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# Impact of functional, communicative, critical and distributed health literacy on self-management behaviors in chronic disease patients across socioeconomic groups

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## Abstract

**Background** Effective self-management behaviors offer a promising pathway to address the health challenges faced by patients with chronic diseases. As a key factor influencing self-management behaviors, multidimensional health literacy has yet to be systematically studied in relation to its impact on patients with chronic diseases across different socioeconomic statuses.

**Objective** To systematically investigate the influence of functional, communicative, critical, and distributed health literacy on self-management behaviors among patients with chronic diseases from different socioeconomic statuses.

**Methods** A modified multidimensional health literacy and self-management behavior questionnaire was used to assess the health literacy and self-management behaviors of patients with chronic diseases. A total of 590 valid samples were obtained, and participants were divided into high and low socioeconomic status groups based on their socioeconomic background. Correlation analysis and multiple linear regression were conducted to explore the influence of various dimensions of health literacy on self-management behaviors across different socioeconomic statuses.

**Results** After controlling for confounding variables, the communicative ( $\beta=0.262$ ,  $P<0.01$ ) and distributed ( $\beta=0.343$ ,  $P<0.01$ ) health literacy dimensions showed a significant positive impact on self-management behaviors in the low socioeconomic status group. In the high socioeconomic status group, critical ( $\beta=0.253$ ,  $P<0.05$ ) and distributed ( $\beta=0.267$ ,  $P<0.01$ ) health literacy demonstrated a significant positive effect on self-management behaviors. No significant impact was observed for functional health literacy in either group.

**Conclusions** The study comprehensively reveals the distinct effects of different dimensions of health literacy on self-management behaviors among patients with chronic diseases from varying socioeconomic statuses. These findings provide a theoretical basis for developing strategies aimed at improving self-management behaviors through health literacy enhancement, particularly tailored to patients from different socioeconomic backgrounds.

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**Keywords** Multidimensional health literacy, Socioeconomic status, Self-management behavior, Chronic disease patients, Health equity

## Introduction

Socioeconomic factors are pivotal in determining health outcomes [1]. Significant disparities exist in health status among chronic disease populations with different socioeconomic statuses, a phenomenon referred to as the “social gradient in health” [2]. Paradoxically, while treatment innovations and public health system advancements have demonstrably extended average lifespans in chronic disease populations [3], health disadvantages persist unabated among socioeconomically disadvantaged populations with chronic conditions [4]. These clinical advancements have failed to effectively mitigate the entrenched social health gradient, thus revealing the limitations of biomedical interventions alone. Global governments and academic communities are actively exploring evidence-based behavioral intervention strategies to improve the health of this vulnerable population [5]. Within this context, self-management behaviors have garnered significant attention due to their potential to transcend structural socioeconomic barriers [6]. A prime example is the Chronic Disease Self-Management Program (CDSMP), pioneered by Dr. Kate Lorig’s team at Stanford University in the 1990s, has been systematically implemented by public health agencies in the United States and adapted nationwide in countries like the United Kingdom and Australia [7].

The chronic and unpredictable nature of these diseases underscores the importance of self-management behaviors in disease management. Effective self-management behaviors are pivotal for controlling chronic diseases [6], although their effectiveness may vary depending on disease type, individual patient characteristics, and environmental contexts. Studies have demonstrated that good self-management behaviors help slow disease progression [8] and enhance the quality of life for patients with chronic diseases [9], providing a potential pathway to addressing the health challenges faced by low-socioeconomic-status populations with chronic diseases [10]. While active patient engagement and the ability to utilize health resources are critical for effective self-management [11], health literacy is recognized as an important determinant, though not in isolation [12]. The relationship between self-management behaviors and health literacy is mediated or confounded by broader socioeconomic and contextual factors, such as healthcare resource accessibility, cultural background, and educational level. Compared to populations with higher socioeconomic status, chronic disease patients of lower socioeconomic strata frequently demonstrate deficiencies in health literacy [13, 14]. These health disparities

are further exacerbated by systemic barriers including restricted educational access, underdeveloped healthcare infrastructure, and insufficient social support networks. These systemic barriers collectively undermine their capacity to access, comprehend, and apply health information [15]. Consequently, their health status and outcomes are relatively poor [16–18].

Health literacy refers to the ability to access, comprehend, and utilize health information to make informed decisions for maintaining and improving health [19]. Based on earlier studies, Nutbeam proposed the widely recognized Functional, Communicative, and Critical Health Literacy (FCCHL) framework [20, 21]. This framework defines functional health literacy as the knowledge, literacy, and abilities required for medical activities; communicative health literacy as the ability to obtain, understand, and communicate health-related information in social interactions; and critical health literacy as the capacity to evaluate the reliability and accuracy of health information and make informed health decisions. More recently, scholars have introduced the concept of “distributed health literacy,” which emphasizes health literacy as a distributed resource available through an individual’s social network [22, 23]. Distributed health literacy has been shown to mitigate the negative impacts of low health literacy [24]. These theoretical frameworks provide a solid foundation for multidimensional health literacy research.

However, current studies have two major limitations. First, the persistent focus on functional health literacy is evident across diverse contexts: studies examining its impact on hypertension management in older adults [25], investigations into antidepressant treatment adherence [26], and research exploring its influence on health-promoting lifestyle behaviors [27]. These studies equate literacy or educational attainment (functional health literacy) with health literacy as a whole, while neglecting systematic exploration of communicative, critical, and distributed health literacy. In particular, the mitigating effect of distributed health literacy among patients with chronic diseases has not been fully elucidated. This neglect of communicative, critical, and distributed dimensions of health literacy may lead to inconsistencies in existing research findings [28]. For instance, Williams did not find a significant correlation between literacy and health outcomes [29] while Schillinger reported worse glycemic control in subjects with lower literacy [30]. Second, many studies emphasize overall population analysis or divide populations based on demographic and disease characteristics in a simplistic manner [31–33]. Few studies have

examined the differences in multidimensional health literacy among individuals from different socioeconomic statuses and their specific roles in chronic disease self-management behaviors. Patients with chronic diseases from lower socioeconomic backgrounds tend to have weaker abilities to access, understand, and evaluate health information and healthcare services [34, 35]. This not only limits the effectiveness of their self-management behaviors [36, 37], but also increases the likelihood of engaging in health-risk behaviors [38, 39]. The lack of research addressing the two critical variables—“multidimensional health literacy” and “socioeconomic status”—leaves us with an incomplete understanding of how different dimensions of health literacy affect self-management behaviors among patients with chronic diseases from various socioeconomic backgrounds. These research gaps also hinder the development of targeted health promotion strategies for low-socioeconomic-status populations with chronic diseases.

Therefore, to address the two main limitations of existing research, this study organically integrates Nutbeam's FCCHL framework with Distributed Health Literacy theory to construct a multidimensional theoretical analysis model. Building on the localized adaptation of the HL-14 health literacy scale and incorporating the core tenets of distributed health literacy, we innovatively developed a composite health literacy scale encompassing four dimensions: functional, communicative, critical, and distributed. Focusing on chronic disease patients across socioeconomic status groups, a multidimensional stratified analysis model was established to address the core research question: Do functional, communicative, critical, and distributed health literacy exert differential impacts on self-management behaviors among chronic disease patients with varying socioeconomic statuses? Through elucidating the interaction mechanisms between multidimensional health literacy and self-management behaviors across socioeconomic groups, this research aims to develop precision intervention strategies for chronic disease management tailored to socioeconomic stratification. The findings are expected to advance health intervention research by facilitating a paradigm shift from “universal behavioral interventions” to “socially structure-adapted interventions” that account for health literacy multidimensionality and social determinants.

## Methods

### Sample and procedure

This study utilized a stratified sampling method to ensure representativeness and accuracy in the analysis. Using fiscal and financial data from the 2023 Ou Hai District Statistical Yearbook published by the district government, the 12 subdistricts were ranked by economic

development level and equally divided into three tiers: low, medium, and high. Within each tier, one subdistrict was selected through simple random sampling, with its primary healthcare institution (community health service center) designated as the survey site. The sample size distribution was determined proportionally to the resident population of each subdistrict to ensure sample representativeness. The sample size calculation was based on the statistical formula for stratified sampling. The theoretical sample size of 609 was calculated using the formula. During the survey, 601 valid questionnaires were collected. Following predefined quality control criteria (missing key variables, privacy-related refusals), 11 invalid responses were excluded, resulting in a final analytical sample of 590. This sample size remained statistically adequate.

The study employed a dual-channel recruitment strategy at community health service centers: Post-consultation recruitment where investigators approached eligible patients after clinicians completed routine outpatient consultations to ensure non-interference with medical services, maintaining voluntary participation principles; Pre-consultation recruitment through informational flyers displayed in waiting areas to facilitate voluntary enrollment. To ethically acknowledge participants' time commitment without inducing bias, a hygiene kit valued at 5 RMB (approximately 0.7 USD) was provided post-survey completion. This incentive protocol, approved by the Ethics Review Committee, aligns with established norms in health behavior research, as evidence indicates such low-value tokens neither influence participation decisions nor compromise response validity [40]. To further mitigate coercion risks, a dual safeguard mechanism was implemented: rigorous ethics review of the incentive design and phased disclosure—participants were informed of the incentive only after providing written informed consent, emphasizing the principle of voluntariness. All data collection was conducted through face-to-face interviews. Before completing the questionnaire, all participants were informed about the purpose, content, and potential risks and benefits of the study and provided written informed consent. Participants completed the standardized questionnaire with assistance from trained investigators. Investigators completed a two-day standardized training: Day 1 covered theoretical modules (scale structures/scoring criteria/ethical guidelines/terminology), Day 2 focused on role-playing simulations reinforcing three core protocols (no leading questions/neutral prompts/standard explanations). Trainees passed mock interviews assessing linguistic accuracy, procedural completeness, and adaptive competence. Data collection employed a three-tier quality assurance system: On-site monitoring with real-time feedback, Daily debriefings to optimize workflows, Validity verification ensuring data quality. Inclusion criteria for participants were:

individuals aged  $\geq 45$  years (this cutoff corresponds with the epidemiological pattern of substantially increased chronic disease prevalence in middle-aged and older populations) [41] who had been diagnosed with one or more chronic diseases and voluntarily agreed to participate in the study. Exclusion criteria included: (1) Individuals with mental disorders or impaired consciousness. (2) Individuals unable to communicate effectively due to language barriers.

This study has been approved by the Ethics Review Committee of Wenzhou Medical University (Approval No. 2024067) and was conducted in strict accordance with the Declaration of Helsinki and China’s relevant laws and regulations.

Instruments

Data collection was conducted using a standardized questionnaire, which consisted of three sections: sociodemographic and health status information, health literacy scale, and self-management behavior scale. Notably, the Health Literacy Scale and the Self-Management Behavior Scale underwent a rigorous translation and cultural adaptation process. Initial forward translations by two bilingual scholars were reconciled by experts to create a unified Chinese version. An independent English-speaking expert performed back-translation, with conceptual consistency verified through semantic comparisons against the original scales. Remaining discrepancies were resolved through iterative revisions with medical humanities and chronic disease management experts, incorporating localized phrasing and supplemental items aligned with linguistic conventions, healthcare practices, and socio-cultural norms. Pretesting ( $n = 30$ ) and cognitive interviews refined comprehensibility and applicability, with final adjustments integrating participant and local

healthcare professional feedback to ensure scientific rigor and cultural appropriateness. An additional file shows this in more detail [see Additional file 1].

The health literacy measurement scale was developed by integrating contributions from both domestic and international research [42], incorporating the Chinese version of the Health Literacy Easy Scale (HL-14) [43] and Nutbeam’s Functional-Communicative-Critical Health Literacy framework [20], as well as the theoretical framework of distributed health literacy [23]. This comprehensive assessment tool, which includes 17 items across four dimensions—functional (3 items), communicative (5 items), critical (5 items), and distributed (4 items) health literacy—was designed using a 5-point Likert scale for scoring. The self-management behavior scale was designed based on the chronic disease self-management theory framework [44] and optimized with findings from Chinese research [45–47]. It consists of four dimensions: disease management, lifestyle management, exercise management, and social functioning and interpersonal management, with a total of 14 items. All items were scored using a 5-point Likert scale.

Assignment criteria

Socioeconomic status was operationalized through three standardized indicators: educational attainment (scored 1–5), occupation (scored 1–5), and personal annual income (scored 1–6). The total socioeconomic status score (range: 3–16 points, all integers) for each participant was calculated by summing the three indicators. Using the midpoint between the highest and lowest scores as the cut-off point, participants were then divided into two groups: low socioeconomic status (3–9 points) and high socioeconomic status (10–16 points). Full scoring thresholds, including exact income brackets, occupational classifications, and educational attainment criteria, are detailed in Table 1.

Statistical analyses

Data analysis was conducted using IBM SPSS Statistics version 27. Cronbach’s alpha coefficient was calculated to assess the internal consistency of the scales, while confirmatory factor analysis was performed using Amos version 27.0 to evaluate the structural validity of the scales. Descriptive statistical methods, including means, standard deviations, and percentages, were used to present the basic demographic and disease characteristics of the sample. Additionally, since the theoretical maximum scores differed across various dimensions of health literacy, standardized health literacy scores (Standardized score = [Actual score / Theoretical maximum score]  $\times$  100) were adopted for comparison of different health literacy dimensions within the same socioeconomic status group. This normalization approach enabled equitable

Table 1 Operationalization of socioeconomic status

variable	assignment
Education	1 = illiterate; 2 = primary school; 3 = middle school; 4 = High School; 5 = college or above
occupation	1 = unemployed; 2 = retirement; 3 = farmers; 4 = freelancer/company staff; 5 = professional personnel/office workers
Personal annual income	1 = less than 40,000 yuan; 2 = 40,000 ~ 59,999 yuan; 3 = 60,000 ~ 79,999 yuan; 4 = 80,000 ~ 99,999 yuan; 5 = 100,000 ~ 149,999 yuan; 6 = 150,000 yuan and above
Socioeconomic status	The socioeconomic status of an individual is measured by adding the scores of education level, occupational status, and annual personal income, with higher values indicating higher socioeconomic status. The lowest score in the sample was 3 points and the highest score was 16 points, both of which were integers. [3,9] = low socioeconomic status group [10,16] = high socioeconomic status group

cross-dimensional comparisons by controlling for scale heterogeneity. Independent sample t-tests were selected to analyze differences in health literacy and self-management behaviors among chronic disease patients with varying socioeconomic status, as this method optimally compares group means between dichotomous socioeconomic categories. Pearson correlation was employed based on the continuous nature of the variables and the preliminary validation of a linear relationship, making it suitable for quantifying symmetric associations. After controlling for demographic and disease characteristics, multiple linear regression was applied to examine the independent effects of multidimensional health literacy on self-management behaviors. This method accommodated the continuous dependent variable, incorporated multiple predictors while adjusting for confounders, and quantified the independent effect sizes with statistical significance for each health literacy dimension, thereby directly elucidating the explanatory role of multidimensional health literacy in self-management behaviors.

## Results

### Reliability and validity of scales

For the Health Literacy Scale. Reliability and validity tests revealed that the overall Cronbach's  $\alpha$  coefficient of the scale was 0.917, with the Cronbach's  $\alpha$  coefficients for each dimension ranging from 0.830 to 0.916, indicating good internal consistency and meeting reliability requirements. Confirmatory factor analysis demonstrated that AVE values (0.553–0.785) and CR values (0.830–0.916) satisfied standard thresholds (AVE > 0.5, CR > 0.7), with standardized factor loadings ranging from 0.620 to 0.898. The square roots of AVE values exceeded inter-factor correlations, supporting discriminant validity. The model results showed  $\chi^2 = 490.711$  (df = 113,  $p < 0.001$ ), and other fit indices (CFI = 0.943, NFI = 0.927, RMSEA = 0.075, SRMR = 0.048) were excellent, confirming that the health literacy scale has robust reliability and validity, including high convergent and discriminant validity.

For the Self-Management Behavior Scale. Exploratory factor analysis showed that the KMO value of the scale was 0.786, and Bartlett's test of sphericity was significant ( $P < 0.01$ ). The cumulative variance contribution rate of the four-factor structure was 62.722%. The four-factor structure aligned with the expected chronic disease self-management framework, indicating that the scale has good validity. The Cronbach's  $\alpha$  coefficients for each dimension ranged from 0.604 to 0.920, with the overall Cronbach's  $\alpha$  coefficient being 0.804, suggesting that the scale has good reliability.

### Basic characteristics of the sample

The majority of participants were aged 65 years or older (64.58%). In terms of marital status, most respondents

were married (86.61%). Regarding place of residence, rural residents accounted for the largest proportion (56.95%). Based on socioeconomic status, the low socioeconomic statuses group comprised 86.10% of the sample, while the high socioeconomic statuses group comprised 13.90%. Among chronic disease cases, the proportion of respondents with only one type of chronic disease was the highest (65.42%). The distribution of disease duration was relatively even, with the largest proportion of respondents having a disease duration of less than 4 years (36.95%). Overweight and obese individuals accounted for 36.78%. Regarding self-rated health, 44.41% of participants rated their health as good (see Table 2).

### Scores of health literacy and Self-Management behaviors across different dimensions and socioeconomic statuses

The results indicated that health literacy levels in the low socioeconomic status group were generally low. Among the various dimensions, communicative health literacy demonstrated the highest standard score, followed by distributed, critical, and functional health literacy. In the high socioeconomic status group, health literacy levels were relatively high, with the highest standard score also observed in communicative health literacy, followed by functional, critical, and distributed health literacy.

Additionally, significant differences were observed in self-management behaviors, functional health literacy, communicative health literacy, and critical health literacy scores between chronic disease patients in different socioeconomic status groups, except for distributed health literacy. Patients from low socioeconomic backgrounds consistently scored lower in all dimensions of health literacy and self-management behaviors compared to their high socioeconomic counterparts (see Table 3).

### The impact of health literacy on self-management behavior in various dimensions

As shown in Table 4, all health literacy dimensions, except functional health literacy in the high socioeconomic group, exhibited significant correlations with self-management behaviors, with correlation coefficients ranging from 0.311 to 0.529. Overall, communicative, critical, and distributed health literacy exhibited stronger correlations with self-management behaviors compared to functional health literacy.

Sociodemographic and health-related characteristics were further examined for their differences in self-management behaviors among chronic disease patients in different socioeconomic status groups. In the low socioeconomic status group, significant differences in self-management behaviors were found across gender, age groups, marital status, primary residence, household size, type of chronic disease, and self-rated health. In contrast,



**Table 2** Description of the sociodemographic and health characteristics (N = 590)

Characteristics	n	Percentage (%)
<b>gender</b>		
male	307	52.03
female	283	47.97
<b>Age Group (years)</b>		
45~	65	11.02
55~	144	24.41
65~	381	64.58
<b>marital status</b>		
married, cohabiting	498	84.41
married, not cohabiting	13	2.20
divorce	5	0.85
widowed	74	12.54
<b>Principal place of residence</b>		
city	145	24.58
urban-rural fringe	109	18.47
countryside	336	56.95
<b>Number of family members</b>		
1~2	326	55.25
3~5	216	36.61
6~9	48	8.14
<b>Socioeconomic status</b>		
low	508	86.10
high	82	13.90
<b>Types of chronic diseases</b>		
1	386	65.42
2	199	33.73
3	5	0.85
<b>Duration of disease (years)</b>		
< 4	218	36.95
4~	207	35.08
≥ 8	165	27.97
<b>Body mass index (BMI)</b>		
< 18.5	22	3.73
18.5~	351	59.49
24~	193	32.71
≥ 28	24	4.07
<b>Self-rated health</b>		
very bad	3	0.51
bad	115	19.49
neutral	210	35.59
good	247	41.86
very good	15	2.55

in the high socioeconomic status group, significant differences were only observed for gender and marital status (see Table 5).

To further explore the effects of different dimensions of health literacy on self-management behaviors within different socioeconomic status groups, multiple linear regression analyses were conducted separately for the low and high socioeconomic status groups. Based on the results of the difference tests in Table 5, variables

**Table 3** Socioeconomic disparities in health literacy and Self-Management scores

Health literacy	Socioeconomic status		t	p
	$(\bar{x} \pm s)$			
	Low (n = 508)	High (n = 82)		
Functional	43.95 ± 18.02	74.72 ± 17.20	-14.433	0.000**
Communicative	67.86 ± 12.85	82.29 ± 9.80	-9.722	0.000**
Critical	49.21 ± 15.27	73.22 ± 11.48	-16.699	0.000**

**Table 4** Pearson's correlations between variables

Low socioeconomic status		High socioeconomic status	
Health literacy	Self-manage- ment behavior	Health literacy	Self-man- agement behavior
Functional	0.311**	Functional	0.208
Communicative	0.491**	Communicative	0.401**
Critical	0.379**	Critical	0.350**
Distributed	0.529**	Distributed	0.422**

\* $p < 0.05$  \*\* $p < 0.01$

**Table 3** Socioeconomic disparities in health literacy and Self-Management scores

Health literacy	Socioeconomic status		t	p
	$(\bar{x} \pm s)$			
	Low (n = 508)	High (n = 82)		
Distributed	60.13 ± 16.10	63.66 ± 16.63	-1.834	0.067
Self-management behavior	51.51 ± 6.37	53.78 ± 6.12	-3.016	0.003**

\* $p < 0.05$  \*\* $p < 0.01$

that could influence self-management behaviors were included as control variables in the regression models, where each dimension of health literacy was treated as an independent variable and self-management behaviors as the dependent variable (see Table 6).

Prior to conducting the multiple linear regression analyses, key assumptions including linearity, independence, homoscedasticity, and normality were systematically verified for both socioeconomic groups. The results of the multiple linear regression analysis (Table 6) indicated that the regression models for both groups were statistically significant, with adjusted  $R^2$  values of 0.522 and 0.460, respectively, suggesting that the models explained 52.2% and 46.0% of the variance in self-management behaviors, with good model fit. Variance inflation factor (VIF) values for all independent variables were below 5 [48], excluding the possibility of multicollinearity. The results showed that, after controlling for confounding variables, functional health literacy no longer had a

**Table 5** Comparison of Self-Management behavior differences by socioeconomic status in chronic disease patients

variable	Low socioeconomic status		High socioeconomic status	
	$\bar{x} \pm s$	t/F	$\bar{x} \pm s$	t/F
<b>gender</b>				
male	49.56 ± 5.96	<b>-7.163**</b>	51.96 ± 6.06	-
female	53.42 ± 6.19		57.48 ± 4.40	<b>4.215**</b>
<b>Age Group (years)</b>				
45~	53.48 ± 6.57	<b>9.786**</b>	54.70 ± 5.64	1.739
55~	53.64 ± 6.20		52.97 ± 6.56	
65~	50.79 ± 6.26		48.00 ± 5.66	
<b>marital status</b>				
married, cohabiting	51.99 ± 6.05	<b>6.191**</b>	54.38 ± 6.05	<b>3.944*</b>
married, not cohabiting	50.67 ± 6.41		47.86 ± 4.60	
divorce	43.00 ± 1.73		52.50 ± 0.71	
widowed	49.15 ± 7.48		—	
<b>Principal place of residence</b>				
city	55.74 ± 5.19	<b>50.456**</b>	54.21 ± 6.35	0.270
urban-rural fringe	53.80 ± 6.15		53.13 ± 6.06	
countryside	49.61 ± 5.94		53.90 ± 5.72	
<b>Number of family members</b>				
1~2	50.72 ± 6.05	<b>7.124**</b>	55.44 ± 7.29	2.631
3~5	52.45 ± 6.61		54.02 ± 5.79	
6~9	54.00 ± 6.86		50.18 ± 4.87	
<b>Types of chronic diseases</b>				
1	51.37 ± 6.47	<b>4.905**</b>	54.10 ± 5.79	0.607
2	51.99 ± 6.07		52.91 ± 7.01	
3	43.20 ± 4.76		—	
<b>Duration of disease (years)</b>				
< 4	51.66 ± 6.86	0.175	54.77 ± 5.41	2.618
4~	51.58 ± 5.76		51.68 ± 7.48	
≥ 8	51.27 ± 6.55		50.33 ± 3.79	
<b>Body mass index (BMI)</b>				
< 18.5	52.45 ± 6.45	0.592	62.50 ± 0.71	2.217
18.5~	51.67 ± 6.53		54.29 ± 6.48	
24~	51.24 ± 6.24		51.95 ± 5.05	
≥ 28	50.00 ± 4.33		52.78 ± 4.97	
<b>Self-rated health</b>				
very bad	52.33 ± 7.37	<b>3.409*</b>	—	1.952
bad	50.33 ± 7.71		51.38 ± 6.86	
neutral	50.88 ± 5.94		54.38 ± 6.04	
good	52.36 ± 5.90		53.81 ± 5.67	
very good	55.07 ± 5.37		65.00	

\*  $p < 0.05$  \*\*  $p < 0.01$ **Table 6** Multiple linear regression analysis

variable	Low socioeconomic status		High socioeconomic status	
	$\beta$	t	$\beta$	t
constant	—	20.490**	—	5.505**
Functional	0.057	1.320	-0.040	-0.377
Communicative	0.262	<b>6.493**</b>	0.215	1.724
Critical	0.032	0.684	0.253	<b>2.410*</b>
Distributed	0.343	<b>9.287**</b>	0.267	<b>3.046**</b>
<b>Gender (control group: male)</b>				
female	0.308	9.274**	0.467	5.353**
<b>Age group (control group: 65~)</b>				
45~	-0.004	-0.106		
55~	0.041	1.210		
<b>Marital status (control group: married, cohabiting)</b>				
Married, not cohabiting	-0.069	-2.178*	-0.084	-0.938
divorce	-0.039	-1.240	-0.107	-1.239
widowed	-0.064	-1.879	—	—
<b>Main place of residence (control group: city)</b>				
urban-rural fringe	0.038	0.900		
countryside	-0.156	-3.477**		
<b>Number of family members (control group: 1~2)</b>				
3~5	-0.020	-0.557		
6~9	-0.021	-0.629		
<b>Types of chronic diseases (control group: 1)</b>				
2	0.038	1.182		
3	-0.025	-0.761		
<b>Self-rated health (control group: neutral)</b>				
Very bad	0.058	1.787		
Not good	-0.056	-1.536		
Good	0.059	1.653		
Very good	0.053	1.637		
Adjust R <sup>2</sup>	0.522		0.460	
F	28.712**		10.857**	

\*  $p < 0.05$  \*\*  $p < 0.01$ 

statistically significant effect on self-management behaviors in either group. In the low socioeconomic status group, communicative health literacy ( $\beta = 0.262$ ,  $P < 0.01$ ) and distributed health literacy ( $\beta = 0.343$ ,  $P < 0.01$ ) had significant positive effects on self-management behaviors. In the high socioeconomic status group, critical health literacy ( $\beta = 0.253$ ,  $P < 0.05$ ) and distributed health literacy ( $\beta = 0.267$ ,  $P < 0.01$ ) had significant positive effects on self-management behaviors.

## Discussion

### The role of functional health literacy was not significant in either the low or high socioeconomic status groups

After controlling for confounding factors, the influence of functional health literacy on self-management behaviors was no longer significant in the low socioeconomic status group ( $\beta = 0.057$ ,  $P = 0.188$ ) or the high socioeconomic status group ( $\beta = -0.040$ ,  $P = 0.707$ ). This finding contradicts previous studies by Schillinger [30], Lima [25], Adams [27], and others that emphasized the significant role of functional health literacy. The reasons may lie in the following aspects. First, unlike previous studies that focused on populations with significant deficiencies in functional health literacy, the sample in this study—particularly the high socioeconomic status group—may have already attained a baseline level of functional health literacy due to the widespread implementation of China's national health education initiatives [49], thereby diminishing its marginal explanatory power. Second, cultural factors may mediate the role of functional health literacy. Within China's cultural context, which emphasizes family and collective support [50], chronic disease patients often rely on family or community networks to interpret health information, potentially weakening the independent influence of individual functional health literacy. Third, functional health literacy—centered on literacy and numeracy—may inadequately address the increasingly complex demands of health information processing in chronic disease management (e.g., accessing, evaluating, and decision-making based on health-related information) [51]. Consequently, as a basic skill for acquiring and comprehending health information [52], functional health literacy demonstrates relatively limited efficacy in supporting self-management behaviors among chronic disease patients [53]. Effective self-management behaviors in chronic disease patients require higher-level skills. For instance, Inoue's study demonstrated that communicative health literacy and critical health literacy significantly enhanced diabetic patients' understanding of disease management [54]. Two studies by Abreu revealed that distributive health literacy also plays a crucial role: asthma patients significantly reduced disease-related life disruptions through support from family members and healthcare providers [55], while diabetic patients' dense social networks could compensate for individual health literacy deficiencies, particularly showing pronounced effectiveness among populations with lower education levels [56]. This highlights the growing academic consensus surrounding Nutbeam's multidimensional health literacy framework [20].

### The effects of critical and communicative health literacy on self-management behaviors differ between chronic disease patients with varying socioeconomic statuses

Among the low socioeconomic status group, critical health literacy ( $\beta = 0.032$ ,  $P = 0.494$ ) did not have a significant effect on self-management behaviors. This may be attributed to the generally lower educational attainment among chronic disease patients in this group [57]. As a higher-order cognitive ability requiring advanced information processing and decision-making skills, critical health literacy is fundamentally constrained by education levels [58]. Moreover, structural barriers such as limited access to professional health information channels, coupled with entrenched sociocultural norms like passive reliance on medical authority, may further constrain its application - even when individuals possess critical health literacy competencies. These compounding factors make it particularly challenging for low socioeconomic status patients to effectively leverage this dimension of health literacy. Consequently, the influence of critical health literacy on self-management behaviors in this group is minimal. In contrast, in the high socioeconomic status group, critical health literacy ( $\beta = 0.253$ ,  $P < 0.05$ ) had a significant positive impact on self-management behaviors. This can be explained by the higher educational levels typically observed in the high socioeconomic status group, which equip patients with stronger abilities to access, evaluate, and make decisions based on health information [58]. These patients are better able to extract key information from complex health resources [59], assess its reliability and validity, and apply it effectively to promote self-management behaviors [60]. While our findings demonstrate the significant role of critical health literacy in high socioeconomic status group, it is important to note that individuals in these groups may rely on more specialized health information channels, which could amplify the effectiveness of critical health literacy.

Communicative health literacy played a key role in the low socioeconomic status group ( $\beta = 0.262$ ,  $P < 0.01$ ), exerting a significant positive effect on self-management behaviors. Chronic disease patients in this group benefit from interacting with healthcare providers, family members, or friends within their social networks to share and disseminate health information. This process helps address the challenges posed by limited health resources and mitigates difficulties in understanding and evaluating health information, compensating for the deficiencies in critical health literacy [61]. This social network-based mechanism for transmitting health information provides low socioeconomic status patients with a feasible and accessible way to acquire health knowledge and skills, thereby enhancing the implementation of self-management behaviors [51]. Conversely, among the high socioeconomic status group, communicative health literacy



did not show a significant effect on self-management behaviors ( $\beta=0.215$ ,  $P=0.089$ ). This may be due to the fact that high socioeconomic status patients often possess abundant health knowledge and independent information-processing capabilities [58], enabling them to effectively filter, evaluate, and apply health information without relying heavily on social network interactions. As a result, the role of communicative health literacy is diminished in this group.

### **The universal importance of distributed health literacy**

Distributed health literacy highlights the capacity of individuals to access, disseminate, and utilize health-related knowledge within their social networks. Known as “health literacy mediators,” these individuals play a pivotal role in facilitating such exchanges [62]. This dimension holds particular value for individuals with deficits in other aspects of health literacy, as it leverages social support to address these shortcomings [23]. Specifically, its mechanisms of action can be manifested in the following aspects: acquiring professional medical advice and community health resources through health literacy mediators to overcome educational barriers; facilitating the sharing of health management experiences within social networks to compensate for individual knowledge gaps and achieve resource compensation; and enhancing the efficacy and sustainability of health behavior implementation through group decision-making. These patients leverage health resources or health literacy mediators within their social networks to receive support and assistance [55], ensuring the effective implementation of self-management behaviors [22]. It not only helps individuals with generally low levels of health literacy improve their self-management behaviors but also benefits chronic disease patients with higher health literacy levels. Our findings further corroborate this perspective. The results show that distributed health literacy had the most significant positive impact on self-management behaviors among the low socioeconomic status group ( $\beta=0.343$ ,  $p<0.01$ ). Chronic disease patients in the low socioeconomic statuses group often face limitations due to lower educational attainment and limited resources, resulting in generally low health literacy levels, especially in critical and functional health literacy [63]. Distributed health literacy provides a crucial compensatory mechanism for this group: by interacting with their social support systems, it alleviates issues such as health information inaccessibility and resource scarcity, overcomes barriers in understanding and applying health information, and compensates for deficiencies in their health management abilities [64]. This enables them to execute self-management behaviors more effectively. Similarly, our findings reveal that distributed health literacy also significantly promotes self-management behaviors among the

high socioeconomic statuses group ( $\beta=0.267$ ,  $p<0.01$ ). Although chronic disease patients in the high socioeconomic statuses group tend to perform well in critical health literacy, they still face other challenges in disease management, such as health information overload—a phenomenon extensively documented in studies examining health consumers’ struggles with excessive and conflicting health information [59]. In such cases, high socioeconomic statuses patients can access accurate and high-quality health information through health literacy mediators, such as professional healthcare providers and peer support groups, which helps them avoid the negative effects of excessive information and ensures the effectiveness of their self-management behaviors. However, the nature of their health literacy mediation may differ substantially. High socioeconomic status patients are more likely to access professional mediators rather than lay community networks. Consequently, key characteristics of mediators—such as professional expertise and accessibility—may further determine the effectiveness of distributed health literacy. These disparities in mediator quality and authority levels explain why distributed health literacy remains impactful even among populations with stronger individual capabilities. This underscores the necessity to develop targeted interventions that strategically leverage these mediating advantages according to different socioeconomic contexts.

The universal importance of distributed health literacy across different socioeconomic statuses groups highlights its role in facilitating the circulation and integration of health information between individuals and their social networks. It provides an efficient mechanism for sharing health knowledge among chronic disease patients. These findings suggest that health interventions should not only focus on improving the individual health literacy of chronic disease patients but also emphasize the construction of robust social health support networks [65].

### **Limitations and future research**

This study has several limitations despite its contributions. First, socioeconomic status was measured by summing education, income, and occupation simplistically, whereas these factors may have differential weighting effects. Future studies should develop more nuanced measurement approaches. Second, cross-sectional studies cannot determine causal direction. Future longitudinal cohort studies should track temporal changes by assessing health literacy and self-management behaviors at multiple timepoints in chronic disease patients to analyze if baseline health literacy predicts behavioral changes. Third, the single-site study in Wenzhou, with its limited sample size and geographic focus, may compromise generalizability by overlooking regional health-cultural contexts. Future research should adopt

multi-site designs across diverse regions, incorporate culturally sensitive indicators, and systematically analyze how regional health beliefs interact with structural factors. This approach would strengthen external validity while uncovering context-specific pathways for tailored interventions. Fourth, participants with different chronic conditions (e.g., diabetes, hypertension, arthritis) were analyzed collectively without examining disease-specific management challenges. Subsequent studies should conduct stratified analyses by disease type to enhance clinical relevance.

## Conclusions

The study innovatively integrates Nutbeam's FCCHL framework with distributed health literacy theory, systematically revealing for the first time the operational mechanisms of multidimensional health literacy in socioeconomic statuses stratification. This approach addresses the limitations of previous research that predominantly focused on functional health literacy or homogeneous populations. The findings demonstrate that distributed health literacy, as a crucial resource within social networks, effectively compensates for deficiencies in other dimensions and significantly enhances self-management behaviors across different socioeconomic statuses groups. This compensatory mechanism proves particularly prominent among low socioeconomic statuses patients, offering critical corrective guidance for current intervention strategies that neglect the role of social networks. Communicative health literacy provides essential support for low socioeconomic status patients by enhancing their communication skills and strengthening social support networks, enabling them to effectively implement self-management behaviors. Critical health literacy helps high socioeconomic status patients evaluate complex information and make informed decisions, thereby improving the quality of their self-management behaviors. The independent role of functional health literacy was found to be relatively limited. This research comprehensively elucidates the differential impacts of multidimensional health literacy on self-management behaviors among various socioeconomic status groups. Furthermore, it challenges the prevailing "one-size-fits-all" intervention paradigm, advocating for socioeconomic statuses stratification strategies grounded in social determinants. The study provides robust evidence for designing precision interventions tailored to socioeconomic realities and advancing health equity, establishing a solid foundation for developing targeted approaches that address the specific needs of diverse population segments while promoting equitable health outcomes.

## Supplementary Information

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Supplementary Material 1

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Not applicable.

## Author contributions

SC and QB took responsibility for the integrity of the data and the accuracy of the data analysis. SC contributed to the writing of the manuscript and statistical analysis. JZ and GL study supervision. All authors read and approved the final manuscript.

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## Data availability

The datasets generated and analyzed during the current study are not publicly available due to the explicit understanding with participants that their data would not be publicly disclosed, but are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

This study was approved by the Ethics Review Department of the Science and Technology Department of Wenzhou Medical University (approval number: 2024067). All participants provided written informed consent to participate in the study. Participation was voluntary. The study was conducted in accordance with the Declaration of Helsinki and relevant legislative guidelines.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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