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The influence of patient self-efficacy on value co-creation behavior and outcomes in chronic disease management: a cross-sectional study

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Abstract

Background In the medical field, value co-creation involves patients' active involvement. By collaborating with service providers, patients can contribute to the creation of more targeted and effective value. Patients' self-efficacy and behavior are crucial in this process, as their active participation and support can enhance their service experience. This study investigated the impact of chronic disease patients' self-efficacy and value co-creation behaviors on the outcomes of value co-creation.

Methods Relevant data were acquired through a questionnaire survey using statistical methods, such as the t-test, analysis of variance, and stratified linear regression. This approach was used to examine the current conditions and factors influencing value co-creation outcomes among community-dwelling patients with chronic diseases. Additionally, a structural equation model was employed to systematically investigate and validate the impact pathways and mechanisms related to the influence of self-efficacy and value co-creation behaviors on value co-creation outcomes. We also explored the moderating effect of digital health technology application capabilities on the relationship between self-efficacy and value co-creation behaviors.

Results Self-efficacy, information search, interactive collaboration, feedback provision, and shared decision-making exert significant positive influences on the value co-creation outcomes among individuals with chronic diseases. The path analysis of the structural equation model indicates that self-efficacy and value co-creation behaviors may directly impact value co-creation outcomes. Concurrently, value co-creation behaviors partially mediate the association between self-efficacy and value co-creation outcomes. Furthermore, the digital health technology application capability exhibits a negative moderating effect in the pathway from self-efficacy to value co-creation behaviors.

Conclusions The implementation of health education and social support measures by healthcare institutions and communities may augment patient self-efficacy, facilitate doctor-patient interactions, and promote shared decision-making. These initiatives could enhance the value of chronic disease services and optimize patient experiences. Additionally, healthcare institution managers are encouraged to focus on optimizing internet hospital platforms, organizing digital health training for patients, and bolstering patients' proficiency in digital health technology applications. This strategy aims to instill a sense of health responsibility among patients with chronic diseases by fostering positive behaviors in interactive collaboration, information search, feedback provision, and other dimensions.

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Keywords Chronic patients, Self-Efficacy, Value Co-creation behavior, Perceived value, Satisfaction

Background

Chronic diseases have emerged as significant challenges to global public health [1]. According to data from the World Health Organization (WHO), approximately 74% of global deaths are attributable to chronic diseases, reaching an alarming rate of 88.5% in China [2]. Faced with this formidable situation in chronic disease prevention and control, healthcare researchers recognize the necessity for collaborative endeavors between healthcare providers and patients. Consequently, patients have embraced a new role as active participants in healthcare, transitioning from passive recipients of medical treatment to engaged contributors to their own well-being [3]. This shift in roles aligns with the fundamental tenets of value co-creation theory, delineating collaborative relationships among various stakeholders and asserting that service providers are not exclusive creators of value; recipients of services can equally contribute to the co-creation of service value [4]. The theory of value co-creation is utilized to explore how different stakeholders collaborate to enhance service quality and improve individual experiences. While it originally emerged from the field of business management, it has been increasingly applied across various domains, including public administration, education, and healthcare [5]. In the healthcare domain, patient value co-creation involves the collaborative process of creating value within a service network through interactions with service providers and the integration of existing resources [6]. Value is the outcome of joint efforts between parties. The outcome of value co-creation refers to the results generated through the collaborative process of jointly creating value [6, 7]. The outcomes of value co-creation among patients with chronic diseases are frequently assessed using variables such as perceived value, satisfaction, and future behavioral intentions [8]. Hence, this study employs the value co-creation theory to identify the factors influencing value co-creation outcomes in chronic disease services from a demand perspective. Our theoretical and practical exploration is aimed at enhancing chronic disease service management and elevating patient value. Various countries are actively exploring the concept of value-based medicine. Value co-creation plays a crucial role in this approach. Patients, as significant beneficiaries of value-based medicine, can unleash the inherent power of positive incentives, boosting enthusiasm and initiative within the medical system. This process fosters a harmonious balance of value among all involved parties, ultimately leading to value co-creation and mutual benefits for all stakeholders.

Internationally, research has predominantly focused on the factors impacting patient value co-creation outcomes through perspectives such as resources and behavior. From a resource standpoint, factors influencing patient value co-creation outcomes primarily encompass motivational (e.g., pleasure motivation, self-esteem, and self-efficacy), capability (e.g., information acquisition and decision-making abilities), and opportunity resources (e.g., emotional and instrumental support) [8, 9]. Research indicates that while value co-creation activities offer benefits, not all customers are ready to take on this responsibility [10]. Value co-creation requires individuals to possess the ability and awareness to "actively integrate resources and engage in interactions," and self-efficacy effectively captures patients' confidence in their ability to successfully assume the role of a "co-creator" [11]. As a focal resource for service recipients, self-efficacy is a critical antecedent of value co-creation [12]. This aligns with Bandura's social cognitive theory, which posits that self-efficacy is the most direct determinant of behavior change and can predict behavioral outcomes [13]. From the perspective of patient behavior, numerous studies have demonstrated that patients' value co-creation behaviors can positively influence their perceived value, amplify satisfaction, and enhance future behavioral intentions [14]. According to Moretta Tartaglione et al. [15], behaviors such as patient information search, information exchange, and feedback provision are closely linked to patient satisfaction. Moreover, the widespread implementation of emerging internet technologies, such as big data, artificial intelligence, and cloud computing, in the health sector has generated new opportunities to address the high prevalence of chronic diseases. Enhancing the digital health technology application capabilities of patients with chronic diseases can narrow the information gap between doctors and patients, foster patient involvement throughout the diagnostic and treatment processes, and enable healthcare professionals to share information and resources to formulate collaborative strategies for addressing diseases [16]. Research has demonstrated that patients' digital health technology application capabilities impact patients' self-efficacy, doctor-patient communication, and treatment compliance [17].

In conclusion, both domestic and international studies have actively explored factors influencing value co-creation outcomes among patients with chronic diseases. Some studies have focused on the relationships among self-efficacy, value co-creation behaviors, and the outcomes of value co-creation. However, existing research has predominantly focused on the direct

effects of self-efficacy and value co-creation behaviors on value co-creation outcomes, with limited attention given to self-efficacy as an antecedent of value co-creation. Additionally, there is often a lack of exploration into the indirect mechanisms or processes involved in this relationship. Moreover, previous research emphasizes the influence of the functionalities and platform characteristics of digital healthcare on patients' value co-creation behaviors, while paying less attention to the moderating role of patients' digital health technology application capabilities in value co-creation behaviors. To address these gaps, focusing on community-dwelling patients with chronic diseases in Zhejiang Province, China, this study employed value co-creation theory to investigate the following aspects: (1) the role of self-efficacy and value co-creation behaviors in value co-creation outcomes among patients with chronic diseases; (2) the mediating effect of value co-creation behaviors on the relationship between self-efficacy and value co-creation outcomes; and (3) the moderating effect of digital health technology application capabilities on the relationship between self-efficacy and value co-creation behaviors. By identifying the key elements influencing value co-creation outcomes, we aim to provide new reference points for mobilizing patients' engagement in the treatment and management of chronic diseases, ultimately enhancing their perceived value, satisfaction, and future behavioral intentions.

Literature review and hypotheses development

Value co-creation theory

The concept of value co-creation originates from the marketing field's notion of value co-production, which challenges the traditional view of customers as mere value users [18]. It emphasizes that the interaction between customers and businesses is at the heart of value creation. In the fields of management and marketing, Prahalad and Ramaswamy [19] were the first to propose the DART (dialogue, access, risk assessment, transparency) model of value creation, providing a foundational framework for understanding how patients and providers jointly create value through participatory engagement and highlighting the importance of interaction and collaboration in the process and arguing that value is embedded in the customer experience. Subsequently, Vargo and Lusch [20] introduced the service-dominant logic-based theory of value co-creation, positing that services form the foundation of all economic exchanges and that consumers are co-creators of value. After three revisions, they further refined the service-dominant logic, defining value co-creation as a collaborative process where all social and economic actors, such as service providers and customers, integrate their resources (e.g., skills and knowledge) through interaction to co-create value for themselves and others [4, 20].With the evolution of economic exchange, the value co-creation theory based on service ecosystems has emerged, which highlights the networked nature of value co-creation in healthcare systems involving patients, providers, and communities [21].

Scholars such as Oliveira [22] and Johnson [23] have developed the "antecedents–process–outcomes" model, which serves as a general framework for value co-creation based on value co-creation theory. This model posits that participants' motivations and resources (antecedents) lead to a range of beneficial outcomes (results) through various behavioral mechanisms (processes). Subsequent studies have widely adopted this framework to explore value co-creation mechanisms in healthcare services. For instance, Peng et al. [8] conducted a literature review that summarized the dimensions of antecedents, behaviors, and outcomes in both online and offline healthcare service contexts. They identified motivations and capabilities as key antecedents, while information sharing and joint decision-making were recognized as representative co-creation behaviors. Furthermore, they classified satisfaction, perceived value, and loyalty as multidimensional outcomes. Some scholars have investigated how patients' co-creation literacy, residents' motivation to participate, and other antecedents facilitate value co-creation behaviors, thereby enhancing overall value outcomes [24]. Building on this theoretical foundation, we identify patients' self-efficacy as a crucial antecedent influencing their engagement in multidimensional co-creation behaviors. Additionally, we examine how these behaviors contribute to various value outcomes, including patient satisfaction and perceived value.

Self-efficacy's impact on value co-creation behaviors and outcomes

Self-efficacy refers to individuals' beliefs about their capability to organize and execute the behaviors necessary to achieve specific goals, manifesting as self-confidence during relevant activities [25]. Personal resources can be identified through the perception of self-efficacy, which is reflected in an individual's choices and the personal effort they apply in practice [26]. A longitudinal study on value co-creation among cancer patients found that when patients' self-efficacy is enhanced, they are more confident in managing their illness. This confidence increases the likelihood of changing their health behaviors by engaging in value co-creation activities such as information searching, interactive communication, and providing feedback, ultimately enhancing the chances of sharing key information with their healthcare providers [27]. Alves and Wagner Mainardes [28] identify self-efficacy as an antecedent of value co-creation behaviors, facilitating collaborative communication and decision-making behaviors among consumers.

Additionally, self-efficacy reflects patients' sense of control in disease management and their confidence about future outcomes, and it is positively correlated with satisfaction in pain management [29]. Li indicates that self-efficacy is closely related to perceived value [30]. Hau [31] reveals that patients with high self-efficacy are more confident in successfully managing their illness. This accumulated sense of success enhances patients' sense of belonging to a healthcare institution, thereby elevating future behavioral intentions, such as revisiting and recommending the institution to others. Consequently, we put forward the following hypotheses:

H1: Self-efficacy positively influences value co-creation behaviors among community-dwelling patients with chronic diseases.

H2: Self-efficacy positively influences value co-creation outcomes among community-dwelling patients with chronic diseases.

The impact of value co-creation behaviors on value co-creation outcomes

Value co-creation behavior refers to "the participation and contribution to the resource integration process of value co-creation," describing an individual's active involvement in the value co-creation process, which includes physical, virtual, and psychological behaviors [32]. Yi and Gong [33] identify two forms of value co-creation behavior: participation behavior (or "role-related" behavior) and citizenship behavior (or "role-external" behavior). Common examples of participation behaviors include information sharing, information searching, and collaborative interaction, while feedback is a typical example of citizenship behavior. Through these behaviors, customers contribute non-monetary resources, such as information and tacit knowledge. McColl-Kennedy et al. [7] find that behaviors such as information exchange, information integration, interactive collaboration, and feedback during the process of co-creating consumer value enable consumers to integrate resources (high motivation, opportunities, and capabilities), thereby increasing their experiential value and perceived happiness. Value co-creation involves the joint creation of emotional and experiential value, where individuals gain unique consumption experiences through co-creation based on the fulfillment of their needs, thereby enhancing perceived value [34]. In the healthcare process, patients actively seek healthcare information, share their health status, interact with healthcare professionals, and demonstrate responsible behaviors, which form the foundation of their perceptions [35]. This value co-creation behavior enhances perceived value, satisfaction, and future behavioral intentions. Akter et al. [36] point out that patients' value co-creation behaviors on shared healthcare platforms positively influence their perceived value and patient welfare (satisfaction and subjective well-being). Marino and Capone [37] argue that shared decision-making between doctors and patients enables service providers to offer reasonable solutions, improving mental health, achieving better medical outcomes, and increasing satisfaction with healthcare services. Jiangyan et al. [38] indicate that patient participation in shared decision-making increases their satisfaction, as patients feel respected and acknowledged during the decision-making process, which alleviates negative emotions and enhances overall satisfaction. Therefore, we propose the following hypotheses:

H3: Value co-creation behaviors among community-dwelling patients with chronic diseases have a positive impact on value co-creation outcomes.

The mediating role of value Co-creation behaviors

Within the value co-creation mechanism, researchers commonly consider consumers' value co-creation behaviors as mediators between the antecedents and outcomes of value co-creation [39]. Mai and Wang [40] demonstrate a positive correlation between self-efficacy and patients' value co-creation behaviors. Simultaneously, patients' value co-creation behaviors positively influence healthcare quality, with the most significant impact on patient satisfaction in the non-technical quality domain. Social cognitive theory emphasizes that individuals with higher self-efficacy levels demonstrate greater confidence and motivation, which encourages them to engage more actively and achieve better outcomes [41]. Wang et al. [42] point out that inpatient participation in medical decision-making fully mediates the relationship between self-efficacy and inpatient satisfaction. Sung and Lee [43] demonstrate that interactions between consumers and businesses can enhance brand sincerity, with value co-creation behaviors acting as a mediating factor between consumer self-efficacy and brand sincerity. Hibbard et al. [44] argue that patients with high self-efficacy are aware of their resources (e.g., skills and knowledge) and are willing to deploy these resources to interact with doctors and make decisions. Patients make decisions conducive to health based on information and knowledge, reducing disease impacts and improving their perceived value. Therefore, we propose the following hypothesis:

H4: The value co-creation behaviors of community-dwelling chronic patients mediate the relationship between self-efficacy and value co-creation outcomes.

The moderating role of digital health technology application capabilities

Digital health technology application capabilities refer to an individual's ability to use information and communication technology (ICT) to promote health and improve the quality, efficiency, and accessibility of healthcare [45].

Liran et al. [46] indicate that enhancing patients' ability to use ICT could influence patient empowerment and self-efficacy, promoting behavioral change, disease management, and control. Kaartemo and Känsäkoski [47] show that individuals' mastery of computers, phones, and other device systems influences their willingness to participate in value co-creation. Huetten et al. [48] suggest that if internet technology can provide timely and effective service support for patients and alleviate their concerns, it will promote the generation of value co-creation behaviors. A review of value co-creation in the healthcare field highlights that ICT provides opportunities for indirect interactions between patients and healthcare professionals [49]. This is primarily because patients' ability to use ICT influences their perception of and confidence in healthcare service information, which, in turn, affects their willingness and confidence to engage in value co-creation. If internet technology creates a negative crisis perception in patients, it may hinder value co-creation. Therefore, in the context of digital health technology's rapid development, we propose the following hypotheses:

H5: Community-dwelling chronic patients' digital health technology application capabilities moderate the relationship between self-efficacy and value co-creation behaviors.

In summary, based on value co-creation theory, this study formulates a theoretical hypothesis model (Fig. 1) with community-dwelling chronic patients' self-efficacy as the independent variable, value co-creation outcomes as the dependent variable, value co-creation behaviors as the mediating variable, and digital health technology application capabilities as the moderating variable.

Methods

Participants and data collection

This study used the latest (2022) GDP rankings of 11 cities in Zhejiang Province, which is located in the economically developed Yangtze River Delta region along the southeast coast of China. The province is known for its healthcare innovations, making it a suitable setting for this study. A cross-sectional survey method was employed, categorizing the 11 cities into three levels based on their economic status. The first level included cities with a total economic output exceeding one trillion, namely Hangzhou and Ningbo. The second level comprised cities with a total economic output greater than 500 billion, including Wenzhou, Shaoxing, Jiaxing, and Taizhou. The third level encompassed cities with a total economic output below 500 billion, including Jinhua, Huzhou, Quzhou, Lishui, and Zhoushan. From each level, one representative city was randomly selected to ensure proportional geographic and economic coverage, with Hangzhou, Jiaxing, and Huzhou being chosen for the study. The multi-stage sampling method was then used for sampling in each city. Stage 1: Five community health centers were randomly selected from official registries, weighted by patient volume. Stage 2: Chronic disease patients were systematically sampled from all outpatient shifts (morning, afternoon, and evening) to minimize temporal bias. Stage 3: Quota sampling was employed to balance gender (targeting 50 ± 5% male participants) and age distribution, with 20% of participants categorized as young adults (18–39 years), 45% as middle-aged (40–59 years), and 35% as elderly (≥ 60 years).

Inclusion criteria for chronic patients were as follows: (1) providing informed consent to participate; (2) suffering from chronic non-communicable diseases; and

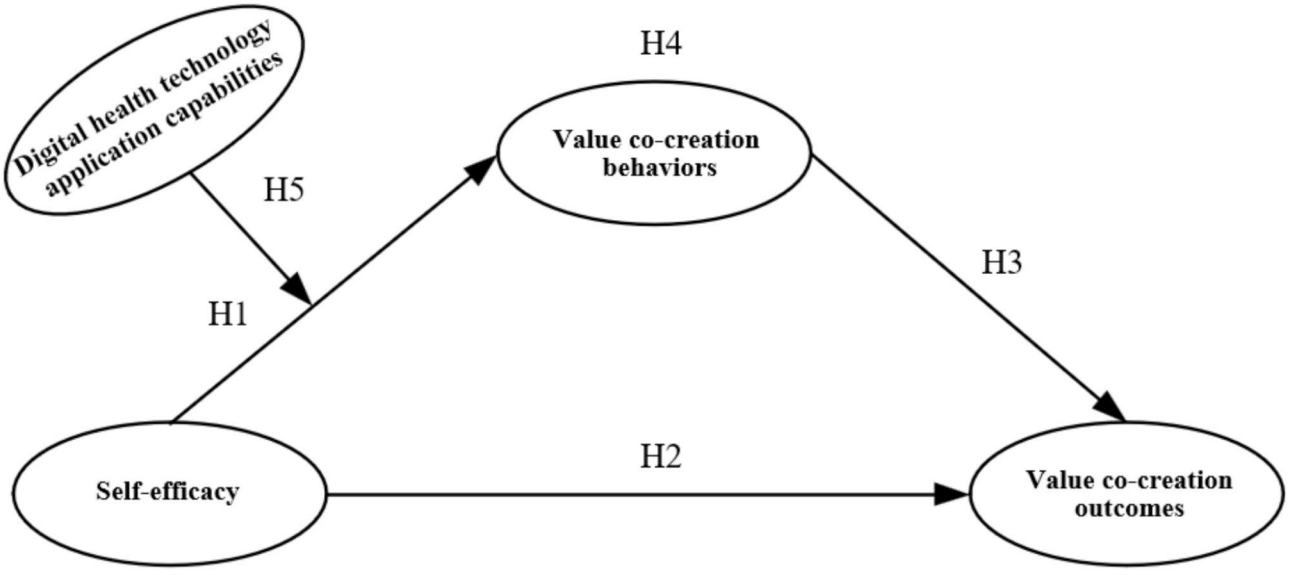

Fig. 1 Theoretical model diagram of mechanisms influencing patient value co-creation outcomes

Table 1 Variable measurement, factor analysis results, and reliability coefficients

Construct	Dimension	Measurement Variables	Cronbach's α	CR	Correlation coefficient	Load [a]	AVE	Overall α value
Self-efficacy	Self-efficacy	A1	0.878	0.879	0.869**	0.833	0.645	0.878
		A2			0.868**	0.838		
		A3			0.864**	0.800		
		A4			0.822**	0.738		
Value co-creation behaviors	Information search	B1	0.891	0.897	0.721**	0.849	0.743	0.928
		B2			0.742**	0.909		
		B3			0.735**	0.826		
	Interactive collaboration	B4	0.886	0.891	0.682**	0.744	0.577	
		B5			0.703**	0.804		
		B6			0.731**	0.801		
		B7			0739**	0.718		
		B8			0.730**	0.755		
		B9			0.648**	0.733		
	Feedback provision	B10	0.823	0.839	0.605**	0.686	0.637	
		B11			0.699**	0.870		
		B12			0.716**	0.827		
	Shared decision-making	B13	0.911	0.921	0.737**	0.882	0.796	
		B14			0.739**	0.941		
		B15			0.720**	0.825		
Value co-creation outcomes	Perceived value	C1	0.929	0.942	0.731**	0.717	0.671	0.946
		C2			0.794**	0.807		
		C3			0.734**	0.743		
		C4			0.795**	0.808		
		C5			0.769**	0.784		
		C6			0.828**	0.862		
		C7			0.768**	0.776		
		C8			0.794**	0.814		
	Satisfaction	C9	0.899	0.897	0.764**	0.759	0.686	
		C10			0.754**	0.833		
		C11			0.796**	0.890		
		C12			0.790**	0.855		
	Future behavioral intentions	C13	0.816	0.909	0.662**	0.882	0.771	
		C14			0.694**	0.944		
		C15			0.766**	0.558		
Digital health technology application capabilities	Digital health technology application capabilities	D1	0.943	0.944	0.956**	0.942	0.850	0.943
		D2			0.964**	0.972		
		D3			0.922**	0.847		

(3) patient use of internet technology during the diagnosis and treatment of chronic diseases (e.g., clinical decision support systems, chronic disease management apps, and remote blood pressure monitors). The exclusion criteria for chronic patients were: (1) mental illness, (2) cognitive impairment, and (3) refusal to participate. Questionnaires were distributed and collected on-site. A total of 900 questionnaires were distributed, and 842 valid responses were received, resulting in an effective response rate of 93.56%.

Measures

(1) General Survey (11 items total): This encompassed gender, age, educational background, household registration, occupation type, monthly family income, chronic disease details, the duration of the chronic disease since diagnosis, awareness of the community's "Two Chronic Diseases" policy, perception of the necessity for patients to participate in the formulation of medical decision-making plans, and whether there is an expectation to have the authority jointly make medical decisions with doctors.

(2) Measurement of self-efficacy: Modifications were made based on Chow and Wong's [50] self-efficacy scale

Table 2 Discriminant validity of Self-Efficacy, value Co-creation behavior, and outcome measurement scales

	AVE	Self-efficacy	Information search	Interactive collaboration	Feedback provision	Shared decision-making	Perceived value	Satisfaction	Future behavioral intentions	Digital health technology Application Capabilities
Self-efficacy	0.645	**0.803**								
Information search	0.743	0.320	**0.862**							
Interactive collaboration	0.577	0.338	0.662	**0.760**						
Feedback provision	0.637	0.376	0.539	0.756	**0.798**					
Shared decision-making	0.796	0.228	0.644	0.553	0.532	**0.892**				
Perceived value	0.671	0.315	0.517	0.561	0.498	0.482	**0.819**			
Satisfaction	0.686	0.314	0.382	0.503	0.497	0.361	0.809	**0.828**		
Future behavioral intentions	0.771	0.261	0.399	0.398	0.493	0.434	0.609	0.641	**0.878**	
Digital health technology application Capabilities	0.850	0.216	0.566	0.416	0.412	0.551	0.370	0.296	0.359	**0.922**

Note: The diagonal represents the square root of average variance extracted (AVE)

for elderly individuals with chronic diseases. This scale comprised one dimension and four items, such as, "I can manage to minimize the impact of illness on my daily life through self-health management activities." A 5-point Likert scale was employed, ranging from 1 (completely disagree) to 5 (completely agree), with higher scores indicating stronger self-efficacy for value co-creation among chronic patients. In this study, this scale's overall Cronbach's alpha was 0.878. The composite reliability (CR) value was 0.879, the average variance extracted (AVE) value for the latent variable was 0.645, and the correlation coefficients between each item and the total score ranged from 0.822 to 0.869 ($p < 0.01$). The square root of the AVE was 0.803, indicating good reliability and validity of this measurement.

(3) Measurement of Value Co-creation Behaviors: Based on Yi and Gong's [33] scale for value co-creation behaviors, revised according to Sweeney et al. [51] and Wu et al. [52], this scale comprised four dimensions: information search (three items), interactive collaboration (three items), feedback provision (three items), and shared decision-making (three items). A 5-point Likert scale was employed, ranging from 1 (completely disagree) to 5 (completely agree), with higher scores indicating a more comprehensive implementation of value co-creation behaviors by chronic patients. In this study, this scale's Cronbach's α coefficient was 0.928, and the Cronbach's α for the four dimensions ranged from 0.823 to 0.911. The CR values for all dimensions were greater than 0.7, and the AVE values for each latent variable ranged from 0.577 to 0.796. The correlation coefficients between each item and the total score ranged from 0.605 to 0.742 ($p < 0.01$), and the square root of the AVE ranged from 0.760 to 0.892, indicating good reliability and validity.

(4) Measurement of Value Co-creation Outcomes: Building on Peng's [8] review of value co-creation in healthcare services and incorporating revisions from Ziqi [53] and Sweeney et al. [51], the scale encompassed three dimensions: perceived value (eight items), satisfaction (four items), and future behavioral intentions (three items). A 5-point Likert scale was employed, ranging from 1 (completely disagree) to 5 (completely agree), with higher scores indicating more significant value co-creation outcomes. In this study, this scale's Cronbach's α coefficient was 0.946, and the CR values for all dimensions were above 0.7. The AVE values for each latent variable ranged from 0.558 to 0.944. The correlation coefficients between each item and the total score ranged from 0.662 to 0.790 ($p < 0.01$), and the square root of the AVE ranged from 0.819 to 0.878, demonstrating the good reliability and validity of this measure.

(5) Measurement of Digital Health Technology Application Capabilities: Drawing on the technology adoption questionnaire developed by Alam et al. [54], the

Table 3 Descriptive statistics of the sample ($N=842$)

Variable	Categorization (*n*)	Frequency (*N*)	Composition
Gender	Men	354	42.04
	Women	488	57.96
Registered residence	Rural	183	21.73
	Urban	659	78.27
Age	29 years and below	35	4.15
	30–39	52	6.18
	40–49	65	7.72
	50–59	170	20.18
	60–69	302	35.87
	70 and above	218	25.9
Educational background	Junior high school and below	278	33.02
	Technical secondary school	249	29.57
	College	133	15.8
	Bachelor's degree and above	182	21.61
Family monthly income	< 10,000 CNY	222	26.37
	10,000 ~ 20,000 CNY	351	41.69
	20,001 ~ 30,000 CNY	172	20.43
	> 30,000 CNY	97	11.51
Occupation type	Professional staff	40	4.75
	Company employees	100	11.88
	Workers in an enterprise	41	4.87
	Freelancers	54	6.41
	Migrant workers	38	4.51
	Farming	68	8.08
	Retirees	501	59.5
Your chronic illness (multiple choices allowed)	Hypertension	429	50.95
	Diabetes	252	29.93
	Cardio-cerebrovascular disease	201	23.87
	Chronic respiratory disease	152	18.05
	Chronic hepatitis	38	4.51
	Psychosis	33	3.92
	Cancer	19	2.26
	Else	87	10.33
Years of diagnosis of chronic diseases	3 years and below	135	16.03
	4–6	200	23.75
	7–9	199	23.63
	10 and above	308	36.59
Do you understand the community's "two chronic diseases" policy?	Don't know at all	163	19.36
	Understand something	624	74.11
	Know well	55	6.53
Do you think it is necessary for patients to participate in medical decision-making?	Yes	748	88.84
	No	94	11.16
Do you expect to have the power to make medical decisions together with your doctor?	Yes	712	84.56
	No	130	15.44

scale comprised a single dimension with three items. A 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree) was employed, with higher scores indicating stronger capabilities in the application of digital health technology. In this study, this scale's Cronbach's α coefficient was 0.943, and the CR values for all dimensions were above 0.7. The AVE values for each latent variable ranged from 0.847 to 0.972. The correlation coefficients between each item and the total score ranged from 0.922 to 0.764 (p <0.01), and the square root of the AVE was 0.922, indicating the scale's excellent reliability and validity.

Table 4 Means, standard deviations, correlation coefficients of the variables

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1 Self-efficacy	4.03	0.63	1								
2 Information search	4.13	0.68	0.294**	1							
3 Interactive collaboration	4.35	0.53	0.301**	0.603**	1						
4 Feedback provision	4.23	0.61	0.328**	0.476**	0.639**	1					
5 Shared decision-making	3.93	0.79	0.225**	0.599**	0.526**	0.487**	1				
6 Perceived value	4.26	0.51	0.300**	0.480**	0.518**	0.437**	0.467**	1			
7 Satisfaction	4.34	0.51	0.285**	0.348**	0.451**	0.435**	0.343**	0.751**	1		
8 Future behavioral intentions	4.17	0.61	0.269**	0.394**	0.414**	0.484**	0.438**	0.649**	0.677**	1	
9 Digital health technology application capabilities	3.39	1.08	0.201**	0.543**	0.396**	0.378**	0.532**	0.347**	0.258**	0.342**	1

Quality control

Prior to data collection, a preliminary survey was conducted with 80 randomly selected patients in Hangzhou City from September 5 to October 1, 2023. Subsequently, our findings were discussed in group sessions, leading to a revision of the questionnaire's ambiguous sections. Based on these discussions, the specific implementation plan for the research and the final version of the survey instrument were clarified. The research protocol, informed consent form, and questionnaire were approved by the Research Ethics Committee of Hangzhou Normal University (approval number 2022 – 1121). The questionnaire was distributed between November 1 and December 31, 2023, and was administered by graduate students with extensive experience in on-site investigations. Prior to the survey, comprehensive training was conducted to ensure consistency in survey standards and methods. Informed consent was obtained from all participants, and the survey was conducted anonymously. To address any misunderstanding among community-dwelling patients with chronic diseases, surveyors provided help as needed. After the survey, the questionnaires were cross-checked and any missing information was promptly supplemented. Following completion of the survey, the questionnaires were uniformly numbered and subjected to double data entry by the research personnel.

Statistical analyses

Statistical data analysis was conducted using SPSS 26.0. First, descriptive analysis was performed to describe the frequency and composition ratios of categorical and continuous variables in the data. Next, Pearson correlation analysis was used to examine the relationships among the dimensions of self-efficacy, value co-creation behaviors, and value co-creation outcomes. T-tests and a one-way analysis of variance (ANOVA) were used to analyze score differences among community-dwelling chronic patients with different demographic characteristics. Additionally, a stratified linear regression analysis was applied to explore the key factors influencing value co-creation outcomes in chronic patients.

Structural equation modeling was conducted using AMOS 26.0 to investigate the specific mechanisms through which self-efficacy and value co-creation behaviors impact value co-creation outcomes. The bootstrap method was employed to examine the mediating effect of value co-creation behaviors. The model fit was assessed using the root mean square error of approximation (RMSEA), and model fit quality was further evaluated by calculating the comparative fit index (CFI) and Tucker-Lewis index (TLI). A CFI and TLI greater than 0.90, along with an RMSEA value less than 0.08, are considered indicators of acceptable model fit. Finally, the moderation effect of digital healthcare technology application ability was tested using Model 7 of the PROCESS macro for SPSS, developed by Hayes [55]. Simple slope analysis was performed by categorizing the digital healthcare technology application ability into three groups: high (M + 1 SD), moderate (M), and low (M − 1 SD). Regression coefficients and confidence intervals for each group were calculated to determine whether the moderation effect was significant and to further examine the interaction effect pattern.

Results

Correlation analysis of self-efficacy, value co-creation behavior, digital health technology application capabilities, and value co-creation outcomes in chronic patients

The results showed a positive correlation between patient self-efficacy and value co-creation behavior and its various dimensions, with correlation coefficients ranging from 0.225 to 0.328 (all $p < 0.01$). Notably, the correlation between self-efficacy and shared decision-making was the lowest ($r = 0.225$, $p < 0.01$). Furthermore, self-efficacy was positively correlated with value co-creation outcomes and their dimensions, with correlation coefficients ranging from 0.269 to 0.300 (all $p < 0.01$). The weakest correlation was observed between self-efficacy and future behavioral intentions ($r = 0.269$, $p < 0.01$). Additionally, a positive correlation was found between self-efficacy and digital health technology application capabilities ($r = 0.201$, $p < 0.01$).

Hierarchical linear regression analysis of value Co-creation outcomes in chronic patients

Initially, dummy variables were assigned to significant non-ordinal multicenter categorical data in the univariate analysis of value co-creation outcomes in community-dwelling chronic patients, such as age, education, occupation type, and monthly income. Subsequently, the independent variables were categorized into three layers: the first layer comprised demographic variables, the second layer included demographic and self-efficacy variables, and the third layer encompassed demographic, self-efficacy, and value co-creation behavior variables. The results indicated a statistically significant $\triangle R^2$ when demographic variables, self-efficacy, and value co-creation behavior were included in the equation. A comparative analysis of $\triangle R^2$ changes revealed that in comparison to demographic variables and self-efficacy, value co-creation behavior has a more substantial impact on patients' value co-creation outcomes, as shown in Table 5.

Comparison of independent variables in Stratum 3 revealed the following results: Using age 29 and below as the reference group, patients aged 50–59 exhibited higher levels of value co-creation outcomes (β = -0.178, p < 0.01); using education up to junior high school as the reference group, patients with a bachelor's degree or higher showed higher scores in value co-creation outcomes (β = -0.156, p < 0.05); taking individuals in public institutions as the reference group for occupational type, patients working as enterprise workers demonstrated higher scores in value co-creation outcomes (β = 0.092, p < 0.05); using lack of awareness of the "Two Chronic Diseases" policy in the community as the reference group, patients who were aware of the policy exhibited higher scores in value co-creation outcomes (β = -0.103, p < 0.001). Additionally, self-efficacy had a positive promoting effect on value co-creation outcomes (β = 0.128, p < 0.001). In various stages of value co-creation behavior, information search, interactive cooperation, feedback provision, and shared decision-making all had positive promoting effects on value co-creation outcomes (β = 0.116, p < 0.01; β = 0.194, p < 0.001; β = 0.166, p < 0.001; β = 0.204, p < 0.001). These results indicate that among patients with chronic diseases, age, education, occupational type, and awareness of community policies affect value co-creation outcomes. Additionally, self-efficacy and active participation in value co-creation behaviors contribute to enhancing patients' value co-creation outcomes in chronic disease management.

Mediation effects

Construction and fitting of the model

Utilizing self-efficacy as an exogenous latent variable, and value co-creation behavior and co-creation outcomes as endogenous latent variables, we constructed a structural equation model, as illustrated in Fig. 2. The fit results of the model indicated that all the paths were statistically significant, although the fit indices did not reach the desired values for model fit. Following Bollen and Stine [56] and Enders [57], an excessively large sample size may lead to a suboptimal overall model fit. In this study, we employed the Bollen–Stine p-value correction method (1992) for model refinement. After 2000 rounds of bootstrap sampling correction, the Bollen–Stine bootstrap p-value was 0.000. The χ^2/df (1.683) fell within the range [1, 3], and goodness of fit (GFI), adjusted goodness of fit (AGFI), normed fit index (NFI), CFI, and TLI were all greater than 0.9, and the RMSEA (90% CI) were less than 0.08. The model exhibited a satisfactory overall fit (Table 6).

Path analysis of value co-creation outcomes in chronic patients

Through the analysis of standardized coefficients, we observed a positive influence of self-efficacy on value co-creation behavior among chronic patients, with a standardized path coefficient of 0.404 (p < 0.001), thus supporting H1. Additionally, both self-efficacy and value co-creation behavior exhibited positive effects on value co-creation outcomes, with standardized path coefficients of 0.090 and 0.656, respectively (p < 0.05, p < 0.001), thereby supporting H2 and H3. Further details are presented in Table 7.

Examination of mediation effects and hypothesis validation results in the model

The mediating effects of value co-creation outcomes in patients with chronic diseases were examined using the bootstrap method, with a confidence interval of 95%. The analysis was conducted using maximum likelihood estimation, and the calculations were performed over 2000 iterations. The results indicated that self-efficacy has a statistically significant direct impact on value co-creation outcomes (p = 0.038). Additionally, self-efficacy exerts a statistically significant indirect influence on value co-creation outcomes through value co-creation behavior (p < 0.001), with an indirect effect value of 0.225. This finding suggests that value co-creation behavior has a partial mediating effect on the model, thus supporting H4. For a detailed analysis of the results, please refer to Table 8.

Analysis of the moderating effect of digital health literacy on value co-creation behavior

Digital health technology application capabilities negatively moderate the relationship between self-efficacy and value co-creation behavior (β = -0.035, p < 0.05), supporting H5. To visually illustrate the moderating effect of digital health technology application capabilities, we

Table 5 Stratified regression analysis of value Co-Creation outcomes in Community-Dwelling patients with chronic diseases

Variable	Model 1	Model 2	Model 3
	Standard Beta	Standard Beta	Standard Beta
Age (reference group: = ≤ 29 years)			
30–39	0.047	0.030	−0.009
40–49	−0.025	−0.023	−0.028
50–59	−0.244**	−0.230**	−0.178**
60–69	−0.310***	−0.283**	−0.171*
70 and above	−0.263**	−0.238**	−0.132
Educational background (reference group: junior high school and below)			
Technical secondary school	−0.093**	−0.093*	−0.069*
College	−0.137***	−0.132***	−0.129***
Bachelor's degree and above	−0.153**	−0.156***	−0.156***
Occupation types (Reference group: Public sector employees)			
Company employee	−0.019	−0.014	−0.012
Enterprise worker	0.076	0.085	0.092*
Freelancer	0.039	0.034	0.027
Migrant worker	0.063	0.050	0.073
Farming	−0.056	−0.053	−0.007
Retiree	0.076	0.055	−0.013
Family monthly income (Reference group: <10000 CNY)			
10,000 ~ 20,000 CNY	−0.195***	−0.165***	−0.066
20,001 ~ 30,000 CNY	−0.188***	−0.143***	−0.015
> 30,000 CNY	−0.077*	−0.040	0.043
Do you understand the community's "Two Chronic Diseases" policy? (reference group: don't know at all)			
Understand something	0.039	0.007	−0.103***
Know well	0.163***	0.140***	0.040
Do you think it is necessary for patients to participate in medical decision-making? (reference group: no)			
Yes	0.054	0.026	0.026
Do you expect to have the power to make medical decisions together with your doctor? (reference group: no)			
Yes	0.188***	0.173***	0.058
Self-efficacy		0.267***	0.128***
Value co-creation behaviors			
Information search			0.116**
Interactive collaboration			0.194***
Feedback provision			0.166***
Shared decision-making			0.204***
R^2	0.177	0.243	0.465
F	8.399	11.962	27.200
$\triangle R^2$	0.177	0.066	0.221
$\triangle F$	8.339	71.604	84.260
VIF_{max}	9.096	9.107	9.230

conducted a simple slope analysis using this process(Fig. 3). The analysis results showed that in situations with higher digital health literacy, the regression line slope of the relationship between self-efficacy and value co-creation behavior is relatively small. This suggests that, as digital health technology application capabilities increase, the positive impact of self-efficacy on value co-creation behavior gradually weakens, as shown in Table 9. Additionally, we conducted a bootstrap test to examine the size of the results at three levels within a 95% confidence interval for the moderating effect of digital health technology application capabilities, as shown in Table 10. For the dimension of digital health technology application capabilities in patients with chronic diseases (within the range from one standard deviation below the mean to one standard deviation above the mean), as the score on the digital health technology application capabilities

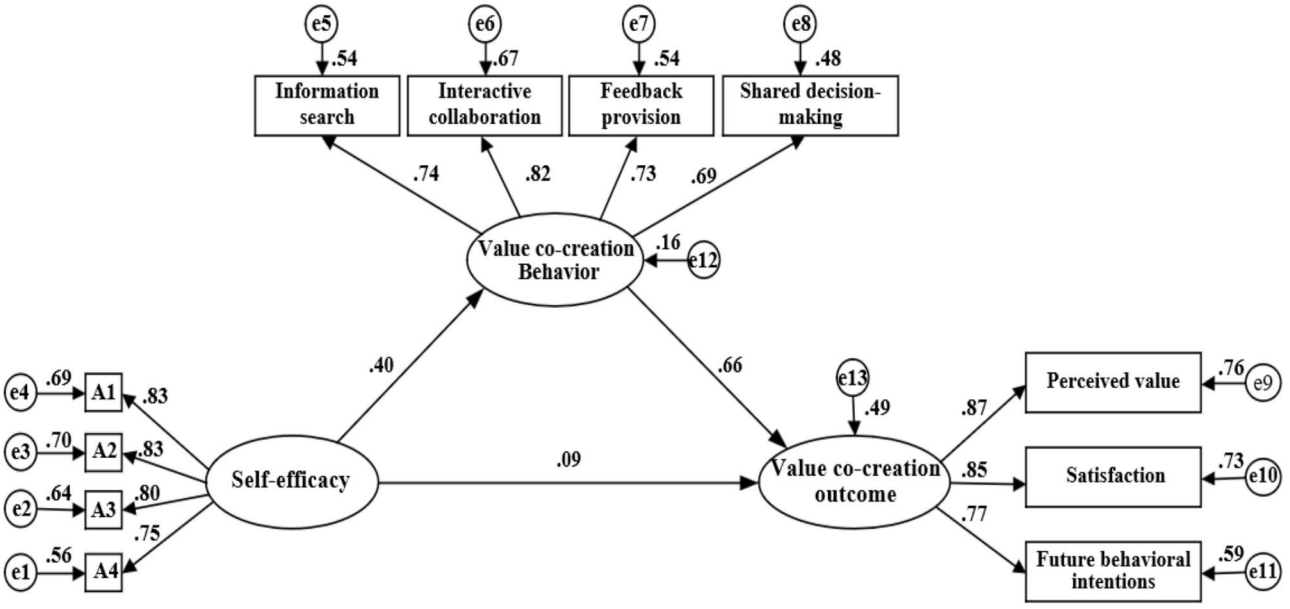

Fig. 2 Model of value co-creation outcomes in chronic patients

Table 6 Results for SEM fit

Fit indices	Standards of fit indices	Original model	B-S modified model
c^2/df	$1<\chi^2/df<3$ good	7.693	1.683
RMSEA (90% CI)	<0.08 acceptable	0.089(0.080 ~ 0.099)	0.029
GFI	>0.9 acceptable	0.945	0.986
AGFI	>0.9 acceptable	0.899	0.965
NFI	>0.9 acceptable	0.938	0.986
CFI	>0.9 acceptable	0.945	0.994
TLI	>0.9 acceptable	0.926	0.992

dimension increases, the positive impact of self-efficacy on value co-creation behavior weakens.

Discussion

This study revealed the significant roles of self-efficacy, value co-creation behavior, and digital health technology application capabilities in value co-creation outcomes among community-dwelling patients with chronic diseases. The findings indicate that self-efficacy and value co-creation behaviors positively influence value co-creation outcomes. Additionally, value co-creation behavior partially mediates the relationship between self-efficacy and value co-creation outcomes. Furthermore, digital health literacy plays a moderating role by negatively influencing the relationship between self-efficacy and value co-creation behaviors. Thus, we constructed a moderated mediation model to elucidate the interrelationships among self-efficacy, value co-creation behavior, digital health literacy, and value co-creation outcomes in community-dwelling patients with chronic diseases.

Table 7 Relationships among factors in the fitted model

Variable	Unstd.	Std.	S.E	Z	*P*	Support hypothesis
Self-efficacy → value co-creation behavior	0.384	0.404	0.039	9.719	< 0.001	H_1
Self-efficacy → value co-creation outcomes	0.076	0.090	0.030	2.526	0.012	H_2
Value co-creation behavior → value co-creation outcomes	0.587	0.656	0.040	14.757	< 0.001	H_3

Table 8 Bootstrap test for mediation effects

Path	Effect of type	S.E	Estimate	Bias-corrected 95% CI			Percentile 95% CI		
				Lower	Upper	*P*	Lower	Upper	*P*
Self-efficacy → Value co-creation outcomes	Total effects	0.052	0.302	0.209	0.414	< 0.001	0.208	0.413	< 0.001
	Direct effects	0.037	0.076	0.004	0.149	0.038	0.008	0.152	0.030
	Indirect effects	0.040	0.225	0.159	0.317	< 0.001	0.155	0.311	< 0.001

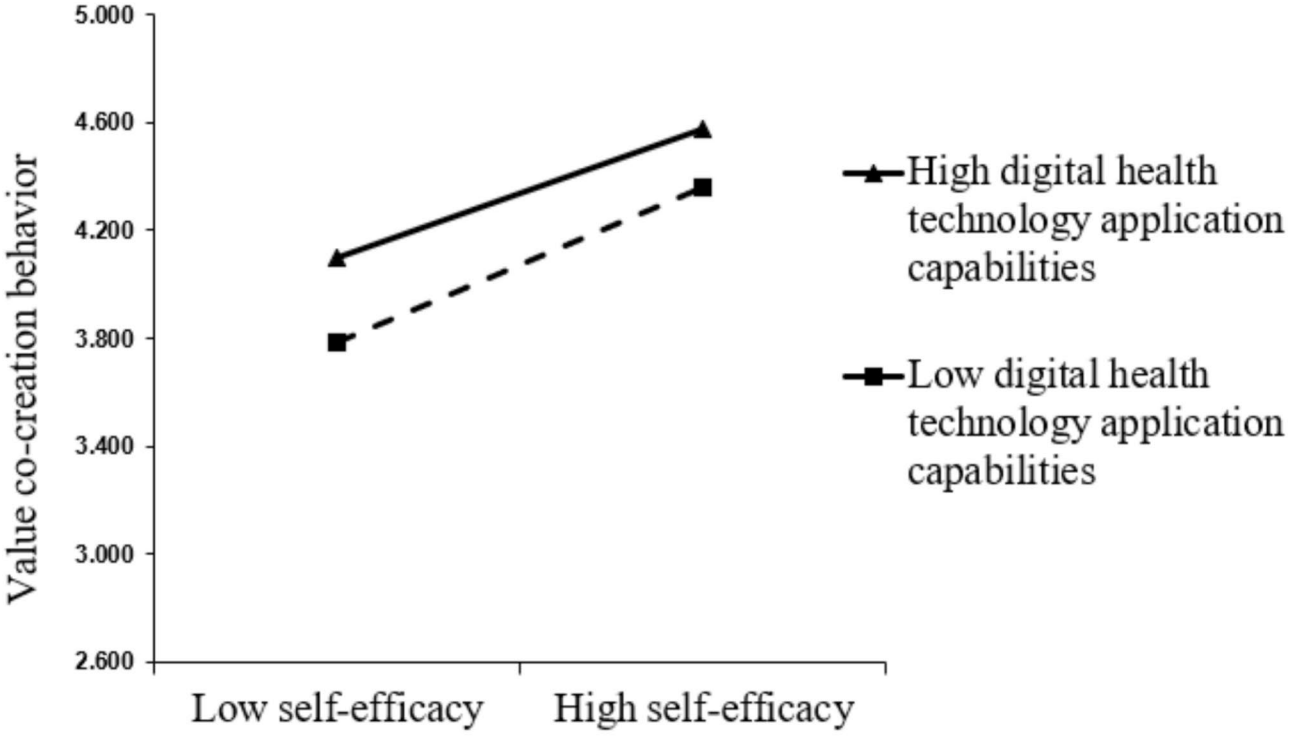

Fig. 3 The moderating effect of digital health literacy on the relationship between self-efficacy and value co-creation behavior

Table 9 Analysis of the moderated mediating effect

Variable	M (Value co-creation behavior)			Y (Value co-creation outcome)		
	β	S.E	t	β	S.E	t
Constant	2.052	0.267	7.690***	1.689	0.118	14.314***
Self-efficacy	0.329	0.066	4.977***	0.095	0.022	4.328***
Digital health technology application capabilities	0.386	0.069	5.511***			
Value co-creation behavior				0.522	0.027	19.321***
Self-efficacy digital health technology application capabilities	-0.035	0.017	-2.081*			
R^2	0.372			0.379		
	F (3, 838) = 163.557***			F (2, 839) = 254.402***		

Table 10 Bootstrap test of moderated mediation effects

Moderating variable	Moderator	Effect	Boot SE	Bootstrap 95% CI	
				Lower end of Boot CI	Higher end of Boot CI
Moderated mediation effect	$M-1SD$	0.129	0.027	0.079	0.184
	M	0.109	0.018	0.076	0.149
	M + 1SD	0.089	0.019	0.058	0.131
Comparison of moderated mediation effects	M-L	−0.020	0.014	−0.047	0.009
	H-L	−0.040	0.029	−0.094	0.018
	H-M	−0.020	0.014	−0.047	0.009

Self-efficacy's impact on value co-creation behaviors and outcomes

Our findings demonstrate that self-efficacy plays a crucial role in influencing the value co-creation behaviors of patients with chronic diseases, in line with those of Cheng [58]. This suggests that patients with high self-efficacy can effectively utilize their subjective initiative, leading to behaviors such as interactive cooperation, information search, and feedback provision. Self-efficacy is a positive psychological resource that, along with hope, optimism, and resilience, determines the level of an individual's behavioral initiative [59]. This argument is empirically supported by AbdelAziz et al. [60], who highlighted the significant impact of self-efficacy on the interactive behavior of customers with small and

medium-sized enterprises, particularly in terms of products and services.

Additionally, our study revealed that self-efficacy positively contributes to value co-creation outcomes for patients, which is consistent with the results of Van Dongen et al. [61]. Patients with higher self-efficacy exhibited elevated levels of satisfaction, perceived value, and intention to engage in future positive behaviors. Sui et al. [62] affirmed that individuals with high self-efficacy are more likely to adopt adaptive thinking, which is conducive to stress reduction, anxiety alleviation, and satisfaction. Therefore, enhancing the self-efficacy of patients with chronic diseases is critical for improving both value co-creation behaviors and outcomes. The self-efficacy of patients engaging in value co-creation is shaped by their cognitive beliefs regarding the control, management, and enhancement of their own health conditions. To bolster the self-efficacy of patients with chronic diseases, the following recommendations are proposed: (1) Patients with chronic diseases should actively seek information pertaining to their diagnosis and treatment, as well as health knowledge related to diet, exercise, and rehabilitation. This proactive approach enhances health literacy and fosters awareness of health responsibility, thereby reinforcing confidence in managing disease and promoting value co-creation behavior. (2) Healthcare institutions should design and implement health education programs focused on chronic disease knowledge to rectify patients' misconceptions about their condition. This initiative can cultivate a positive and proactive mindset, encourage patients to actively participate in the diagnosis and treatment processes, adhere to medical advice, and improve the overall effectiveness of disease treatment. (3) Family members should provide consistent daily care and psychological support to mitigate the negative psychological impact of chronic disease pain. This support empowers patients to face difficulties because of increased courage and perseverance.

The impact of value co-creation behaviors on value co-creation outcomes

This study confirms that the value co-creation behaviors of patients with chronic diseases positively influence their value co-creation outcomes. This finding was consistent with those reported by Kim [63]. Patient value co-creation behaviors enhance outcome value through customized services, improved service quality, cost reduction, and increased control. Behaviors such as providing feedback and sharing information offer doctors valuable insights into patients' treatment needs and preferences, enabling them to deliver tailored treatment plans that better align with both the patients' needs and their individual value systems [64]. Our study further revealed that the shared decision-making behavior of patients with chronic diseases had the greatest impact on value co-creation outcomes, aligning with the conclusions of Sweeney et al. [51]. Actively engaging in discussions with doctors, participating in the formulation of disease diagnoses and treatment plans, and exercising autonomy in decision-making all improve the quality of medical services, thereby increasing satisfaction and perceived value. However, in this study, the impact of information search behavior on the value co-creation outcomes of patients with chronic diseases was relatively small, which differs from Osei-Frimpong et al.'s findings [65]. This may be attributed to the UK's higher economic development level, where patients with chronic diseases have higher electronic health literacy and stronger abilities to search for and filter information, enabling them to better access and utilize information resources to create value. To enhance value co-creation outcomes for patients, it is crucial to improve their value co-creation behavior. Therefore, the following recommendations are proposed: (1) Healthcare professionals should strengthen health education on medical decision-making for patients with chronic diseases, promote the concept of "active health," enhance patients' decision-making abilities, encourage patient understanding and participation in decision-making processes, and collaboratively formulate medical plans. (2) Hospitals should establish an open communication platform, regularly collect opinions and feedback from patients with chronic diseases, maintain harmonious doctor-patient relationships, increase interaction between patients and healthcare service providers, motivate patient participation in value co-creation behaviors (enhancing feedback and interactive cooperation), and create more value for patients.

The mediating role of value co-creation behaviors

Our findings indicate that value co-creation behaviors play an intermediary role in the relationship between self-efficacy and the outcomes of value co-creation. This aligns with Mai's findings [40], suggesting that patients with higher self-efficacy are more inclined to interact with healthcare professionals, enhancing the effectiveness of treatment plan discussions and decisions, which in turn contributes to patients' assessment of the quality of interactions, including perceived value and satisfaction. Al-Kumaim et al. [66] point out that self-efficacy enhances an individual's willingness to invest resources in value co-creation (e.g., time, effort, and knowledge), and this resource mobilization behavior lays the foundation for effective interaction. In a healthcare context, patients with high self-efficacy are more likely to use their cognitive resources to engage in in-depth conversations with doctors [67]. Through value co-creation behaviors such as co-developing treatment plans and participating in decision-making processes, they transform their internal

efficacy into actionable interaction patterns. This allows them to achieve goals within value co-creation, leading to higher satisfaction and perceived value. Osei-Frimpong [68] also emphasizes that customers need sufficient motivation to engage in value co-creation. When they act autonomously, they are more likely to actively promote their resource integration activities and value co-creation behaviors, thereby driving their perception and determination of value. Therefore, as an intermediary variable between self-efficacy and the outcomes of value co-creation, value co-creation behaviors underscore the critical role of interactions and behaviors in patients' health management and doctor-patient interactions. This insight can contribute to governments' and healthcare institutions' development of targeted health interventions and social support strategies, thereby fostering the collaborative creation of health value.

The moderating role of digital health technology application capabilities

Our findings revealed that digital health technology application capabilities have a negative moderating effect on self-efficacy and value co-creation behavior; the stronger the digital technology application capability of patients with chronic diseases, the weaker the facilitating effect of self-efficacy on value co-creation behavior. This phenomenon can be explained by the double-edged effect of technology embedding. Park et al. [69] highlight the inherent tension between technological competence and information dependence, suggesting that technological reliance may weaken the positive impact of technological competence on self-efficacy. Specifically, individuals with high digital technology application capabilities tend to critically evaluate online resources, whereas those with lower digital technology application capabilities are more prone to developing technological dependence. Patients with chronic diseases who overly rely on health information obtained through digital health technology, rather than on their own feelings and judgments, may experience the "technology substitution effect," which weakens the positive impact of self-efficacy on proactive behavior [70]. Notably, this finding contrasts with that of Wijesundara et al. [71], who emphasize that the use of digital health technology can enhance patients' autonomy and self-awareness, improve their self-management of health conditions, and increase their involvement in medical decision-making. This difference may be attributed to Wijesundara et al.'s focus on younger patients, who are more likely to develop a sense of control through deep technological engagement (e.g., online doctor-patient collaborative decision-making), thereby reducing the negative effects of technological dependence. This suggests that when improving the digital health technology application capabilities of patients with chronic diseases, healthcare decision-makers should consider providing training for both patients and caregivers on digital health technology skills. Additionally, they should strengthen information discernment and decision-making skills through digital health literacy education, thus maintaining subjective judgment in the use of technology.

Strengths and limitations

This study elucidates the role of self-efficacy and value co-creation behaviors in chronic disease management, providing both theoretical and practical insights for public health. In terms of theoretical contributions, this study identifies self-efficacy as a key antecedent of value co-creation behaviors and examines its cognitive influence on the cocreation process. By adhering to the logical sequence of "patient cognition – behavior execution – co-creation outcomes," a dedicated theoretical framework for value co-creation among patients with chronic diseases was constructed. This framework not only offers a novel theoretical perspective for enhancing patient satisfaction, perceived value, and related outcomes but also contributes to the development of human-centered approaches and healthcare applications within the value co-creation theory. Regarding practical contributions, the findings emphasize that enhancing patient self-efficacy is a crucial strategy for encouraging active participation in the co-creation process. Healthcare institutions should consider leveraging health education and supportive interventions to build patient confidence, promote the expression of individual needs, and facilitate engagement in shared decision-making. These efforts can assist in developing a patient-centered co-creation ecosystem in chronic disease management. Furthermore, through empirical research, we revealed that digital health technology application capabilities may weaken the influence of self-efficacy on value co-creation behavior. This finding is crucial because it suggests the possibility of flaws in the technology experience. The double-edged effect of technology embedding may have a profound impact on chronic disease patients' self-efficacy and value co-creation behavior patterns. This insight underscores the importance for healthcare institutions and health educators to develop digital health programs that focus on enhancing patients' self-efficacy in technological environments, strengthening patients' health autonomy, and promoting value co-creation behaviors.

Despite the aforementioned contributions, this study had some limitations. First, as this was a cross-sectional study, it had inherent limitations in establishing causal relationships among variables and preventing causal inferences. Future research should employ longitudinal or intervention studies for a more in-depth exploration. Second, the study lacked sample representativeness, while our stratified approach enhances intra-provincial

generalizability, extrapolation to less developed western/central regions requires caution due to disparities in health system financing, primary care workforce density, and patient health literacy. Future multi-provincial cohort studies should incorporate rural-urban gradients and socioeconomic vulnerability indices to strengthen external validity. Finally, in this study, the independent variables and research subjects were relatively limited. Other potential antecedents of value co-creation may include factors such as health literacy and social support, and the participants in value co-creation extend beyond just patients to include doctors, nurses, and other healthcare professionals. Future research could further explore additional antecedents of value co-creation and examine the roles and behaviors of healthcare providers in value co-creation, enriching both the research subjects and content.

Conclusions

This study adopts a value co-creation perspective, following a cause-behavior-outcome framework. The findings show that self-efficacy positively influences the value co-creation outcomes for patients, with value co-creation behavior serving as a mediator between self-efficacy and value co-creation outcomes. These findings contribute to enhancing the awareness and education of community-based patients with chronic diseases regarding their participation in value co-creation. Furthermore, this research offers valuable guidance for healthcare institutions and communities to enhance value co-creation among patients with chronic diseases. For example, healthcare institutions and communities can enhance patient self-efficacy through health education, social support, and other means, thereby promoting doctor-patient interactions and shared decision-making to improve the chronic disease service experience. Additionally, given the negative moderating role of digital health technology application capabilities, healthcare administrators should provide more user-friendly digital health training to reduce technological barriers. This would improve patients' self-efficacy and digital health literacy, encouraging more active participation in value co-creation.

Supplementary Information

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Supplementary Material 1

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Author contributions

Conceptualization, X. H.; data curation, J. T. and W.Y.; methodology, J. T.; software, X. Y. and Z. M.; validation, X. Y. and J. J.; formal analysis, H. Z.; investigation, Y. G. and W.Y.; writing—original draft preparation, J. T. and Y. G.; writing—review and editing, X. H. and H. Z.; visualization, Z. M.; supervision, H. Z. All authors have read and agreed to the published version of the manuscript.

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Data availability

The raw data supporting the conclusions of this article will be made available within supplementary information (File Name:20240218.sav).

Declarations

Competing interests

The authors declare no competing interests.

Institutional review board statement

This study was approved by the Institutional Review Board of Hangzhou Normal University (approval number: 2022 – 1121). All procedures were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration.

Informed consent statement

Informed consent was obtained from all participants involved in the study.

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