

5G Bedside Interactive Terminal Health Education to Enhance Treatment Adherence in Elderly Patients with Chronic Diseases: The Mediating Role of Self-Efficacy

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Objective: To evaluate the acceptance of 5G-enabled bedside interactive terminal health education among elderly patients with chronic diseases and analyze its impact on treatment adherence, focusing on the mediating role of self-efficacy.

Methods: A cross-sectional survey was conducted with 294 elderly inpatients with chronic diseases (January 2022–January 2023). Acceptance was measured using a technology acceptance model (TAM)-based Health Education Acceptance Scale, self-efficacy with the Chronic Disease Self-Efficacy Scale (CDSSES), and adherence via the 5-item Medication Adherence Report Scale, Exercise Adherence Rating Scale, and self-developed Dietary Adherence Scale. Hierarchical linear regression was constructed to analyze the impact of acceptance on adherence, controlling for demographics/clinical variables. The mediating effect of self-efficacy was examined by Bootstrap testing.

Results: Participants reported moderately high acceptance (TAM_score: 64.29 ± 17.26) and moderate self-efficacy (CDSSES score: 6.95 ± 1.97). Adherence scores were 19.99 ± 3.22 (medication), 16.29 ± 4.30 (exercise), and 27.93 ± 5.73 (diet). Acceptance was significantly associated with all adherence domains (all $P < 0.001$). Self-efficacy partially mediated the effects on medication (indirect effect = 0.0159, 95% CI: 0.0075–0.0252) and exercise adherence (indirect effect = 0.0218, 95% CI: 0.0098–0.0360). Among TAM dimensions, perceived usefulness most stably predicted adherence, independently and positively influencing exercise adherence ($B = 0.212$, 95% CI: 0.062–0.361, $P = 0.006$).

Conclusion: 5G terminal-based health education was significantly associated with better treatment adherence among elderly patients with chronic diseases. Self-efficacy serves as a crucial mediator, particularly for medication and exercise behaviors. Optimizing terminal interactivity and enhancing self-efficacy are crucial for improving long-term disease management outcomes.

Keywords: 5G technology, bedside interactive terminal, health education, technology acceptance model, self-efficacy, treatment adherence, elderly patients with chronic diseases

Introduction

The accelerating global aging population presents a formidable public health challenge, accompanied by a significant rise in the prevalence of chronic non-communicable diseases (NCDs) such as hypertension, diabetes, stroke, and coronary heart disease.¹ These conditions typically require long-term self-management and sustained treatment adherence. Previous research confirms that high-quality health education is a key strategy for improving patients' disease knowledge, lifestyle modifications, and adherence behaviors.^{2,3} However, traditional clinical education models, often reliant on verbal explanations and printed materials, frequently fail to meet the specific needs of elderly patients. Age-related declines in vision, hearing, and cognitive processing often result in poor retention of information from these one-way communication methods. The lack of personalized interaction can lead to passive learning, contributing to suboptimal treatment adherence and negatively impacting disease prognosis.⁴

In recent years, with the proliferation of mobile health technologies, digital education models based on tablets and infotainment systems have gradually been applied in clinical settings. While multimedia education can be more engaging than printed materials, early bedside terminal systems were often limited by network bandwidth and hardware performance, experiencing technical bottlenecks such as video buffering, complex interfaces, and a lack of real-time feedback. These limitations significantly hindered the user experience for elderly patients, perpetuating the issue of “digital exclusion”. The introduction of fifth-generation mobile communication technology (5G) offers a revolutionary solution to overcome these barriers. Leveraging its high bandwidth, low latency, and massive connectivity, 5G enables bedside interactive terminals to stream 4K/8K ultra-high-definition medical videos smoothly, support virtual reality (VR) immersive experiences, and facilitate real-time remote patient-provider interaction and family participation.⁵ This technological advancement holds great promise for lowering the barriers to information access for the elderly and strengthening their health beliefs.

Despite rapid progress in the infrastructure of 5G-enabled smart healthcare, a research gap remains at the clinical application level. Current literature primarily focuses on the use of 5G in remote surgery and the medical Internet of Things. Empirical research on the psychological acceptance process and influencing factors regarding 5G bedside interactive terminals among the specific vulnerable group of hospitalized elderly patients with chronic diseases remains scarce. More importantly, existing studies often emphasize assessing the short-term impact of digital tools on patient knowledge levels, lacking in-depth exploration of the associative mechanisms between technology acceptance and long-term treatment adherence.⁶ According to the technology acceptance model (TAM), users’ perceived usefulness and ease of use of a technology not only determine their intention to use it but may also influence their health behaviors by altering their sense of self-efficacy. However, whether this pathway holds true in the context of 5G-enabled healthcare requires validation.

Therefore, this cross-sectional study aims to assess the current acceptance level of 5G bedside interactive terminals among elderly patients with chronic diseases and to analyze in depth the correlation and predictive effect of various dimensions of technology acceptance on patient adherence behaviors. The findings will help identify key factors influencing elderly patients in bridging the digital divide and provide a scientific basis for healthcare institutions to optimize chronic disease management strategies for the elderly using 5G technology.

Materials and Methods

Study Participants

This cross-sectional survey employed convenience sampling to recruit elderly inpatients with chronic diseases admitted to the Cardiovascular, Endocrine, and Neurology Departments of our hospital between January 2022 and January 2023. All enrolled patients received and actually used the 5G bedside interactive terminal during their current hospitalization and were included in the survey analysis after meeting the inclusion and exclusion criteria. Sample size estimation was performed using G*Power 3.1 software. Based on a multiple linear regression analysis model (for predicting adherence behaviors), with a medium effect size (f^2) of 0.15, a significance level (α) of 0.05, statistical power ($1-\beta$) of 0.95, and an estimated inclusion of 10 predictor variables, the minimum required sample size was calculated to be 172. Considering potential invalid questionnaires and an approximate 20% sample attrition rate, 294 patients were ultimately recruited to ensure statistical power. This study was approved by the hospital’s Ethics Committee (Ethics Approval Number: 2021K-11-04) and strictly adhered to the ethical principles of the *Declaration of Helsinki*. Prior to the survey, researchers explained the study purpose, anonymity, and confidentiality to all participants, who retained the right to withdraw at any time.

Inclusion criteria were: (1) Age ≥ 60 years; (2) Clinically confirmed diagnosis of at least one chronic disease among hypertension, type 2 diabetes, stroke (recovery phase), or coronary heart disease; (3) Actual use of the 5G bedside interactive terminal during hospitalization for viewing or interacting with health education content (cumulative duration ≥ 30 minutes); (4) Clear consciousness, possessing basic verbal communication skills, and adequate visual/auditory function (or corrected to normal); (5) Informed consent provided and consent form signed by the patient or their legal guardian.

Exclusion criteria included: (1) Comorbid severe cognitive impairment or neuropsychiatric disorders (eg, Alzheimer's disease) documented in the medical records that could prevent patients from completing the questionnaire independently or with assistance; (2) Critically ill (eg, acute heart failure, coma in acute stroke phase) and unable to cooperate with the survey; (3) Previous participation in similar smart healthcare research, potentially introducing the Hawthorne effect.

The 5G-Enabled Bedside Interactive Health Education System

This study was conducted in a smart ward equipped with a dedicated 5G network, utilizing the bedside interactive terminal as the health education platform. The system architecture consisted of three main layers: (1) Infrastructure layer: The system operated on a hospital-dedicated 5G slicing network, leveraging its high bandwidth (> 1 Gbps) and low latency (< 10 ms) to ensure high-speed transmission of nursing education content. The hardware terminal was a 13.3-inch high-definition anti-glare touchscreen mounted on a bedside swivel arm, integrated with a high-fidelity microphone array, supporting 24/7 online operation. (2) Interaction experience layer: The user interface (UI) underwent in-depth aging-friendly design tailored to the physiological characteristics of elderly patients. A default "Elderly Mode" featured large fonts, high contrast, and a flat menu structure. To lower the technical barrier, the system supported multimodal interaction, allowing both touch operation and intelligent voice control. Notably, the voice engine incorporated local dialect recognition, enabling patients to interact with the device using their native dialect, thereby eliminating language barriers. (3) Application logic layer: The built-in education module was rigorously constructed based on the health belief model (HBM). Through algorithms, the system automatically matched the corresponding educational material library according to the patient's admission diagnosis (eg, hypertension, diabetes) and delivered structured content push aligned with the six dimensions of HBM (perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy). Specific intervention content strategies and corresponding terminal functions for each dimension are detailed in [Table 1](#).

Table 1 5G Bedside Interactive Terminal Intervention Content Based on HBM

HBM Theoretical Dimension	Intervention Objective	5G Terminal Functions and Strategies
Perceived susceptibility and severity	Enhance patient awareness of disease risk, complication consequences, and economic burden.	1. Intelligent assessment and push: Assess knowledge gaps upon admission; automatically push personalized educational materials via 5G high bandwidth. 2. Multimedia visualization: Play high-definition pathological animations vividly depicting the disease's impact on activities of daily living. 3. Reality impact: Visually display long-term medical costs and economic pressure associated with disease deterioration to counter illusion of invulnerability.
Perceived benefits	Strengthen patient belief in the positive outcomes of adherence behaviors (medication, diet, exercise).	1. Visualized benefits: Present specific data and cases on how standard treatment slows disease progression and prevents complications. 2. Skill guidance: Provide video tutorials on correct medication use, DASH diet preparation, and scientific exercise. 3. Quality of life vision: Emphasize the positive impact of improved adherence on reducing family caregiving burden and enhancing quality of life.

(Continued)

Table 1 (Continued).

HBM Theoretical Dimension	Intervention Objective	5G Terminal Functions and Strategies
Perceived barriers	Identify and reduce physiological or psychological resistance that patients encounters in following medical advice.	1. Aging-friendly design: Provide large-print interface and dialect voice assistant to eliminate operational barriers for the elderly. 2. Interactive problem-solving: Offer interactive Q&A and solution libraries for common difficulties like “forgetting medication” or “dietary control challenges”. 3. Remote Q&A: Patients can use the terminal’s “one-touch call” function for remote interviews with medical staff to jointly develop strategies for overcoming barriers.
Cues to action	Provide external triggers to convert health intentions into actual behaviors.	1. In-hospital instant reminders: The terminal screen displays prominent pop-up reminders for medication, education tasks, and exercise check-ins. 2. Post-discharge extension: Synchronize important reminders and health materials to the patient’s or family’s WeChat account. 3. Discharge preparation: Generate a QR code for the “Discharge Health Diary” for family members to scan and save, ensuring continued behavioral prompts.
Self-efficacy	Enhance patient confidence and initiative in performing health behaviors.	1. Personalized plan panel: Display dietary principles and exercise plans in graphical/text format on the bedside screen for easy reference. 2. Goal & feedback: Set short-term phased goals; patients check off completed tasks (eg, watching videos, exercising), receiving instant positive feedback from the system. 3. Peer & social support: Push success stories of rehabilitation role models; support family participation in education via 5G remote video for emotional support.

Abbreviations: HBM, Health belief model; DASH, Dietary approaches to stop hypertension.

Measurement Instruments

Interpretations of score levels were based on the theoretical score ranges and midpoint values of the Likert scales used.

General Information and Clinical Indicators

- (1) Demographics: Demographic characteristics were collected via questionnaire, including gender, age, marital status, education level, occupational status (employed/retired/unemployed), and medical payment method.
- (2) Disease data: Disease data were extracted from electronic medical records (EMRs), including chronic disease type, duration, and past hospitalization history.
- (3) Clinical indicators: Clinical indicators were collected on the survey day, including systolic/diastolic blood pressure (SBP/DBP), fasting blood glucose (FBG), glycated hemoglobin (HbA1c), and lipid profile [total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C)]. Height and weight were measured on-site to calculate body mass index (BMI).

Acceptance of 5G Health Education

The acceptance was measured using a Health Education Acceptance Scale adapted from the TAM.⁷ The scale contains 20 items across 4 dimensions: perceived usefulness (PU, 5 items), perceived ease of use (PEOU, 5 items), attitude toward use (ATT, 5 items), and interaction (5 items). A 5-point Likert scale was used (1 = strongly disagree to 5 = strongly agree). Dimension scores range from 5 to 25, and the total score ranges 20–100, with higher scores indicating greater acceptance. In this study, Cronbach’s α for this scale was 0.89.

Self-Efficacy

Self-efficacy was assessed using the Chronic Disease Self-Efficacy Scale (CDESES).⁸ Self-efficacy comprises two dimensions: symptom management (5 items) and general self-management (5 items). A 10-point Likert scale was used (1 = not at all confident to 10 = totally confident). Following the original scoring method, each dimension score is the average of its 5 items (range 1–10), and the total score is the average of the two dimension scores (range 1–10). Higher scores indicate stronger self-efficacy. Cronbach's α was 0.91 in this study.

Treatment Adherence

The adherence scales assessed patients' usual self-management behaviors related to chronic disease rather than behaviors strictly limited to the hospital stay. Prior to the formal survey, a pilot test involving 30 elderly patients with chronic diseases was conducted to evaluate the preliminary reliability and construct validity of the scale. A multidimensional combination assessment was used:

- (1) Medication adherence: It was measured by the 5-item Medication Adherence Report Scale (MARS-5).⁹ Five items reflect patient adherence behaviors regarding medication. Each item uses a 5-point Likert scale (1 = never to 5 = always). Total score ranges 5–25, with higher scores indicating better medication adherence.
- (2) Exercise adherence: It was measured by the Exercise Adherence Rating Scale (EARS).¹⁰ Six items, each scored 0–4, assess exercise performance over a past period. Total score ranges 0–24, with higher scores indicating better exercise adherence.
- (3) Dietary adherence: It was assessed using a self-developed Dietary Adherence Scale based on dietary approaches to stop hypertension (DASH) diet principles¹¹ and World Health Organization (WHO) chronic disease dietary guidelines. Ten items cover three dimensions: ① salt restriction (3 items); ② healthy food intake (fruits/vegetables/whole grains, 4 items); ③ unhealthy food restriction (high-fat, high-sugar, processed foods, 3 items). A 5-point Likert scale was used (1 = never to 5 = always). Total score ranges from 10 to 50, with higher scores indicating better dietary adherence. In a pilot survey, this scale showed a Kaiser-Meyer-Olkin (KMO) value of 0.85, significant Bartlett's sphericity test ($P < 0.001$), extracted one common factor explaining 62.5% of variance, and had a Cronbach's α of 0.88.

Data Collection and Quality Control

Data collection was performed by two uniformly trained research nurses. To mitigate difficulties for elderly patients due to vision or writing challenges, a one-on-one interview method (researcher asks, patient responds, researcher records) was employed. Questionnaires were administered during the patient's hospitalization. To minimize clinical interference, surveys were typically completed 1–2 days before discharge. These respondents were part of the continuity of care from the same hospitalized cohort and did not constitute an independent outpatient sample, maintaining consistency of the study population. Before the formal survey, the study purpose was explained, data confidentiality for research purposes was assured, and informed consent was obtained.

Statistical Analysis

Statistical analysis was performed using SPSS 26.0. Cronbach's α coefficients were calculated for all scales to assess reliability, and Harman's single-factor test was used to evaluate common method bias. Continuous variables were presented as mean $\pm$ standard deviation (SD). Differences in 5G health education acceptance, self-efficacy, and treatment adherence across demographic characteristics were compared using independent samples *t*-tests or one-way analysis of variance. To explore the impact of 5G health education acceptance on treatment adherence, hierarchical linear regression models were constructed. The first layer included demographic and clinical characteristics; the second layer added the total acceptance score (TAM_total) as the independent variable. The mediating effect of self-efficacy was tested using the Bootstrap method (5000 resamples), with significance determined by a 95% confidence interval (CI) not containing zero. Furthermore, the four dimensions of the TAM (PU, PEOU, ATT, and interaction) were simultaneously included in a multiple linear regression model to further analyze the differential effects of various acceptance dimensions on treatment adherence behaviors. All statistical tests were two-tailed, with $P < 0.05$ considered statistically significant.

Results

Baseline Characteristics of Participants

A total of 294 elderly inpatients with chronic diseases were included: 161 males (54.8%) and 133 females (45.2%). Mean age was 70.12 ± 5.71 years. Mean BMI was $24.43 \pm 2.95 \text{ kg/m}^2$. Regarding marital status, most were married (198, 67.3%), followed by widowed (65, 22.1%), divorced (19, 6.5%), and unmarried (12, 4.1%). Education levels were predominantly junior high school (99, 33.7%) and primary school or below (76, 25.9%), followed by high school/vocational school (75, 25.5%), and college or above (44, 15.0%). Most participants were retired (233, 79.3%), with 31 employed (10.5%) and 30 unemployed (10.2%). Primary payment methods were urban employee medical insurance (143, 48.64%) and urban-rural resident medical insurance (138, 46.94%), and a small proportion paid out-of-pocket (13, 4.42%). Chronic disease distribution was as follows: hypertension 63.3%, diabetes 38.4%, stroke 20.7%, and coronary heart disease 14.9%. Mean number of comorbidities was 1.53 ± 0.75 , with 50% having one chronic condition and 50% having two or more. Median disease duration was 9 years (IQR: 6–13 years), with a range of 1–30 years. Clinical indicators were as follows: SBP $136.17 \pm 15.28 \text{ mmHg}$, DBP $79.81 \pm 10.06 \text{ mmHg}$; FBG $7.57 \pm 1.90 \text{ mmol/L}$, HbA1c $7.70 \pm 1.50\%$, TC $5.05 \pm 0.92 \text{ mmol/L}$, TG $1.65 \pm 0.84 \text{ mmol/L}$, LDL-C $2.97 \pm 0.80 \text{ mmol/L}$, and HDL-C $1.17 \pm 0.29 \text{ mmol/L}$. Overall, the sample exhibited typical elderly chronic disease characteristics, with trends toward suboptimal blood pressure and glucose control and a high proportion of multimorbidity. Harman’s single-factor test indicated that the first unrotated factor explained 28.4% of the total variance ($< 40\%$), suggesting no severe common method bias.

Distribution of Health Education Acceptance and Self-Efficacy Scores

Analysis of health education acceptance and self-efficacy levels is shown in Table 2. Overall acceptance of 5G health education was moderately high (TAM_total: 64.29 ± 17.26). Among the four dimensions, PU scored the highest (17.02 ± 4.96), followed by PEOU (16.21 ± 4.91), ATT (15.68 ± 5.15), and interaction (15.38 ± 5.08). Score distributions for each dimension are shown in Figure 1A. Box plots indicate moderate distributions with some inter-dimensional variation.

For self-efficacy, the total CDESES score was 6.95 ± 1.97 , indicating a moderate level. The symptom management dimension score (7.16 ± 2.12) was higher than the general self-management score (6.69 ± 2.19). Distributions for both dimensions are shown in Figure 1B. Overall, patients expressed greater confidence in managing their symptoms than in general chronic disease management behaviors.

Distribution of Medication, Exercise, and Dietary Adherence Scores

Adherence was comprehensively assessed across medication, exercise, and diet using the MARS-5, EARS, and the self-developed DASH/WHO-based Dietary Adherence Scale (Table 3). Overall, total medication adherence score was 19.99 ± 3.22 (theoretical range 5–25), indicating a moderately good level. Total exercise adherence score was 16.29 ± 4.30 (theoretical range 0–24), relatively low. Total dietary adherence score was 27.93 ± 5.73 (theoretical range 10–50), at

Table 2 Distribution of Health Education Acceptance and Self-Efficacy Scores (n = 294)

Indicator	Mean	SD	Min	Max
PU	17.02	4.96	5	25
PEOU	16.21	4.91	5	25
ATT	15.68	5.15	5	25
Interaction	15.38	5.08	5	25
TAM_total	64.29	17.26	20	100
Symptom management	7.16	2.12	1	10
General self-management	6.69	2.19	1	10
Total CDESES score	6.95	1.97	1	10

Abbreviations: PU, Perceived usefulness; PEOU, Perceived ease of use; ATT, Attitude toward use; TAM_total, Total acceptance score; CDESES, Chronic Disease Self-Efficacy Scale.

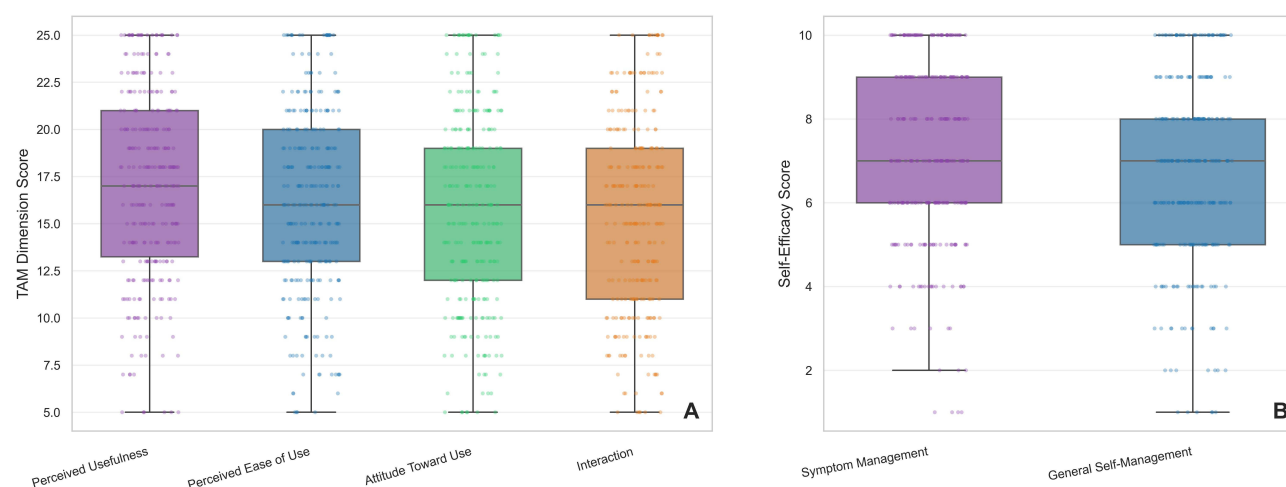


Figure 1 Score distributions for dimensions of 5G health education acceptance and self-efficacy.

Notes: (A) Box plots showing score distributions for the four dimensions of TAM-based HEAS: perceived usefulness, perceived ease of use, attitude toward use, and interaction. (B) Score distributions for the two CDESE dimensions: symptom management and general self-management.

Abbreviations: TAM, Technology acceptance model; HEAS, Health Education Acceptance Scale; CDESE, Chronic Disease Self-Efficacy Scale.

a moderate level. The total composite adherence score was 72.50 ± 12.46 , suggesting that most patients demonstrated a moderate degree of adherence, but with significant room for improvement.

Score distributions for the three adherence types are shown in Figure 2. Box plots indicate the highest median score for medication adherence, with relatively concentrated distribution. Dietary adherence was next, with some patients scoring low. Exercise adherence scored the lowest with greater dispersion, highlighting the prominent challenge of maintaining regular exercise among elderly patients with chronic diseases.

Hierarchical Linear Regression Analysis of the Impact of Health Education Acceptance on Treatment Adherence

In the regression model with medication adherence (MARS-5) as the dependent variable, Model 1 (demographic and clinical characteristics) explained 2.7% of the variance ($R^2 = 0.027$). Adding the TAM_total in Model 2 showed a significant positive association between TAM_total and MARS-5 score ($\beta = 0.057$, 95% CI: 0.036–0.078, $P < 0.001$), with a standardized regression coefficient of 0.304. The model's explanatory power increased to 11.6% ($R^2 = 0.116$, $\Delta R^2 = 0.089$) (Table 4). Acceptance was significantly associated with all adherence domains. For the model with exercise adherence (EARS) as the dependent variable, the R^2 of Model 1 was 0.032. Adding TAM_total revealed

Table 3 Distribution of Adherence Dimension Scores in Elderly Patients with Chronic Diseases (n = 294)

Scale	Mean	SD	Min	Max
MARS-5	19.99	3.22	10	25
EARS	16.29	4.30	4	24
DASH/WHO-based Dietary Adherence Scale	27.93	5.73	14	40
Total composite adherence score	72.50	12.46	31	100

Notes: The total composite adherence score (Adherence_total) was calculated by the researchers based on standardized weighting of the three dimensions and is presented only for supplementary description of overall adherence level.

Abbreviations: MARS-5, 5-item Medication Adherence Report Scale; EARS, Exercise Adherence Rating Scale; DASH, Dietary approaches to stop hypertension; WHO, World Health Organization.

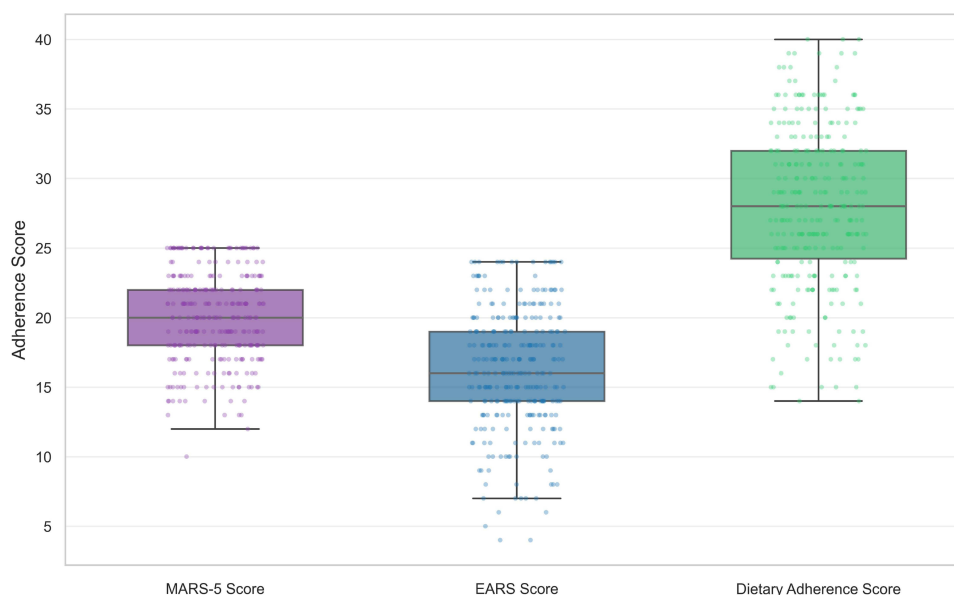


Figure 2 Distribution of medication, exercise, and dietary adherence scores in elderly patients with chronic diseases.

a significant positive correlation ($\beta = 0.068$, 95% CI: 0.040–0.096, $P < 0.001$), with a standardized coefficient of 0.272. The model's explanatory power increased to 10.3% ($R^2 = 0.103$, $\Delta R^2 = 0.071$; Table 5). This suggests that higher health education acceptance is associated with better exercise adherence. For the model with total dietary adherence score as the dependent variable, Model 1 showed an R^2 of 0.052. Adding TAM_total also showed a significant positive association ($\beta = 0.070$, 95% CI: 0.033–0.108, $P < 0.001$), with a standardized coefficient of 0.212. The model's explanatory power rose to 9.5% ($R^2 = 0.095$, $\Delta R^2 = 0.043$), as seen in Table 6.

Table 4 Hierarchical Regression Analysis of Health Education Acceptance on Medication Adherence (MARS-5)

Variable	β	95% CI	P	Standardized β
Model 1 (controlling variables)				
Constant	16.553	9.574 ~ 23.532	<0.001	—
Gender (female = 1)	0.352	−0.400 ~ 1.104	0.358	0.055
Age	0.034	−0.032 ~ 0.100	0.314	0.06
Education level	0.294	−0.074 ~ 0.663	0.117	0.093
BMI	−0.074	−0.200 ~ 0.053	0.255	−0.067
Disease duration (years)	−0.007	−0.067 ~ 0.052	0.81	−0.014
Number of comorbidities	0.067	−0.431 ~ 0.566	0.791	0.016
SBP	0.017	−0.008 ~ 0.041	0.175	0.08
FBG	−0.035	−0.231 ~ 0.162	0.728	−0.021
LDL-C	−0.015	−0.487 ~ 0.456	0.949	−0.004
Model 1 R^2	0.027	—	—	—
Model 2 (adding TAM_total)				
TAM_total	0.057*	0.036 ~ 0.078	<0.001	0.304
Model 2 R^2	0.116	—	—	—
ΔR^2	0.089*	—	—	—

Note: * $P < 0.05$.

Abbreviations: MARS-5, 5-item Medication Adherence Report Scale; BMI, body mass index; SBP, systolic blood pressure; FBG, fasting blood glucose; LDL-C, low-density lipoprotein cholesterol; TAM_total, total acceptance score.

Table 5 Hierarchical Regression Analysis of Health Education Acceptance on Exercise Adherence (EARS)

Variable	β	95% CI	P	Standardized β
Model 1 (controlling variables)				
Constant	11.423	2.117 ~ 20.729	0.016	—
Gender (female = 1)	-0.37	-1.373 ~ 0.633	0.469	-0.043
Age	0.057	-0.031 ~ 0.145	0.203	0.076
Education level	0.305	-0.186 ~ 0.796	0.223	0.072
BMI	-0.022	-0.191 ~ 0.147	0.801	-0.015
Disease duration (years)	-0.07	-0.150 ~ 0.009	0.082	-0.104
Number of comorbidities	0.269	-0.396 ~ 0.934	0.427	0.047
SBP	0.006	-0.027 ~ 0.038	0.717	0.021
FBG	0.087	-0.175 ~ 0.349	0.515	0.038
LDL-C	-0.11	-0.739 ~ 0.518	0.73	-0.02
Model 1 R^2	0.032	—	—	—
Model 2 (adding TAM_total)				
TAM_total	0.068	0.040 ~ 0.096	<0.001	0.272
Model 2 R^2	0.103	—	—	—
ΔR^2	0.071***	—	—	—

Note: ***P < 0.001.

Abbreviations: EARS, Exercise Adherence Rating Scale; BMI, body mass index; SBP, systolic blood pressure; FBG, fasting blood glucose; LDL-C, low-density lipoprotein cholesterol; TAM_total, total acceptance score.

Table 6 Hierarchical Regression Analysis of Health Education Acceptance on Dietary Adherence

Variable	β	95% CI	P	Standardized β
Model 1 (controlling variables)				
Constant	11.809	-0.450 ~ 24.069	0.059	—
Gender (female = 1)	1.064	-0.258 ~ 2.385	0.114	0.093
Age	0.12	0.004 ~ 0.236	0.042	0.12
Education level	0.617	-0.031 ~ 1.264	0.062	0.109
BMI	-0.018	-0.241 ~ 0.205	0.873	-0.009
Disease duration (years)	0.108	0.003 ~ 0.212	0.043	0.119
Number of comorbidities	-0.122	-0.998 ~ 0.753	0.783	-0.016
SBP	0.033	-0.010 ~ 0.076	0.132	0.088
FBG	0.165	-0.180 ~ 0.510	0.348	0.055
LDL-C	-0.142	-0.970 ~ 0.687	0.737	-0.02
Model 1 R^2	0.052	—	—	—
Model 2 (adding TAM_total)				
TAM_total	0.070	0.033 ~ 0.108	<0.001	0.212
Model 2 R^2	0.095	—	—	—
ΔR^2	0.043***	—	—	—

Note: ***P < 0.001.

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; FBG, fasting blood glucose; LDL-C, low-density lipoprotein cholesterol; TAM_total, total acceptance score.

Analysis of the Mediating Role of Self-Efficacy Between Health Education Acceptance and Treatment Adherence

The Bootstrap method (5000 resamples) was used to test the mediating effect of self-efficacy between health education acceptance and the three adherence types (Table 7). The overall mediation model path structure is illustrated in Figure 3, and specific indirect effects for each dimension are shown in Figure 3. In the medication adherence model, the total effect

Table 7 Mediation Analysis of Self-Efficacy Between Health Education Acceptance and Treatment Adherence

Outcome	Total Effect (<i>c</i>)	Direct Effect (<i>c'</i>)	Indirect Effect (<i>a*b</i>)	SE	95% CI Lower	95% CI Upper	P
MARS-5	0.0588	0.0430	0.0159	0.0046	0.0075	0.0252	< 0.001
EARS	0.0694	0.0478	0.0218	0.0068	0.0098	0.0360	0.0004
Dietary adherence	0.0742	0.0589	0.0150	0.0080	−0.00009	0.0311	0.0564

Abbreviations: MARS-5, 5-item Medication Adherence Report Scale; EARS, Exercise Adherence Rating Scale.

of health education acceptance on MARS-5 score was significant ($c = 0.0588$). After including self-efficacy, the direct effect remained significant but attenuated ($c' = 0.0430$). The indirect effect via self-efficacy was 0.0159 (95% CI: 0.0075–0.0252), not containing zero, indicating that self-efficacy plays a partial mediating role. In the exercise adherence model, the total effect on EARS score was significant ($c = 0.0694$). The direct effect decreased but remained significant after including self-efficacy ($c' = 0.0478$). The indirect effect was 0.0218 (95% CI: 0.0098–0.0360), also not containing zero, and was the largest among the three adherence types, suggesting that self-efficacy is a crucial psychological pathway through which health education promotes exercise adherence. In the dietary adherence model, the total effect on dietary adherence score was significant ($c = 0.0742$), and the direct effect remained significant ($c' = 0.0589$). However, the indirect effect via self-efficacy was 0.0150 (95% CI: −0.00009–0.0311), crossing zero and thus not statistically significant.

Differential Impact of Various TAM Dimensions on Treatment Adherence

To further clarify the relative role of different dimensions within the TAM in promoting treatment adherence, this study, after controlling for gender, age, education level, BMI, disease duration, number of comorbidities, SBP, FBG, and LDL-C, simultaneously incorporated PU, PEOU, ATT, and interaction into multiple linear regression models. The dependent variables were medication adherence, exercise adherence, and dietary adherence, respectively. The results are shown in Table 8.

In the exercise adherence model, PU had an independent positive predictive effect on exercise adherence ($B = 0.212$, 95% CI: 0.062–0.361, $P = 0.006$), while PEOU, ATT, and interaction did not reach statistical significance. In the medication adherence model, none of the TAM dimensions showed an independent significant association with medication adherence, although PU demonstrated a marginal positive correlation ($B = 0.104$, $P = 0.069$). In the dietary adherence model, the regression coefficients for all dimensions generally showed positive or mildly fluctuating trends, but none reached statistical significance (all $P > 0.05$).

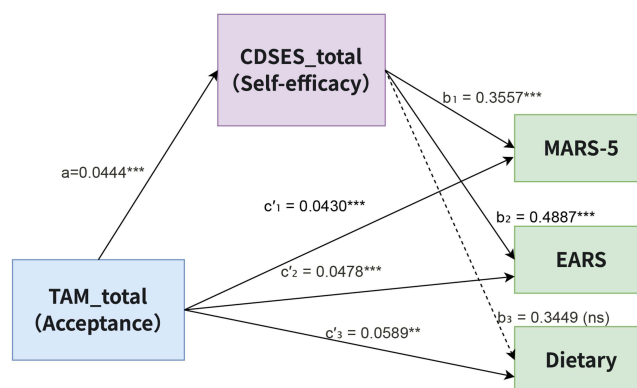


Figure 3 Mediation path diagram of relationships of health education acceptance and self-efficacy with medication, exercise, and dietary adherence.

Notes: (a) represents the path from TAM total (acceptance) to CDSES_total (self-efficacy); (b_1 – b_3) represent the paths from CDSES total to MARS-5, EARS, and dietary adherence, respectively; (c'_1 – c'_3) represent the direct paths from TAM_total to each adherence outcome. Values indicate standardized regression coefficients. ** $P < 0.01$, *** $P < 0.001$; ns = not significant.

Table 8 Multiple Linear Regression Analysis of Different TAM Dimensions on Treatment Adherence (n = 294)

TAM Dimension	Medication Adherence (MARS-5) B (95% CI)	P	Exercise Adherence (EARS) B (95% CI)	P	Dietary Adherence B (95% CI)	P
PU	0.104 (−0.008, 0.215)	0.069	0.212 (0.062, 0.361)	0.006	0.133 (−0.067, 0.333)	0.192
PEOU	0.064 (−0.047, 0.175)	0.259	0.011 (−0.138, 0.159)	0.888	−0.142 (−0.341, 0.056)	0.159
ATT	0.003 (−0.098, 0.103)	0.958	0.005 (−0.130, 0.139)	0.944	0.132 (−0.047, 0.312)	0.148
Interaction	0.058 (−0.050, 0.166)	0.292	0.046 (−0.099, 0.191)	0.535	0.153 (−0.041, 0.347)	0.123

Abbreviations: TAM, Technology acceptance model; PU, Perceived usefulness; PEOU, Perceived ease of use; ATT, Attitude toward use; MARS-5, 5-item Medication Adherence Report Scale; EARS, Exercise Adherence Rating Scale; CI, Confidence interval.

Overall, in the models incorporating all TAM dimensions simultaneously, PU was the most stable predictor among the four dimensions, particularly standing out for exercise adherence. This suggests that the impact of 5G-based health education on treatment adherence is primarily closely related to patients' perception of the technology's usefulness.

Discussion

Chronic disease management in the elderly is progressively shifting from a provider-led passive model toward an active participation model emphasizing patient self-management capacity.¹² In this process, the usability and patient acceptance of digital health tools have become increasingly important factors influencing the effectiveness of health education.¹³ However, elderly patients often face limitations in using digital technology due to operational barriers, insufficient self-efficacy, and difficulties in accessing health information. Therefore, how to enhance their acceptance and behavior change through technological design and health education strategies remains a core issue in current research. Through this cross-sectional survey of elderly patients with chronic diseases in our hospital, this study comprehensively analyzed the relationships between acceptance of health education via a 5G bedside interactive terminal, self-efficacy, and three types of treatment adherence. The results reveal key psychological and technological mechanisms underlying patient behavior change, providing additional empirical evidence for understanding how technology acceptance, self-efficacy, and treatment adherence are related in the context of 5G-enabled smart health education.

Elderly Patients with Chronic Diseases Show High Acceptance of the 5G Health Education Terminal

This study found that elderly patients' overall acceptance of the 5G bedside interactive terminal was moderately high. This aligns with the trend of increasing adoption of digital health devices among the elderly and continuous optimization of aging-friendly design. Although several interface features such as larger fonts and simplified menus contributed to usability, the dedicated 5G network provided the technical foundation for stable high-definition multimedia delivery and real-time interaction, which supported the effective implementation of the bedside health education system. Previous research indicates that PU and PEOU are core factors determining elderly users' willingness to use digital health tools.^{14,15} The high scores for PU and PEOU in this study confirm the good operability and educational value of the 5G terminal design. Furthermore, the relatively lower score for interaction suggests that elderly patients may remain cautious about digital interactive functions, consistent with findings that elderly users often prefer simple, linear learning experiences over multi-dimensional interactive interfaces.¹⁶ This indicates that future system optimizations should strengthen operational guidance and contextualized interactive experiences to enhance patient engagement.

Acceptance of 5G Health Education Significantly Predicts Three Types of Treatment Adherence

Hierarchical regression analysis showed that, after controlling for demographic and clinical variables, health education acceptance (TAM_total) significantly predicted medication, exercise, and dietary adherence. This finding supports the applicability of TAM in healthcare settings, indicating that higher technology acceptance is associated with greater patient engagement in self-health management. Previous literature also suggests that multimedia health education can

improve elderly patients' understanding and execution of treatment plans.¹⁷ This study further validated that interactive terminals based on 5G technology may increase learning interest and may be related to improvements in adherence-related behaviors. Mechanistically, the immersive educational videos, aging-friendly interface, and personalized push notifications of the 5G terminal may enhance patients' awareness of disease risks and behavioral benefits, contributing to more stable health beliefs and thus promoting behavior execution.¹⁸ Additionally, such terminals can provide immediate feedback and opportunities for repeated learning, enhancing memory retention and potentially improving medication and dietary behaviors; meanwhile, video demonstrations and check-in features may lower the threshold for initiating exercise behaviors.¹⁹ These mechanisms likely collectively contribute to improved adherence.

Self-Efficacy Plays a Key Mediating Role in the Impact of Health Education Acceptance on Treatment Adherence

The mediation model results indicated that self-efficacy played a partial mediating role in both the health education acceptance→medication adherence and health education acceptance→exercise adherence pathways, but its mediating effect on dietary adherence was not significant. This is consistent with the perspective of social cognitive theory, which posits self-efficacy as a key psychological factor driving individual health behavior change. Previous studies also note that behavior change in elderly patients with chronic diseases heavily depends on confidence in their own capabilities, and digital education can enhance self-efficacy by strengthening knowledge comprehension and skill mastery.²⁰ In this study, medication and exercise adherence were more significantly influenced by self-efficacy, potentially because these behaviors require clearer skill execution paths and self-monitoring abilities. The video demonstrations, reminders, and feedback mechanisms provided by the terminal may more easily enhance patients' confidence in their ability to perform these behaviors.²¹ In contrast, dietary behavior is influenced by more complex factors such as family dietary structure, economic status, and personal habits.²² Simply improving self-efficacy may not be sufficient to significantly alter dietary behavior, explaining the non-significant mediation effect in the dietary pathway. These findings extend previous research on technology acceptance and health behavior by demonstrating that this theoretical pathway also applies in the context of 5G-enabled bedside health education for elderly patients with chronic diseases.

Differential Roles of TAM Dimensions in Treatment Adherence

This study found that although the overall technology acceptance significantly predicted medication, exercise, and dietary adherence, when the TAM was further broken down into PU, PEOU, ATT, and interaction, only PU remained an independent significant predictor for exercise adherence. This result suggests that the overall effect is not driven by a single dimension but is more likely due to the synergistic action of multiple acceptance dimensions.

Theoretically, PU is the core construct in the TAM most closely linked to behavioral outcomes, reflecting the patient's judgment of the practical value of the health education technology. For elderly patients with chronic diseases, exercise behavior requires continuous effort and self-regulation. When they clearly perceive the practical benefits of the 5G bedside interactive terminal in providing exercise guidance and behavioral feedback, they are more likely to translate the educational content into long-term exercise behavior. This may explain the prominent role of PU in exercise adherence.

In contrast, the other dimensions did not show independent significant effects in the multi-dimensional model, which may be related to high correlations among them. When multiple dimensions are entered into the model simultaneously, they compete in explaining treatment adherence, thereby weakening the statistical significance of any single dimension. This phenomenon has also been reported in previous health behavior research based on the TAM, suggesting that comprehensively improving the overall technology acceptance experience may be more crucial than optimizing a single technical feature.²³

Combined with the mediation analysis results, self-efficacy plays a vital psychological bridging role between technology acceptance and treatment adherence. This indicates that the core value of 5G-based health education lies not only in the usability of the technology itself but also in its ability to enhance patients' confidence in performing health behaviors. Future designs of smart ward health education should prioritize highlighting the practical functional value of

the technology and further promote long-term behavioral change in elderly chronic disease patients through clear guidance and feedback mechanisms.

Implications and Limitations

This study confirms that 5G-enabled bedside interactive terminals can serve as effective platforms for health education among elderly patients with chronic diseases. Their good acceptability provides a practical basis for optimizing health education models within the smart ward setting. The finding that patient acceptance of the terminal not only reflects their adaptability to digital health education but also serves as an important predictor of their treatment adherence is valuable for clinical staff in identifying high-risk patients who may struggle with behavior execution. Furthermore, self-efficacy plays a key psychological mediating role between health education acceptance and treatment adherence. This suggests that future health education program design should consider enhancing patient self-efficacy as a core strategy, using methods like visual demonstrations, step-by-step guidance, and goal feedback to strengthen patients' confidence in performing health behaviors. Overall, this study provides theoretical support and practical direction for hospitals to develop stratified, individualized, and precise chronic disease management strategies based on 5G technology.

However, this study has several limitations. First, the single-center, cross-sectional design, while reflective of elderly patients' usage of the 5G health education terminal in the current hospital environment, cannot infer causality between variables. Future longitudinal studies or randomized controlled trials are needed to further validate the inferences drawn here. Second, participants were limited to inpatients who actually used the 5G terminal for ≥ 30 minutes. This may introduce selection bias, as results may not fully represent the broader population of elderly patients with chronic diseases who do not use or are unwilling to use digital terminals. Third, core variables including health education acceptance, self-efficacy, and treatment adherence relied on self-reported scales. Although Harman's single-factor test suggested no severe common method bias, results may still be influenced by subjective reporting bias. Future studies are recommended to incorporate objective behavioral data for validation. In addition, all major variables were measured using self-report questionnaires at a single time point, which may introduce potential common method variance. Finally, dietary adherence is influenced by multiple external factors such as family structure, economic status, and lifestyle habits. The explanatory power of the mediation model for dietary behavior was relatively limited in this study. Subsequent research could incorporate factors like family support and social environment to construct a more comprehensive behavioral mechanism model. Because this study used a cross-sectional design, causal relationships between technology acceptance, self-efficacy, and treatment adherence cannot be established.

Conclusion

Health education delivered via a 5G bedside interactive terminal demonstrates high acceptance among elderly patients with chronic diseases and was significantly associated with medication, exercise, and dietary adherence. Self-efficacy plays an important mediating role in this relationship, particularly for medication and exercise behaviors. Future clinical practice should focus on strengthening personalized, interactive health education designs based on 5G technology and prioritize the enhancement of self-efficacy to further improve long-term behavior management and health outcomes in patients with chronic diseases.

Data Sharing Statement

The data used and/or analyzed during the current study are available from the corresponding author.

Human Ethics and Consent to Participate Declarations

This cross-sectional survey was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Human Ethics Committee of Taizhou Central Hospital (Taizhou University Hospital) (Ethics Approval Number: 2021K-11-04). All participants were informed about the purpose of the study, and written informed consent was obtained from all participants or their legal guardians prior to participation.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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