

# Validation of the Longitudinal Effect of an Integrated Nursing Intervention Based on the Integrated Theory of Health Behavior Change (ITHBC) on Multidimensional Health Indicators in Older Radiotherapy Patients

Jing Jiang\*, Luxi Qian\*, Jie Chen\*, Juan Lu, Huanfeng Zhu, Bo Zhang, Yalan Zhao, Jing Tian, Qiuping Zhang, Xia He

The Affiliated Cancer Hospital of Nanjing Medical University, Department of Radiotherapy, Jiangsu Cancer Hospital, Jiangsu Institute of Cancer Research, Nanjing, Jiangsu Province, People's Republic of China

\*These authors contributed equally to this work

Correspondence: Xia He, Email hexiabm@163.com

**Introduction:** The Integrated Theory of Health Behavior Change (ITHBC) offers a structured framework for promoting sustained health behavior change through cognitive beliefs, self-regulation, and social facilitation. However, its application in geriatric oncology remains unexplored.

**Methods:** This quasi-experimental study enrolled 291 older adult patients who underwent radiotherapy at the Jiangsu Cancer Hospital. Patients hospitalized from July to December 2024 (n=146) received ITHBC-guided multidisciplinary nursing intervention, while those treated from January to June 2024 (n=145) received conventional individualized nursing care. Key outcomes, including disease cognition, self-management efficacy, and quality of life, were assessed at baseline and five months post-intervention using validated instruments. Statistical analyses included t-tests, ANCOVA, and effect-size calculations.

**Results:** After 5 months, the intervention group showed significantly greater improvements in disease cognition ( $\Delta=+23.5$  vs  $+16.4$ ), self-management efficacy ( $\Delta=+10.63$  vs  $+3.77$ ), and quality of life scores ( $\Delta=+22.07$  vs  $+6.98$ ), all  $P < 0.001$ . The effect size for disease cognition was 1.32 (95% CI: 1.08–1.56).

**Discussion:** These findings confirm the efficacy of the ITHBC-based nursing model in enhancing cognitive, behavioral, and psychosocial outcomes in older patients undergoing radiotherapy. Structuring geriatric oncology care around behavioral theories, such as ITHBC, yields measurable benefits and supports its broader application in nursing interventions.

**Keywords:** Integrated theory of health behavior change, nursing intervention, radiotherapy, older adult patients, health behavior, self-management, oncology care

## Introduction

Radiation therapy plays a key role in cancer treatment, aiming at the precise local control of tumors and curbing the remote spread of the disease. According to relevant data, nearly 70% of patients with tumors receive radiation therapy as part of their anti-cancer treatment plan. The widespread use of radiation therapy stems from its ability to reduce the remote spread of the disease while precisely controlling the tumor locally.<sup>1</sup> Older adult radiotherapy cancer patients are cancer patients who are older than 65 years of age and undergoing radiation therapy. This population may face more complex therapeutic challenges in radiotherapy due to their physiological aging and disease states. For this specific group of older adult patients undergoing radiation therapy, corresponding complications are inevitable during the course of radiation therapy, of which

radiation dermatitis is a common complication.<sup>2</sup> Radiation dermatitis can, to varying degrees, lead to symptoms such as pain, edema, erythema, peeling, and flaking of the skin at the site of irradiation, as well as varying degrees of damage such as flushing, ulceration, and tissue necrosis, which can cause pain and discomfort to the patient.<sup>3,4</sup> The prevention and management of radiation dermatitis are important clinical challenges. Health behaviors refer to the various patterns of behaviors and habits that individuals adopt to maintain and promote health.<sup>5</sup> According to the guidance of the Healthy China Action (2019–2030) of Health Promotion Action for older adults, positive health behaviors can enhance the level of health cognition, self-management ability, quality of life, and reduce the occurrence of treatment-related complications in older adult patients.<sup>6</sup> However, studies have shown that factors such as poor living habits and a lack of regular follow-up examinations among older adult patients undergoing radiation therapy can affect their health behaviors.<sup>7</sup> Current interventions focus on health information education, but patients lack the willingness to actively change undesirable behaviors or have difficulty sustaining health behaviors even when adopted, resulting in poor outcomes.<sup>8</sup>

In the field of behavioral change, multiple theories such as the Health Belief Model (HBM) and the Transtheoretical Model (TTM) have been used to guide interventions.<sup>9,10</sup> However, these theories often emphasize either individual cognition or stages of change and lack an integrative, process-based framework that supports sustained behavior transformation. The Integrated Theory of Health Behavior Change (ITHBC) proposed by Ryan (2009) combines multiple theoretical perspectives and emphasizes a patient-centered, interactive, and motivational process of behavior change.<sup>11</sup> Its three core constructs—knowledge and beliefs, self-regulation skills and abilities, and social facilitation—serve as mechanisms that drive health behavior change. The theory emphasizes the process of transforming from health beliefs to behaviors, stimulating patient motivation, enhancing the motivation for health behavior change, and helping patients establish and adhere to health behaviors, thereby improving health.<sup>12,13</sup> Several recent studies and meta-analyses have confirmed the efficacy of theory-based behavioral interventions, including those guided by ITHBC, in improving self-care and health outcomes in populations with chronic diseases.<sup>14–16</sup> However, its application in older adult patients undergoing radiation therapy has not been reported. Therefore, there is a clear research gap in testing the effectiveness of ITHBC-based nursing interventions among older oncology patients, particularly those undergoing RT. In this study, we conducted a nursing intervention based on the theory of ITHBC in older adult patients undergoing radiation therapy, with the aim of exploring its impact on patients' health behaviors.

## Materials and Methods

### Study Design and Participants

This was a quasi-experimental, two-group, comparative study based on time-based cohort assignments. A total of 291 older adult patients who underwent radiotherapy at Jiangsu Provincial Cancer Hospital between January and December 2024 were included in this study. Patients hospitalized from January to June 2024 ( $n=145$ ) comprised the control group, while those hospitalized from July to December 2024 ( $n=146$ ) comprised the experimental group. Owing to practical limitations in clinical settings, convenience sampling was adopted and random assignment was not feasible. Although the two groups showed comparable baseline characteristics, non-randomized, time-based allocation may have introduced potential temporal or seasonal bias.

The inclusion criteria were as follows: (1) age  $\geq 65$  years, diagnosis of malignant tumor, and receipt of radiotherapy; (2) clear consciousness and ability to cooperate with follow-up; and (3) agreement to participate in the study. The exclusion criteria were as follows: (1) severe comorbidities involving the heart, brain, or kidneys, and (2) diagnosed psychiatric illness. The dropout criteria were as follows: (1) serious complications or disease worsening during follow-up and (2) voluntary withdrawal or loss to follow-up.

The minimum required sample size was calculated based on a two-independent-means formula, assuming a medium effect size ( $d=0.5$ ), power of 0.80, and  $\alpha=0.05$ , resulting in at least 118 participants per group. To accommodate an estimated attrition rate of 20%, we targeted 142 patients per group. The actual attrition rate was 3.5%, with 146 (experimental) and 145 (control) participants.

To minimize assessment bias, outcome assessors were not informed of the group allocation status (assessor blinding). Although this study was not registered in a clinical trial registry, the full intervention protocol underwent an institutional

ethical review and approval, ensuring procedural traceability and ethical compliance. The study protocol was approved by the Institutional Ethics Committee (Ethics No.: KY-2024-103).

This study did not involve formal clinical trial registration, as it was designed as a quasi-experimental nursing intervention conducted in routine care settings. However, the full intervention protocol for transparency and reproducibility is available in the supplementary materials.

## Research Methods

### Intervention Method of the Experimental Group

Based on standard nursing measures, the trial group adopted a customized health management program based on the ITHBC theory to intervene in older adult cancer patients undergoing RT.

**Construction of a multidisciplinary health management team:** A multidisciplinary health management team consisting of radiotherapy, internal medicine, psychology, nutrition, and nursing experts was established to jointly design a personalized health management plan for older adult radiotherapy patients. Nurses in the radiotherapy department were responsible for comprehensively collecting data on health behavioral problems in older adult patients undergoing radiation therapy and implementing appropriate health management plans. Internal medicine and radiotherapy physicians were responsible for assessing and regulating the patients' photo-dermatologic conditions, blood cell conditions, and vital signs. The psychologist assessed and intervened with the patient's psychological condition. The dietitian assessed and guided older adult radiation therapy patients according to their nutritional status during treatment. Team members received comprehensive training, including ITHBC theory, radiation therapy-related knowledge, learning of the physical fitness assessment of older adult patients, and application of an intelligent platform.

**Developing a strategy for health behavior change based on integrated theory-based nursing intervention:** (1) The ITHBC theoretical framework takes cognitive beliefs, self-management ability, and social support as the core and achieves health promotion goals through a four-stage intervention system: first, individualized screening of disease risk perception and psychological status assessment of older adult patients undergoing radiotherapy; second, targeted goal setting and cognitive interventions; and second, the construction of a behavioral monitoring system and a social support network. Through the triple path of cognitive restructuring, skills training, and environmental optimization, the model aims to improve the effectiveness of patient health management and ultimately achieve the dual goals of short-term symptom relief and long-term quality of life improvement.<sup>17</sup>

(2) Based on the core elements of the ITHBC model, the construction of the nursing intervention program followed a three-stage evidence-based pathway: 1. Evidence integration phase: systematic search of six major databases (in English and Chinese), including PubMed and Embase, using a composite search ("radiation therapy" AND "health behavior" AND "skin management at radiotherapy sites") to obtain guideline-type literature, with a focus on selecting geriatric radiotherapy specialty guidelines and multidisciplinary consensus documents covering the key areas of nutritional support and skin protection;<sup>18–21</sup> 2. Program construction phase: integrating evidence-based evidence and clinical practice experience and forming a draft intervention after interdisciplinary team discussion; 3. Expert validation phase: The Delphi method was used to conduct expert consultations in five areas: radiotherapy, internal medicine, nursing, psychology, and nutrition, and after three rounds of validation and revision to form the ITHBC theory-driven systematic nursing intervention program (Table 1).

**Nursing interventions based on integration theory for strategic implementation of health behavior change:** (1) Customized assessment of the core objective of this stage is to understand the current level of health behavior of older adult radiotherapy patients and their willingness to change their health behavior. The current health behavior status of radiotherapy in older adult patients was analyzed by assessing their skin condition, medication, and vital signs. With the help of tools such as the Disease Awareness Questionnaire for older adult patients undergoing radiotherapy, the level of patients' awareness of disease risk factors and diseases was assessed, and the factors that play a key role in changing the health behaviors of older adult patients undergoing radiotherapy were identified to help the patients recognize the importance of self-management and motivate them to change their unhealthy behaviors.

(2) Teaching skills, knowledge teaching skills, and knowledge about the health conditions of older adult patients undergoing RT. The aim of this stage is to set health goals for patients based on the results of individual health behavior

**Table I** Programs of Nursing Interventions Leading to Health Behavior Change Based on Integration Theory

Step	Frequency	Specifics (Radiotherapy Exposure Skin Condition Monitoring, Diet, Exercise, Vital Signs, etc.)	Form	Duration (min)
Customized Assessment	At first admission; after 5 months of intervention	Evaluation of older adult patients undergoing radiation therapy: 1. Assessment of health status, including the course of disease development, photo dermatologic conditions, diet, exercise, and vital signs. 2. Health behavior was assessed by distributing health behavior assessment questionnaires, including self-management questionnaires, quality of life assessment forms and disease awareness questionnaires for older adult patients. The questionnaires were instructed by specialized nurses to complete and submit the questionnaires to the patients, and then a follow-up nursing intervention program was developed based on the report of the results.	Face-to-face interviews; Distribution of questionnaires	20–30
Skills and Knowledge Transfer	1-2 times per week	1. In the area of skin protection from radiation therapy exposure, we provide tips on the use of skin-protecting agents, methods for monitoring skin conditions, and guidance on the treatment and prevention of skin conditions in grades 0–2. (2. In the area of diet, information is provided on recommended dietary recipes, nutritional measurement charts, and palm food measurements for older adult patients undergoing radiotherapy. 3. In terms of exercise instruction, exercise methods and exercise levels suitable for older adult radiotherapy patients are recommended to avoid mechanical injuries. 4. In the area of vital signs monitoring, provide information on medication guidelines and the importance of monitoring. 5. In terms of psychological care, psychological interventions such as positive stress reduction and relaxation training are recommended.	Health education in the form of graphics, voice, video, etc.; Radiation therapy health education booklet	15–20
Health Status Tracking and Assessment	Uploading health data once a day; evaluating health behaviors once a week	1. Submit Record: Use tools such as food calorie calculator, exercise tracker, skin protection diary form and radiation therapy skin lesion assessment to record the daily dietary intake, exercise, skin condition and vital signs of older adult patients undergoing radiation therapy. If a patient forgets to upload the information, the specialist nurse will assist with reminders and help the patient establish a habit of regular adherence to health data monitoring. 2. Based on the patient's various recorded data, team members analyze the current health status of the older adult patients undergoing radiation therapy on a weekly basis and follow up with them via phone calls in the first week, one month, three months, and five months after discharge from the hospital. By understanding the presence of adverse health behaviors, the patients were urged and assisted to establish good habits and flexibly adjust the nursing intervention plan.	Patients share data on skin condition, diet, etc. on a daily basis	10–15
Building a Supportive Social Ecosystem	Ongoing throughout the study	1. Establish a WeChat group for older adult radiotherapy patients and their families, and release health education content regularly every week. 2. Providing online consultation services on family medicine and nursing care, with online Q&A sessions with experts every Tuesday; patients can post photos and texts in the WeChat group to record and share their health management experience. 3. Organize monthly activities and invite older adult radiotherapy patients to attend to share self-care skills and exchange experiences with each other.	Online and offline communication activities for older adult radiotherapy patients and their families	20–30

assessments. With the help of the APP, health education knowledge for older adult patients undergoing radiation therapy is taught in various forms, such as graphics, voice, and video, and guidance on self-management skills is provided to enhance patients' self-management level and cultivate their confidence in improving their health behaviors. Expected goals for each health indicator: 1. The goal of photographic skin damage control was <3 grade or less. 2. Dietary control goal: Increased intake of protein, vitamin A, and zinc. 3. Exercise control goal: avoiding mechanical injury. 4. Weight control goal: ideal weight (kg) = height (cm)-105, controlled within  $\pm 10\%$  of the ideal weight. 5. Blood pressure control goal: blood pressure lower than 140/90 mmHg. 6. Blood cell test goal: White blood cells, platelets, and other indicators were normal.

(3) Health status tracking and assessment: At this stage, radiotherapy older adult patients are encouraged to actively participate in self-management; patients are asked to self-monitor in accordance with the established goals and share data on photosensitive skin conditions, diet, exercise, vital signs, etc.; the team analyzes the patients' abnormal indicators and reminds the patients of their diets, exercise, and medication plans, which prompts the patients to form good health habits and ensure that the health behavioral changes in older adult patients are radiotherapy continuity and effectiveness.

(4) Constructing a supportive social ecology The key to this stage is to create a supportive social environment, to involve family members and society in the health management of older adult radiotherapy patients, to mobilize family members and patients with the same disease, and to provide emotional and psychological support. Through information channels such as clubs and online platforms, patients are provided with convenient ways to acquire disease-related knowledge, helping them manage their health behaviors with strong beliefs and positive attitudes, and improve the overall health status of older adult radiotherapy patients.

The full intervention protocol and all the self-reported measurement instruments used in this study are provided in Supplementary File 1 to facilitate transparency and replication.

## Control Group Intervention

The measure used was routine nursing. (1) At the time of admission, a comprehensive assessment of the disease stage, disease duration, photoluminescent skin condition, and vital signs of the older adult patients undergoing radiation therapy was conducted. (2) During the hospitalization period, a personalized health education plan was formulated for the patients according to the assessment results, covering photoluminescent skin care, nutritional guidance, exercise guidance, medication guidance, vital signs monitoring, etc. (3) When the patients were discharged from the hospital, instructions on the use of medication and follow-up skin condition testing were provided. When patients were discharged from the hospital, instructions on drug use and follow-up skin condition were provided, followed by telephone follow-up at the 1st week, 1, 2, and 5 months after discharge to prompt patients to seek timely medical review.

## Outcome Assessments

Patients were assessed at baseline and five months post-intervention. The testing tools used in this study are presented in [Supplementary file 1–2](#) to promote transparency and replicability.

1. Disease cognition (short-term indicator) Assessed via the Brief Illness Perception Questionnaire (BIPQ).<sup>22</sup> The questionnaire included nine items across four domains (comprehension, emotional representation, cognitive representation, and causality). Items were rated on a 0–10 Likert scale, and the total score range from 0–80. Cronbach's  $\alpha = 0.77$ . For interpretability, the scores were categorized: 0–39: poor perception; 40–59, moderate; 60–80: good perception.
2. Self-management (long-term indicator) was Measured with the Self-Management Efficacy Scale for Cancer Patients (28 items, 3 domains) using a 5-point Likert scale. Score interpretation:  $\geq 103$ , high efficacy; 66–102, moderate;  $\leq 65$ , low efficacy. Cronbach's  $\alpha = 0.970$ .<sup>23</sup>
3. Quality of life was assessed using the EQ-5D-5L, covering five domains (mobility, self-care, daily activities, pain/discomfort, and anxiety/depression), each rated on a 5-point scale.<sup>24</sup> Cronbach's  $\alpha = 0.73$ . Each dimension was scored individually and categorized from Level 1 (no problem) to Level 5 (extreme problem).

## Data Collection Procedures

All research staff members received standardized training. Participants signed an informed consent form and were surveyed pre-intervention and again at a 5-month follow-up by trained nurses. The questionnaires were immediately reviewed to resolve discrepancies.

## Statistical Analysis

Data were double-entered and analyzed using SPSS 26.0. Normality was assessed using the Shapiro–Wilk test. The homogeneity of variance was tested using Levene’s test. Count data were analyzed using  $\chi^2$ -tests, ranked data via rank sum test, and normally distributed measurement data were expressed as mean  $\pm$  SD ( $\bar{x} \pm s$ ) and compared with independent sample t-tests. A two-tailed  $P < 0.05$  was considered statistically significant.

## Results

### Participant Recruitment and Baseline Characteristics

A total of 296 older adults who underwent radiotherapy were initially screened. During the 5-month follow-up period, 2 participants in the intervention group and 3 in the control group withdrew. Ultimately, 146 participants in the intervention group and 145 participants in the control group completed the study, with a final sample size of 291. There were no statistically significant differences between the two groups in terms of sex ( $\chi^2 = 0.071$ ,  $P = 0.710$ ), age ( $t = 1.512$ ,  $P = 0.125$ ), disease duration ( $Z = -0.572$ ,  $P = 0.377$ ), educational level ( $\chi^2 = 0.16$ ,  $P = 0.761$ ), or primary caregiver type ( $\chi^2 = 0.59$ ,  $P = 0.652$ ), indicating comparability of baseline characteristics between the two groups. The detailed data are shown in Table 2.

### Descriptive and Comparative Analysis of Disease Cognition

Before the intervention, there was no significant difference in disease cognition scores between the two groups (Intervention group:  $3.05 \pm 1.17$  vs Control group:  $3.12 \pm 1.26$ ,  $P = 0.663$ ). After five months of intervention, both groups showed improvement, but the increase was significantly greater in the intervention group (Post-intervention:  $7.68 \pm 1.29$  vs  $5.68 \pm 1.48$ ,  $t = 12.58$ ,  $P < 0.001$ ). The effect size (Cohen’s  $d$ ) for the intervention group was 1.32, indicating a strong intervention effect (Table 3). As shown in Figure 1, the improvement in disease cognition scores was more pronounced in the intervention group than in the control group, with a steeper upward trajectory across all the related dimensions.

**Table 2** Comparison of General Information Between the Two Groups

Item	Research Group (n=146)	Control Group (n=145)	Test Statistic	P-value
Sex [cases (%)]			$\chi^2 = 0.071$	0.710
Male	80 (54.79%)	77 (52.74%)		
Female	66 (45.21%)	69 (47.26%)		
Age (years, Mean $\pm$ SD)	68.90 $\pm$ 5.65	67.41 $\pm$ 3.81	$t = 1.512$	0.125
Disease duration (years, Mean $\pm$ SD)	5.54 $\pm$ 4.32	7.48 $\pm$ 2.60	$Z = -0.572$	0.377
Educational level [cases (%)]			$\chi^2 = 0.16$	0.761
Junior high school and below	60 (41.10%)	65 (44.52%)		
High school and above	86 (58.90%)	81 (55.48%)		
Primary caregiver [cases (%)]			$\chi^2 = 0.59$	0.652
Self	35 (23.97%)	34 (23.29%)		
Sons and daughters	50 (34.25%)	49 (33.56%)		
Spouse	61 (41.78%)	63 (43.15%)		

**Note:** 1)  $\chi^2$  values for categorical variables, 2) t-values for age, and 3) Z-values for disease duration.

**Table 3** Comparison of Disease Cognition Level Between the Two Groups Before and After Intervention (Points,  $\bar{x} \pm s$ )

Group	Number of Cases	Pre-Intervention	Post-Intervention	t-value	P-value
Research group	146	3.05 ± 1.17	7.68 ± 1.29 <sup>#*</sup>	0.42	0.663
Control group	145	3.12 ± 1.26	5.68 ± 1.48 <sup>#</sup>	12.58	<0.001

**Note:** Comparison with pre-intervention in the same group, <sup>#</sup>P < 0.05; between-group comparison, \*P < 0.05.

## Changes in Self-Management Ability Across Subdomains

Self-management ability was assessed using three dimensions: positive attitude, coping with stress, and self-determination. At baseline, the intervention group had slightly higher total scores than the control group ( $20.97 \pm 3.86$  vs  $17.08 \pm 4.72$ ,  $P = 0.047$ ), although the difference was only marginally significant. After the intervention, the total score in the intervention group increased significantly to  $24.65 \pm 3.86$ , while the control group only improved to  $18.27 \pm 4.14$ . Comparisons of the subdomains revealed that the intervention group showed significantly greater improvement in coping with stress and self-determination (see [Table 4](#)).

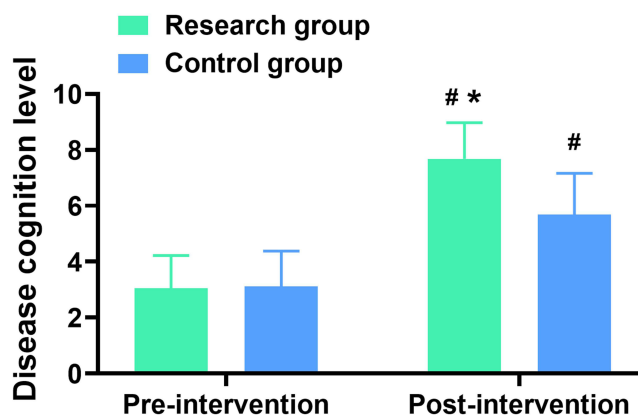
The most notable increase was observed in the self-determination dimension ( $\Delta = 3.14$  for the intervention group vs 1.13 for the control group), which aligns closely with the ITHBC model's emphasis on strengthening behavioral skills. Detailed item-level distributions of self-management behaviors are shown in [Figure 2](#).

## Improvement in Quality of Life and Clinical Significance

The total EQ-5D-5L score in the intervention group improved from  $51.49 \pm 10.70$  to  $73.56 \pm 8.17$ , a gain of 22.07 points—more than double the minimum important difference (MID = 2.56). In contrast, the control group increased from  $66.40 \pm 13.48$  to  $73.38 \pm 11.41$ , a smaller gain of 6.98 points (see [Table 5](#)). Repeated measures ANOVA revealed a statistically significant interaction effect between group and time ( $\eta^2 = 0.412$ ,  $P < 0.001$ ), further supporting the efficacy of the intervention. [Figure 3](#) illustrates the changes in quality-of-life scores between the two groups.

## Summary and Supplementary Materials

Cross-variable correlation analysis revealed that improvements in disease cognition were strongly associated with enhancements in self-management ( $r = 0.69$ ,  $P < 0.001$ ) and quality of life ( $r = 0.61$ ,  $P < 0.001$ ), further validating the integrative mechanism proposed by the ITHBC framework. The complete set of questionnaire tools, scoring criteria, and item-level data is available in [Supplementary Files 1](#) and [2](#).



**Figure 1** Comparison of disease cognition level between the two groups before and after intervention.

**Note:** (points,  $\bar{x} \pm s$ ), comparison with Pre-intervention in the same group, <sup>#</sup>P < 0.05; Between-group comparison, \*P < 0.05.

**Table 4** Comparison of Self-Management Levels Between the Two Groups Before and After the Intervention (Points,  $\bar{x} \pm s$ )

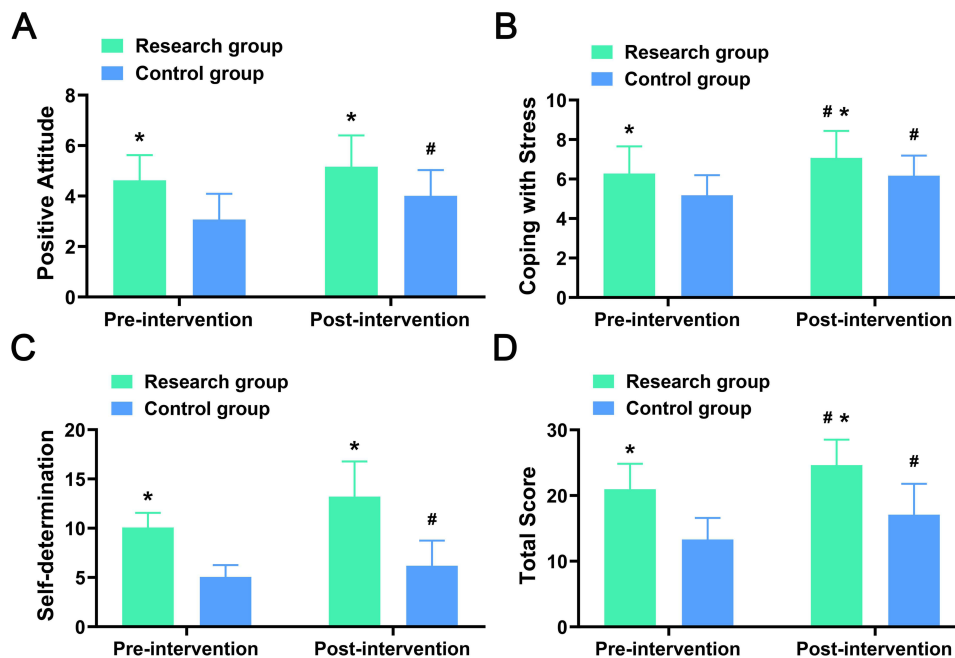
Dimension	Group	Pre-Intervention	Post-Intervention	t-value	P-value
Positive Attitude	Research (n=146)	4.62 ± 1.00*	5.16 ± 1.24*	0.78	0.370
	Control (n=145)	3.07 ± 1.02	4.01 ± 1.02 <sup>#</sup>	-6.81	<0.001
Coping with Stress	Research	6.28 ± 1.37*	7.07 ± 1.37 <sup>**</sup>	2.24	0.023
	Control	5.18 ± 1.02	6.17 ± 1.02 <sup>#</sup>	-2.24	0.023
Self-determination	Research	10.07 ± 1.49*	13.21 ± 3.56*	0.76	0.411
	Control	5.06 ± 1.19	6.19 ± 2.55 <sup>#</sup>	-14.16	<0.001
Total Score	Research	20.97 ± 3.86*	24.65 ± 3.86 <sup>**</sup>	1.71	0.047
	Control	13.31 ± 3.28	17.08 ± 4.72 <sup>#</sup>	-8.99	<0.001

**Note:** Comparison with pre-intervention in the same group, <sup>#</sup>P < 0.05; between-group comparison, \*P < 0.05.

## Discussion

This study provides compelling evidence that a structured nursing intervention guided by the ITHBC can produce substantial improvements in cognitive, behavioral, and quality of life outcomes among older adults undergoing RT. The effectiveness of the intervention was demonstrated by significant post-intervention enhancements in disease awareness, self-management competence, and overall health-related quality of life. These outcomes reflect not only statistically robust gains, but also clinically meaningful progress in managing complex care needs in a high-risk, underrepresented population.

The theoretical foundation of ITHBC, anchored in the synergy between cognitive belief systems, self-regulatory capacities, and social facilitation, proved to be highly applicable in the oncology setting. While previous studies employing ITHBC have predominantly focused on chronic non-cancer populations such as patients with type 2 diabetes or hypertension, this study marks a significant expansion in the model’s use in geriatric oncology.<sup>25–27</sup> The cognitive load and emotional burden experienced by older adults with cancer often lead to fragmented health behaviors, low treatment adherence, and poor psychosocial outcomes, underscoring the need for theory-based multidimensional intervention



**Figure 2** Comparison of self-management levels between the two groups before and after the intervention. (A) Positive Attitude score; (B) Coping with Stress score; (C) Self-determination score; (D) Total score.

**Note:** (points,  $\bar{x} \pm s$ ), comparison with Pre-intervention in the same group, <sup>#</sup>P < 0.05; Between-group comparison, \*P < 0.05.

**Table 5** Comparison of Quality of Survival Scores Between the Two Groups Before and After Intervention (Points,  $\bar{x} \pm s$ )

Dimension	Group	n	Pre-Intervention	Post-Intervention	$\Delta$ (Post-Pre)	MID
Disease Cognition	Research	146	52.3 $\pm$ 4.1	75.8 $\pm$ 3.2#*	+23.5	2.79
	Control	145	51.9 $\pm$ 3.8	68.3 $\pm$ 4.6#	+16.4	1.64
Self-management	Research	146	14.02 $\pm$ 3.86	24.65 $\pm$ 3.86#*	+10.63	2.13
	Control	145	13.31 $\pm$ 3.28	17.08 $\pm$ 4.72#	+3.77	1.15
Quality of Life	Research	146	51.49 $\pm$ 10.70*	73.56 $\pm$ 8.17#	+22.07	2.56
	Control	145	66.40 $\pm$ 13.48	73.38 $\pm$ 11.41#	+6.98	0.54

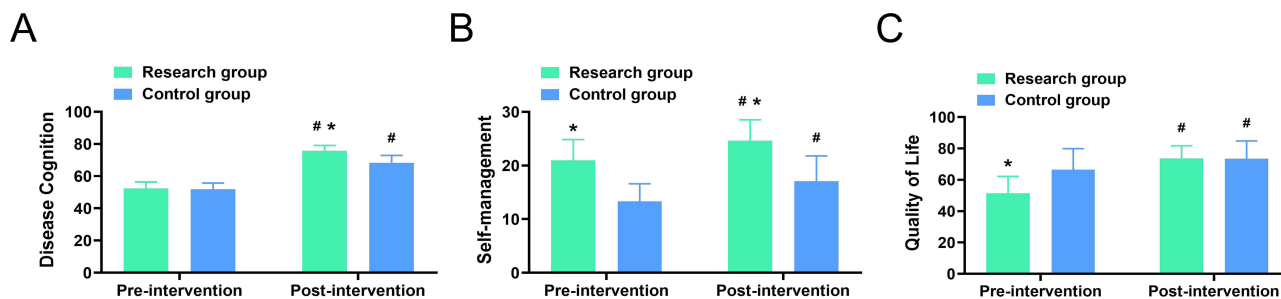
**Note:** Comparison with pre-intervention in the same group, #P < 0.05; between-group comparison, \*P < 0.05.

strategies. These challenges necessitate interventions that address not only knowledge gaps, but also emotional support and behavioral skill building to improve patients’ comprehensive self-management abilities.

Our approach incorporates several key innovations compared to the existing literature. First, the intervention integrated real-time self-monitoring tools with tailored educational content, enabling patients to receive timely feedback and adapt their behavior accordingly. Digital health tools have been shown to enhance patient engagement and adherence by providing personalized data and facilitating timely communication between patients and health care providers. Second, unlike prior applications of the ITHBC, which often emphasized either individual-or family level support, our model embedded a dual-layered support system that involved both family caregivers and peer patients.<sup>28,29</sup> This structure amplifies motivation through shared experience and emotional resonance, creating a cohesive behavioral reinforcement loop. Peer support has been demonstrated to effectively reduce feelings of isolation and promote positive health behaviors among cancer patients.<sup>30</sup>

Moreover, intervention outcomes were assessed through a triad of indicators—disease-related knowledge, behavioral self-efficacy, and patient-reported quality of life—within a unified theoretical schema. This comprehensive measurement design offers a more integrative understanding of how behavioral changes unfold in clinical practice. Notably, compared to Shen et al’s study of breast cancer survivors who utilized psychoeducational counseling without structured theoretical underpinning, our intervention operationalized each ITHBC domain through clearly defined strategies: cognitive restructuring, skill acquisition, and ecological support.<sup>31</sup> This enhances the clarity, reproducibility, and theoretical fidelity of the intervention, providing a more rigorous framework for behavioral change interventions in oncology nursing.

These findings have practical significance. Given the rising aging population and the increasing use of radiotherapy among older adults, there is an urgent need for structured, scalable, and evidence-based nursing interventions. By demonstrating that behavioral theory can be translated into effective multidisciplinary care models, this study contributes not only to the theoretical enrichment of health behavior science, but also to the practical advancement of geriatric oncology nursing. The incorporation of interdepartmental collaboration and digital health applications further supports the ongoing informatization of geriatric care, aligning with national and international health priorities. In addition to its



**Figure 3** Comparison of quality of survival scores between the two groups before and after intervention. (A) Disease Cognition score; (B) Self-management score; (C) Quality of Life score. (points,  $\bar{x} \pm s$ ).

**Note:** comparison with Pre-intervention in the same group, #P < 0.05; Between-group comparison, \*P < 0.05.

demonstrated effectiveness, the feasibility, cost-effectiveness, and scalability of this intervention warrant further consideration. From a feasibility standpoint, the intervention was successfully delivered within the routine radiotherapy nursing schedule, requiring minimal restructuring of the clinical workflows. Most components, such as peer support meetings, mobile-based self-monitoring, and interdisciplinary consultations, were implemented using existing institutional resources, indicating good compatibility with standard-care settings. In terms of cost-effectiveness, the use of digital tools (eg, health apps) reduced the demand for repeated face-to-face sessions and allowed for more efficient patient follow-up, suggesting potential long-term savings in human resources and healthcare costs. Regarding scalability, the modular design of the intervention, comprising motivation enhancement, behavior skill training, and sustained social support, permits adaptation across various oncology departments and different patient populations. Future implementation studies should further evaluate these aspects using standardized economic and operational metrics to confirm the intervention's value in broader health care systems.

Despite these strengths, several limitations of this study warrant consideration. First, the quasi-experimental design with time-based grouping may have introduced potential selection bias and confounding variables. Future studies should implement randomized controlled trials (RCTs) to strengthen causal inferences. Second, the relatively short follow-up period (5 months) may not fully capture long-term intervention effects or delayed adverse outcomes, such as chronic radiation dermatitis. Long-term follow-up ( $\geq 12$  months) is recommended to evaluate sustainability. Third, although the control group received routine individualized health education, this may have attenuated between-group differences. Subsequent research should more rigorously define and control for intervention intensity and fidelity. In summary, this study validated the utility of ITHBC as a guiding framework for developing structured nursing interventions tailored to older adults undergoing radiotherapy. The integration of cognitive, behavioral, and social components into a coherent intervention model provides a replicable template for promoting health behavioral changes in this vulnerable population. These findings have important implications for enhancing patient-centered care and improving health outcomes in geriatric oncology settings.

## Conclusion

This study demonstrated that a nursing intervention model based on the ITHBC significantly improves disease cognition, self-management ability, and quality of life among older adult patients undergoing radiotherapy. The intervention program effectively operationalized the theoretical components—cognitive beliefs, self-regulation, and social facilitation—through structured and interdisciplinary strategies. Unlike the control group, which received routine health education, the experimental group benefited from a systematized, theory-driven intervention that incorporated personalized assessments, goal-oriented skills training, and digital tools for behavior tracking. The integration of family and peer support mechanisms also fostered a reinforcing social ecology for sustained behavioral improvements. Thus, this study provides a novel and practical framework for geriatric radiotherapy nursing, contributing valuable theoretical and empirical insights. Future applications of this model in broader clinical contexts are warranted to promote precision, continuity, and patient-centered care in aging populations.

## Data Sharing Statement

All the results are presented in the article. Further inquiries can be directed to the corresponding authors.

## Ethics Statement

The research protocol was approved by the Ethics Committee of Jiangsu Cancer Hospital (No. KY-2024-103). All experiments and procedures were performed according to the Declaration of Helsinki (as revised in 2013).

## 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

The authors report no conflicts of interest in this work.

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