Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 3
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Impact of Early Shoulder Joint Functional Exercise Program on Quality of Life of Survivors after Modified Radical Mastectomy

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Abstract: This study aimed to evaluate the effects of an early shoulder joint functional exercise program on shoulder joint function and quality of life among breast cancer survivors who underwent modified radical mastectomy. Breast cancer remains the most prevalent malignancy among women worldwide. With advances in early detection and comprehensive treatment, survival rates among breast cancer survivors have markedly improved. Consequently, the focus of postoperative care has shifted from disease control to long-term functional recovery and quality of life enhancement. However, shoulder joint dysfunction following modified radical mastectomy (MRM) remains a common and debilitating complication, significantly affecting upper limb function, daily activities, and overall quality of life. Although early shoulder joint functional exercises have been reported to be beneficial, their systematic integration into routine postoperative nursing care and their effects on both shoulder function and quality of life require further empirical investigation. A quantitative, quasi-experimental, non-equivalent control group design was employed. Sixty female breast cancer survivors who underwent unilateral MRM were recruited from a tertiary hospital in Shandong Province, China, and were allocated into an experimental group (n = 30) and a control group (n = 30) using sequential recruitment and sealed draw assignment. The experimental group received a structured, phase-based early shoulder joint functional exercise program beginning 1–3 days postoperatively, while the control group received routine postoperative functional exercise guidance. Shoulder joint function was assessed using the Constant–Murley Score (CMS) at baseline (preoperative), postoperative day 10, and postoperative day 30. Quality of life was measured using the Functional Assessment of Cancer Therapy–Breast (FACT-B) at postoperative day 30. Data were analyzed using descriptive statistics, independent and paired t-tests, and correlation analysis. Baseline comparisons revealed no statistically significant differences in demographic characteristics or shoulder function scores between the experimental and control groups of breast cancer survivors ($p > 0.05$), indicating that the two groups were well-matched at the outset of the study. Following the intervention, shoulder function improvement in the experimental group was significantly greater than that in the control group. For instance, assessments using the Constant–Murley Shoulder Score (CMS) demonstrated that the experimental group exhibited statistically significant increases in shoulder function scores at both postoperative day 10 and day 30 compared to baseline levels ($p < 0.05$), with a consistent upward trend. In contrast, although the control group also showed improvement at the same time points, the extent of improvement was markedly smaller. Intergroup comparisons further confirmed that CMS scores in the experimental group

were significantly higher than those in the control group at both postoperative day 10 and day 30 ($p < 0.05$). With respect to quality of life, as evaluated by the Functional Assessment of Cancer Therapy–Breast (FACT-B) scale, the experimental group exhibited significantly higher total quality-of-life scores than the control group at postoperative day 30 ($p < 0.05$). Improvements were particularly notable in the physical well-being and functional well-being domains. Further correlation analysis indicated a significant positive relationship between shoulder function scores and overall quality-of-life scores among breast cancer survivors who received early shoulder rehabilitation interventions ($p < 0.05$). This suggests that greater improvement in shoulder function is associated with better self-perceived quality of life in this population. Early shoulder joint functional exercise significantly improved shoulder joint function and quality of life among breast cancer survivors after modified radical mastectomy. The findings support the systematic incorporation of structured early shoulder joint functional exercises into routine postoperative nursing care to promote functional recovery and enhance overall quality of life.

Keywords: Breast cancer survivors; Modified radical mastectomy; Early shoulder joint functional exercise; Shoulder joint function; Quality of life; Nursing intervention

Online publication: Apr 21, 2026

1. Introduction

1.1. Background

BC is now rampant malignant tumors of women. Data released by the World Health Organization (WHO) in 2024, breast cancer is the most common type of malignant tumor Recently, breakthroughs have been made in early screening, diagnosis and treatment technology, which have significantly increased the five-year survival rate of breast cancer survivors [1]. With the prolongation of survival time, the research focus of breast cancer care has gradually shifted from disease control to long-term function recovery and quality of life improvement of breast cancer survivors.

In the complete Breast Cancer control set operation is most common. Although surgery can much improve the quantity of oncological benefits for breast cancer survivors but postoperative complications still bring troubles [2]. Ipsilateral shoulder dysfunction is one of the most common and functionally disabling sequelae of the population [3]. Shoulder pain, limited range of motion and upper limb function impairment caused by manifestation not only reduce the ability of survivors to carry out daily life, but also hinder survivors in returning to work and lasting recovery of social role and family [4]. These factors all lead to a decline in rehabilitation quality and hinder successful social reintegration.

Previously, functional exercise worked well on early period in helping the shoulder function of the person breast cancer survivor and increasing quality of lives [3,5]. During the perioperative period, especially in the hospitalization stage, nursing personnel are important staff responsible for guiding the rehabilitation exercise of breast cancer survivors, which also requires nursing personnel to master and implement scientific and standardized guidance on shoulder functional exercise [6]. However, actual clinical nursing practice of early shoulder function rehabilitation has not yet been developed into standard postoperative and varied nursing routine, content and other aspects of rehabilitation is present.

The Burden of breast cancer on the public health system is still significant. In the world, about 2.3 million new cases of breast cancer were reported in women in 2022, and about 670,000 deaths were caused by the disease [7]. Women with breast cancers across the earth were 11.7% [8]. China reports the most cases of breast cancer in the world (18.4%) of the world's total cases. The main age group is 55–60 years old [9]. With the growth of the number of breast cancer survivors, long-term functional limitations and quality-of-life problems after surgery have become more prominent and have become one of the problems that need to be addressed urgently in the field of public health and nursing.

Depending on the tumor stage and receptor status of the breast cancer survivors (BCSs) they might get either a surgery, endocrine therapy, immunotherapy, chemotherapy or radiotherapy [10]. There are many kinds of breast cancer's therapies, but a mastectomy is still one of the main types of therapies. And among this modified radical mastectomy (MRM) has been practiced widely to this day because it is able to remove fully the breast and most, if not all the axillary lymph nodes, but without removing the pectoralis major [11].

While MRM can eradicate cancer effectively, it frequently results in the patient suffering from shoulder complications because of the changes in muscles and lymph nodes, pain from the incisions, use of drainage tubes and scarring [12]. The limitation of shoulder motion after the surgery is experienced by 3051% of breast cancer survivors (BCSs), with some studies reporting even 91% which leads to loss of function, postponement of daily activities, and lesser quality of life [13,14]. More survivors help nurses focus on how bodies feel and how happy people are. Poor shoulder movement ties to lower quality of life [14]. Many experts say starting rehab right after surgery matters [15].

This investigates early shoulder work impacts movement and everyday life in women after breast cancer surgery. It checks scores before and after the exercises, comparing those who do workouts with others getting regular care. Now a number of studies have demonstrated how structured rehab could significantly improve the recovery process.

1.2. Theoretical framework

Bandura's Self, Efficacy Theory and Cognitive Therapy Theory highlighted the importance of enhancing the quality of life of breast cancer survivors (BCSs) after MRM. Self-Efficacy Theory centered on developing the sense of capability through various ways such as obtaining mastery experiences, involving oneself with the observing of peers, receiving feedback, and getting rid of the feeling of anxiety. This is done with the help of these provisions and BCSs are likely to feel the sense of their capabilities and to be inspired to perform shoulder rehabilitation exercises. Cognitive Therapy Theory can be considered a harmonious extension to the aforementioned by taking into account the changing of negative thoughts and emotional barriers, thereof encouraging positive exercise behaviors, decreasing the anxiety associated with pain or limited movement, and empowering an individual's confidence in oneself. On the way of supporting one's regular engagement in shoulder function exercises, these theories, accompanying one another also help to boost recovery and ultimately well, being (see **Figure 1**).

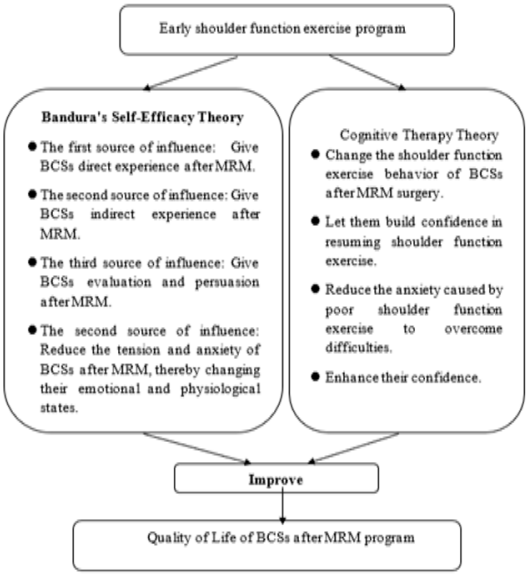

Figure 1. Conceptual framework.

1.3. Research paradigm

Figure 2 describes the effect of early shoulder joint functional exercise program on joint mobility and quality of life of breast cancer survivors (BCSs). The independent variable is the early shoulder joint functional exercise program; dependent variable 1 is the quality of life of breast cancer survivors (BCSs). At the same time, the relationship between the two variables is verified.

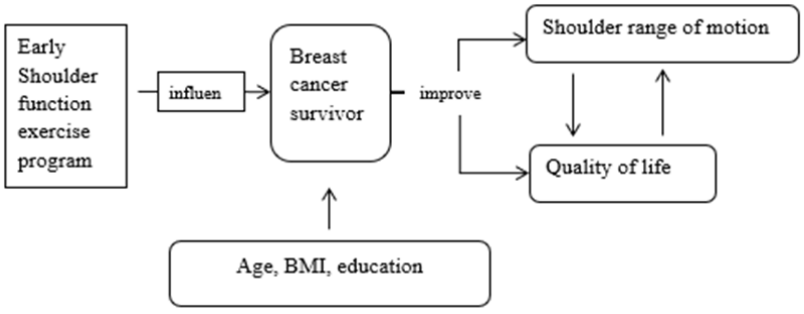

Figure 2. Research paradigm.

2. Research methodology

2.1. Research design

This study used the quantitative-quasi-experimental design with the non-equivalent control group to identify whether an intervention produces an effect and to quantify by how much through large scale non-random or part randomized studies comparing before and after interventions.

2.2. Population and sampling

Population comprised breast cancer survivors (BCSs). The sample size was 30 in the experimental group and in the control group. The participants were from Zibo Central Hospital which received an average of two MRM BCSs per day. Simple random sampling was used.

2.2.1. Inclusion criteria

(1) Survivors diagnosed with unilateral breast cancer;
(2) Female breast cancer survivors (BCSs);
(3) Breast cancer survivors (BCSs) who have undergone modified radical mastectomy;
(4) Breast cancer survivors (BCSs) with normal bilateral upper limb function prior to surgery;
(5) Breast cancer survivors (BCSs) with normal cognitive function capable of comprehending and completing questionnaires;
(6) Breast cancer survivors (BCSs) aged between 20 and 70 years;
(7) Breast cancer survivors (BCSs) who voluntarily participate in the study after understanding the research procedures and objectives.

2.2.2. Exclusion criteria

(1) Breast cancer survivors (BCSs) who were pregnant or lactating;
(2) Breast cancer survivors (BCSs) with inflammatory or metastatic disease;

(3) Breast cancer survivors (BCSs) with a history of upper limb trauma or major thoracic surgery prior to the intervention;
(4) Breast cancer survivors (BCSs) presenting with shoulder dysfunction;
(5) Breast cancer survivors (BCSs) diagnosed with severe disorders of major organs, such as the brain, heart, liver, or kidneys.

2.3. Research locale

This study was conducted at Zibo Central Hospital in Shandong Province. The hospital was established in 1950 and is the largest tertiary grade-A general hospital in the local area. The breast surgery department has 95 open beds and admits approximately 2 cases of breast cancer surgery BCSs per day on average. All the research subjects were taken from the female breast cancer survivors (BCSs) that were hospitalized and underwent Modified Radical Mastectomy (MRM) during the course of the study.

2.4. Research instrument

Four research tools were used to gather data in an objective and systematic manner: a measuring instrument, a survey, and two standardized scales. A universal goniometer (model 55643) with two stainless, steel vestiges assessed the range of motion of the shoulder forward flexion and lateral elevation which are part of the components of motion in the Constant, Murley Score (CMS). The Age, BMI, and level of education were obtained using a self-made questionnaire. The functionality of the shoulder was measured using the CMS, a tool that assesses pain, daily activities, range of motion, and muscle strength. The quality of life was evaluated with the Chinese edition of the Functional Assessment of Cancer Therapy Breast (FACT, B) scale that measures the different well-being dimensions: physical, social/family, emotional, and functional, as well as additional breast cancer issues using a five-point Likert scale.

2.5. Data collection procedure

The research followed these phases of data collection.

2.5.1. Pre experimental phase

Before the experiment started, the researcher obtained approval from ethics and the hospital. Participants signed consent forms, filled out basic details and shoulder function checks using the CMS. Then, we split them into two groups using sealed envelopes.

2.5.2. Experimental phase

In the experiment, the active group did a set of early shoulder exercises from day 1 to 3, guided by trained staff and with teaching tools. The control group got usual care, no special exercises or help. So, the researcher recorded everything, and staff did not check up later.

2.5.3. Post experimental phase

Afterward, the researcher collected data on days 10 and 30 using the CMS. On day 30, the researcher used the Chinese FACT, B to check quality of life. Data were reviewed and analyzed. Then these were privately and safely saved.

2.6. Statistical treatment of data

Microsoft Excel and SPSS 25.0 were used for analysis. Mean ± standard deviation to describe the age and BMI of the two groups of subjects. The independent sample t test was used to compare the differences between the two groups. The Mann-Whitney U test was used for comparison. Frequency and percentage were to describe the educational level. The chi-square test was used for comparison. Fisher's z transformation was used to see if there is a meaningful difference in the correlation coefficients of the two groups.

3. Results and discussion

3.1. Problem No. 1

The control group (CG) consisted of a mean age of 53.90 ± 7.60 years, whereas the experimental group (EG) had 53.80 ± 7.07 years, with the difference between two groups not statistically significant ($t = 0.053$, $p = 0.958$), which means that the age characteristics were similar before the intervention. Besides, the age range mentioned is not out of line with the ones that have been reported in breast cancer onset among Asian women [16]. The CG had a BMI of 25.86 ± 2.66 and the EG 24.38 ± 3.12. There was no significant difference between the two ($t = 1.984$, $p = 0.052$). As for education level, there were also no significant differences ($\chi^2 = 0.341$, $p = 0.559$). The baseline homogeneity was confirmed and the acceptance of H_{01} was supported. See **Table 1**.

Table 1. Demographic profile of the control group and experimental group (Mean ± SD, t/χ^2)

Demographic	Group	n (%)	Mean ± SD	t/χ^2	p
Age	CG [a]	30	53.90 ± 7.60	0.053	0.958
	EG [b]	30	53.80 ± 7.07		
BMI	CG [a]	30	25.86 ± 2.66	1.984	0.052
	EG [b]	30	24.38 ± 3.12		
Educational	CG [a]	23 (77) [c] / 7 (23) [d]	-	0.341	0.559
	EG [b]	21 (70) [c] / 9 (30) [d]	-		

Notes: a) EG = Experimental Group; b) CG = Control Group; c) high school and above; d) below high school.

3.2. Problem No. 2

Preoperatively (TO), both groups felt the same in pain, daily life, muscle power, and how far they could move their shoulders. By day 10 after surgery, the group doing early exercises reported less pain, 8.67 ± 2.916 vs. 10.17 ± 2.451, $p = 0.018$, and better daily tasks, 9.07 ± 3.562 vs. 11.17 ± 2.972, $p = 0.008$. This denotes motion helps ease pain and speeds up recovery. This aligns with a previous study which pointed out that that structured resistance exercises help enhance upper-limb strength, mobility, and physical functioning, which are often affected after breast cancer surgery [17]. Muscle strength in both groups remained at the same level throughout the follow-up period ($p = 0.414$). The therapy was mainly directed at enhancing flexibility but not strength [18]. On the other hand, the active group had a significant increase in shoulder range of motion at day 10 and day 20, they went from 20.07± 5.669 to 32.27 ± 4.448, $p < 0.001$ and $p = 0.006$ respectively, indicating that the benefits were not limited to the first week only. That corresponds to a previous study stating that it is likely that this is one of the factors that contribute to patients' improved recovery after surgery and their continued good quality of life as breast cancer survivors [19]. See **Table 2**.

Table 2. Pre- and post-intervention shoulder function scores in breast cancer survivors (BCSs) using the CMS tool (Mean ± SD, t)

Time	Dimensions	EG [a] (Mean ± SD)	CG [b] (Mean ± SD)	t	p
T0	Pain	14.50 ±1.526	14.67 ± 1.269	0.358	0.324
	Daily Life	19.93 ± 0.365	20.00 ± 0.000	0.043	0.161
	Strength of Abduction	25.00 ± 0.000*	25.00 ± 0.000*	-	-
	Range of Motion	39.60 ± 1.522	39.60 ± 1.329	1	0.5
T1	Pain	10.17 ± 2.451	8.67 ± 2.916	0.017	0.018
	Daily Life	11.17 ± 2.972	9.07 ± 3.562	0.059	0.008
	Strength of Abduction	21.50 ± 2.980	21.33 ± 2.916	0.75	0.414
	Range of Motion	20.07 ± 5.669	12.67 ± 6.397	0.217	<.001
T2	Pain	14.83 ±0.913	14.5 ± 1.526	0.038	0.154
	Daily Life	18.1 ± 1.749	16.87 ± 2.3	0.193	0.011
	Strength of Abduction	24.33 ± 1.729	24.33 ± 1.729	1	0.5
	Range of Motion	32.27 ± 4.448	28.73 ± 5.953	0.066	0.006

Notes: a) EG = Experimental Group; b) CG = Control Group; *. Since the standard deviation of both groups is 0, t cannot be calculated.

3.3. Problem No. 3

There was no statistical difference in physiological state scores between the experimental group and the control group (12.7 ± 1.643 vs. 12.5 ± 1.776, $p = 0.326$). The 30th day after surgery, the subjective experience of fatigue, pain, nausea and other physical symptoms in the two groups was similar. This may be impacted by short duration of intervention. Physiological recovery after breast cancer surgery usually involves complex biological processes such as tissue repair, relief of inflammatory response, and regulation of hormone levels, and these changes are difficult to show significant improvement in a short period of time under short-term exercise intervention of light to moderate intensity. This result is consistent with the research conclusions of Chinese scholars who disclosed that through multivariate regression analysis that anxiety within 1 month after surgery is an important predictor of FACT-B quality of life score [20]. See **Table 3**.

Table 3. FACT-B quality of life scores of breast cancer survivors (BCSs) before and after intervention (Mean ± SD, *t*)

Dimensions	EG (Mean ± SD)	CG (Mean ± SD)	t	p
Physiological status	12.7 ±1.643	12.5 ±1.776	0.565	0.326
Social / Family situation	23.03 ± 1.79	19.77 ± 2.417	0.084	< 0.001
Emotional state	19.17 ± 3.239	16.5 ± 2.98	0.181	< 0.001
Functional status	21.23 ± 4.057	17.2 ± 4.213	0.33	< 0.001
Additional attention	19.73 ± 2.864	18.6 ± 2.343	0.364	0.049

Notes: a) EG = Experimental Group; b) CG = Control Group.

The experimental group had much higher scores for social and family support than the control group (23.03 ± 1.79 vs. 19.77 ± 2.417, $p < 0.001$, d = 1. 49). The effect size was large. The experiment suggested that, through structured early functional exercise interventions, family interaction, interpersonal support, and social functioning are developed in breast cancer survivors (BCSs). As the survivors are likely to rely on family care during their healing phase, when the family members are actively involved in the home, based program, it has the result of strengthening the emotional and social support. This discovery is consistent with a previous study which highlighted the role of social and spiritual support after mastectomy [21].

Concerning emotional state, the experimental group disclosed significantly higher scores (19.17 ± 3.239 vs. 16.5 ± 2.98, $p < 0.001$, d = 0.85). One possible reason that early shoulder rehabilitation exercises might lead to better emotional states is the almost immediate effect they have on mood stabilization and on the reduction of psychological distress. Proper physical exercise can serve as a natural and effective way to reduce stress, anxiety, and depression by the production of endorphins and by a positive impact on the neuroendocrine system. A previous study reported same results which confirmed these findings [22].

Concerning functional status, the experimental group was ahead (21.23 ± 4.057 versus 17.2 ± 4.213, $p < 0.001$, d = 0.95). This result suggests, based on the main indices, that daily functioning and mobility levels have improved. Shoulder rehabilitation from an early stage helps to avert the problem of frozen shoulder, a very common cause of shoulder stiffness, and also promotes the recovery of self, care activities. This finding is in line with a previous study which highlighted the importance of postoperative rehabilitation training [23].

With breast cancer-specific problems, the gap was minimal but came up to the level of significance (19.73 ± 2.864 vs. 18.6 ± 2.343, $p = 0.049$, d = 0.42). This change in the score indicates better psychological adaptation [24].

3.4. Problem No. 4

As shown in **Table 4**, before the intervention (T0), the average CMS score of the experimental group (EG) was 99.03 (SD = 3.189), while that of the control group (CG) was 99.27 (SD = 2.556). The scores of the two groups were quite close. An independent samples T-test produced a T-value of 0.505 and a P-value of 0.378 which is far above significance at 0.05, the difference between the groups is not significant. This suggests that the shoulder joint function levels of the two groups were at the same level before intervention, showing good comparability of the pretest. In order to lay a solid foundation for the subsequent comparison of the effect of intervention and to minimize the influence of the differences at the beginning on the results of the study.

Table 4. Comparison of CMS scores between the experimental group and the control group before and after intervention (Mean ± SD, *t*)

Time- point	Group	n (%)	Mean ± SD	t	p
T0 - Before surgery	EG [a)]	30	99.03 ± 3.189	0.505	0.378
	CG [b)]	30	99.27 ± 2.559		
T1 - 10 days after surgery	EG [a)]	30	62.90 ± 12.293	0.080	<.001
	CG [b)]	30	51.73 ± 14.179		
T2 - 30 days after surgery	EG [a)]	30	89.53 ± 6.832	0.209	0.011
	CG [b)]	30	84.43 ± 9.755		

Notes: a) EG = Experimental Group; b) CG = Control Group.

The results show that in the tenth day after surgery (T1), the experimental group had a significantly better recovery of shoulder function than the control group. The average CMS of the EG group was 62.90 ± 12.293, significantly higher than the CMS of the CG group at 51.73 ± 14.179 (t = 0.080, p < 0.001). It can be seen from the above results that the rehabilitation program in the experimental group achieved the greatest improvement of shoulder function and recovery in the early postoperative period. And this result matches to a study which is about shoulder function exercise post breast cancer surgery [25]. This study has shown, that giving a survivor systematic shoulder functional exercises right from the start can make the BCSS get much better at recovering their shoulder after breast cancer surgery and make their lives so much better.

In addition, 30 days postoperatively (T2), although both groups showed significant improvement, the differences between them were still large. The average CMS score of the experimental group (EG) was 89.53 (SD = 6.832), while it was 84.43 (SD = 9.755) in the control group (CG), with a t value of 0.209 and a p value of 0.011, still being statistically significant. This means that although the scores of EG are close to those of CG during the middle and later stages of rehabilitation, full convergence has not yet been achieved. It means that the earlier promotion of the shoulder exercise program in the intervention group has formed a distinct overall recovery curve relative to that of the control group, and the recovery curve remains partly separated.

Based on the CMS scores obtained on the 10th day (T1) and the 30th day (T2) after surgery, it can be seen that there are statistically significant differences in the scores of the experimental group and the control group at different post-intervention stages, thus refuting $H_0$2. The results show that I do think shoulder joint functional exercise interferences sooner do have effect on shoulder recovery after surgery. However, during the early postoperative phase, the recovery outcomes in the intervention group were inferior to those in the control group, suggesting that the implementation methods, pacing, or content of the early-stage exercise program may require further optimization to better align with the actual rehabilitation needs of BCSs following breast cancer surgery.

3.5. Problem No. 5

Table 5 shows that after 30 days of rehabilitation intervention, the total FACT-B quality of life score of BCSs in the experimental group (EG) reached 95.87 ± 9.142, significantly higher than the 84.57 ± 7.328 in the control group (CG) (mean difference of 11.3 points). Independent sample t-test analysis showed that the difference between the two groups was highly statistically significant (t = 5.283, p < 0.01), confirming the positive effect of early rehabilitation intervention on improving the quality of life of BCSs after breast cancer surgery. This result is consistent with the conclusion in a study about the best intervention time of exercise for breast cancer survivors and further proves the clinical significance of systematic rehabilitation exercises in enhancing the quality of life of BCSs post-operation [26].

Table 5. Comparison of quality-of-life scores (FACT-B) between the experimental and control groups before and after early shoulder function exercise intervention (Mean ± SD)

Group	n (%)	Mean ± SD	t	p
Experimental group	30	95.87 ± 9.142	5.283	<.001
Control group	30	84.57 ± 7.328		

Because the p-value is much less than the pre-set significance level (α = 0.05), the null hypothesis H_0 3 is rejected. This indicates that the change in the quality-of-life score for the experimental group and the control group

after this intervention has statistical difference. This result again proves that the early functional training program can significantly enhance the overall quality of life of BCSs after breast cancer surgery, providing an experimental basis for promoting the refinement of postoperative rehabilitation nursing intervention models.

3.6. Problem No. 6

Table 6 shows the results of the Pearson correlation analysis. On the 30th day after surgery, the Pearson correlation coefficient between the CMS score and the FACT-B quality of life total score was r = 0.448, which was a statistically significant moderate positive correlation ($p < 0.05$). This result shows that BCSs with higher shoulder function scores generally report a higher quality of life. This finding is consistent with the results of a previous study on the improvement of shoulder function, functional ability, quality of life, anxiety and depression in women with breast cancer by shoulder exercise training [27]. More exercise not only helps to improve physical function and shoulder range of motion, but also significantly improves their overall quality of life.

Table 6. Pearson correlation analysis between early shoulder joint function scores and FACT-B total quality of life scores(r)

Time	r	p	Interpretation
T2 [a] - CMS	0.448*	$p < 0.05$	Moderate positive correlation, statistically significant
(T2-T1)[b]-CMS	0.302		Weak to moderate positive correlation, close to significant level

a) 30 days after surgery; b) changes between the 30th day and the 10th day after surgery.

The results show that active functional exercise in the early postoperative period may not only promote the improvement of limb mobility, but also indirectly improve the survivor's subjective perception of quality of life. It can be seen that the recovery of physical function has a positive impact on the overall health status of breast cancer BCSs.

For the change in shoulder score from day 10 to day 30 (T2–T1), the analysis results showed that the Pearson correlation coefficient with the FACT-B total score was r = 0.302. This correlation is in the range of "weak to moderate positive correlation". Although it has not reached a strict statistical significance level, its positive trend suggests that short-term functional improvement may still have a positive impact on quality of life.

Changes in quality of life may lag functional improvements. BCSs may need time to adapt after their physical functions improve, and improvements in emotional state, daily role functions, etc. may also require a longer recovery period to appear.

3.6.1. Scatter plot analysis

Figure 3 shows the scatter plot of CMS endpoint score (T2) and FACT-B quality of life total score, showing the relationship between shoulder function score (T2) and quality of life total score (FACT-B) on day 30 after surgery. It can be observed from the figure that the data points tend to distribute to the upper right, indicating a positive linear relationship. The slope of the fitted straight line is positive, which further supports the moderate positive correlation between the two (r = 0.448). In addition, most of the data points are relatively concentrated, and there are no obvious outliers, indicating that the correlation has a certain stability and representativeness.

Figure 4 shows the scatter plot of the change in CMS score (T2–T1) and the total score of FACT-B. This figure reflects the relationship between the change in shoulder function from the 10th day to the 30th day after sur-

gery (i.e., T2–T1) and the total score of FACT-B quality of life. As can be seen in the figure, the data points show a slight upward trend, and the fitted straight line also has a positive slope, but the overall correlation is relatively scattered, which supports the weak to moderate positive correlation (r = 0.302) results obtained in the statistical analysis. Although there is a certain positive trend, the data points in the figure are more discrete, suggesting that the relationship between short-term functional recovery and improvement in subjective quality of life is not as strong as the endpoint score, which may be affected by multiple factors such as individual differences and psychological adjustment.

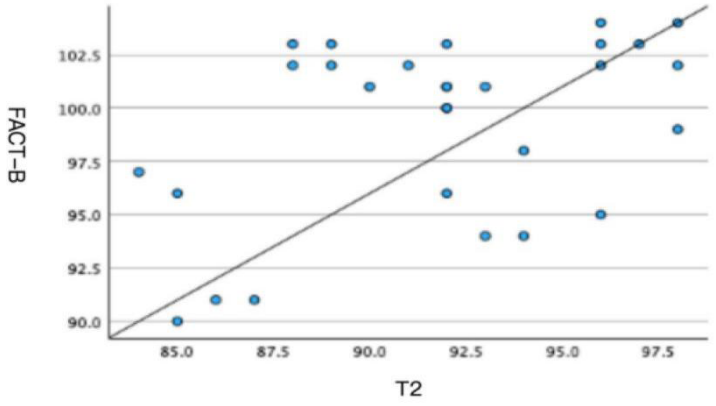

Figure 3. Scatter plot of endpoint CMS score (T2) and FACT-B total score.

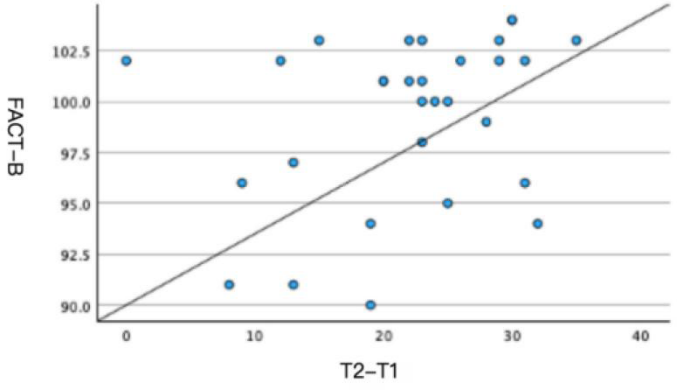

Figure 4. Scatter plot of CMS functional change (T2–T1) and FACT-B total score.

The relationship between the endpoint score (T2) on the 30th day after surgery and the quality of life is closer, which supports the use of T2 as an important indicator to measure the relationship between postoperative recovery and QoL improvement. Although the short-term change (T2–T1) also showed a positive trend, its explanatory power was relatively weak, suggesting that nursing intervention should focus on the time difference and asynchronous characteristics between functional recovery and quality of life.

The correlation coefficient between the shoulder function score on the 30th day after surgery (T2) and the total score of FACT-B was r = 0.448. As the coefficient was $p < 0.05$, the correlation was considered statistically significant. Therefore, the null hypothesis $H_0$4 was rejected. Most current studies support that early shoulder joint functional training is positively correlated with quality of life, but the causal relationship and mechanism of action need to be further explored.

4. Summary of findings, conclusions, and recommendations

4.1. Summary of findings

There was no statistically significant difference in age, BMI, education level and CMS score before surgery between the two groups, resulting to a good baseline comparability and provided a solid foundation for subsequent comparison of intervention effects and evaluation of research intervention effectiveness. Early shoulder joint functional training significantly improved the shoulder joint function of breast cancer BCSs on the 10th and 30th days after surgery. The experimental group was superior to the control group in the total CMS score and each dimension, especially pain relief, daily living ability and range of motion (such as T1 pain $p = 0.018$, ROM $p < 0.001$). However, no significant difference was found in the muscle strength dimension (T2 $p = 0.500$), which may be due to the limited intervention time and the low priority of physiological recovery. The experimental group also performed significantly better than the control group in terms of total quality of life score (FACT-B) (95.87 ± 9.14 vs. 84.57 ± 7.33, $p < 0.001$), and achieved clinical significance in dimensions such as social support, emotional state, and functional status, indicating that the intervention not only improved physical function, but also enhanced BCSs' psychological and social adaptability. The CMS score on the 30th day after surgery was moderately positively correlated with the total score of FACT-B ($r = 0.448$, $p < 0.05$), verifying the hypothesis that "physical function recovery promotes improvement in quality of life". Physical function has close relationships to the subjective sense of well-being, emotion, and participation of the survivor, these are an indication that the importance of survivor centeredness on postoperative rehabilitation is emphasized again.

4.2. Conclusion

Organized early post-surgery shoulder activities enhance shoulder mobility and uplift the living standards of survived women with breast cancer after undergoing modified radical mastectomy. The effects of confounding demographic characteristics were ruled out. The experimental group saw a larger increase in Constant Murley Shoulder Scores (CMS) as well as the FACT-B quality- of-life scores in comparison to the control group. A day 30 post-surgery examination showed a fair positive association between shoulder capability and quality of living indicating strong link. Early shoulder exercises with a well-planned structure in the routine postoperative treatment was key strategy in promoting the functional restoration as well as the overall health of breast cancer survivors.

Disclosure of statement

The authors declare no conflict of interest.

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