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The impact of nursing model supported by digital health technology (wearable device-assisted monitoring and online rehabilitation guidance) on the negative emotions, self-efficacy and quality of life of breast cancer patients: A retrospective study

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Abstract: Objective: To explore the impact of nursing model supported by Digital health technology (DHT) on the quality of life, negative emotions, and self-efficacy of breast cancer patients, with a view to providing a basis for the scientific management and intervention of breast cancer patients. **Methods:** This study retrospectively included 138 breast cancer patients who were treated at The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University from January 2022 to December 2024. According to their nursing models, patients were divided into intervention group (70 patients received the nursing model supported by DHT) and control group (68 patients received the conventional nursing model). The differences in the scores of the Self-Rating Anxiety Scale (SAS), Self-Rating Depression Scale (SDS), Functional Assessment of Cancer Therapy - Breast (FACT-B) scale, and Self-Efficacy Scale for Patients with Breast Cancer (SUPPH) between the two groups were compared before discharge and three months after discharge. **Results:** The patients intervened by the nursing model based on DHT had lower scores of SAS ($t = 3.308$, $P = 0.001$) and SDS ($t = 2.482$, $P = 0.014$), while the scores of FACT-B ($t = 7.274$, $P = 0.014$) and SUPPH ($t = 1.975$, $P = 0.050$) were higher. **Conclusion:** This study conducted in-hospital and out-of-hospital nursing interventions for breast cancer patients through the nursing model supported by DHT, and explored the impact of the new nursing model on the quality of life, depression level, and self-efficacy of them. The results show that the nursing model based on DHT has a positive impact on the quality of life, negative emotions, and self-efficacy of patients.

Keywords: Digital health technology; nursing model; breast cancer; anxiety; depression; quality of life; self-efficacy

1. Introduction

Breast carcinoma originates from the breast epithelial tissue. It has surpassed lung cancer to become the most common cancer globally and ranks fifth among the causes of cancer-related deaths. According to relevant statistical analysis, in 2020, it was estimated that there were 2.3 million cases of breast cancer patients, and approximately 685,000 deaths. Its incidence rate ranks first among female cancers, accounting for about 24.5% of all female cancer cases and 15.5% of all causes of female cancer-related deaths [1]. Currently, it has become a major global public health problem [2]. The main treatment for breast cancer is surgical treatment, followed by adjuvant therapies such as chemotherapy, radiotherapy, targeted therapy, and immunotherapy. The diagnosis and adjuvant treatment of breast cancer are major blows to every patient. As essential treatment methods for breast cancer, surgery and

adjuvant therapies can suppress tumor cells, but they also lead to breast loss in patients, as well as symptoms such as nausea, vomiting, and menstrual disorders. Breast cancer mostly affects middle - aged women. Women at this age play an important role in family income. The diagnosis of breast cancer can affect family income, and the costs of treatment deplete family finances. Coupled with the lack of understanding, care, and support from family members, all these factors increase the risk of negative emotions such as depression and anxiety in breast cancer patients [3,4]. Negative psychology can significantly reduce the number of T-cell subsets [5], leading to a decrease in patients' immune function, which in turn increases the occurrence of complications and promotes the development of tumors [6,7], seriously affecting patients' survival rate and quality of life [8–11]. However, when the quality of life decreases, it will increase the risk of negative emotions such as depression and anxiety, forming a vicious cycle over time.

Some relevant scholars' research indicates that the prevalence rates of depression and anxiety among female breast cancer patients globally are 32.29% and 41.9% respectively [12]. Among Chinese female breast cancer patients, the prevalence rates of depression and anxiety are 61.0% and 48.8% respectively [13], which are higher than the global levels. This may be related to differences in race, culture, and religious beliefs, as well as the fact that most Chinese female patients are too conservative in their thinking, unwilling to communicate and interact with others, and tend to endure when they are ill. With the transformation from the traditional medical model to the bio-psycho-social model, the field of oncology has generally regarded the quality of life as the ultimate indicator for evaluating the treatment and rehabilitation outcomes of cancer patients. The treatment of cancer patients has gradually shifted from simply emphasizing the extension of survival time in the past to improving the quality of life of patients at present.

The World Health Organization [14] in the “Global Strategy on Digital Health 2020–2025”, defines digital health as the domain of knowledge and practice related to the development and utilization of digital technologies for health improvement. Digital health technology (DHT) can support the active self-management of chronic diseases through education, monitoring and support, timely feedback, and remote access to healthcare professionals [15]. If successfully designed and implemented, digital health interventions present an opportunity to support the quadruple aims of healthcare, namely, improving health outcomes, enhancing the patient experience, reducing healthcare costs, and increasing clinician satisfaction [16]. The American Medical Association (AMA) defines digital health tools as systems and solutions that enable patients to engage in clinical purposes, collect, organize, interpret, utilize clinical data, and manage outcomes and other measures of care quality. These include telemedicine, mHealth (mobile health), wearable devices, remote monitoring, and applications. The AMA Digital Health Survey classifies digital health solutions into seven categories: remote monitoring for efficiency improvement, remote monitoring and management for care enhancement, clinical decision-support, patient engagement, remote consultations, point-of-care, and tools for consumers to access clinical data [17]. The existing research on the impact of Nursing Model Supported by Digital Health Technology on Breast Cancer Patients tends to focus on the study of quality of life and

neglects the study of its emotional impact, and the research results are unclear [18–20]. This article aims to explore the impact of the nursing model supported by digital health technology on the quality of life, negative emotions, and self-efficacy of breast cancer patients, with the expectation of providing a basis for the scientific management and intervention of breast cancer patients.

2. Methods

2.1. Materials and methods

This study retrospectively included 138 breast cancer patients who were treated at The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University from January 2022 to December 2024. Our grouping relied on information already recorded during patient care. According to their nursing models, the patients were divided into an intervention group (70 patients who received the nursing model supported by digital health technology) and a control group (68 patients who received the conventional nursing model).

Inclusion criteria: (I) Initially diagnosed with breast cancer through relevant clinical examinations. (II) Females over 18 years old with capacity for civil conduct. (III) Patients with normal cognitive function, no communication barriers, and capable of completing relevant questionnaires. (IV) Without severe organ dysfunctions, such as myocardial infarction, heart failure, or malignancies of other organs. (V) With complete clinical data.

Exclusion criteria: (I) Patients with a life expectancy of ≤ 6 months. (II) Lactating or pregnant women.

2.2. Sample size

The sample size was estimated based on relevant research reports [13] and the results of preliminary pre-tests. Approximately 60% of breast cancer patients receiving conventional nursing had negative emotional problems, while 35% of patients receiving DHT-based nursing had such problems. With an alpha risk of 5% and a beta risk of 10%, 40 subjects should be included (20 in each group). And we included 130 patients to avoid attrition bias. Screening was carried out according to the inclusion and exclusion criteria, and 12 patients with incomplete or missing data were excluded.

2.3. Intervention

Control group: During hospitalization, all patients were provided with routine diagnosis, treatment, nursing care, and health education in the department of breast tumor surgery. At the time of discharge, patients received routine discharge instructions, including dietary guidance, exercise guidance, advice on avoiding pregnancy, adherence to treatment, regular breast examinations, and education on maintaining the affected limb. In addition, patients were informed that the researcher herself would serve as a telephone contact nurse and an outpatient follow-up nurse to conduct follow-up visits. The follow-up was carried out once a month within 6 months after discharge to understand the functional recovery of the affected limb and provide corresponding health guidance.

Intervention group: The intervention group received additional support from DHT. During the hospitalization period, wearable electronic devices (Nursing Cloud v1.1.22, Qingdao Hushitong Medical Technology Co., Ltd.) were used to monitor patients' vital signs in real-time, such as heart rate, blood pressure, and blood oxygen saturation. This enabled real-time monitoring and assessment of patients' conditions, allowing for the timely detection of potential health problems and the implementation of corresponding adjustment measures. Nursing cloud has two modes: the cared for person and the caregiver. The cared for person mode can monitor physical sign data in real time and understand their own treatment plan; The caregiver mode allows for real-time monitoring of patients' physical signs, alerting them to health changes, and providing solutions. The hospital information system (HIS) was integrated with a mobile application (App), facilitating medical staff in managing patients' medical records. Patients could also use the App to access information about their hospital arrangements, such as the surgery time and examination appointments. This helped to reduce patients' anxiety and improve their satisfaction with the hospital admission process. After surgery, the wearable devices continued to monitor patients' vital signs. The data provided by these devices were useful for the timely detection of postoperative complications, such as bleeding and respiratory depression.

After discharge, wearable devices and home medical monitoring equipment (such as electronic blood pressure monitors, blood glucose meters, etc.) continued to function. Patients could upload the data collected by these devices (such as blood pressure, blood glucose, body weight, etc.) to the cloud server via a mobile phone App. Medical staff could remotely view this data to timely understand the patients' physical recovery status. For example, for breast cancer patients who needed endocrine therapy, through remote monitoring, medical staff could adjust the dosage of therapeutic drugs according to the data or suggest that patients adjust their lifestyles. Patients could record the degree, frequency, and duration of breast pain through the APP. The App used a visual method, such as a pain rating scale (0–10 points), allowing patients to score and record daily. At the same time, for common side effects of breast cancer treatment, such as nausea, vomiting, fatigue, and other symptoms, patients could also record their occurrence in the App. Through the statistical analysis of these symptom data, doctors could more accurately assess the tolerance and effectiveness of the treatment and timely adjust the drug dosage or treatment method.

Psychological Support and Rehabilitation Guidance: During the post-discharge rehabilitation process, patients may experience psychological stress due to factors such as changes in body image and concerns about disease recurrence. VR technology can create virtual psychological therapy scenarios, such as support group meetings and relaxation training environments. Patients can use VR devices at home to participate in these psychological therapy activities, share experiences with other patients, and relieve psychological burdens.

Treatment Plan and Reminders: The App generates a detailed treatment plan schedule based on the patient's treatment protocol (such as surgery date, chemotherapy cycle, radiotherapy time, etc.). Before the start of each treatment stage, push notifications are sent to remind patients to get prepared. For example, one day before chemotherapy, patients are reminded to pay attention to their diet and check blood

routine and other indicators. During radiotherapy, patients are reminded to protect their skin and apply protective ointment on time.

At the same time, the App regularly provides patients with popular science knowledge about treatment. It explains to patients the mechanism of action of chemotherapy drugs, possible side effects, and corresponding coping methods.

2.4. Nursing staff

All nursing staff are professionally trained in daily breast cancer patient care. Prior to using the Nursing Cloud APP for intervention, they receive standardized training on its functions and operations. Training covers features like real-time vital sign monitoring, health diary recording, and health consultation processes. It also includes how to use in-app health guidance for patient management and effective communication via the APP. Through theoretical teaching, simulations, case studies, and practical drills, nurses can proficiently and uniformly use the APP for high-quality care.

2.5. Intervention period and frequency

The intervention starts when a patient is diagnosed with breast cancer and joins the Nursing Cloud APP project, ending at the stable recovery stage post-treatment. The duration varies by patient condition and treatment, typically 3 months. Nurses check patients' daily-uploaded health data on the APP, communicate with patients online at least once a week, and increase communication frequency (3 times a week) for patients in chemotherapy or radiotherapy. Patients are required to record daily health diaries.

2.6. Quality control

Quality control is maintained in several ways. A comprehensive nurse operation manual is established, clearly stating APP-based nursing operation standards. A regular evaluation mechanism for nurses is set up, analyzing communication records, data accuracy, and patient satisfaction. The APP itself has a data quality monitoring function, alerting nurses and patients to abnormal or missing data.

2.7. Patient compliance strategies

To ensure patient compliance, nurses provide detailed APP usage guidance when patients first use it, explaining its importance. The APP has a simple interface and operation process, along with reminder functions. Nurses also give timely feedback and encouragement to patients, praising compliant ones and helping those with difficulties.

2.8. Evaluation indicators

The general situation questionnaire includes demographic data (such as age, residence, marital status, family type, education level, and occupation) and clinical data (such as comorbidities, pathological and clinical stages, and surgical methods).

Self-rating Anxiety Scale (SAS) [21]: The SAS is one of the most commonly used anxiety assessment tools currently. Its Cronbach's α coefficient is 0.78. It was developed by Professor W.K. Zung, a Chinese-American professor at an American

medical school. It uses a 4-point Likert scale for scoring and consists of a total of 20 questions. The scale is designed as a psychological assessment tool by dividing the degree of anxiety based on people's psychological characteristics. The classification of standard scores is as follows: 50–59 points indicate mild anxiety, 60–69 points indicate moderate anxiety, and 70 points or more indicate severe anxiety. (The calculation method of the standard score is the sum of the scale scores multiplied by 1.25).

Zung's Self-Rating Depression Scale (SDS): The SDS is a standardized self-assessment scale for depression, used to evaluate the degree of depression in patients. It is widely applied in clinical practice and has high credibility and effectiveness. This scale consists of 10 positively-scored items and 10 negatively-scored items. Each item adopts a 4-level scoring system to assess the frequency of symptoms. For positively-scored items, the scores are presented in ascending order: 1) rarely or none of the time; 2) a little of the time; 3) a good part of the time; 4) most of the time or all of the time. Negatively-scored items are presented in descending order. The total score is obtained by adding up all the item scores, multiplying by 1.25, and then rounding to the nearest whole number to get the standard score. A score less than 50 indicates normal status, 50–59 indicates mild depression, 60–69 indicates moderate depression, and a score of 70 or above indicates severe depression. The Cronbach's α value of this scale is 0.92 [22].

The Functional Assessment of Cancer Therapy-Breast (FACT-B) is the first-choice scoring scale for evaluating the quality of life of postoperative breast cancer patients. This scale is divided into five dimensions, namely, physical condition, social and family condition, somatic condition, emotional condition, and additional concerns. It consists of 36 items, including 17 positively-scored items and 19 negatively-scored items. The FACT-B adopts a 5-level scoring system, which are “not at all”, “a little”, “somewhat”, “quite a bit”, and “very much”. The score range of FACT-B is from 0 to 144 points, and a higher score indicates a better quality of life. The Cronbach's α values of the five dimensions of this scale are between 0.772 and 0.810, and the total value is 0.88 [23].

Strategies Used by People to Promote Health (SUPPH): The SUPPH, also known as the Health Strategy Promotion Scale, is mainly designed to measure the self-care efficacy of cancer patients. This scale contains 4 elements, and the Chinese version is composed of 28 items to evaluate the self-efficacy of cancer patients. Each item of the SUPPH is scored on a 5-point confidence level scale, with 1 indicating “rarely”, increasing incrementally, and 5 indicating “quite a lot”. A higher score indicates a stronger self-efficacy of the patients. The total Cronbach's α value of this scale is 0.93 [24,25]. See **Table 1**.

Table 1. Reliability coefficients of four common scales in breast cancer research.

Scale name	Scale purpose	Cronbach's alpha coefficient
SAS	To assess the anxiety level of individuals	0.78
SDS	Mainly used to measure the depression level of individuals	0.92
FACT-B	Specifically designed for breast cancer patients to measure their quality of life	0.88

Table 1. (Continued).

Scale name	Scale purpose	Cronbach's alpha coefficient
SUPPH	Used to evaluate the self-efficacy of individuals, especially in the context of breast cancer treatment and rehabilitation	0.93

2.9. Data collection methods

A database was established for all enrolled patients to record their general information. The questionnaire survey results of patients before the intervention and three months after the intervention were recorded. The questionnaires were filled out by the patients. After completion, the questionnaires were immediately collected and the filling quality was checked. The general information was filled out only for the first time, while the rest of the information needed to be filled out on both occasions. If the patients came to the hospital but were not hospitalized during the two filling times, they could complete the questionnaires in the outpatient department. If the patients did not come to the hospital, the data could be collected via telephone or other means.

2.10. Statistical analysis

During the data statistics process, the integrity of the data was first checked. After ensuring accuracy, the data was entered by two people. All data were statistically analyzed using the SPSS 22.0 statistical software. To ensure the accuracy of the results, all data calculations were repeated more than twice. Measurement data were analyzed using the t -test, and count data were analyzed using the χ^2 test. For within-group pre-and post-comparisons, paired t -tests and Wilcoxon signed-rank tests were used for statistical description. A P -value less than 0.05 indicated a statistically significant difference.

3. Results

3.1. Comparison of general patient data

A total of 138 patients were included in this study. The personal information and medical records of the two groups of patients were statistically organized. The personal information included age, marital status, family type, education level, place of residence, occupation, and income. The results showed that there was no statistically significant difference ($P > 0.05$). The medical records included clinical stage, surgical method, presence of comorbidities, and presence of cancer pain. The results indicated that there was no statistically significant difference ($P > 0.05$). See **Table 2** for details.

Table 2. Baseline data.

Item N (%)	Control group	Intervention group	X^2	P
Age(year)				
<40	4(5.9)	6(8.6)	1.254	0.458
40~50	23(33.8)	19(27.1)		
51~60	24(35.3)	29(41.4)		

Table 2. (Continued).

Item N (%)	Control group	Intervention group	X ²	P
>60	17(25.0)	53(38.4)		
Marital status				
Unmarried	2(2.9)	3(4.3)		
Married	53(77.9)	56(80.0)	3.143	0.287
Divorced	5(7.4)	1(1.4)		
Widowed	8(11.8)	10(14.3)		
Family type				
Living alone	53(77.9)	55(78.6)		
Living with spouse	12(17.6)	12(17.1)	3.009	0.370
Living with descendants	3(4.4)	1(1.4)		
Extended family	0(0)	2(2.9)		
Education level				
Junior high school or below	39(57.4)	33(47.1)		
High school/technical secondary school	16(23.5)	22(31.4)	1.562	0.394
College or above	13(19.1)	15(21.4)		
Address				
Countryside	36(52.9)	32(45.7)	0.721	0.740
City	32(47.1)	38(54.3)		
Monthly per-capita family income (yuan)				
>3000	20(29.4)	21(30.0)		
3000~6000	29(42.6)	34(48.6)	0.863	0.650
>6000	19(27.9)	15(21.4)		
Occupation				
Institution	9(13.2)	15(21.4)		
Enterprise	18(26.5)	19(27.1)		
Freelance	11(16.2)	9(12.9)	4.047	0.280
Unemployed	13(19.1)	17(24.3)		
Retired	17(25.0)	10(14.3)		
Disease stage				
I	17(25.0)	10(14.3)		
II	39(57.4)	45(64.3)	2.548	0.390
III	12(17.6)	15(21.4)		
Surgical method				
Breast-conserving surgery	13(19.1)	12 (17.1)	0.091	0.827
Modified radical mastectomy	55(80.9)	58(82.9)		
With comorbidities				
Yes	32(47.1)	39(55.7)	1.035	0.496
No	36(52.9)	31(44.3)		
With cancer-related pain				
Yes	16(23.5)	11(15.7)	1.339	0.400
No	52(76.5)	59(84.3)		

Analysis of the Influencing Factors and Correlation of Depression and Anxiety in Breast Cancer Patients

The research findings demonstrated that the per-capita monthly household income, surgical methods, and the presence of cancer-related pain had statistically significant differences in the SAS and SDS scores of breast cancer patients ($P < 0.05$). See **Table 3** for details.

Table 3. Comparison of anxiety and depression scores among breast cancer patients with different characteristics.

	SAS		SDS	
	<i>t/F</i>	<i>P</i>	<i>t/F</i>	<i>P</i>
Age	1.916	0.009	1.329	0.141
Marital status	1.228	0.223	0.620	0.941
Family type	0.518	0.978	0.634	0.932
Education level	0.668	0.894	0.955	0.545
Address	0.894	0.687	0.825	0.732
Monthly per-capita family income	7.383	0.000	11.002	0.000
Occupation	1.160	0.286	0.696	0.833
Disease stage	0.669	0.893	0.660	0.913
Surgical method	2.692	0.000	1.770	0.016
With comorbidities	1.370	0.126	1.306	0.156
With cancer-related pain	2.870	0.000	1.775	0.015

3.2. Comparison of quality of life between the two groups

When comparing the quality of life of the two groups of patients, it was found that before discharge, there were no statistically significant differences in the sub-groups (physical condition, social and family condition, emotional condition, functional condition, additional concerns) and the total scores of the quality of life between the two groups of patients ($P > 0.05$). Three months after the intervention, the score results of the intervention group were better than those of the control group, and the difference between the two groups was statistically significant ($P < 0.05$). See **Table 4** for details.

Table 4. Comparison of the quality of life between the two groups of patients before and after the intervention.

Item		Physiological condition	Social function	Emotional condition	Functional condition	Additional concerns	General health
Before nursing	Control group	16.46 ± 2.88	15.87 ± 1.97	16.56 ± 2.81	16.66 ± 2.77	19.96 ± 3.02	85.5 ± 6.19
	Intervention group	16.06 ± 2.91	15.86 ± 2.06	17.01 ± 2.53	15.99 ± 2.43	19.49 ± 2.95	84.16 ± 5.52
<i>t</i>		0.808	0.031	1.001	1.523	0.925	1.123
<i>p</i>		0.421	0.976	0.319	0.130	0.357	0.263
After nursing	Control group	17.24 ± 2.57	17.12 ± 1.86	17.38 ± 2.55	16.59 ± 2.1	20.46 ± 2.79	88.78 ± 4.67
	Intervention group	18.1 ± 1.87	18.13 ± 2.12	18.73 ± 1.66	17.31 ± 1.88	21.87 ± 2.24	94.14 ± 3.97
<i>t</i>		2.260	2.977	3.685	2.145	3.289	7.274
<i>P</i>		0.025	0.003	0.000	0.034	0.001	0.000

Using the paired-samples t-test to compare the quality-of-life scores of the two groups of patients before and after the intervention within the group, it was found that in the control group, except for social function and General health, there were no statistically significant differences in other scores before and after the intervention ($P > 0.05$). However, in the intervention group, there were statistically significant differences in the scores of each group before and after the intervention ($P < 0.05$). See **Table 5** for details.

Table 5. Within-group comparison of the quality of life of the two groups of patients before and after the intervention.

Item		Physiological function	Social function	Emotional condition	Functional condition	Additional concerns	General health
Control group	Before nursing	16.46 ± 2.88	15.87 ± 1.97	16.56 ± 2.81	16.66 ± 2.77	19.96 ± 3.02	85.5 ± 6.19
	After nursing	17.24 ± 2.57	17.12 ± 1.86	17.38 ± 2.55	16.59 ± 2.1	20.46 ± 2.79	88.78 ± 4.67
<i>t</i>		1.663	3.808	1.790	0.174	1.002	3.486
<i>p</i>		0.099	0.000	0.076	0.862	0.318	0.001
Intervention group	Before nursing	16.06 ± 2.91	15.86 ± 2.06	17.01 ± 2.53	15.99 ± 2.43	19.49 ± 2.95	84.4 ± 5.29
	After nursing	18.1 ± 1.87	18.13 ± 2.12	18.73 ± 1.66	17.31 ± 1.88	21.87 ± 2.24	94.14 ± 3.97
<i>t</i>		4.934	6.432	4.736	3.616	5.387	12.323
<i>P</i>		0.000	0.000	0.000	0.000	0.000	0.000

3.3. Comparison of anxiety and depression between the two groups

Before discharge, there was no significant difference in the SAS and SDS scores between the two groups of patients ($P > 0.05$). Three months after the intervention, the SAS and SDS scores of the patients in the intervention group were significantly lower than those in the control group, and the difference was statistically significant ($P < 0.05$). See **Table 6**, **Figures 1** and **2** for details.

3.4. Comparison of self-efficacy between the two groups

Before discharge, there was no significant difference in the self-efficacy scores between the two groups of patients ($P > 0.05$). Three months after the intervention, the intervention effect of the intervention group was significantly higher than that of the control group, and the difference in the self-efficacy scores between the two groups of patients was statistically significant ($P < 0.001$). See **Table 7** for details.

Table 6. Comparison of SAS and SDS scores of the two groups of patients before and after intervention.

Item		SAS	SDS
Before nursing	Control group	56.75 ± 6.31	57.35 ± 8.67
	Intervention group	55.04 ± 6.49	57.54 ± 7.78
<i>t</i>		1.566	0.135
<i>P</i>		0.120	0.892
After nursing	Control group	50.04 ± 7.73	51.62 ± 8.89
	Intervention group	46.19 ± 5.88	48.17 ± 7.37

Table 6. (Continued).

Item	SAS	SDS
<i>t</i>	3.308	2.482
<i>P</i>	0.001	0.014

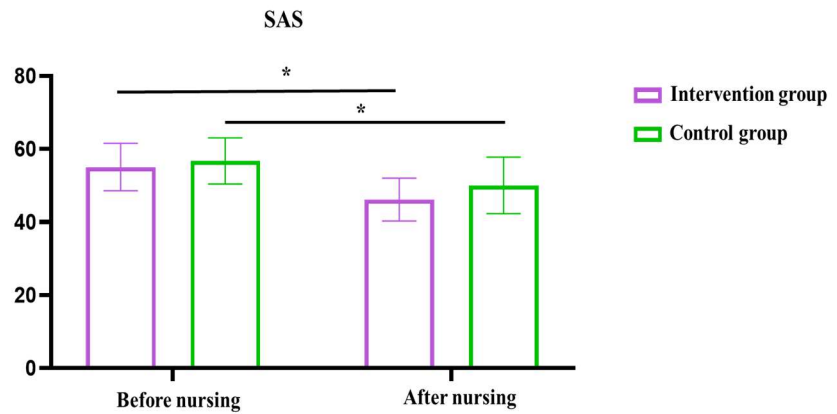


Figure 1. Comparison of SAS scores between the two groups.

* means $P < 0.05$.

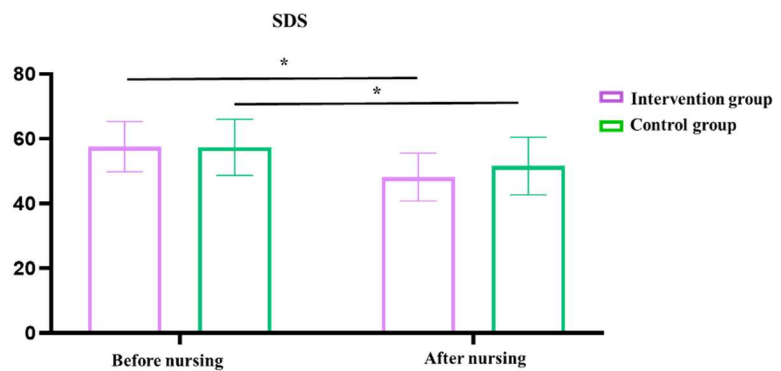


Figure 2. Comparison of SDS scores between the two groups.

* means $P < 0.05$.

Table 7. Comparison of self-efficacy scores of the two groups of patients before and after the intervention.

Item	Control group	Intervention group	<i>t</i>	<i>P</i>
Before nursing	63.22 ± 4.18	64.24 ± 3.78	1.508	0.134
After nursing	85.93 ± 6.99	88.74 ± 9.53	1.975	0.050
<i>t</i>	23.000	19.997		
<i>P</i>	0.000	0.000		

4. Discussion

A total of 150 patients were enrolled in this study. 7 patients in the control group and 5 patients in the intervention group were excluded due to incomplete data. Finally, 138 patients completed the study. In contrast to previous studies, this research employs a more comprehensive and fine-grained data-collection method. Many prior works relied on intermittent self-reported data from patients, which may be subject to recall

bias. In our study, the wearable devices in the DHT-supported nursing model continuously and objectively monitor patients' physiological parameters in real - time. This real-time data collection provides a more accurate and dynamic picture of patients' physical conditions throughout the in-hospital and post-discharge periods. Another new aspect is the sample scope. Most existing research focuses on a single stage of breast cancer treatment or a specific patient subgroup. Our study encompasses a diverse range of breast cancer patients at different treatment stages, from newly diagnosed cases to those in long-term post-treatment rehabilitation. This broad sample scope allows for a more generalized conclusion about the effectiveness of the DHT-supported nursing model across the entire breast-cancer patient population. Among the patients participating in this study, the majority were over 40 years old, which is consistent with the results of other studies [26]. There was no significant difference in the personal information and disease-related data between the two groups of patients, which made the intervention in this study more feasible. Due to the early detection of breast cancer and the advancement of medical technology, the number of breast cancer survivors has been increasing year by year. For early-stage breast cancer patients, the 5-year survival rate has exceeded 90% [27]. The quality of life of breast cancer patients, such as physical condition, psychological state, and living standard, is closely related to the side - effects caused by disease treatment. Some studies have shown that the physical function and emotional state of breast cancer patients decline in a short period after treatment. For example, breast - conserving surgery patients have better overall health conditions than those who undergo simple mastectomy [28] which is also in line with our research findings. Although chemotherapy and radiotherapy for breast cancer have significant curative effects, the negative impacts of these treatment methods on patients' psychological state, cardiovascular system, and metabolism are also quite obvious. Most cancer patients enter a state of anxiety and depression upon first learning of their cancer diagnosis. Different from the physical discomfort during treatment, patients' fear of death, insufficient social support, life pressure, and changes in body image all increase their level of depression [29,30]. This study also found that most breast cancer patients have a negative attitude. Three months after the intervention of the two nursing models in this study, the depression scores of patients receiving DHT-based nursing decreased significantly. In the control group receiving routine care, the depression score also decreased after intervention compared to before intervention, but not as significantly as in the intervention group. This may be attributed to the fact that the nursing cloud app provides patients with a convenient way to obtain health information, allowing them to constantly understand their own disease and rehabilitation knowledge, reducing anxiety caused by uncertainty. At the same time, through health diary records and frequent online communication with nurses, patients feel sustained care and support, thereby enhancing their confidence in coping with the disease and improving their self-efficacy. The DHT - based nursing model can dynamically manage and timely intervene in patients at different stages, enabling them to better adapt to the breast cancer treatment process. Self-efficacy is an indicator of an individual's confidence in performing relevant behaviors in self-care situations and is closely related to the physical and mental health of cancer patients. In order to promote patients' self-care behaviors and improve their psychological and functional states, it is necessary to first improve patients' self-

efficacy [31,32]. Patients with a higher level of self-efficacy are more confident in their ability to combat the disease and manage the adverse reactions during cancer treatment [33]. Breast cancer is a complex disease. Patients need to understand knowledge about the disease progression, treatment methods, and side-effect management, etc., so as to better participate in the self-care process, enhance their confidence in self-care ability, and improve their quality of life. Digital health technology, by releasing real - time health knowledge, meets patients' corresponding knowledge needs, provides online scenarios to relieve stress and emotions, and offers various means to cope with physical discomfort. Psychologically, it reduces or eliminates patients' anxiety, depression, and other emotional disorders related to breast cancer, enhances patients' confidence in disease recovery, enables them to face life more positively and get out of the shadow of the disease, which helps to improve patients' self-efficacy.

5. Conclusion

From the perspective of theoretical contributions, this study enriches the theoretical system of digital technology application in the nursing field. Although previous studies have mentioned digital health technology, there has been a lack of systematic and in-depth exploration. This study has confirmed that the DHT-based nursing model can significantly enhance patients' self-efficacy, which is consistent with the view in social cognitive theory that individuals can enhance their sense of self-efficacy through external support. It provides new empirical evidence for the application of this theory in nursing practice. At the same time, the remarkable effect of this nursing model in alleviating patients' anxiety and depression expands the theoretical understanding of the integration of psychological nursing and digital technology, indicating the importance of providing continuous psychological support through digital platforms to improve patients' psychological state.

In terms of practice, the effectiveness of the DHT-based nursing model in the nursing of breast cancer patients has been clarified. This model, with the help of tools such as the Nursing Cloud APP, provides patients with convenient access to health information and an efficient communication channel with nursing staff. This not only improves patients' self-care ability, making them more active in disease management, but also effectively improves patients' quality of life. This provides powerful practical guidance for medical institutions to promote digital health technology in nursing practice, encouraging more hospitals to introduce such nursing models, optimize nursing service processes, and improve the overall quality of nursing care.

6. Limitations

The intervention duration of this study was only three months. Given that the treatment cycle of breast cancer patients is relatively long, it was impossible to continuously monitor the patients' physical and mental conditions, depressive states, and self-efficacy. Moreover, the sample size was small and homogeneous, resulting in poor representativeness. In future research, multi-center sampling will be conducted to avoid potential biases and enhance the persuasiveness of the research findings.

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Ethical approval: The procedures for both T1 and T2 surveys adhered to the (i) Declaration of Helsinki, and (ii) ethical principles for medical, psychological, and sociological research involving human participants. The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University Research Ethics Committee approved the study protocol. The protocol code is KY-2024-083-01 and the approval date is 05/07/2024. All participants: Signed the informed consent in this study.

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