replacing basic tasks that are highly repetitive, labor-intensive, and low-skill, but also emphasize the expansion and upgrading of nursing robot functionalities. In particular, there should be a deeper exploration into areas such as consulting, education, and emotional support. By integrating technological innovation with user experience optimization, more intelligent and comprehensive nursing solutions can be developed, ultimately better meeting the needs of CVD patients and enhancing the clinical application value of nursing robots. Furthermore, the original intention of nursing robots is to improve care quality and better serve patients, thereby alleviating the current shortage of nursing staff [34]. Therefore, it is essential for specialized cardiovascular nurses to actively listen to patient needs and, when necessary, provide professional insights into product design and development to facilitate the creation of more specialized, effective, and user-friendly intelligent products.

Currently, comprehensive and specific guidelines for the management CVD patients using AI products are still lacking within the industry. Although the latest scientific statement from the American Heart Association [35]acknowledges the potential of AI to enhance the quality of cardiovascular care, the strategies for its specific application in clinical practice are not thoroughly elaborated. As a result, most treatment interventions involving intelligent nursing robots are confined to specific medical pilots or affluent areas due to environmental and economic factors. Undoubtedly, productivity gaps have emerged as a significant barrier to access to smart medical services [36]. As the population of CVD patients continues to grow and their demand for long-term rehabilitation and management increases, the future healthcare system may increasingly rely on primary healthcare institutions to manage the rehabilitation and care of cardiovascular patients [37]. However, despite these promising prospects, current primary healthcare institutions face challenges in adopting advanced technologies such as AI nursing robots, primarily due to insufficient professional knowledge and training, as well as inadequate technology and infrastructure [31]. In the near future, it is hoped that more cost-effective and convenient nursing robots will become available for community-based institutions. The limited yet positively received functional areas identified in our study—such as consulting education, rehabilitation physiotherapy, and nutritional care—can all be effectively implemented at grassroots healthcare units, thereby facilitating the distribution and integration of medical resources. In this model, tertiary hospitals would primarily manage more severe cases, while primary healthcare units could offer continuous care for less critical conditions. Currently, many comprehensive hospitals are exploring the formation of healthcare alliances with primary care centers, recognizing the potential benefits of remote devices and mobile healthcare technologies in community settings and patient homes [38]. Looking ahead, nursing robots are anticipated to serve as significant auxiliary tools, delivering more personalized care services for patients with cardiovascular disease.

limitations

There are some limitations to our study. First, there may be a potential bias due to the small sample size and convenience sampling only for Wuhan Asia Heart Hospital. Secondly, the differences in individual cultural background and occupational type have a particular impact on patient's needs and preferences, which is worthy of further analysis and discussion in future research.

Summary

The presence of robots and the advent of more advanced robotics technologies have led to an increase in studies assessing user acceptance of robots and needs analysis in the past two years. Wichmann research shows that perceived usefulness, attitude, and trust significantly and positively predict AI's willingness and use behaviors in short-term and long-term treatment [39]. In our view, clarifying the needs of patients can effectively improve users' acceptance of AI and may become a shortcut to achieving intelligent medical care in China. Our study explores the differences in prioritizing the need for nursing robots from the perspective of patients with cardiovascular disease. The paper suggests that researchers should emphasize understanding the patient experience, which is crucial for advancing various fields, including counselling, education, companion care, and more. We hope our research can help robot developers design targeted functional services for patients with cardiovascular diseases, promoting the continuous development and application of nursing robotics and innovation and progress in the medical field.

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Data availability statement

The authors state that no data are shared in the present study.

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Conflicts of Interest

None declared.

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Abbreviations

AI: artificial intelligence

CVD: Cardiovascular Disease

Supplementary Files

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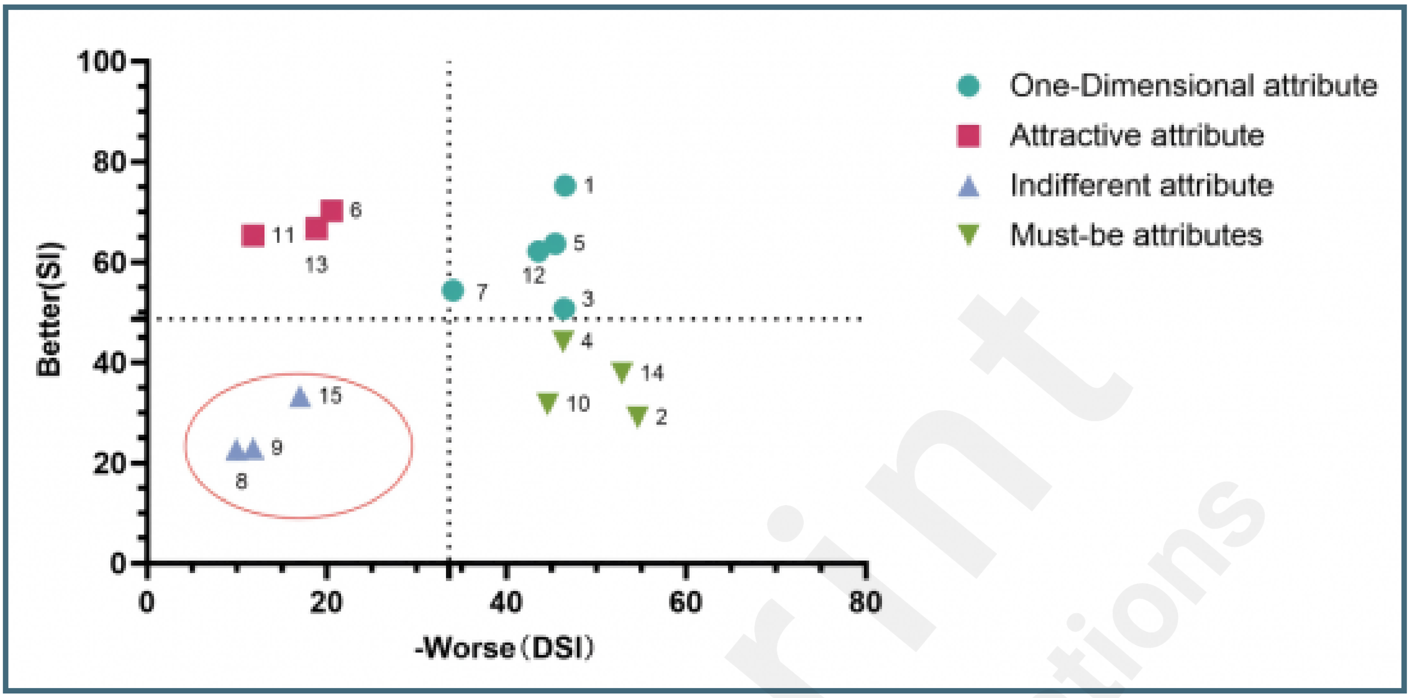
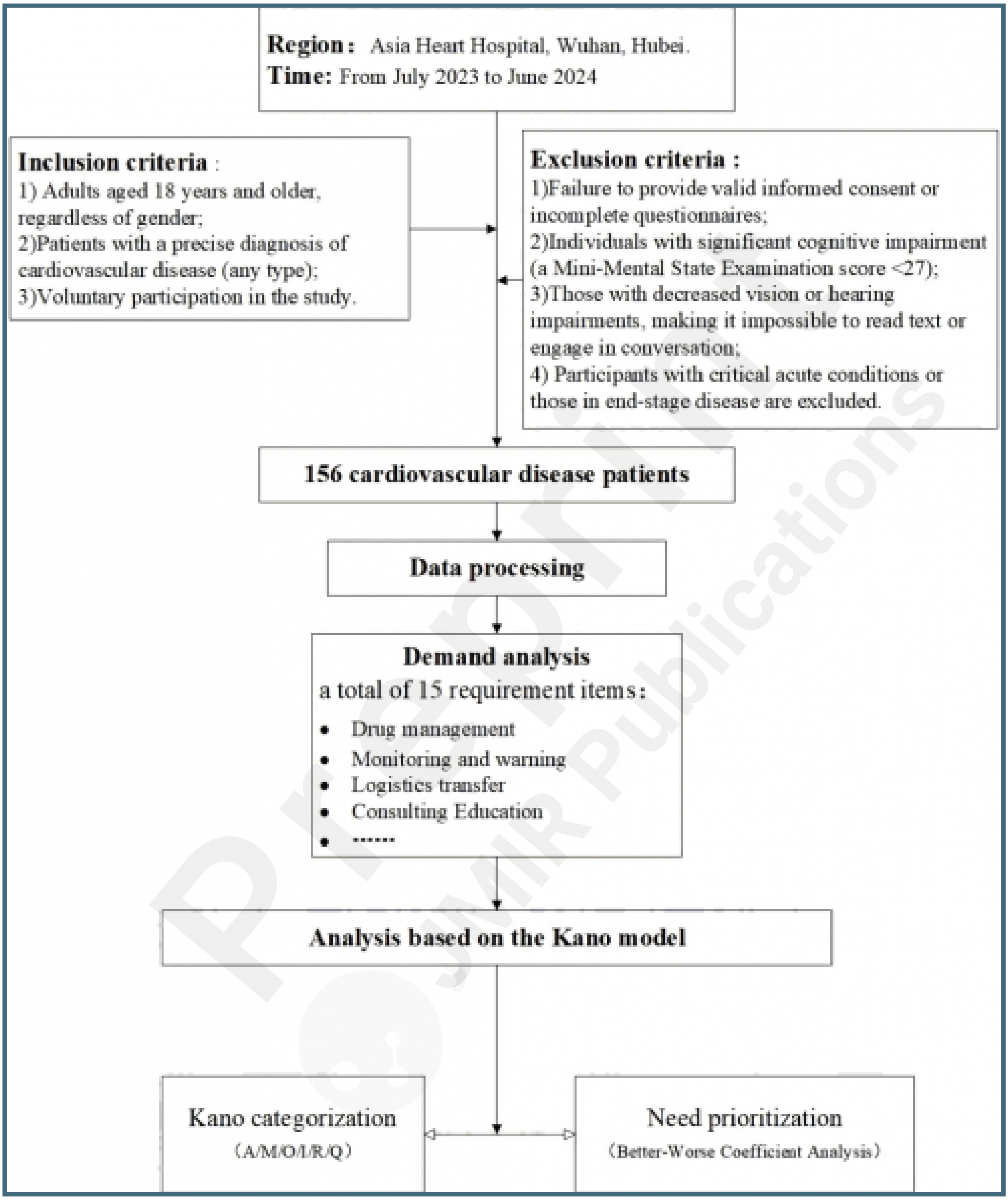
Kano quadrant diagram of cardiovascular disease patients' demands for nursing robot functions.



Figures

Flow diagram of the study.



SI and DSI of Functional Requirements for Nursing Robots by Patients with CVD.