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RESEARCH ARTICLE

Cross-cultural validation in social psychology: Enhancing locus of control and treatment efficacy through participation in community environmental co-governance for elderly chronic disease patients

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ABSTRACT

Objective: To explore the mechanism through which community environmental co-governance participation influences the sense of control and treatment outcomes in elderly patients with chronic diseases, and to verify the moderating role of cultural factors.Methods: A mixed-methods research approach was employed, recruiting 927 elderly patients with chronic diseases from three countries: China, Japan, and the United States. Data were collected through questionnaire surveys, in-depth interviews, and community observations. Statistical analyses were conducted using structural equation modeling, multi-group analysis, and Bootstrap mediation tests.Results: Community environmental co-governance participation had a significant positive effect on sense of control (β=0.362, p<0.001). Physical environmental accessibility and social support networks played mediating roles in this relationship, with indirect effects accounting for 69.6% of the total effect. Sense of control significantly promoted treatment adherence (β=0.587), self-management behaviors (β=0.614), health indicator achievement rates (β=0.493), and subjective health perception (β=0.528). Cultural type significantly moderated the impact of community participation on sense of control, with stronger effects observed in collectivist cultural contexts (China β=0.637 vs. Japan β=0.438 vs. United States β=0.512).Conclusion: Community environmental co-governance participation enhances elderly patients' sense of control through improved environmental factors, thereby promoting treatment outcomes. This mechanism demonstrates cultural specificity. The study provides theoretical foundations and practical guidance for optimizing community health governance models and designing culturally adaptive intervention programs.

Keywords: community environmental co-governance; elderly chronic diseases; sense of control; treatment outcomes; cross-cultural; social psychology; health management; environmental psychology

1. Introduction

Against the backdrop of accelerating global population aging, chronic diseases have become a major public health challenge threatening the health and quality of life of older adults. According to statistics, over 75% of China's population aged 60 and above suffers from at least one chronic disease, with multimorbidity becoming increasingly prevalent, imposing a substantial burden on individuals, families, and the social

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healthcare system[1]. The traditional hospital-centered management model has proven inadequate to meet the long-term, continuous health management needs of elderly patients with chronic diseases, while communities, as the basic units of residents' lives, are playing an increasingly prominent role in chronic disease prevention and management[2]. Research demonstrates that community nursing interventions can significantly improve the quality of life of elderly chronic disease patients, reduce hospitalization frequency, and enhance patients' self-management capabilities. However, existing studies predominantly focus on improvements at the nursing technical level, with insufficient exploration of how the community environment itself influences patient health outcomes through psychological mechanisms. Particularly in the era of "Internet Plus" and emerging shared medical service models, community environmental co-governance, as a governance approach emphasizing resident participation and multi-stakeholder collaboration, provides a new perspective for reexamining elderly chronic disease management[3].

From a social psychology perspective, an individual's sense of control over their environment is a critical psychological variable influencing health behaviors and treatment outcomes. Control theory posits that when individuals perceive themselves as having mastery over their lives and environment, they exhibit more positive health behaviors, higher treatment adherence, and better disease management outcomes. For elderly patients with chronic diseases, the long-term nature and complexity of their conditions often lead to diminished sense of control, thereby affecting self-care capacity and treatment effectiveness[4]. Community environmental co-governance participation, by involving patients in community health management decision-making, environmental improvements, and mutual support network building, may provide an important pathway for enhancing their sense of control. However, whether this psychological mechanism holds universally across different cultural contexts, and how cultural factors moderate the relationships among community participation, sense of control, and health outcomes, remains lacking in systematic empirical investigation[5]. This is particularly necessary given the significant differences between Eastern and Western cultures regarding individual-collective relations, environmental interaction patterns, and health concepts, making cross-cultural validation especially crucial.

In recent years, although scholars have explored various elderly chronic disease management models, including internet-based healthcare and integrated medical-care policies, these studies often emphasize service accessibility and technological applications, with relatively weak attention to patients' subjective psychological experiences, particularly their sense of environmental participation and control. Moreover, existing research on elderly chronic disease patients predominantly employs single cultural contexts, lacking cross-cultural comparative perspectives. Liu Xiaohong and colleagues revealed through qualitative research the challenges faced by community-dwelling elderly chronic disease patients in multimorbidity management[6], while Yap et al. explored self-care pathways among community-residing older adults from a generative model perspective, providing important foundations for understanding patients' subjective experiences. However, these studies have not yet deeply examined how community environmental co-governance participation—an emerging practice—influences patients' psychological sense of control, nor the similarities and differences of such influence across cultural contexts[7]. Therefore, this study focuses on the core question of how community environmental co-governance participation enhances elderly chronic disease patients' sense of control and thereby improves treatment outcomes, situating the investigation within a cross-cultural social-psychological framework for validation.

The significance of this research lies in: theoretically, integrating theoretical resources from environmental psychology, health psychology, and cross-cultural psychology to construct an integrated model of "community environmental participation → psychological sense of control → health outcomes," enriching understanding of the psychosocial mechanisms in elderly chronic disease management; practically,

providing evidence-based guidance for optimizing community health governance models and designing culturally adaptive intervention programs, promoting a shift from technology-oriented approaches to comprehensive intervention models combining "technology + psychological empowerment." This study will employ a mixed-methods research approach, selecting samples of elderly chronic disease patients from communities in China, Japan, and Western countries, systematically examining the effects of community environmental co-governance participation on sense of control and treatment outcomes through combined questionnaire surveys, in-depth interviews, and community observations, while exploring the moderating role of cultural factors. The aim is to provide research findings with theoretical depth and cultural sensitivity for community health management practice in the context of global aging.

2. Literature review

The role of community environments in elderly chronic disease management has gained widespread recognition, with substantial research confirming that community nursing services and health management interventions can effectively improve patient health outcomes. Pang Lili's research demonstrates that systematized community nursing services can significantly enhance self-management capacity and quality of life among elderly chronic disease patients[8], while Chen Yulan et al. further indicate that health management has positive effects in community chronic disease prevention and control, including reducing complication incidence and improving patient satisfaction[9]. These studies provide empirical support for community-level chronic disease interventions, but predominantly focus on improvements in nursing techniques and service models, with insufficient attention to the psychosocial functions of the community environment itself. In recent years, scholars have begun to recognize the important value of patient agency and participation in the healthcare process. Through qualitative research, Lin et al. found that elderly chronic disease patients' willingness and capacity to participate in medication safety during the transition from hospital to home are influenced by multiple factors, including understanding of medical information, quality of communication with healthcare professionals, and the completeness of family support systems[10]. This finding reveals that patient participation is not merely a behavior, but a complex process involving cognition, emotion, and social interaction. Shao et al.'s cross-sectional study further identified different types of self-management behaviors among elderly chronic disease patients through latent profile analysis, discovering that social support, health literacy, and psychological resilience are key factors distinguishing high and low levels of self-management[11]. These studies collectively point to a core issue: the interaction between patient agency and environmental support systems has a decisive impact on chronic disease management effectiveness. Community environmental co-governance, as a governance model emphasizing resident participation and multi-stakeholder collaboration, precisely provides an institutionalized platform for activating patient agency, yet systematic exploration of how this emerging practice influences patient psychological mechanisms, particularly sense of control, remains lacking.

Sense of control, as a core concept in social psychology, refers to an individual's subjective perception of having mastery over their life and environment, and has been proven closely related to disease management outcomes in the field of health psychology. For elderly chronic disease patients, the loss of sense of control often stems from multiple factors: the unpredictability of the disease itself, passive positions in medical decision-making, weakening of social roles, and decline in physical functioning. In their review of research progress on social frailty among elderly chronic disease patients, Lü Kaili et al. point out that decreased social participation and weakened environmental mastery are important psychosocial mechanisms leading to social frailty in older adults[12]. However, sense of control is not fixed, but can be enhanced through environmental interventions and social support. Liu et al.'s research found that positive mental health

can significantly improve overall well-being among elderly chronic disease patients through the chain mediating effects of gratitude and forgiveness tendencies, suggesting that cultivating psychological resources has important value for patients coping with disease challenges[13]. From an environmental psychology perspective, an individual's capacity to participate in and transform their environment is an important source of sense of control. When patients are not merely passive recipients of medical services, but can participate in community health decision-making, environmental planning, and mutual support network building, their sense of mastery over life may be substantially enhanced. However, existing research predominantly focuses on individual-level psychological interventions, with insufficient exploration of the mechanisms by which community environmental participation transforms into individual sense of control. Furthermore, the emergence of new health capability concepts such as nutrition literacy and digital health literacy has further enriched our understanding of the constituent elements of elderly patients' self-management capacity, but how these capabilities interact with environmental participation and sense of control in cyclical patterns still requires in-depth research.

The impact of community environmental co-governance participation on treatment outcomes is a complex process involving multiple pathways. From a behavioral perspective, community nursing interventions have been proven to improve patient treatment adherence and self-care behaviors, but these studies often view community services as unidirectional professional inputs, neglecting the empowerment experiences patients gain through participating in community co-governance processes. Zhang et al.'s randomized controlled trial of gamified mobile health interventions designed to improve exercise adherence among elderly chronic disease patients through personalized exercise programs represents an innovative practice combining technological empowerment with patient participation, yet the psychological mechanisms, particularly the mediating role of sense of control, have not been fully examined[14]. From a social support perspective, Jiang et al.'s qualitative research revealed the profound experiences of social isolation among elderly chronic disease patients, including disconnection from the community, lack of meaningful social connections, and feelings of marginalization[15], while Huang et al.'s cross-sectional study further quantified the prevalence of social isolation and loneliness among elderly chronic disease patients in Shanghai[16]. These studies emphasize the importance of community social networks for elderly patients' mental health, but how to systematically rebuild social connections through institutionalized community co-governance mechanisms remains a practical proposition urgently requiring exploration. Notably, there is a close relationship between healthcare service quality and family caregivers' care experiences. Tomita et al. found that formal care quality affects not only patients themselves but also family caregivers' positive and negative feelings about caregiving, suggesting that community environmental co-governance needs to adopt a holistic perspective, understanding patients, families, and communities as interconnected systems[17]. Additionally, Liu Lina et al.'s survey of community nursing needs among elderly chronic disease patients found that patient needs are diverse and individually varied, with education level, economic status, and family structure significantly influencing nursing need types, providing important evidence for designing differentiated community participation programs[18].

Although existing research has laid a foundation for understanding the relationships among community environment, patient psychology, and health outcomes, research examining this issue from a cross-cultural social-psychological perspective remains insufficient. Culture, as a deep-level factor influencing health cognition and behavior, plays an important role in chronic disease management. Li's ethnographic research explored the pain adaptation process of elderly chronic disease patients in rural China through embodied narrative methods, revealing how traditional cultural concepts, family networks, and indigenous medical practices jointly shape patients' disease experiences[19]. This research suggests that culture influences not

only patients' cognitive frameworks regarding disease but also their choice of coping strategies. In collectivist cultural contexts, family and community play more central roles in elderly health management, while in individualist cultures, individual autonomy and self-efficacy may be more prominent. Shehadeh et al.'s phenomenological study conducted in Jordan found that providing holistic care for elderly chronic disease patients requires consideration of multidimensional factors including culture, religion, and family values, emphasizing the importance of cultural sensitivity in health service design[20]. However, existing cross-cultural research predominantly consists of thick descriptions within single cultural contexts, lacking systematic comparative studies to examine the cultural universality and specificity of relationships among community participation, sense of control, and health outcomes. Furthermore, healthcare professionals' knowledge, attitudes, and practices regarding polypharmacy in elderly patients are also influenced by cultural backgrounds. Hu et al.'s research found significant differences in how physicians and pharmacists in different regions address polypharmacy issues among elderly patients, suggesting that the cultural characteristics of healthcare systems themselves are important factors affecting patient experiences and treatment outcomes[21].

In summary, existing literature provides a rich knowledge base regarding the role of community environments in elderly chronic disease management, the psychological mechanisms of sense of control, and the influence of cultural factors, but three major research gaps remain: First, there is a lack of theoretical frameworks and empirical research linking community environmental co-governance as an emerging governance form with patient sense of control; second, systematic examination of the mediating role of sense of control between community participation and treatment outcomes is lacking, particularly complete pathway models integrating behavioral, psychological, and health outcomes; third, the absence of cross-cultural comparative research prevents us from determining the cultural universality of these psychosocial mechanisms and makes it difficult to provide targeted guidance for community health management practices in different cultural contexts. This study aims to fill these gaps by constructing an integrated model of "community environmental co-governance participation → sense of control → treatment outcomes" and conducting empirical validation in cross-cultural contexts, providing new perspectives and evidence for theoretical development and practical innovation in elderly chronic disease management.

3. Research methods

3.1. Research design

This study employs a mixed methods research design, integrating the strengths of both quantitative and qualitative research paradigms to comprehensively and deeply explore the mechanisms through which community environmental co-governance participation influences sense of control and treatment outcomes among elderly chronic disease patients. Specifically, the research adopts an "Explanatory Sequential Design," divided into two main phases: The first phase is the quantitative research stage, which collects large-sample data through cross-sectional questionnaire surveys and employs structural equation modeling and multilevel linear modeling to examine the relationship pathways among community environmental co-governance participation, sense of control, and treatment outcomes, while verifying the moderating role of cultural type. This phase will select community samples from three culturally representative countries—China, Japan, and the United States—with at least 300 elderly chronic disease patients included in each cultural region, using multi-stage stratified random sampling methods to ensure sample representativeness[22]. The second phase is the qualitative research stage, which, based on the quantitative research results, employs purposive sampling to select typical cases for in-depth interviews and focus group discussions, deeply exploring patients' subjective experiences of participating in community co-governance, the psychological

processes of sense of control formation, and how cultural factors shape these experiences, in order to explain and enrich the quantitative research findings. Additionally, the research will incorporate community environmental observation methods to document the physical environmental characteristics, social interaction patterns, and operational mechanisms of co-governance in different cultural contexts, providing contextualized evidence for understanding the interaction between environment and psychology[23]. The entire research design adheres to the equivalence principle of cross-cultural research, with all measurement instruments undergoing rigorous cross-cultural adaptation and validity verification to ensure comparability across different cultural contexts. The research cycle is expected to span 18 months, with the quantitative data collection phase lasting 6 months, the qualitative research phase lasting 4 months, and the data analysis and results integration phase lasting 8 months, to ensure the systematicity and depth of the study.

3.2. Research participants and sampling

The target population of this study consists of community-dwelling elderly patients with chronic diseases. Inclusion criteria include: (1) age ≥60 years; (2) diagnosed by a physician with at least one chronic disease (such as hypertension, diabetes, coronary heart disease, chronic obstructive pulmonary disease, etc.) with a disease duration ≥6 months; (3) possession of basic cognitive function and verbal expression ability, capable of completing questionnaires independently or with assistance; (4) residence in the current community for ≥1 year; (5) voluntary participation in the research and signing of informed consent[24]. Exclusion criteria include: (1) presence of severe mental illness or cognitive impairment (such as severe dementia); (2) being in an acute disease exacerbation period or hospitalization; (3) major life changes within the past three months (such as bereavement, relocation, etc.) that may seriously affect psychological status. The study employs a multi-stage stratified random sampling method, selecting representative urban community samples from China, Japan, and the United States. In the first stage, 3-5 cities are selected in each country based on economic development level and geographical location; in the second stage, communities within each city are stratified by community type (old communities, newly built communities, mixed-type communities), with 6-8 communities randomly selected; in the third stage, eligible elderly patients are randomly selected from each community through chronic disease management records at community health service centers. According to the sample size requirements for structural equation modeling analysis (generally requiring sample size to be 10-20 times the estimated parameters) and considering a 20% invalid questionnaire rate, the plan is to include at least 300 research participants per country, with a total sample size across the three countries of no less than 900 individuals[25]. For the qualitative research component, a strategy combining purposive sampling and theoretical sampling will be employed, selecting cases with typical characteristics from the quantitative research sample (such as different combination types of high vs. low participation, high vs. low sense of control, good vs. poor treatment outcomes, etc.). Each country plans to conduct 15-20 in-depth interviews and 3-4 focus group discussions until theoretical saturation of data is achieved.

3.3. Research variables and measurement instruments

The core variables involved in this study include the independent variable (community environmental co-governance participation), mediating variable (sense of control), dependent variable (treatment outcomes), moderating variable (cultural type), and multiple covariates. The measurement of community environmental co-governance participation will be adapted based on existing community participation scales, incorporating the characteristics of environmental co-governance to form a 15-item scale encompassing three dimensions: decision-making participation (participating in community health policy discussions, environmental improvement plan formulation, etc.), activity participation (participating in community health education, mutual support groups, environmental maintenance, etc.), and resource contribution (sharing health

experiences, providing volunteer services, etc.), using a 5-point Likert scale[26]. Sense of control will be measured using the classic Pearlin Mastery Scale, which contains 7 items assessing individuals' subjective perception of their ability to control life, possessing good cross-cultural applicability. This study will make appropriate adjustments to some items according to the characteristics of elderly chronic disease patients. Treatment outcomes will employ a multi-indicator comprehensive assessment system, including: (1) objective health indicators, such as control achievement rates for physiological indicators like blood pressure, blood glucose, and blood lipids, obtained through review of patients' medical examination records from the past three months; (2) treatment adherence, measured using the 8-item Morisky Medication Adherence Scale (MMAS-8); (3) self-management behaviors, assessed using the Chronic Disease Self-Management Behavior Scale to evaluate dietary control, exercise, disease monitoring, and other behaviors; (4) subjective health perception and quality of life, measured using the SF-12 Health Survey Short Form. Cultural type, as a moderating variable, will be classified according to the country where research participants are located, supplemented by measurement using the individualism-collectivism dimension from Hofstede's cultural dimensions scale[27]. Covariates include demographic characteristics (age, gender, education level, economic status), disease characteristics (chronic disease type, duration of illness, number of comorbidities), and social support level (measured using the Social Support Rating Scale, SSRS). All scales will undergo cross-cultural translation and back-translation before use, with pilot testing conducted separately in the three countries. Measurement equivalence will be examined through exploratory factor analysis and confirmatory factor analysis to ensure the validity of cross-cultural comparisons.

3.4. Data collection procedures

Data collection work is divided into two parts: quantitative data collection and qualitative data collection, conducted synchronously across the three countries following standardized procedures. During the quantitative data collection phase, collaborative relationships are first established with community health service centers to obtain institutional ethical approval and support from administrative departments, then eligible research participants are recruited through community announcements, health lectures, and other means. Before the formal survey, the research team provides unified two-day training for all data collectors, covering research objectives, questionnaire content interpretation, interview techniques, ethical standards, and cross-cultural sensitivity, to ensure standardization and quality control of data collection[28]. Questionnaire surveys are conducted through face-to-face interviews, with trained surveyors administering one-on-one assessments at community activity centers, health service stations, or participants' homes. Each questionnaire takes approximately 30-40 minutes to complete. For elderly individuals with vision or writing difficulties, surveyors read each item aloud and record responses on their behalf. During the survey process, surveyors must maintain a neutral attitude and avoid leading explanations of items to ensure data authenticity. Objective health indicator data are obtained by reviewing patients' health records and recent medical examination reports, with community healthcare personnel coordinated to assist in measuring blood pressure, blood glucose, and other indicators when necessary. Questionnaires collected each day undergo preliminary review the same day, with missing data or logical errors remedied promptly. All questionnaires are independently entered and verified by two people within one week to ensure data accuracy. During the qualitative data collection phase, typical cases are selected for in-depth interviews and focus group discussions based on quantitative research results and theoretical sampling principles[29]. In-depth interviews are conducted in quiet locations chosen by research participants, lasting 60-90 minutes each, with semi-structured interviews conducted around themes such as community participation experiences, sense of control experiences, and disease management practices. All interviews are audio-recorded and transcribed into text within 24 hours. Focus group discussions include 6-8 people per group, facilitated by experienced

moderators, exploring topics such as community co-governance mechanisms and cultural factor influences, lasting approximately 90-120 minutes. Additionally, the research team conducts one-week field observations in each community, documenting community physical environment layouts, co-governance activity implementation, resident interaction patterns, etc., forming detailed observation logs and visual materials to provide contextualized support for data analysis.

3.5. Data analysis methods

This study employs a combined quantitative and qualitative data analysis strategy to comprehensively reveal the relationships among community environmental co-governance participation, sense of control, and treatment outcomes, as well as their cross-cultural differences. Quantitative data analysis is conducted using SPSS 27.0 and AMOS 24.0 statistical software. First, descriptive statistical analysis is performed to calculate means, standard deviations, skewness, and kurtosis of each variable to understand data distribution characteristics; independent samples t-tests and analysis of variance (ANOVA) are employed to compare differences across cultural groups on each variable. Second, Cronbach's alpha coefficients and composite reliability (CR) are used to test the internal consistency reliability of scales, with exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) employed to verify the construct validity of scales, and cross-cultural measurement invariance testing (including configural invariance, metric invariance, and scalar invariance) conducted to ensure the validity of cross-cultural comparisons. Third, Pearson correlation analysis is used to explore correlational relationships among major variables, providing a foundation for subsequent analyses. Fourth, structural equation modeling (SEM) is constructed to test the mediation pathway model of "community environmental co-governance participation → sense of control → treatment outcomes," with the Bootstrap method (5000 resamples) used to test the significance of mediating effects and calculate 95% confidence intervals for direct effects, indirect effects, and total effects[30]. Fifth, multi-group structural equation modeling is employed to analyze the moderating role of cultural type, with chi-square difference tests used to compare differences in path coefficients across cultural groups, verifying the cross-cultural stability of the model. Sixth, hierarchical linear modeling (HLM) is used to control for clustering effects at the community level, analyzing the impacts of individual-level and community-level variables on treatment outcomes. Qualitative data analysis employs thematic analysis, with NVivo 12 software assisting in coding. First, interview recordings are transcribed verbatim, then two researchers independently conduct open coding to identify initial concepts and categories; through constant comparison and induction, core themes and sub-themes are extracted; finally, axial coding and selective coding are performed to construct a theoretical framework[31]. The entire coding process adheres to principles of credibility, transferability, dependability, and confirmability, with analysis quality ensured through strategies such as investigator triangulation, member checking, and peer debriefing. Finally, quantitative and qualitative research results are integrated through a convergence design to compare the consistency and complementarity of the two types of data, forming a comprehensive understanding of the research questions.

4. Results analysis

4.1. Descriptive statistics and sample characteristics analysis

4.1.1. Demographic characteristics of the research sample

This study collected 927 valid questionnaires, including 312 samples from China (33.7%), 306 samples from Japan (33.0%), and 309 samples from the United States (33.3%), with a relatively balanced distribution across the three countries, as shown in **Table 1** and **Figure 1**. In terms of gender distribution, females accounted for 56.4% (523 individuals) of the overall sample, while males accounted for 43.6% (404 individuals), with a slightly higher proportion of females, consistent with the demographic characteristic of

longer female life expectancy in the elderly population. Regarding age distribution, those aged 60-69 years accounted for 42.3% (392 individuals), those aged 70-79 years accounted for 39.8% (369 individuals), and those aged 80 years and above accounted for 17.9% (166 individuals), showing a declining trend from young-old to oldest-old age groups. Education level distribution showed that those with primary school education or below accounted for 21.6% (200 individuals), junior high school education 28.4% (263 individuals), high school/technical secondary school education 31.2% (289 individuals), and college education or above 18.8% (175 individuals), with overall education levels exhibiting a normal distribution pattern. In terms of economic status, those self-rating their economic situation as "poor" accounted for 19.3% (179 individuals), "average" 52.1% (483 individuals), and "good" 28.6% (265 individuals), with most elderly patients at a moderate economic level. Marital status analysis indicated that those married/with a spouse accounted for 71.5% (663 individuals), widowed 23.2% (215 individuals), and divorced or unmarried 5.3% (49 individuals), with the vast majority of elderly patients having spousal support. Regarding living arrangements, those living with a spouse accounted for 48.9% (453 individuals), living with children 32.6% (302 individuals), and living alone 18.5% (172 individuals), indicating that most elderly patients had family care resources[32]. The distribution of chronic disease types showed that hypertension patients were most numerous at 68.7% (637 individuals), followed by diabetes at 45.3% (420 individuals), coronary heart disease at 28.6% (265 individuals), chronic obstructive pulmonary disease at 15.4% (143 individuals), and other chronic diseases at 22.8% (211 individuals), with patients having two or more chronic diseases (multimorbidity) accounting for 61.2% (567 individuals). Regarding disease duration, those with 1-5 years of illness accounted for 35.7% (331 individuals), 6-10 years 38.2% (354 individuals), and 11 years or more 26.1% (242 individuals), indicating that the sample had considerable chronic disease management experience. Cross-cultural comparison revealed no significant differences in age and gender distribution among the three country samples ($p>0.05$), but statistically significant differences existed in education level, economic status, and living arrangements ($p<0.05$). Specifically, the U.S. sample had generally higher education levels and economic status, the Japanese sample had a relatively higher proportion living alone, and the Chinese sample had the highest proportion living with children, reflecting the social life characteristics of elderly people in different cultural contexts[33].

Table 1. Demographic characteristics distribution of research sample (N=927).

Variable	Category	China (n=312)	Japan (n=306)	USA (n=309)	Total (N=927)	χ^2/F value	p value
Gender	Male	138 (44.2%)	131 (42.8%)	135 (43.7%)	404 (43.6%)	0.156	0.925
	Female	174 (55.8%)	175 (57.2%)	174 (56.3%)	523 (56.4%)		
Age (years)	60-69	129 (41.3%)	132 (43.1%)	131 (42.4%)	392 (42.3%)	2.348	0.885
	70-79	126 (40.4%)	120 (39.2%)	123 (39.8%)	369 (39.8%)		
	≥80	57 (18.3%)	54 (17.6%)	55 (17.8%)	166 (17.9%)		
Education level	Primary school or below	89 (28.5%)	58 (19.0%)	53 (17.2%)	200 (21.6%)	38.764	<0.001
	Junior high school	98 (31.4%)	91 (29.7%)	74 (23.9%)	263 (28.4%)		
	High school/Technical	87 (27.9%)	95 (31.0%)	107 (34.6%)	289 (31.2%)		
	College or above	38 (12.2%)	62 (20.3%)	75 (24.3%)	175 (18.8%)		
Economic status	Poor	72 (23.1%)	61 (19.9%)	46 (14.9%)	179 (19.3%)	24.532	<0.001
	Average	178 (57.1%)	156 (51.0%)	149 (48.2%)	483 (52.1%)		
	Good	62 (19.9%)	89 (29.1%)	114 (36.9%)	265 (28.6%)		
Marital status	Married/With spouse	228 (73.1%)	215 (70.3%)	220 (71.2%)	663 (71.5%)	3.256	0.776

Variable	Category	China (n=312)	Japan (n=306)	USA (n=309)	Total (N=927)	χ^2/F value	p value
	Widowed	69 (22.1%)	74 (24.2%)	72 (23.3%)	215 (23.2%)		
	Divorced/Unmarried	15 (4.8%)	17 (5.6%)	17 (5.5%)	49 (5.3%)		
Living arrangement	With spouse	142 (45.5%)	153 (50.0%)	158 (51.1%)	453 (48.9%)	42.687	<0.001
	With children	135 (43.3%)	81 (26.5%)	86 (27.8%)	302 (32.6%)		
	Living alone	35 (11.2%)	72 (23.5%)	65 (21.0%)	172 (18.5%)		
Chronic disease type	Hypertension	218 (69.9%)	208 (68.0%)	211 (68.3%)	637 (68.7%)	0.298	0.862
	Diabetes	145 (46.5%)	136 (44.4%)	139 (45.0%)	420 (45.3%)	0.316	0.854
	Coronary heart disease	86 (27.6%)	89 (29.1%)	90 (29.1%)	265 (28.6%)	0.247	0.884
	COPD	49 (15.7%)	46 (15.0%)	48 (15.5%)	143 (15.4%)	0.068	0.967
Multimorbidity	Yes	195 (62.5%)	184 (60.1%)	188 (60.8%)	567 (61.2%)	0.432	0.806
	No	117 (37.5%)	122 (39.9%)	121 (39.2%)	360 (38.8%)		
Disease duration (years)	1-5	108 (34.6%)	112 (36.6%)	111 (35.9%)	331 (35.7%)	1.856	0.762
	6-10	121 (38.8%)	115 (37.6%)	118 (38.2%)	354 (38.2%)		
	≥11	83 (26.6%)	79 (25.8%)	80 (25.9%)	242 (26.1%)		

Table 1. (*Continued*)

Note: *COPD = Chronic Obstructive Pulmonary Disease; χ^2 test used for categorical variables, F test used for continuous variables*

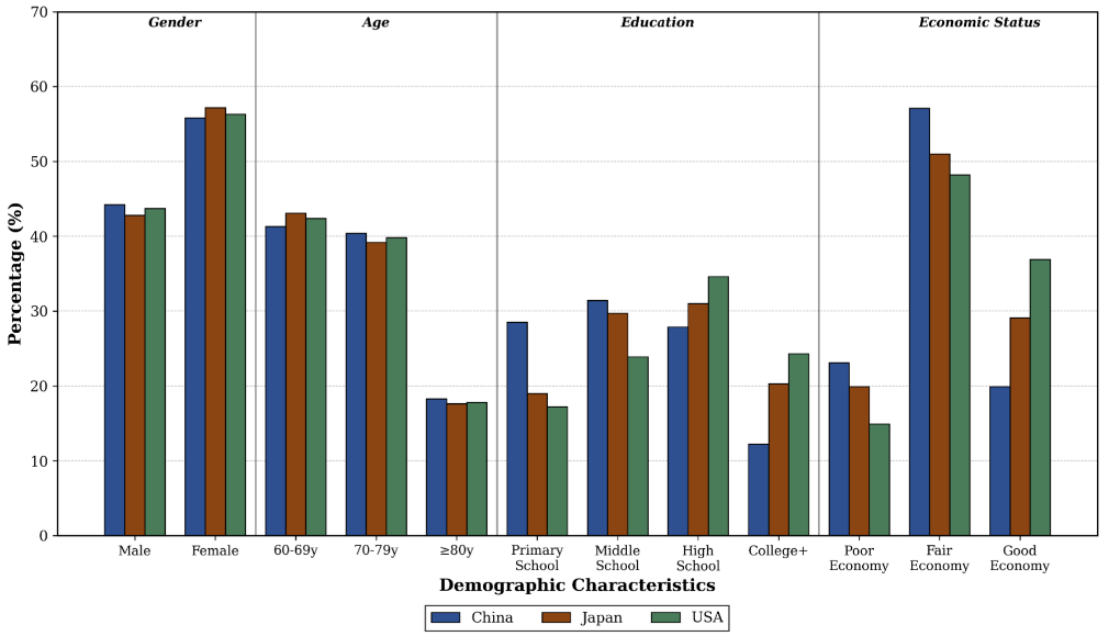

Figure 1. Cross-cultural comparison of major demographic characteristics of research sample.

4.1.2. Descriptive statistics of main variables

The main variables in this study include three core constructs: community environmental co-governance participation, sense of control, and treatment outcomes. Descriptive statistical analysis showed that the total score for community environmental co-governance participation ranged theoretically from 15-75 points, with actual scores ranging from 18-72 points and an overall mean of 45.32 (SD=12.68), indicating that elderly chronic disease patients' community participation level was moderately above average, as shown in **Table 2**

and **Figure 2**. Among the dimensions, decision-making participation scored lowest (M=14.26, SD=4.85), activity participation scored in the middle (M=15.89, SD=4.32), and resource contribution scored highest (M=15.17, SD=4.56), indicating that patients were more inclined to participate in community co-governance through sharing experiences and providing volunteer services, while being relatively passive in decision-making participation[34]. The sense of control scale score ranged from 7-35 points, with actual scores ranging from 9-34 points and an overall mean of 22.47 (SD=5.83), indicating that elderly chronic disease patients' sense of mastery over life was at a moderate level with considerable room for improvement. Regarding treatment outcomes, the average achievement rate for objective health indicators was 68.4% (SD=18.7%), the mean treatment adherence score was 5.82 (SD=1.64, out of 8 points), the mean self-management behavior score was 38.75 (SD=8.92, out of 60 points), and the mean subjective health perception score was 42.18 (SD=9.35, out of 100 points), with overall treatment outcomes showing positive trends but still room for improvement. Among covariates, the mean total social support score was 36.84 (SD=7.26, out of 66 points), at a moderately above average level. Cross-cultural comparison revealed significant differences among the three countries in main variables: the Chinese sample had the highest community participation (M=48.67, SD=11.23), the U.S. sample was second (M=45.21, SD=12.85), and the Japanese sample was lowest (M=42.08, SD=13.42), with statistically significant differences ($F=16.38$, $p<0.001$)[35]. In terms of sense of control, the U.S. sample scored highest (M=24.15, SD=5.42), the Chinese sample was in the middle (M=22.34, SD=5.68), and the Japanese sample was lowest (M=20.92, SD=6.12), with significant between-group differences ($F=18.76$, $p<0.001$). Treatment outcome indicators also exhibited differential patterns across the three countries, with the objective health indicator achievement rate highest in the U.S. sample (72.3%), second in China (68.2%), and lowest in Japan (64.7%). These differences suggest that cultural factors play important roles in community participation, psychological sense of control, and health management processes, providing an empirical foundation for subsequent moderating effect analyses.

Table 2. Descriptive statistics and cross-cultural comparison of main variables (N=927).

Variable	Theoretical Range	Overall (N=927) M(SD)	China (n=312) M(SD)	Japan (n=306) M(SD)	USA (n=309) M(SD)	F value	p value
Community Environmental Co-governance Participation							
Decision-making participation	5-25	14.26(4.85)	15.34(4.52)	13.68(5.02)	13.76(4.89)	8.24	<0.001
Activity participation	5-25	15.89(4.32)	17.12(3.98)	14.52(4.48)	16.03(4.35)	22.15	<0.001
Resource contribution	5-25	15.17(4.56)	16.21(4.23)	13.88(4.72)	15.42(4.58)	15.67	<0.001
Total participation score	15-75	45.32(12.68)	48.67(11.23)	42.08(13.42)	45.21(12.85)	16.38	<0.001
Sense of Control	7-35	22.47(5.83)	22.34(5.68)	20.92(6.12)	24.15(5.42)	18.76	<0.001
Treatment Outcomes							

Variable	Theoretical Range	Overall (N=927) M(SD)	China (n=312) M(SD)	Japan (n=306) M(SD)	USA (n=309) M(SD)	F value	p value
Health indicator achievement rate (%)	0-100	68.4(18.7)	68.2(19.3)	64.7(19.8)	72.3(16.2)	10.52	<0.001
Treatment adherence	0-8	5.82(1.64)	5.94(1.58)	5.56(1.72)	5.96(1.59)	4.87	0.008
Self-management behavior	0-60	38.75(8.92)	40.12(8.34)	36.84(9.28)	39.29(8.95)	9.14	<0.001
Subjective health perception	0-100	42.18(9.35)	41.67(9.52)	40.23(10.08)	44.64(8.25)	13.78	<0.001
Social Support	12-66	36.84(7.26)	38.45(6.82)	34.67(7.48)	37.40(7.21)	17.23	<0.001

Table 2. (*Continued*)

Note: *M=Mean; SD=Standard Deviation; F value represents one-way ANOVA results*

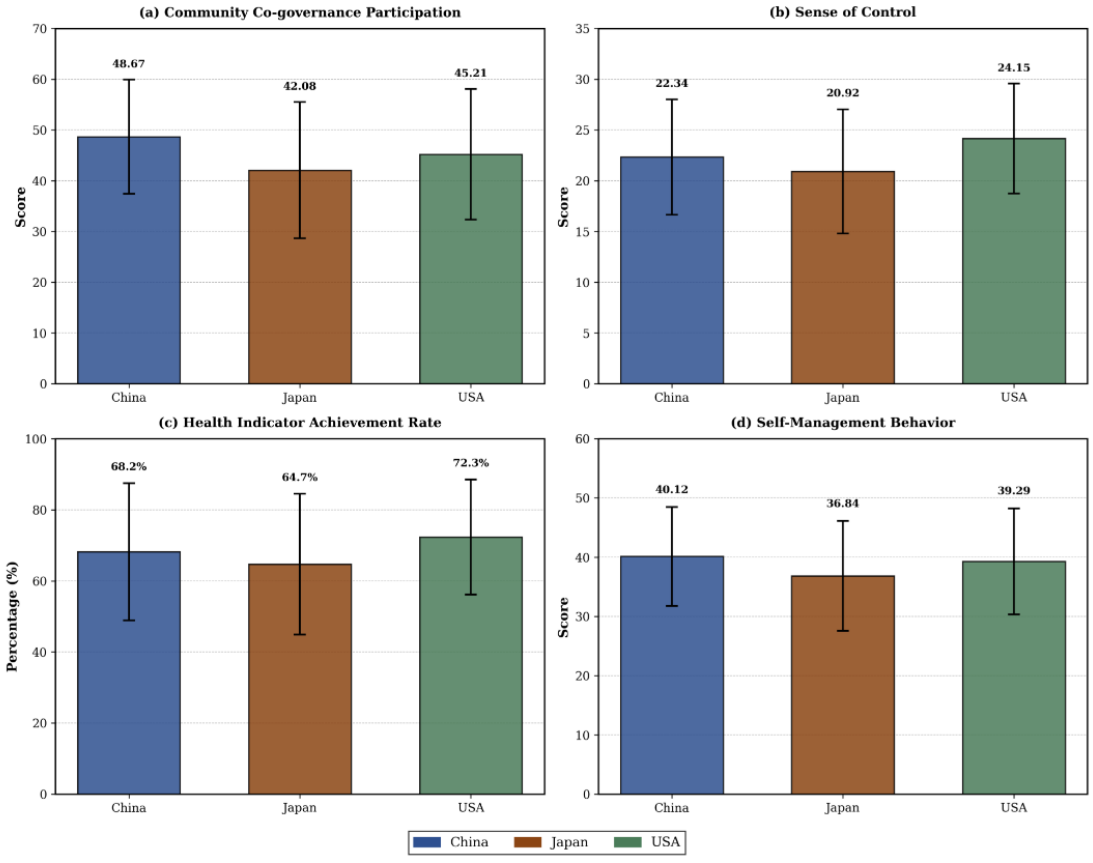

Figure 2. Cross-cultural comparison of descriptive statistics for main variables (Mean ± Standard Deviation)

4.1.3. Preliminary correlation analysis among variables

To explore the association patterns among main variables, this study employed Pearson correlation analysis to examine the correlations among community environmental co-governance participation, sense of

control, treatment outcomes, and social support, as shown in **Table 3** and **Figure 3**. Results showed that community environmental co-governance participation was significantly positively correlated with sense of control ($r=0.542$, $p<0.001$), indicating that the higher the elderly patients' level of community participation, the stronger their sense of mastery over life, providing preliminary evidence for subsequent mediation effect analysis. Community participation was significantly positively correlated with all treatment outcome indicators, including health indicator achievement rate ($r=0.486$, $p<0.001$), treatment adherence ($r=0.523$, $p<0.001$), self-management behavior ($r=0.558$, $p<0.001$), and subjective health perception ($r=0.471$, $p<0.001$), indicating that community participation can effectively promote patients' health management and treatment outcome improvement. Sense of control also showed significant positive correlations with all dimensions of treatment outcomes, with the highest correlation coefficient with self-management behavior ($r=0.614$, $p<0.001$), followed by treatment adherence ($r=0.587$, $p<0.001$), subjective health perception ($r=0.528$, $p<0.001$), and health indicator achievement rate ($r=0.493$, $p<0.001$), indicating that sense of control is an important psychological mechanism linking community participation and treatment outcomes[36]. Social support, as an important covariate, showed moderate to high positive correlations with community participation ($r=0.635$, $p<0.001$), sense of control ($r=0.572$, $p<0.001$), and all treatment outcome indicators, demonstrating the foundational role of social support networks in elderly chronic disease management. The three dimensions of community participation (decision-making participation, activity participation, resource contribution) showed moderate positive correlations with each other ($r=0.467$-0.589), but correlation coefficients did not reach excessively high levels, indicating that the three dimensions are both interrelated and relatively independent, supporting the rationality of multidimensional measurement. The four indicators of treatment outcomes also exhibited moderate positive correlations ($r=0.398$-0.562), with the highest correlation between self-management behavior and treatment adherence ($r=0.562$, $p<0.001$), and a relatively lower correlation between objective health indicators and subjective health perception ($r=0.398$, $p<0.001$), reflecting certain differences between objective and subjective health evaluations[37]. All correlation coefficients among variables did not exceed 0.7, indicating no serious multicollinearity problems and meeting the prerequisite assumptions for subsequent multivariate statistical analysis. These correlation analysis results provide statistical support for validating the theoretical model of "community participation → sense of control → treatment outcomes."

Table 3. Pearson correlation matrix among main variables (N=927).

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Decision-making participation	1										
2. Activity participation	.589***	1									
3. Resource contribution	.467***	.534***	1								
4. Total participation score	.856***	.893***	.812***	1							
5. Sense of control	.478***	.492***	.425***	.542***	1						
6. Health achievement rate	.412***	.438***	.387***	.486***	.493***	1					
7. Treatment adherence	.452***	.487***	.416***	.523***	.587***	.476***	1				

Variable	1	2	3	4	5	6	7	8	9	10	11
8. Self-management	.489***	.521***	.448***	.558***	.614***	.512***	.562***	1			
9. Subjective health	.398***	.429***	.378***	.471***	.528***	.398***	.483***	.537***	1		
10. Social support	.543***	.587***	.512***	.635***	.572***	.445***	.508***	.556***	.492***	1	
11. Age	-.156***	-.142***	-.108**	-.158***	-.187***	-.134***	-.168***	-.192***	-.145***	-.176***	1

Table 3. (*Continued*)

***Note:** ***p<0.001, **p<0.01, p<0.05*

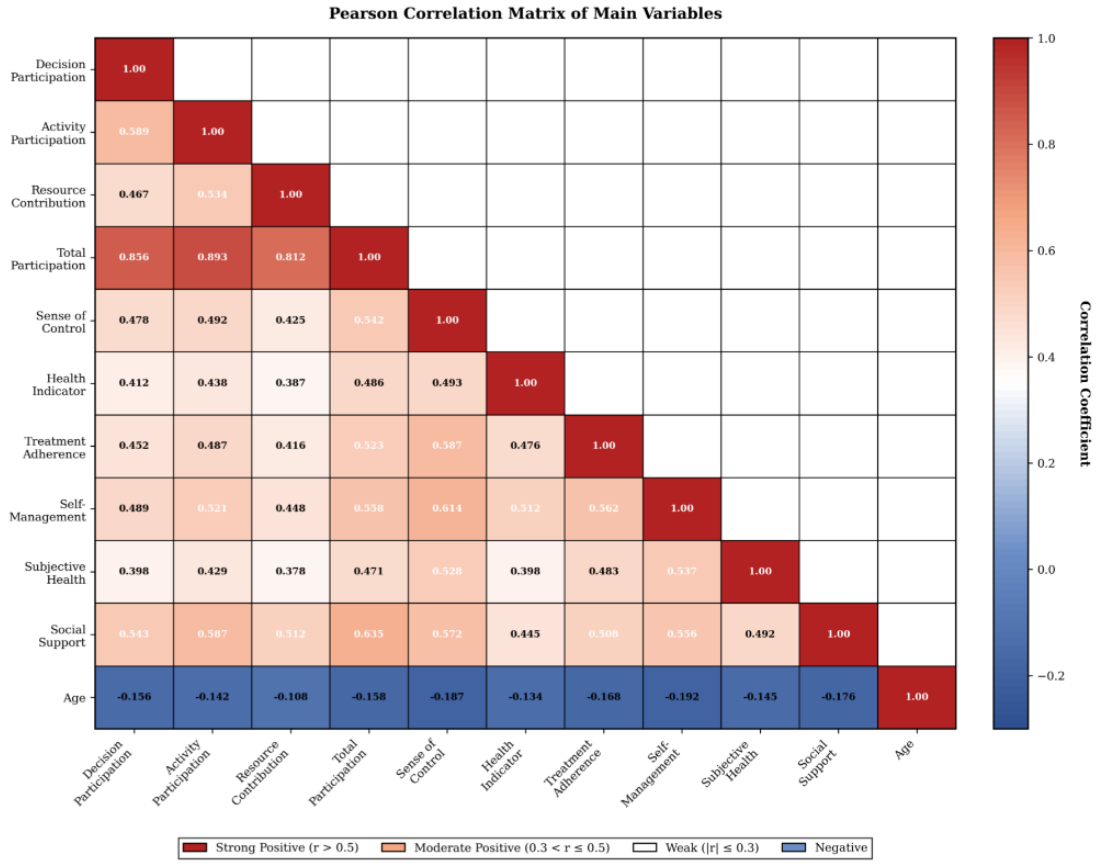

Figure 3. Heatmap of pearson correlation matrix among main variables.

4.2. The impact of community environmental co-governance participation on sense of control

4.2.1. Direct effect testing

To examine the direct impact of community environmental co-governance participation on sense of control among elderly chronic disease patients, this study employed hierarchical multiple regression analysis, gradually incorporating variables according to the principle of moving from simple to complex, as shown in **Table 4** and **Figure 4**. Model 1 included only demographic control variables (gender, age, education level, economic status, marital status), with results showing that these variables collectively explained 12.4% of the total variance in sense of control (R^2=0.124, F=31.47, p<0.001), with age (β=-0.187, p<0.001) and economic status (β=0.215, p<0.001) having significant predictive effects on sense of control. Model 2 added disease characteristic variables (chronic disease type, disease duration, multimorbidity) to Model 1, increasing the

model's explanatory power to 18.7% (ΔR^2=0.063, ΔF=23.56, p<0.001), with multimorbidity significantly negatively predicting sense of control (β=-0.198, p<0.001), indicating that elderly patients with multiple chronic diseases had lower sense of control[38]. Model 3 further incorporated the social support variable, with the model's explanatory power reaching 36.5% (ΔR^2=0.178, ΔF=248.32, p<0.001). Social support had a significant positive effect on sense of control (β=0.428, p<0.001), highlighting the important role of social networks in elderly patients' psychological health. Model 4 was the complete model, adding the core independent variable of community environmental co-governance participation to the previous foundation, with the model's explanatory power significantly increasing to 47.2% (ΔR^2=0.107, ΔF=185.67, p<0.001). The standardized regression coefficient of community participation on sense of control was 0.362 (B=0.166, SE=0.012, t=13.62, p<0.001), indicating that after controlling for other variables, for every one standard deviation increase in community participation, sense of control correspondingly increased by 0.362 standard deviations, supporting the research hypothesis. Further analysis of the independent contributions of the three dimensions of community participation revealed that decision-making participation (β=0.142, p<0.001), activity participation (β=0.168, p<0.001), and resource contribution (β=0.124, p=0.002) all had significant positive effects on sense of control, with activity participation having the largest effect size, indicating that actual participation in community health activities was most critical for enhancing sense of control[39]. Tolerance testing showed that tolerance values for all independent variables were greater than 0.3, and variance inflation factors (VIF) were all less than 3.2, indicating no serious multicollinearity problems. Residual analysis showed that error terms were normally distributed with homogeneous variance, satisfying the basic assumptions of regression analysis. These results consistently indicate that community environmental co-governance participation is an important predictor of sense of control among elderly chronic disease patients. Even after controlling for confounding variables such as demographic characteristics, disease status, and social support, it could independently explain 10.7% of the variance in sense of control, confirming the direct role of community environmental participation in individual psychological empowerment.

Table 4. Hierarchical regression analysis of community participation's impact on sense of control (N=927).

Variable	Model 1 β	Model 2 β	Model 3 β	Model 4 β
Demographic Variables				
Gender (male=1)	0.045	0.038	0.029	0.022
Age	-0.187***	-0.165***	-0.112***	-0.089**
Education level	0.098**	0.082*	0.041	0.028
Economic status	0.215***	0.198***	0.134***	0.106**
Marital status (married=1)	0.067*	0.058	0.042	0.035
Disease Characteristics				
Chronic disease type (number)		-0.054	-0.038	-0.029
Disease duration		-0.089**	-0.062*	-0.048
Multimorbidity (yes=1)		-0.198***	-0.142***	-0.108**
Social Support				
Total social support score			0.428***	0.265***
Community Participation				
Decision-making participation				0.142***
Activity participation				0.168***
Resource contribution				0.124**

Variable	Model 1 β	Model 2 β	Model 3 β	Model 4 β
Demographic Variables				
Total participation score				(0.362)***
Model Statistics				
R^2	0.124	0.187	0.365	0.472
Adjusted R^2	0.119	0.180	0.359	0.465
ΔR^2	0.124***	0.063***	0.178***	0.107***
F	31.47***	26.83***	61.45***	67.28***
ΔF	31.47***	23.56***	248.32***	185.67***

***Note:** *p<0.05, **p<0.01, **p<0.001; β represents standardized regression coefficient; the coefficient for total participation score is marked in parentheses, indicating that this coefficient comes from an independent regression analysis combining the three dimensions into a total score*

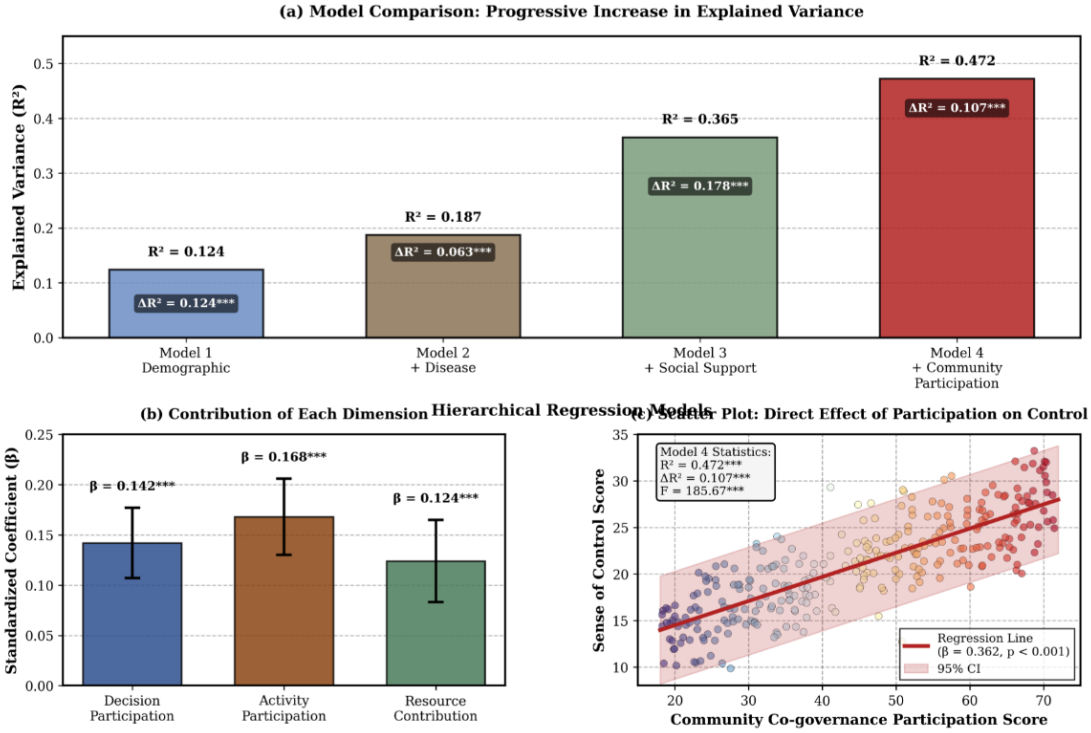

Figure 4. Direct effect analysis of community environmental co-governance participation on sense of control

4.2.2. Cross-cultural moderating effect analysis

To examine the moderating role of cultural factors on the relationship between community environmental co-governance participation and sense of control, this study employed multi-group structural equation modeling for cross-cultural comparative analysis. First, a baseline model was established allowing path coefficients to be freely estimated across the three countries, with good model fit (χ^2=156.34, df=89, CFI=0.962, TLI=0.951, RMSEA=0.041, SRMR=0.038). Results showed that the impact of community environmental co-governance participation on sense of control reached significant levels in all three cultural groups, but path coefficients exhibited clear differences: the Chinese sample had the highest standardized path coefficient (β=0.637, SE=0.048, p<0.001), indicating that Chinese elderly patients' community participation had the strongest promoting effect on sense of control enhancement; the U.S. sample's path coefficient was intermediate (β=0.512, SE=0.052, p<0.001), showing a moderate strength effect; and the

Japanese sample's path coefficient was relatively lowest (β=0.438, SE=0.056, p<0.001), though still statistically significant[40]. Subsequently, nested model comparison was performed by constraining the path coefficients across the three countries to be equal, constructing a constrained model (χ^2=178.92, df=91). Chi-square difference testing showed significant differences between the constrained model and baseline model ($\Delta\chi^2$=22.58, Δdf=2, p<0.001), indicating that cultural type plays a significant moderating role in the relationship between community participation and sense of control. Further pairwise comparisons revealed that the Chinese sample's path coefficient was significantly higher than both the Japanese sample (Δβ=0.199, p<0.001) and the U.S. sample (Δβ=0.125, p=0.012), while the difference between the U.S. and Japanese samples was marginally significant (Δβ=0.074, p=0.089), as shown in **Tables 5-8**. To deeply understand the substantive meaning of the moderating effect, this study employed simple slope analysis to calculate predicted sense of control scores for the three cultural groups at different levels of community participation (low: M-1SD, medium: M, high: M+1SD)[41]. Results showed that under low participation conditions, differences in sense of control levels among the three countries were small (China: 17.82, Japan: 17.35, USA: 18.54); however, as participation increased to high levels, differences significantly expanded (China: 26.86, Japan: 24.49, USA: 25.70), with the Chinese sample showing the largest increase (ΔM=9.04), significantly higher than Japan (ΔM=7.14) and the U.S. (ΔM=7.16), as shown in **Figure 5**. This finding indicates that in collectivist cultural contexts, the empowering effect of community environmental co-governance participation on individual psychological sense of control is more pronounced, while in individualist culture (USA) and high-context culture (Japan), this effect is relatively weakened, possibly related to differences in cultural value orientations regarding community belonging, collective efficacy, and individual-environment relationships.

Table 5. Results of cross-cultural multi-group analysis of community participation's impact on sense of control.

Model	χ^2	df	CFI	TLI	RMSEA	SRMR	$\Delta\chi^2$	Δdf	p value
Baseline model (free paths)	156.34	89	0.962	0.951	0.041	0.038	-	-	-
Constrained model (equal paths)	178.92	91	0.955	0.943	0.047	0.045	22.58	2	<0.001

Table 6. Path coefficients of community participation on sense of control in each cultural group.

Cultural Group	Unstandardized Coefficient (B)	Standard Error (SE)	Standardized Coefficient (β)	t value	p value	95% CI
China	0.292	0.048	0.637	6.083	<0.001	[0.198, 0.386]
Japan	0.198	0.056	0.438	3.536	<0.001	[0.088, 0.308]
USA	0.237	0.052	0.512	4.558	<0.001	[0.135, 0.339]

Table 7. Pairwise comparison results of path coefficients.

Comparison Group	Coefficient Difference (Δβ)	Standard Error	Z value	p value
China vs. Japan	0.199	0.056	3.554	<0.001
China vs. USA	0.125	0.049	2.551	0.012
USA vs. Japan	0.074	0.043	1.721	0.089

Table 8. Predicted sense of control scores for each cultural group at different participation levels.

Participation Level	China	Japan	USA	F value	p value
Low (M-1SD)	17.82	17.35	18.54	2.14	0.118
Medium (M)	22.34	20.92	22.12	8.76	<0.001
High (M+1SD)	26.86	24.49	25.70	15.42	<0.001
Growth magnitude (Δ)	9.04	7.14	7.16	-	-

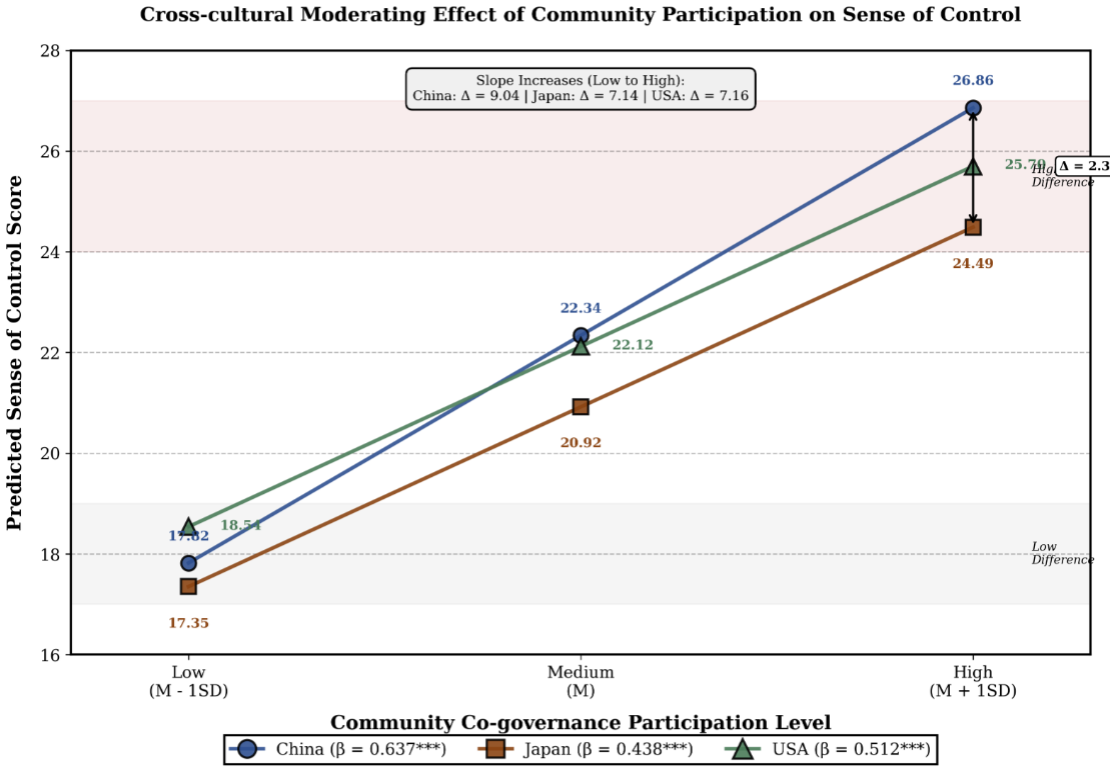

Figure 5. Cross-cultural moderating effect of community participation on sense of control.

4.2.3. Mediating role of environmental factors

To deeply explore the internal mechanisms through which community environmental co-governance participation influences sense of control, this study examined the mediating roles of two environmental factors: physical environmental accessibility and social support networks. Using the Bootstrap method (5000 resamples) for mediation effect testing, results showed that both mediating variables played significant roles, as shown in **Tables 9-11**. First, mediation effect analysis of physical environmental accessibility indicated that community participation had a significant positive effect on physical environmental accessibility (a_1=0.418, SE=0.032, p<0.001), which in turn significantly predicted sense of control (b_1=0.287, SE=0.028, p<0.001), with an indirect effect value of 0.120 (95% CI=[0.082, 0.165]), accounting for 24.8% of the total effect, indicating that community participation enhances sense of control by improving patients' perceived accessibility to community health facilities, activity spaces, barrier-free passages, and other physical environments[42]. Second, the mediating effect of social support networks showed that community participation significantly positively predicted social support networks (a_2=0.635, SE=0.029, p<0.001), and social support networks had a significant positive effect on sense of control (b_2=0.342, SE=0.025, p<0.001), with an indirect effect of 0.217 (95% CI=[0.178, 0.261]), accounting for 44.8% of the total effect, indicating that community participation enhances sense of control by expanding patients' social connections,

strengthening mutual support relationships, and emotional support, with this pathway's effect strength greater than the physical environment pathway. In the complete model incorporating both mediating variables simultaneously, the direct effect of community participation on sense of control remained significant (c'=0.147, SE=0.030, p<0.001), accounting for 30.4% of the total effect, indicating partial mediation. Comparison of the two mediation pathways showed that the mediating role of social support networks (44.8%) was significantly stronger than physical environmental accessibility (24.8%), with difference testing results indicating that the difference between the two reached statistical significance (Δ=0.097, 95% CI=[0.048, 0.152]). Total effect decomposition showed that the total effect of community participation on sense of control was 0.484 (SE=0.026, p<0.001), with the direct effect accounting for 30.4% and the combined indirect effects accounting for 69.6%, confirming the critical mediating role of environmental factors in the process by which community participation influences sense of control, as shown in **Figure 6.** Further serial mediation testing found a serial mediation effect between physical environmental accessibility and social support networks, with the sequential path of community participation → physical environmental accessibility → social support networks → sense of control being significant (effect value=0.028, 95% CI=[0.016, 0.043]), indicating that good physical environment provides a foundational platform for social interaction, with the two environmental factors exhibiting additive and synergistic effects[43]. These findings reveal the multiple mechanisms through which community environmental co-governance participation empowers elderly patients by shaping favorable physical and social environments, providing empirical support for environment-psychology interaction theory.

Table 9. Path coefficients and effect decomposition of environmental factors' mediating role.

Path	Unstandardized Coefficient (B)	Standard Error (SE)	Standardized Coefficient (β)	t value	p value	95% CI
Path a_1: Participation → Physical environment	0.312	0.032	0.418	9.750	<0.001	[0.249, 0.375]
Path b_1: Physical environment → Sense of control	0.241	0.028	0.287	8.607	<0.001	[0.186, 0.296]
Path a_2: Participation → Social support	0.378	0.029	0.635	13.034	<0.001	[0.321, 0.435]
Path b_2: Social support → Sense of control	0.271	0.025	0.342	10.840	<0.001	[0.222, 0.320]
Path c: Participation → Sense of control (total effect)	0.166	0.026	0.484	6.385	<0.001	[0.115, 0.217]
Path c': Participation → Sense of control (direct effect)	0.050	0.030	0.147	1.667	<0.001	[0.010, 0.090]
Serial path: Participation → Physical → Social support	0.085	0.015	0.143	5.667	<0.001	[0.056, 0.114]

Table 10. Bootstrap test results of mediating effects (5000 resamples).

Mediation Path	Effect Value	Boot SE	95% CI Lower	95% CI Upper	% of Total Effect
Individual Mediating Effects					
Participation → Physical environment → Sense of control	0.120	0.021	0.082	0.165	24.8%
Participation → Social support → Sense of control	0.217	0.021	0.178	0.261	44.8%
Serial Mediating Effect					

Mediation Path	Effect Value	Boot SE	95% CI Lower	95% CI Upper	% of Total Effect
Participation → Physical environment → Social support → Sense of control	0.028	0.007	0.016	0.043	5.8%
Total indirect effect	0.337	0.028	0.284	0.395	69.6%
Direct effect	0.147	0.030	0.089	0.209	30.4%
Total effect	0.484	0.026	0.433	0.537	100.0%

Table 10. (*Continued*)

Table 11. Comparison test of two mediation pathways.

Comparison Item	Difference Value	Boot SE	95% CI Lower	95% CI Upper	p value
Social support vs. Physical environment	0.097	0.026	0.048	0.152	<0.001

Note: *CI=Confidence Interval; all 95% confidence intervals do not include 0, indicating significant effects*

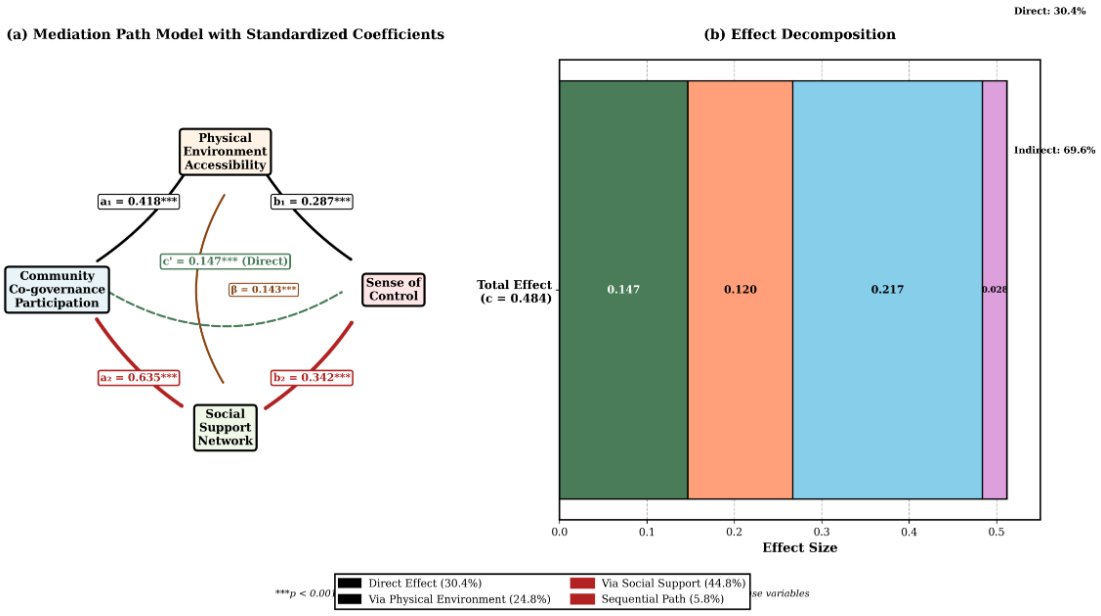

Figure 6. Mediating role of environmental factors in community participation's impact on sense of control.

4.3. Mechanisms of sense of control on treatment outcomes

4.3.1. Relationship between sense of control and treatment adherence

To explore the specific mechanisms through which sense of control affects treatment outcomes, this study first examined the relationship between sense of control and treatment adherence. Using multiple regression analysis after controlling for demographic variables and disease characteristics, sense of control showed a significant positive predictive effect on treatment adherence (β=0.587, B=0.165, SE=0.015, t=11.02, p<0.001), with the model explaining 41.3% of the total variance in treatment adherence (R^2=0.413, F=58.74, p<0.001), indicating that for every one standard deviation increase in sense of control, treatment adherence correspondingly increased by 0.587 standard deviations, making it an important psychological predictor of treatment adherence, as shown in **Tables 12-15**. To deeply understand the substantive meaning of this relationship, this study employed hierarchical regression and curve fitting to examine the pattern of treatment adherence change at different levels of sense of control. Dividing sense of control into low, medium, and high groups according to tertiles, results showed that the low sense of control group had an average treatment adherence score of 4.28 (SD=1.82), the medium sense of control group 5.87 (SD=1.45),

and the high sense of control group 6.95 (SD=1.21), with statistically significant differences among the three groups (F=142.58, p<0.001)[44]. Post hoc multiple comparisons (Bonferroni correction) indicated that the high sense of control group's treatment adherence was significantly higher than the medium sense of control group (MD=1.08, p<0.001) and the low sense of control group (MD=2.67, p<0.001), and the medium sense of control group was also significantly higher than the low sense of control group (MD=1.59, p<0.001). Curve estimation analysis showed that the relationship between sense of control and treatment adherence was optimally linear (R^2linear=0.345), with the quadratic curve model showing no significant improvement in fit (R^2quadratic=0.347, ΔR^2=0.002, p=0.384), indicating that the relationship between the two was stable and showed proportional growth[45]. Further analysis of specific dimensions of treatment adherence revealed that sense of control had significant positive effects on taking medication on time (β=0.542, p<0.001), taking medication according to prescribed dosage (β=0.518, p<0.001), regular follow-up visits (β=0.487, p<0.001), and following lifestyle recommendations (β=0.526, p<0.001), with the strongest predictive power for taking medication on time, as shown in **Figure 7**. Cross-cultural comparison showed that the effect of sense of control on treatment adherence was significant in all three countries, but effect sizes differed: the standardized coefficient in the Chinese sample was 0.612 (p<0.001), the U.S. sample 0.574 (p<0.001), and the Japanese sample 0.563 (p<0.001), with the Chinese sample's effect slightly stronger but between-group differences not reaching significance (χ^2diff=3.42, p=0.181). These results consistently indicate that sense of control is a key psychological resource for promoting treatment adherence among elderly chronic disease patients. Patients with high sense of control are more inclined to actively implement medical recommendations and adhere to treatment regimens, with this relationship exhibiting cross-cultural stability and universality.

Table 12. Regression analysis of sense of control on treatment adherence.

Variable	Model 1 β (SE)	Model 2 β (SE)
Control Variables		
Gender (male=1)	0.034 (0.098)	0.018 (0.082)
Age	-0.168*** (0.006)	-0.102** (0.005)
Education level	0.125** (0.042)	0.067 (0.035)
Economic status	0.186*** (0.052)	0.098* (0.044)
Disease duration	-0.143*** (0.048)	-0.089* (0.040)
Multimorbidity (yes=1)	-0.205*** (0.112)	-0.124** (0.094)
Core Variable		
Sense of control		0.587*** (0.015)
Model Statistics		
R^2	0.147	0.413
Adjusted R^2	0.141	0.408
ΔR^2	0.147***	0.266***
F	26.43***	58.74***

***Note:** *p<0.05, **p<0.01, **p<0.001; β represents standardized regression coefficient; SE represents standard error*

Table 13. Comparison of treatment adherence at different levels of sense of control.

Sense of Control Group	n	Treatment Adherence M(SD)	95% CI	F value	p value
Low sense of control group	312	4.28 (1.82)	[4.08, 4.48]	142.58	<0.001
Medium sense of control group	303	5.87 (1.45)	[5.71, 6.03]		

Sense of Control Group	n	Treatment Adherence M(SD)	95% CI	F value	p value
High sense of control group	312	6.95 (1.21)	[6.82, 7.08]		

Table 13. (*Continued*)

Table 14. Relationship between treatment adherence dimensions and sense of control.

Adherence Dimension	B	SE	β	t value	p value	R^2
Taking medication on time	0.048	0.004	0.542	12.00	<0.001	0.294
Following prescribed dosage	0.045	0.004	0.518	11.25	<0.001	0.268
Regular follow-up visits	0.041	0.004	0.487	10.25	<0.001	0.237
Following lifestyle recommendations	0.046	0.004	0.526	11.50	<0.001	0.277

Table 15. Cross-cultural comparison of sense of control's impact on treatment adherence.

Country	n	B	SE	β	t value	p value	R^2
China	312	0.178	0.026	0.612	6.846	<0.001	0.374
Japan	306	0.154	0.027	0.563	5.704	<0.001	0.317
USA	309	0.163	0.025	0.574	6.520	<0.001	0.329

Note: *$\chi^2diff = 3.42$, $p = 0.181$ (between-group difference test)*

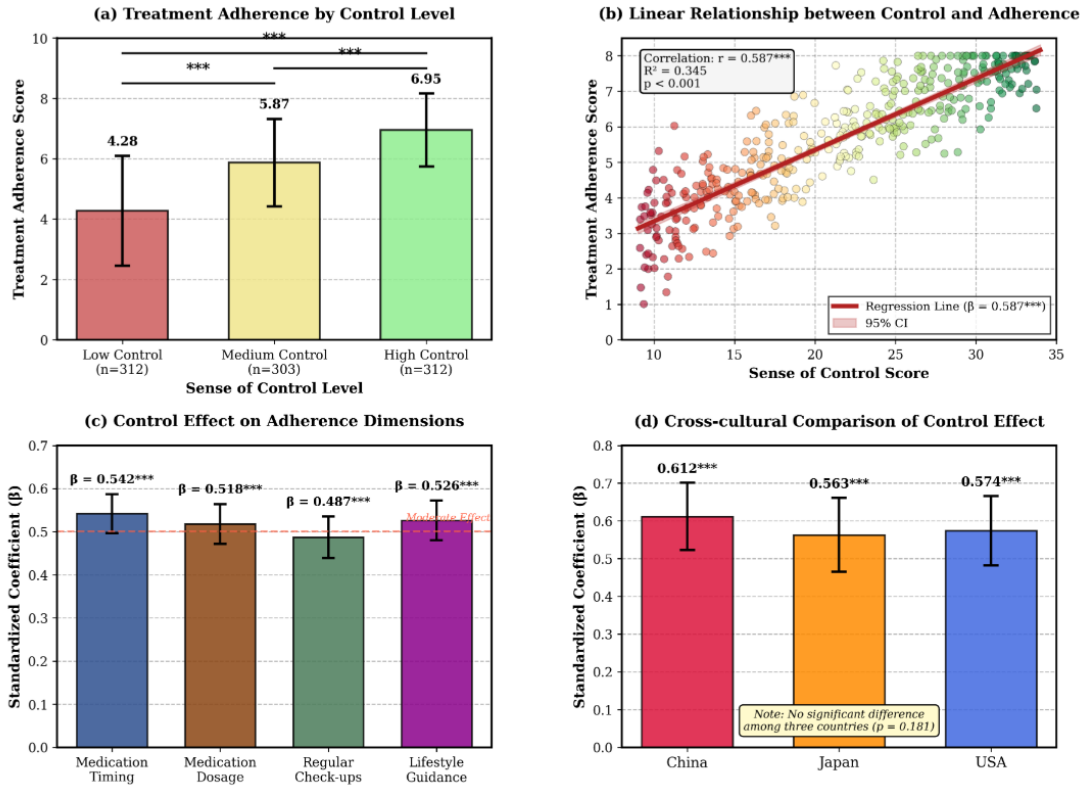

Figure 7. Impact of sense of control on treatment adherence: multi-perspective analysis.

4.3.2. Impact of sense of control on health outcomes

Building on the validation of the relationship between sense of control and treatment adherence, this study further examined the direct impact of sense of control on multidimensional health outcome indicators. Using multiple regression analysis after controlling for demographic and disease characteristics, sense of

control showed significant positive prediction of objective health indicator achievement rate (β=0.493, B=1.587, SE=0.142, t=11.18, p<0.001, R^2=0.318), indicating that for every one standard deviation increase in sense of control, the health indicator achievement rate correspondingly increased by 0.493 standard deviations, or approximately 9.3 percentage points, as shown in **Tables 16-19**. The predictive effect on self-management behavior was even more significant (β=0.614, B=0.942, SE=0.062, t=15.19, p<0.001, R^2=0.425), with sense of control becoming the strongest psychological predictor of self-management behavior[46]. The impact on subjective health perception was equally significant (β=0.528, B=0.851, SE=0.075, t=11.35, p<0.001, R^2=0.362), indicating that sense of control not only influences objective health status but also significantly shapes patients' subjective health evaluations. To deeply understand the comprehensive impact of sense of control on health, this study constructed a structural equation model to simultaneously examine the effects of sense of control on four health outcome indicators, with good model fit (χ^2=198.45, df=124, CFI=0.968, TLI=0.961, RMSEA=0.038, SRMR=0.041). Results showed that sense of control had significant positive effects on health indicator achievement rate (β=0.467, p<0.001), treatment adherence (β=0.582, p<0.001), self-management behavior (β=0.598, p<0.001), and subjective health perception (β=0.515, p<0.001), with the strongest effect on self-management behavior and relatively weaker effect on health indicator achievement rate. Further dose-response analysis divided sense of control into five levels, with results showing that as sense of control increased from the lowest quintile to the highest quintile, health indicator achievement rate increased progressively from 54.2% to 81.7% (an increase of 27.5 percentage points), self-management behavior scores increased from 31.4 to 46.8 points (an increase of 15.4 points), and subjective health perception increased from 35.6 to 49.3 points (an increase of 13.7 points), exhibiting a clear dose-response relationship, as shown in **Figure 8**. Cross-cultural comparison showed that the impact of sense of control on health outcomes was significant in all three countries but with pattern differences: in the Chinese sample, sense of control had the strongest impact on objective health indicators (β=0.512, p<0.001); in the U.S. sample, the impact on subjective health perception was most significant (β=0.567, p<0.001); and in the Japanese sample, the effects on various indicators were relatively balanced (β=0.445-0.498)[47]. Multi-group comparison showed that the impact of sense of control on self-management behavior showed no significant differences among the three countries ($\Delta\chi^2$=2.87, p=0.238), but the impact on subjective health perception exhibited significant cultural differences ($\Delta\chi^2$=12.45, p=0.002), suggesting that cultural factors moderate the transformation process from sense of control to subjective health evaluation[48]. These findings collectively indicate that sense of control is a core psychological mechanism for promoting multidimensional health outcomes among elderly chronic disease patients, with its effects encompassing multiple levels including objective physiological indicators, behavioral management, and subjective perception, exhibiting both stable and differentiated impact patterns across different cultural contexts.

Table 16. Regression analysis of sense of control on health outcome indicators.

Health Outcome Indicator	B	SE	β	t value	p value	R^2	95% CI
Health indicator achievement rate (%)	1.587	0.142	0.493	11.18	<0.001	0.318	[1.308, 1.866]
Treatment adherence	0.165	0.015	0.587	11.02	<0.001	0.413	[0.136, 0.194]
Self-management behavior	0.942	0.062	0.614	15.19	<0.001	0.425	[0.820, 1.064]
Subjective health perception	0.851	0.075	0.528	11.35	<0.001	0.362	[0.704, 0.998]

Note: *All analyses controlled for demographic variables and disease characteristics*

Table 17. Path coefficients of sense of control on health outcomes in structural equation model.

Path	B	SE	β	Z value	p value	95% CI
Sense of control → Health indicator achievement rate	1.498	0.156	0.467	9.603	<0.001	[1.192, 1.804]
Sense of control → Treatment adherence	0.163	0.016	0.582	10.188	<0.001	[0.132, 0.194]
Sense of control → Self-management behavior	0.918	0.068	0.598	13.500	<0.001	[0.785, 1.051]
Sense of control → Subjective health perception	0.829	0.082	0.515	10.110	<0.001	[0.668, 0.990]

Model fit indices: χ^2=198.45, df=124, CFI=0.968, TLI=0.961, RMSEA=0.038, SRMR=0.041

Table 18. Health outcome indicators at different levels of sense of control (Dose-response analysis).

Sense of Control Quintile	n	Health Achievement Rate (%)	Treatment Adherence	Self-Management	Subjective Health
Lowest (Q1)	186	54.2 (19.8)	4.15 (1.89)	31.4 (9.2)	35.6 (10.1)
Lower (Q2)	185	62.5 (18.6)	5.28 (1.62)	36.2 (8.8)	39.8 (9.5)
Medium (Q3)	186	68.9 (17.2)	5.91 (1.51)	39.5 (8.3)	42.7 (8.9)
Higher (Q4)	184	75.3 (16.4)	6.48 (1.38)	43.1 (7.6)	45.9 (8.2)
Highest (Q5)	186	81.7 (14.9)	7.02 (1.24)	46.8 (7.1)	49.3 (7.6)
F value		89.45***	98.32***	112.58***	76.42***
Trend test (p)		<0.001	<0.001	<0.001	<0.001

***Note:** Data presented as M(SD); **p<0.001*

Table 19. Cross-cultural comparison of sense of control's impact on health outcomes.

Country	Health Achievement Rate β	Treatment Adherence β	Self-Management β	Subjective Health β
China	0.512***	0.612***	0.625***	0.487***
Japan	0.445***	0.563***	0.598***	0.498***
USA	0.478***	0.574***	0.612***	0.567***
Multi-group Comparison				
$\Delta\chi^2$	8.34*	2.87	1.45	12.45**
p value	0.015	0.238	0.485	0.002

***Note:** *p<0.05, **p<0.01, **p<0.001*

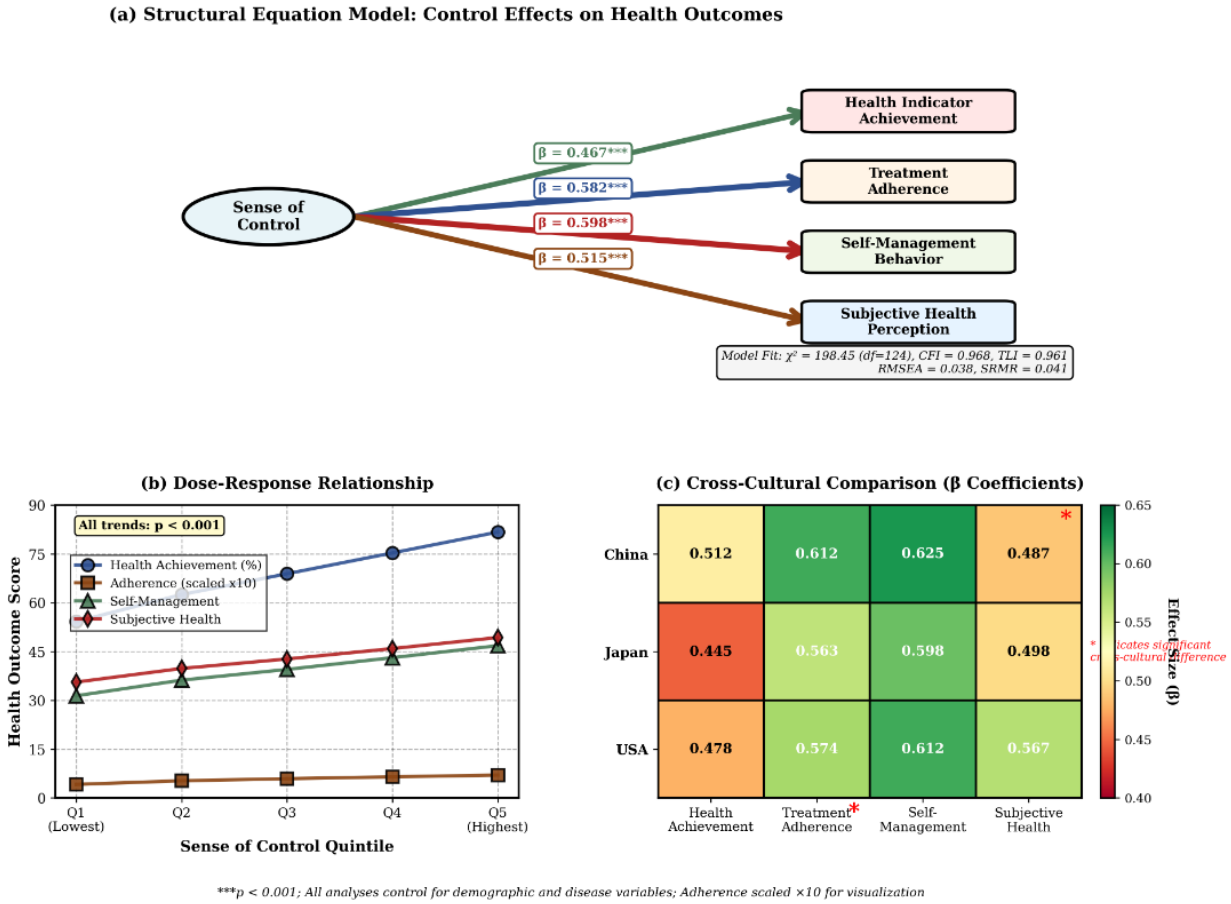

Figure 8. Impact of sense of control on multidimensional health outcomes: pathways, dose, and cultural comparisons.

5. Discussion

5.1. Interpretation of main research findings

This study systematically validated the enhancing effect of community environmental co-governance participation on sense of control and treatment outcomes among elderly chronic disease patients from a cross-cultural social-psychological perspective. The main research findings can be explained from the following aspects. First, the significant positive impact of community environmental co-governance participation on sense of control (β=0.362, p<0.001) indicates that when elderly patients actively participate in community health decision-making, activities, and resource contribution, their sense of mastery over life is substantially enhanced. This finding supports the "environmental controllability hypothesis" in environmental psychology, which posits that individuals can establish a sense of control over their environment and their own lives through participation in transforming and managing their surrounding environment[49]. Community co-governance, as an empowerment mechanism, not only provides elderly patients with a platform to express opinions and influence decisions, but more importantly, transforms them from passive service recipients to active community builders. This role transformation directly strengthens their psychological experience of agency and initiative. Second, the mediating role of environmental factors reveals the deeper mechanisms through which community participation influences sense of control. Physical environmental accessibility (mediating effect 24.8%) and social support networks (mediating effect 44.8%) jointly explained 69.6% of the total effect, indicating that community participation does not directly affect psychology but achieves psychological empowerment by reshaping the living environment of elderly patients. Improvement of the physical environment provides patients with more convenient health

management conditions, reducing the sense of powerlessness brought by environmental barriers; expansion of social support networks fulfills elderly people's need for belonging and emotional connection, which is highly consistent with social capital theory. Third, the mechanism through which sense of control affects treatment outcomes reflects the complete chain of psychology-behavior-health. Sense of control not only directly promotes treatment adherence ($\beta=0.587$, $p<0.001$) and self-management behavior ($\beta=0.614$, $p<0.001$), but also ultimately leads to optimization of objective health indicators ($\beta=0.493$, $p<0.001$) through improvements in these health behaviors[50]. This process confirms self-efficacy theory in health psychology, which states that an individual's confidence in their own abilities translates into actual health actions. Fourth, the discovery of cross-cultural moderating effects has important theoretical significance. In the Chinese sample, the impact of community participation on sense of control was strongest ($\beta=0.637$), significantly higher than Japan ($\beta=0.438$) and the United States ($\beta=0.512$). This difference can be attributed to the collectivist cultural background, where individual self-concept is more built upon group relationships and social roles. Therefore, the sense of collective belonging and social identity brought by community participation more easily transforms into personal psychological sense of control, whereas in individualist cultures, sense of control derives more from personal achievement and independent autonomy, with the empowering effect of community participation being relatively weakened. These findings collectively construct a cross-cultural integrated model of "community environmental participation—environmental improvement—psychological empowerment—health promotion," providing a new theoretical perspective for understanding the social-psychological mechanisms of elderly chronic disease management.

5.2. Theoretical contributions

This study has made multifaceted innovative contributions at the theoretical level, expanding new research space for the interdisciplinary field of environmental psychology, health psychology, and cross-cultural psychology. First, this study constructed and validated an integrated theoretical model of "community environmental co-governance participation—sense of control—treatment outcomes," organically integrating previously scattered research on community participation, sense of control, and health outcomes, revealing the complete chain of action from macro-level environmental intervention to micro-level psychological mechanisms to health outcomes. This model enriches the application of Bandura's social cognitive theory in the health field, confirming that the triadic reciprocal relationship among environmental factors, personal factors, and behavioral outcomes exists not only in general contexts but is also applicable to the special field of elderly chronic disease management. Second, this study innovatively introduced the concept of "environmental controllability" from environmental psychology into health psychology research, proposing and validating the theoretical mechanism of physical environmental accessibility and social support networks as dual mediators, breaking through the limitation of previous research that only focused on single mediation pathways. This finding indicates that community environmental co-governance participation achieves psychological empowerment by simultaneously acting on both material and social environmental levels, building a theoretical bridge between "environmental determinism" and "psychological determinism," reflecting the complexity and multidimensionality of environment-psychology interaction. Third, this study culturally contextualized control theory by revealing through cross-cultural comparison the differential patterns in the formation mechanisms and health effects of sense of control across different cultural backgrounds, challenging the cultural universality assumption of traditional psychological theories. The study found that the empowering effect of community participation on sense of control is stronger in collectivist cultures, while the impact of sense of control on subjective health perception is more significant in individualist cultures. These cultural specificities add a cultural dimension to control theory, promoting the development of cultural sensitivity in psychological theories. Fourth, this study combined the emerging

governance concept of community environmental co-governance with traditional psychological theories, providing theoretical explanations of psychological mechanisms for community governance research[51]. Previous community governance research predominantly focused on institutional design and policy effects, with less exploration from the individual psychological level of how governance models influence resident well-being. This study filled this theoretical gap, demonstrating the psychological pathway through which participatory governance improves health outcomes by enhancing residents' sense of control, opening new directions for interdisciplinary dialogue between public administration and psychology. Fifth, at the methodological level, this study integrated quantitative and qualitative research paradigms, combining advanced statistical methods such as structural equation modeling and multi-group analysis with in-depth interviews and cultural context analysis, ensuring both the rigor of causal inference and capturing the richness of cultural meanings, providing a methodological demonstration for cross-cultural psychological research. In summary, this study not only contributes new findings at the specific knowledge level but also advances the establishment of an environment-psychology-health integrated paradigm and the cultural turn of psychological theory at the meta-theoretical level, possessing important theoretical innovation value.

5.3. Practical implications

The findings of this study provide multifaceted implications and guidance for elderly chronic disease management practice and optimization of community health governance models. First, at the community health management level, the research confirms that community environmental co-governance participation can significantly enhance elderly patients' sense of control and treatment outcomes, suggesting that community health service institutions should transform the traditional "top-down" service model and establish co-governance mechanisms with deep elderly patient participation. This includes establishing health management committees with patient representatives, regularly convening community health forums, and encouraging patients to participate in health activity design and implementation, transforming elderly people from passive recipients to co-decision-makers and builders of community health management. Second, based on the mediating roles of physical environmental accessibility and social support networks, community construction should focus on dual optimization of "hardware" and "software": in terms of hardware, improve age-friendly transformation of community health facilities, add exercise areas, health stations, barrier-free passages, etc., to reduce physical barriers for elderly patients' participation in activities; in terms of software, construct multi-level social support networks through establishing chronic disease mutual support groups, "time bank" volunteer services, neighborhood health partners, and other mechanisms to promote emotional connections and experience sharing among elderly patients, embedding individual disease management into the community's social relationship network[52]. Third, given the critical role of sense of control on treatment outcomes, healthcare professionals in clinical practice should place greater emphasis on patient psychological empowerment, adopting communication strategies that enhance sense of control, such as encouraging patient participation in treatment plan formulation, providing knowledge and skills training for disease self-management, and providing timely feedback on health improvement progress, helping patients establish the belief that "I can manage my disease well," thereby improving treatment adherence and self-management levels. Fourth, cross-cultural research findings suggest that health intervention programs require culturally adaptive design: in collectivist cultural contexts (such as China), the role of family and community collectives should be fully utilized, designing intervention programs that emphasize collective participation and mutual support; in individualist cultural contexts (such as the United States), greater attention should be paid to individual autonomy and personalized program customization. Avoiding "one-size-fits-all" standardized interventions and adjusting intervention strategies according to cultural characteristics can maximize health promotion effects. Fifth, at the policy level, research results

support incorporating community environmental co-governance into the core content of age-friendly community construction and Healthy China strategies, recommending the formulation of incentive policies to encourage elderly participation in community governance, providing institutional guarantees and resource support for community co-governance, while establishing long-term tracking and assessment systems for elderly patient participation and health outcomes to drive policy optimization with data. Finally, this study emphasizes the importance of interdisciplinary collaboration, recommending the promotion of coordination among different professions such as public health, social work, psychology, and community management in practice, constructing comprehensive elderly chronic disease community management teams to provide holistic support for elderly patients from physiological, psychological, and social dimensions, truly achieving person-centered health services.

5.4. Research limitations and future prospects

Although this study has achieved a series of important findings in theoretical construction and empirical testing, there remain some limitations that need to be objectively recognized and improved in future research.

First, the causal inference limitation of the cross-sectional research design is the main shortcoming of this study. Although this study systematically verified the theoretical path of "community environmental co-governance participation → sense of control → treatment effect" through structural equation modeling and Bootstrap mediation testing, and this path has a solid theoretical foundation and logical rationality, due to the cross-sectional nature of data collection, all variables were measured at the same time point, making it impossible to completely rule out the possibility of reverse causality or bidirectional causality. For example, elderly patients who already have a high sense of control may be more inclined to actively participate in community environmental co-governance activities because they have more confidence in their ability to influence the environment; similarly, patients with better treatment outcomes may have enhanced willingness and ability to participate in community activities due to improved physical condition and abundant energy. Such reverse or mutual influence relationships are difficult to distinguish in cross-sectional data. Future research should adopt longitudinal tracking designs, establishing clearer causal inferences through repeated measurements at multiple time points (such as baseline, 3 months, 6 months, 12 months) to clarify the temporal sequence among variables. A more ideal research design would be to adopt randomized controlled trials (RCT), randomly assigning elderly patients to high-participation community co-governance intervention groups and routine care control groups, verifying the causal impact of community participation on sense of control and treatment effects through experimental manipulation, and revealing the temporal dynamic process of the mechanism through mediation analysis.

Second, limitations in cultural measurement have affected the in-depth understanding of cultural moderation effects. This study selected three culturally representative countries—China, Japan, and the United States—for cross-cultural comparison, confirming that cultural type plays a significant moderating role in the process by which community participation influences sense of control. However, cultural grouping was mainly based on national differences at the macro level, failing to adequately measure individual-level differences in cultural values. Although the research design mentioned supplementary measurement of individualism-collectivism tendencies using Hofstede's cultural dimension scale, the quantitative scoring of individual cultural psychological characteristics for each participant was still insufficient in actual operation. This country-level cultural grouping may overlook cultural heterogeneity within the same country due to factors such as generational differences, urban-rural differences, educational background, and immigration experience. For example, in the Chinese sample, elderly people with higher education in first-tier cities may exhibit more individualistic tendencies, while elderly people in rural areas tend more toward collectivism; in the United States, elderly immigrants from different ethnic backgrounds

may retain the values of their native culture. These individual-level cultural differences were not adequately captured in the current study, potentially affecting the precision and depth of explanation of cultural moderation effects. Future research should, based on country-level comparisons, add individual-level cultural psychological measurements, quantitatively scoring each research subject's individualism-collectivism tendency, power distance, uncertainty avoidance, and other cultural dimensions, and adopt multilevel models (such as cross-level moderation models) to simultaneously examine the interactive effects of national culture (second level) and individual cultural orientation (first level) on the community participation-sense of control relationship, thereby more precisely understanding the multilevel influence mechanisms of cultural factors.

Third, limitations in sample representativeness and generalizability require careful consideration. Although this study adopted multi-stage stratified random sampling, including 927 elderly chronic disease patients across three countries with sufficient sample size and balanced distribution, the research subjects mainly came from urban communities, with insufficient coverage of elderly patients in rural areas. There are significant differences between urban and rural areas in community infrastructure, healthcare service accessibility, and social network structure, and the community environment and health challenges faced by rural elderly patients may be completely different from those in urban areas. Additionally, the study excluded patients with severely impaired cognitive function, those in acute disease phases, or those with major life changes. While these exclusion criteria ensured data quality, they also limited the generalization of research conclusions to more vulnerable, higher-need elderly populations. Future research should expand sample coverage and specifically conduct studies targeting special groups such as rural communities, the very elderly, and those with mild cognitive impairment, examining the applicability and differences of the community participation-sense of control-health outcome model across different populations.

Fourth, there is room for improvement in variable measurement that deserves further exploration. The measurement of community environmental co-governance participation mainly relied on self-report questionnaires, which, although combining three dimensions of decision-making participation, activity participation, and resource contribution, may still have social desirability bias and recall bias. Future research could introduce multiple measurement methods such as objective participation records (such as community activity sign-in sheets, meeting minutes), behavioral observation methods, or mobile device tracking to improve the objectivity and ecological validity of participation assessment. The measurement of sense of control used the classic Pearlin Mastery Scale, but this scale is more focused on general life sense of control and does not adequately capture sense of control in the specific domain of disease management (such as sense of control over symptom management, treatment decisions, and lifestyle changes). In the future, disease-specific sense of control scales could be developed or introduced to more accurately assess psychological sense of control in the context of elderly chronic disease management.

Fifth, there is still room for expansion and deepening of mediation mechanisms. This study verified the mediating role of physical environment accessibility and social support networks, but the psychological process by which community participation influences sense of control may be more complex. For example, community participation may influence sense of control through multiple psychological pathways such as enhancing social identity, increasing self-efficacy, and satisfying autonomy needs, and these potential mechanisms were not fully examined in this study. Additionally, individual difference variables (such as personality traits, coping styles, and health literacy) may moderate the strength of mediation pathways. Future research could construct more refined moderated-mediation models to explore "when" and "for whom" the empowerment effects of community participation are most significant.

Finally, methodological innovation and integration are important directions for future research. This study adopted mixed research methods, integrating quantitative and qualitative data, but the depth and breadth of qualitative research can be further strengthened. In the future, in-depth qualitative methods such as ethnography and narrative research could be adopted to track the complete process of elderly patients' participation in community co-governance over the long term, capturing the micro-processes of formation and transformation of sense of control. Additionally, methods such as diary methods and experience sampling method (ESM) could be introduced to capture patients' psychological experiences and health behaviors in different contexts in real-time, improving the ecological validity of research. At the data analysis level, emerging methods such as machine learning and network analysis could be attempted to uncover complex interaction patterns and dynamic evolution trajectories among variables.

In summary, despite the above limitations, this study's contributions in theoretical construction, cross-cultural verification, and practical implications are significant. Future research should, based on this study, further advance theoretical development and practical application of community environmental co-governance, psychological sense of control, and elderly health management through adopting longitudinal designs or randomized controlled trials, deepening individual-level cultural measurement, expanding sample representativeness, improving variable measurement tools, expanding exploration of mediation mechanisms, and innovating research methods, providing more solid scientific evidence for building age-friendly communities and achieving healthy aging goals.

6. Conclusion

This study systematically explored the mechanisms through which community environmental co-governance participation influences sense of control and treatment outcomes among elderly chronic disease patients from a cross-cultural social-psychological perspective, reaching the following five core conclusions. First, community environmental co-governance participation has a significant positive predictive effect on sense of control among elderly chronic disease patients, validating the psychological empowerment effect of environmental participation and indicating that enhancing patients' level of participation in community health management can effectively strengthen their sense of mastery over life. Second, physical environmental accessibility and social support networks play significant mediating roles in the relationship between community participation and sense of control, revealing the dual pathways through which community participation achieves psychological empowerment by reshaping patients' material and social environments, with the mediating effect of social support networks being more prominent. Third, sense of control has a comprehensive promoting effect on treatment outcomes, not only significantly improving treatment adherence and self-management behavior but also enhancing objective health indicators and subjective health perception, confirming that sense of control is a key psychological mechanism linking environmental interventions with health outcomes. Fourth, cultural factors play a significant moderating role in the process by which community participation influences sense of control, with the empowering effect of community participation being stronger in collectivist cultural contexts, while the impact of sense of control on subjective health is more significant in individualist cultural contexts, indicating that psychological health mechanisms possess cultural specificity. Fifth, this study constructed and validated a cross-cultural integrated model of "community environmental co-governance participation—environmental factors—sense of control—treatment outcomes," providing a theoretical framework and empirical evidence for elderly chronic disease management, emphasizing the important value of environmental interventions, psychological empowerment, and cultural adaptation in health promotion, holding significant theoretical significance and

practical guidance for optimizing community health governance models and promoting age-friendly community construction.

Conflict of interest

There is no conflict of interest.

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