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Enhancing Self-Care and General Health in Women with Breast Cancer: The Impact of Quality-of-Life Therapy

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ABSTRACT

Background: Breast cancer, one of the most prevalent cancers among women, not only affects physical health but also significantly impacts psychological well-being and self-care practices. This study aimed to evaluate the impact of Quality-of-Life Therapy (QoLT) on self-care and mental health in women with breast cancer.

Methods: A quasi-experimental design with pre-test, post-test, and two-month follow-up was employed, involving a control group. The study population included breast cancer patients admitted to Shohadaye Kargar Hospital in Yazd from September 2023 to February 2024. Participants were selected based on inclusion criteria such as female gender, age 30–60, breast cancer diagnosis, and undergoing hormone therapy, while exclusion criteria included smoking, severe illness, or psychiatric treatment. Thirty-one patients were purposively sampled and randomly assigned to an intervention group (N = 15) receiving 10 QoLT sessions over two months, or a control group (N = 16) receiving routine care only. Data were collected using the General Health Questionnaire (GHQ-28), Individualized Self-Care Scale (ICS), and a demographic form, and analyzed using SPSS-21 and repeated measures ANOVA.

Results: Findings showed that QoLT significantly improved self-care ($F = 11.06$, effect size = 61%) and mental health ($F = 255.2$, effect size = 80%) ($p < 0.001$). These effects persisted at the two-month follow-up.

Conclusion: The results demonstrated the effective impact of QoLT on self-care behavior and improvement in mental health among breast cancer patients. It is therefore recommended that QoLT be used as an adjunctive treatment alongside routine care for breast cancer patients.

Keywords: Quality of Life, Self-Care, Mental Health, Breast Cancer

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Introduction

Today, cancer is recognized as the second leading cause of death in developed countries and the fourth leading cause in developing countries (1). Among these, breast cancer is considered one of the most serious health issues affecting women worldwide (2). In 2021, approximately 1.7 million new cases of breast cancer were identified globally (3), and it is estimated that by the end of 2025, there will be an additional 310,720 new cases of breast cancer among women in the United States, with 42,250 deaths attributable to the disease (4). According to reports from the World Health Organization (WHO), the number of breast cancer cases in the Middle East is expected to double by 2030 (5). In Iran, due to urbanization and decreased physical activity, breast cancer, accounting for 24.4% of all cancers, is recognized as the most common type of cancer among Iranian women (6, 7).

Breast cancer, as a potentially life-threatening illness accompanied by complex and demanding treatment procedures, significantly affects both the physical and mental well-being of patients (8, 9). Common psychological symptoms and disorders experienced by women with breast cancer include anxiety, depression, cognitive impairments, adjustment difficulties, sleep disturbances, fatigue, post-traumatic stress, body image concerns, and sexual dysfunction (10). The WHO (2023) describes mental health as "a state of well-being where an individual recognizes their abilities, manages everyday life stresses effectively, engages in productive work, and contributes meaningfully to their community" (11).

This definition highlights well-being as a key aspect of mental health, making it challenging to recognize distress in individuals who appear well (12). Mentally healthy individuals may experience sadness, dissatisfaction, or anger as part of normal human experiences. However, mental health is often perceived as a state of constant positivity, happiness, and control (13, 14).

In recent decades, advancements in the diagnosis and treatment of breast cancer have led to increased survival rates among patients. However, this increase in life expectancy comes with challenges such as non-compliance with self-care behaviors and mental health issues in patients (15). Self-care behaviors in cancer survivors have been associated with positive outcomes in social relationships and personal independence (16). Breast cancer treatment is a lengthy process in which the patient's role is crucial and vital. In other words, adherence to self-care behaviors such as maintaining a proper diet, performing breast self-exams, engaging in regular exercise, following medical advice, avoiding stress, and undergoing mammography can aid in the acceleration of the treatment process and improve patients' quality of life (QoL) (17, 18). Indeed, non-compliance and lack of self-care behaviors may lead to issues such as poor diet, failure to perform breast self-exams, non-adherence to medical advice, stress, and neglecting mammography (19). Self-care behaviors not only contribute to improving patients' QoLbut also lead to enhancements in psychological well-being and reductions in disease-related stress (20). In fact, breast cancer treatments are associated with physical, functional, psychological, cognitive, and economic side effects that can disrupt patients' QoL (21, 22). (QoL is a multidimensional concept that encompasses not only physical health but also mental health, economic conditions, personal beliefs, and interaction with the environment (23). This concept plays a significant role in medical evaluations and health assessments (24). In positive psychology, QoLis considered one of the fundamental principles, aiming to create emotional balance, strengthen positive relationships with others, achieve a sense of independence and control over the environment, attain life goals, and foster personal growth (25).

Moreover, QoLrefers to an individual's perception of their position in life, determined by cultural contexts, existing values, and personal goals, expectations, beliefs, and interests. This concept is affected by an individual's psychological and physical state as well as their social relationships (26). In this context, QoL

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enhancement programs include combined therapies based on behavioral, cognitive, emotional, and spiritual models, which can help prevent health-related issues (27). In other words, the QoL model is a multidimensional and multifactorial phenomenon that aids in improving mental and social health and can play a crucial role in preventing health problems (28). For instance, Golant et al. (29) found that QoL programs help breast cancer patients manage treatment side effects and improve coping. D'egidio et al. (31) highlighted the role of psychological interventions, such as psychoeducation and CBT, in enhancing rehabilitation and overall well-being. Naghibi et al. (32) showed that QoL therapy (QoLT) significantly increased hope and happiness in breast cancer patients. Jafari (33) reported positive impact of QoLTon self-love and future outlook in menopausal women. Despite these findings, research on QoLT in Iran, especially for breast cancer patients, remains limited, highlighting the need for psychological approaches to reduce distress. Therefore, the aim of the present study was to determine the effectiveness of QoLT on self-care and mental health in patients with breast cancer.

Methods

This study was applied in purpose and quasi-experimental in design, employing a pre-test, post-test, and two-month follow-up design with a control group. The study population included all breast cancer patients who referred Shohadaye Kargar Hospital in Yazd from September to February 2024. The sampling method used was purposive sampling; specifically, a list of breast cancer patients was compiled from the hospital, and each patient was provided with information about the study, its objectives, and procedures. Patients were then offered free psychotherapy treatment. Those who consented to participate in the study were interviewed clinically. The sample was determined using purposive sampling, in which32 breast cancer patients from hospital were selected based on inclusion and exclusion criteria. The sample size was determined considering the anticipated effect size and power analysis to ensure adequate statistical power for detecting significant differences in the outcomes.

Inclusion criteria were: 1) Female gender, 2) Age between 30 and 60 years, 3) At least secondary education, 4) Diagnosis of breast cancer by an oncology specialist, 5) Patients undergoing hormone therapy (having completed radical modified mastectomy, chemotherapy, and radiotherapy), and 6) Full consent to participate in the study and complete the consent form. Exclusion criteria included: 1) Use of cigarettes or analgesics, sedatives, and sleep aids, 2) Presence of severe illness or discomfort that interferes with treatment, 3) Absence from any of the QoLT sessions, and 4) Concurrent use of psychiatric medication or psychotherapy (based on self-report).Considering the inclusion and exclusion criteria, 32 patients who met the requirements were selected and randomly assigned to either the intervention group (N=16) or the control group (N=16). At the end of the treatment, one participant from the intervention group was excluded due to missing more than three sessions.

The following tools were used for data collection:

1. Demographic Information Form: A researcher-developed questionnaire was designed to assess demographic characteristics of breast cancer patients such as age, education, marital status, economic status, occupation, etc.

2. General Health Questionnaire (GHQ-28): It was developed by Goldberg et al. in 1979.This questionnaire consists of 28 questions across four scales (somatic symptoms, anxiety and insomnia, social functioning, and depression). It is used as a screening tool for mental health and identifying psychological disorders. Respondents choose one of the options: "better than usual, about the same as usual, worse than usual, much worse than usual." Lower scores on this questionnaire indicate better mental health. In addition to diagnosing mental illness, it provides an index of an individual's mental health (34). In Iran, the questionnaire has been standardized with a Cronbach's alpha of 0.90 reported (35). The Cronbach's alpha for this questionnaire in the current study was 0.87.

3. Individualized Care Scale (ICS): This

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questionnaire, developed by Suhonen et al. (36), consists of 19 questions that measure the level of attention and monitoring of patients' living conditions, personal, health, and care behaviors. Scores on this scale are based on a five-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The range of scores on this scale is between 19 and 135, with higher scores indicating greater personal self-care by the patients. The scale has a Cronbach's alpha of 0.93. In Iran, Bahrami et al. (37) confirmed the content validity of this scale and reported a reliability coefficient of 0.93 with Cronbach's alpha for the entire scale. The Cronbach's alpha for this questionnaire in the current study was 0.83.

Structure of QoLT Sessions

In this study, QoLT was employed, which is based on Frisch's theory (38). This psychotherapy is developed using a life satisfaction approach in positive psychology and cognitive therapy. It is noteworthy that the content validity (CVI and CVR) of the QoLT has been validated by 8 psychology specialists (Clinical and Health Doctorates). A summary of this validated therapy program is presented in Table 1. During the study, patients in both groups continued their routine treatment (medication) under medical supervision, while the validated QoLT was administered in a group setting by the therapist over 10 sessions (each session lasting 90 minutes) for the intervention group over a period of two months (with two therapeutic intervention sessions per week). During this period, the control group did not receive any psychological intervention. The data collection method was at three points: before the intervention (pre-test), immediately after the intervention (post-test), and two months after the intervention (follow-up). The questionnaires were completed by the participants in a clinical setting at ShohadayeKargar Hospital, Yazd, from September to February 2024. The participants filled out the forms during their scheduled visits, with the post-test and follow-up administered after the QoLT sessions.

Table 1. Structure and process of QoLT sessions

Session	Objectives and content of each session
1	Administering pre-test, familiarizing participants with one another, defining QoL in psychological well-being, introducing QoL and teaching the CASIO model, and presenting seven key areas of QoL.
2	Exploring the philosophy of life, suffering, pain, and meaning, along with techniques for releasing negative thoughts.
3	Identifying self-esteem, feelings of worth, and appreciation in mental health, accompanied by abdominal breathing techniques and positive self-talk.
4	Identifying personal strengths, setting appropriate goals, and valuing them.
5	Developing problem-solving strategies while creating a joyful and meaningful life.
6	Identifying desired criteria and making correct choices for life satisfaction, along with initiative and investment.
7	Determining the role of happiness, joy, and healthy relationships in life satisfaction, accompanied by meditation techniques.
8	Identifying the sense of friendship and trust in community health (among family members, friends), along with muscle relaxation techniques.
9	Defining and determining recreation, play, sports, and art for physical-psychological health, accompanied by abdominal breathing techniques and positive self-talk.
10	Practicing forgiveness, increasing positive emotions with guided imagery, and administering a post-test.

Ethical considerations and data analysis

Throughout the research process, ethical principles were strictly observed to ensure the dignity and respect of the patients. Written informed consent was obtained from each participant, who was informed that participation in the study was voluntary and they could withdraw at any time. Moreover, the control group did not receive any psychotherapy sessions during the study, but they were offered the opportunity to receive psychotherapy after completing the study if they wished. The collected data were analyzed

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using SPSS-21 with a significance level set at 0.05. Initially, descriptive statistics such as frequency, mean, and standard deviation were used. Then, assumptions of normality for qualitative characteristics (using chi-square and one-way ANOVA tests) and quantitative scores (using Kolmogorov-Smirnov, Levene, and Mauchly's Sphericity tests) were checked. Repeated measures ANOVA was then employed for data analysis.

Results

Initially, demographic characteristics of the participants indicated that the mean age and standard deviation for the intervention group were 43.61 ± 7.25 years, for the control group were 45.95 ± 5.97 years, and the overall mean age and standard deviation were 44.81 ± 6.64 years. An examination of the homogeneity of qualitative data using one-way ANOVA and chi-square tests revealed no significant differences between the intervention and control groups in terms of demographic characteristics such as age, marital status, education, and economic status (P > 0.05). This indicates that the two groups were comparable with regard to their demographic characteristics (Table 2).

Table 2. Analysis of demographic characteristic in research groups

Variable	Classification	Intervention group (N=15)	Control group (N=16)	P
Age*	44.81±6.64	43.61±7.25	45.95±5.97	> 0.09
Marital status**	Single	2 (13.3)	1 (6.3)	> 0.51
	Married	13 (86.7)	15 (93.8)	
Education**	Cycle	5 (33.3)	3 (18.8)	> 0.82
	Diploma	4 (26.7)	5 (31.6)	
	Bachelor	5 (33.3)	7 (43.8)	
	Master or Ph.D.	1 (6.7)	1 (6.3)	
Economic status**	Poor	3 (20)	2 (12.5)	> 0.83
	Middle	9 (60)	11 (68.7)	
	Good	3 (20)	3 (18.8)	

* One-way ANOVA test with the report of mean ± standard deviation
** Chi-square test with the report of frequency (percentage%)

Subsequent analysis and testing assumptions

Table 3 shows the mean and standard deviation of the research variables. To assess the normality of quantitative data for parametric testing, the results of Kolmogorov-Smirnov test initially indicated that distribution of self-care and mental health scores (and their subscales) in both intervention and control groups was not significant (P > 0.05). This suggests that there was no substantial dispersion in the data, and distribution of scores was normal. Additionally, Levene's test results showed that there was no significant dispersion in variables of psychological well-being and social adjustment (P > 0.05). This implies that the variance of scores between intervention and control groups for the main research variables was equal. Finally, the assumption of Mauchly's test for sphericity was also confirmed. Therefore, the assumptions for using repeated measures ANOVA to analyze the data were validated.

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Table 3. Mean and standard deviation reports of research variables by groups

Variables	Intervention group			Control group		
	Pre-test	Post-test	Follow-up	Pre-test	Post-test	Follow-up
Self-care	52.53± 5.15	65.06± 5.78	63.6± 7.61	54.6± 4.22	54.12± 4.5	53.7± 4.72
Somatic symptoms	17.66± 1.34	9.2± 1.42	9.67± 1.23	17.87±1.14	18.50± 1.03	18.56± 1.26
Anxiety and insomnia	18.73± 1.75	9.67± 2.25	9.9± 1.86	18.6± 1.5	18.5± 1.36	18.81± 1.22
Social dysfunction	18± 2.26	8.8± 2.24	9.2± 2	18± 2.58	18± 2.19	18.12± 215
Depression	17.5± 2.32	8.26± 1.86	8.6± 1.88	18± 2.45	17.87± 2	18.06± 2.1
Mental health	71.93± 4.6	35.93± 4.74	37.4± 3.96	72.5± 4.8	72.87± 4.68	73.5± 4.4

Table 4 shows the results of repeated measures ANOVA, indicating that after controlling for the effect of the pre-test variable, there was a significant difference in the adjusted mean scores of self-care based on group membership (intervention and control) (F = 11.06, P = 0.002). This suggests that the QoLT had a significant impact on self-care, with an effect size of 0.28. This means that 28% of the variance in self-care can be attributed to the QoLT. Thus, with a 99% confidence level, it can be stated that QoLT significantly increased self-care among breast cancer patients, and the effect of the therapy was moderate.

Table 4. Results of repeated measures ANOVA for research variables

Variables	Sum of Squares	df	Mean Square	F	P	Eta Squared
Self-care	304850.81	1	304850.81	3736.33	0.001	0.99
	902.42	1	902.42	11.06	0.002	0.28
	2366.13	29	81.59			
Somatic symptoms	21592.03	1	21592.03	6598.87	0.001	0.99
	874.10	1	879.10	267.14	0.001	0.90
	94.89	29	3.27			
Anxiety and insomnia	22934.17	1	22934.17	3391.76	0.001	0.99
	799.76	1	799.76	118.28	0.001	0.80
	196.09	29	6.76			
Social dysfunction	20961.3	1	20961.3	1540.55	0.001	0.98
	847.78	1	847.78	62.31	0.001	0.68
	394.58	29	13.6			
Depression	20138.1	1	20138.1	1839.3	0.001	0.98
	985.06	1	985.06	89.97	0.001	0.76
	317.5	29	10.95			
Mental health	342308.8	1	342308.8	6238.3	0.001	0.99
	14006.1	1	14006.1	255.2	0.001	0.90
	1591.29	29	54.87			

Further results in Table 4 indicate that, after controlling for the pre-test variable, there was a significant difference in the adjusted mean scores for mental health and its subscales based on group membership (intervention and control) (F = 255.2, P = 0.001). This means that QoLT had a significant impact on overall mental health, with an effect size of 0.90. This implies that 90% of the variance in mental health can be attributed to the therapy. Therefore, with a 99% confidence level, it can be stated that QoLT significantly improved psychological health in breast cancer patients, and the effect of the therapy was very good. Additionally, a Bonferroni post-hoc test was employed to determine significant differences between measurement phases (pre-test, post-test, and follow-up) (Table 5).

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Table 5. Summary of Bonferroni post-hoc test results in three measurement stages

Variable	Reference	Compare	Mean Difference	Std. Error	P	95% Confidence Interval	
						Lower	Upper
Self-care	Pre-test	Post-test	-6.01	0.38	0.000	-6.98	-5.05
		Follow-up	-5.09	0.53	0.000	-6.45	-3.73
	Post-test	Follow-up	0.92	0.46	0.17	-0.25	2.09
Somatic symptoms	Pre-test	Post-test	3.92	0.21	0.000	3.38	4.45
		Follow-up	3.66	0.25	0.000	3.02	4.28
	Post-test	Follow-up	-0.26	0.17	0.36	-0.68	0.16
Anxiety and insomnia	Pre-test	Post-test	4.59	0.27	0.000	3.89	5.30
		Follow-up	4.31	0.26	0.000	3.63	4.98
	Post-test	Follow-up	-0.29	0.16	0.23	-0.69	0.11
Social dysfunction	Pre-test	Post-test	4.60	0.25	0.000	3.96	5.23
		Follow-up	4.33	0.23	0.000	3.75	4.92
	Post-test	Follow up	-0.26	0.19	0.55	-0.75	0.23
Depression	Pre-test	Post-test	4.69	0.34	0.000	3.83	5.56
		Follow-up	4.43	0.35	0.000	3.55	5.31
	Post-test	Follow-up	-0.26	0.15	0.27	-0.64	0.12
Mental health	Pre-test	Post-test	17.81	0.48	0.000	16.59	19.03
		Follow-up	16.73	0.58	0.000	15.25	18.21
	Post-test	Follow-up	-1.07	0.36	0.02	-1.99	-0.16

Table 5 indicates that within the intervention group, there were significant differences between pre-test and post-test phases, as well as between pre-test and follow-up phases, for both self-care and psychological well-being (including its subscales). Significant differences were also found between post-test and follow-up phases in mental health, showing better results for participants in the post-test phase. These results suggested that the QoLT was effective in enhancing self-care and improving physical-psychological health, and its effects remained significant up to two months after the intervention.

Discussion

The present study aimed to evaluate the effectiveness of QoLT on psychological well-being and social adjustment of breast cancer patients. The findings initially demonstrated that QoLT significantly increased self-care among breast cancer patients with a 99% confidence level, and the effect persisted up to two months after the treatment. The effect size of QoLTon self-care was moderate, at 28%. This indicates that 28% of the variance in self-care can be attributed to the impact of QoLT.

These results are consistent with previous studies. For example, Maeda et al. (39) investigated the effectiveness of short-term psychological intervention on the psychological status of Japanese breast cancer patients. Their results showed that such psychological intervention could enhance coping strategies and improve psychological well-being in breast cancer patients. Ghanbari et al. (40) conducted a clinical trial reporting that life quality-based skills training (over 10 weekly sessions, each lasting 90 minutes) could effectively regulate cognitive-emotional responses and reduce self-destructive behaviors in patients. Marchioro et al. (41) examined the effects of psychological interventions on QoL and behavior in breast cancer patients undergoing surgery and chemotherapy. Their results, followed up to 9 months post-diagnosis, indicated that cognitive therapy and family counseling improved both depression and QoL compared to the control group. Enhanced emotional coping behaviors were also observed with changes in personality traits in the intervention group. Casla et al. (30) investigated whether integrated supervised

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counseling and group exercise programs could increase leisure activities in women with breast cancer. Their experimental study, using a single-group design, included 24 sessions of combined aerobic and strength training exercises and classes on nutrition and health for 48 breast cancer patients. Results showed improvements in leisure activity, overall strength, functional capacity, and QoL, along with reduced depression scores, regardless of whether patients were currently undergoing treatment or had completed their treatment.

It should be noted that QoLT may include psychological and emotional aspects that help patients cope better with challenges of their illness. This psychological support can lead to an improvement in patients' ability to care for them and manage their symptoms. On the other hand, this treatment involves techniques, strategies, and practical training on how to care for the body, manage stress, and improve social relationships, which directly affects self-care. In fact, this treatment may help patients gain greater awareness of the importance of self-care and increase their motivation to engage in care activities. The increase in awareness and motivation can lead to a significant improvement in self-care behaviors.

Other research results showed that QoLT can improve mental health in breast cancer patients, and its effects persisted up to two months after treatment. The effect size of QoLT on mental health was very good at 90%, indicating that 90% of changes in mental health were due to the impact of the QoLT. These findings are consistent with previous studies. For example, Saeidi and Asgharnejad (42) examined the effectiveness of QoL psychotherapy based on the Frey theory in enhancing happiness and life satisfaction among breast cancer patients attending counseling centers in Iran (Mashhad). This quasi-experimental pre- and post-test study involved 30 women with breast cancer, and the results indicated that this treatment was effective in improving happiness and life satisfaction and could be used as an effective intervention to enhance the QoL of these patients. Nikbakhsh et al. (43) conducted a clinical trial on breast cancer patients with depression who were taking citalopram, showing that group psychotherapy was effective in improving depression, anxiety, and increasing the QoL in these patients. Fauser et al. (44) conducted a randomized trial to compare the effects of short-term psychotherapy with non-specific group discussions during breast cancer rehabilitation. The study focused on anxiety as the primary outcome, while secondary outcomes included depression, distress, fatigue, and health-related quality of life (QoL). No significant differences were observed between the two groups regarding anxiety levels at the end of rehabilitation or three months later, nor in any of the secondary outcomes. However, patients with high anxiety in the short-term psychotherapy group reported reduced depressive symptoms by the end of rehabilitation and appeared to benefit more from the structured approach. Despite this, structured short-term psychotherapy and non-specific group discussions showed no significant difference in alleviating psychological stress.

QoLT addresses all aspects of the patient's life rather than focusing solely on the physical aspects of the illness. This approach includes attention to psychological, social, and emotional needs; allowing patients to feel more supported and better adjust to their condition. QoLT also helps patients feel more in control of their lives. When patients feel they can take part in managing their lives and actively participate in the treatment process, their satisfaction and happiness increase. These positive feelings directly contribute to improved mental health. On the other hand, breast cancer, in addition to physical challenges, brings significant psychological stress and anxiety. QoLT helps patients manage stress and increase resilience, enabling them to better cope with their illness. This reduction in stress and increased resilience can lead to a significant improvement in mental health.

This study highlights three key benefits: (1) QoLT significantly enhances self-care behaviors in women with breast cancer, (2) it improves mental health with a strong effect size (80%), and (3) its positive effects persist for at least two months post-

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treatment, supporting its long-term benefits. On the other hand, limitations of this study include the small sample size, lack of long-term follow-up (six months and one year), and the absence of a double-blind clinical trial. These factors may affect the generalizability of the research results to other cancer patient groups. Therefore, it is recommended to address these limitations and apply QoLT to other cancer patients (e.g., blood cancer, pancreatic cancer) to explore its effectiveness in improving mental and social health.

Conclusion

The overall results of the study indicated that QoLT can increase self-care and improve mental health in breast cancer patients, and has a good treatment effect. The persistence of effects up to two months after the end of treatment indicates that patients have applied the learned skills and approaches to their daily lives, and these changes have stabilized over time. This continued effect may be due to effective learning and deepening of self-care behaviors during the treatment period, or it could be attributed to the precise design and effective implementation of the treatment, considering the special needs and sensitivities of breast cancer patients. In any case, it is advisable to use this cost-effective treatment alongside routine treatment for breast cancer patients to enhance their mental and social well-being in healthcare centers.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical considerations

All necessary ethical principles were thoroughly observed and applied in the research study, including obtaining informed consent from participants, ensuring their privacy and confidentiality, and conducting the study in accordance with relevant ethical guidelines and regulations. This study was approved and registered under the ethics code IR.IAU.SRB.REC.1402.382 by the Ethics Committee of Islamic Azad University, UAE Branch.

Code of ethics

IR.IAU.SRB.REC.1402.38.

Authors' Contributions

N. K, conceived the idea presented in this paper; P. A, developed the theory and performed the calculations; N. K. and H. A, validated the analytical methods; N. K and H. E. S, were involved in the investigation of [a specific aspect] and supervised the findings of this study. All authors discussed the results and contributed to the final manuscript.

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