

# Breast Cancer-Related Lymphedema Risk-Management Behaviors Among Chinese Breast Cancer Survivors and Relationships with Socio-Demographic and Clinical Characteristics: A Longitudinal Study

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**Purpose:** We sought to determine changes in breast cancer-related lymphedema (BCRL) risk-management behaviors in the six-month period after surgery among Chinese breast cancer survivors and to explore the relationship between their socio-demographic and clinical characteristics and these behaviors.

**Patients and Methods:** A longitudinal study design was adopted. Females aged  $\geq 18$  years with a first breast cancer diagnosis and who had undergone modified radical mastectomy were recruited from a cancer hospital in China. Respondents with a history of other malignant tumors, mental illness, or cognitive impairment were excluded from the study. Socio-demographic and clinical factors were assessed at baseline. BCRL risk-management behaviors were assessed with the Lymphedema Risk-Management Behavior Questionnaire (LRMBQ) and Functional Exercise Adherence Scale (FEAS) in the first, third, and sixth months after surgery. Repeated-measures analysis of variance was used to examine changes in BCRL risk-management behaviors over the three study time periods, and a generalized linear mixed model was used to determine socio-demographic and clinical factors associated with BCRL risk-management behaviors.

**Results:** A total of 166 participants completed all three assessments. The scores of the total LRMBQ and its "Skin care" and "Lifestyle" subscales did not change significantly, but those of the "Avoidance of limb compression and injury" and "Other matters requiring attention" subscales changed over the three study time periods. Additionally, scores of the total FEAS and most of its subscales changed over the three study time periods. Furthermore, BCRL risk-management behaviors were significantly related to patients' geographic residence, education level, and tumor stage.

**Conclusion:** Some dimensions of BCRL risk-management behaviors changed over time, and several socio-demographic and clinical factors are related to BCRL risk-management behaviors. It is recommended that health care professionals consider the dynamic nature of BCRL risk-management behaviors and related factors when planning health education and promotion interventions.

**Keywords:** breast cancer, lymphedema, risk reduction, functional exercise adherence

## Introduction

Breast cancer has exceeded lung cancer as the most commonly diagnosed cancer globally<sup>1</sup> and in 2020, China had the largest number of breast cancer cases in the world.<sup>2</sup> Surgery is the first choice for breast cancer treatment, and modified radical mastectomy is a common surgical method used clinically.<sup>3</sup> However, the potential for complications caused by surgery for breast cancer, such as breast cancer-related lymphedema (BRCL), should not be overlooked.<sup>4,5</sup> BCRL is a chronic progressive disease

characterized by an abnormal accumulation of lymphatic fluid in the upper limbs due to lymphatic system damage.<sup>6</sup> It not only affects the body image of breast cancer survivors (BCS) but also seriously threatens their physical and mental health and quality of life.<sup>7-9</sup> While the exact incidence of BCRL is unknown, more than one out of five BCS are estimated to be affected by BCRL.<sup>10</sup> Studies indicate that, BCRL may appear as early as one month after surgery,<sup>11</sup> though it can develop at any time in the postoperative period.<sup>12</sup> Thus, the prospect of BCRL remains a constant threat throughout the lifetime of BCS.

BCRL risk-management behaviors include skin care, avoidance of limb compression and injury, lifestyle, functional exercise, and other matters requiring attention.<sup>13</sup> Internationally accepted guidelines (eg, from the National Lymphedema Network, American Cancer Society, and National Cancer Institute) recommend that BCS adopt lifelong risk-management behaviors to minimize the risk of BCRL and integrate the behaviors into their daily lives.<sup>14-16</sup> Because BCS's the lymphatic systems have been damaged, treatment of BCRL is a time-consuming, expensive, and difficult process. Thus, it is important to adopt optimal risk-management behaviors as early as possible to prevent BCRL.

The transtheoretical model suggests that it takes at least 6 months for individuals to obtain and maintain a health behavior.<sup>17,18</sup> Therefore, understanding the changes in BCRL risk-management behaviors from the first to the sixth month post-surgery is imperative for the development of effective and targeted interventions to promote the acquisition and stability of optimal BCRL risk-management behaviors.

Previous research has shown that the BCRL risk-management behaviors of BCS change dynamically. Sherman et al investigated BCS in the United States and found that overall adherence to BCRL risk-management behaviors significantly increased over 12 months.<sup>19</sup> McLaughlin et al conducted a longitudinal study of 120 BCS in the United States and found that BCRL risk-management behaviors remained stable from 6–12 months post-surgery.<sup>20</sup>

The results of previous studies also suggest that the behaviors of BCS are related to socio-demographic and clinical factors. Deveci et al found that BCS with lower levels of education demonstrated reduced adherence to BCRL risk-management behaviors.<sup>21</sup> A qualitative study showed that financial restraints lead to reduced BCRL risk-management behaviors, and patients with higher family income levels are more likely to exhibit better BCRL risk-management behaviors.<sup>22</sup> However, previous relevant studies on the relationship between socio-demographic and clinical factors and BCRL risk-management behaviors among BCS have relied on cross-sectional study designs. To our knowledge, no longitudinal studies have examined the relationship between BCRL risk-management behaviors and socio-demographic and clinical factors, and patient factors that might influence BCRL risk-management behaviors have yet to be fully elucidated.

To sum up, for BCS, early acquisition of optimal BCRL risk-management behaviors is necessary, but few relevant studies to date have examined changes in BCRL risk-management behaviors, and no such studies have been performed among BCS in China. Thus, this study aimed to describe the changes in BCRL risk-management behaviors from the first to the sixth month post-surgery and determine whether BCRL risk-management behaviors were affected by any of the following socio-demographic and clinical factors: age, geographic residence, education level, marital status, employment status, monthly family income per person, tumor stage, or dominant limb affected.

## Patients and Methods

### Study Design

A longitudinal design was used for this investigation.

### Patients and Procedure

A convenience sampling method was adopted. The present study was approved by the ethics committee of the Sixth Affiliated Hospital of Sun Yat-sen University (L2019ZSLYEC-001). This study was performed in compliance with the Declaration of Helsinki. The patient cohort was recruited between August 2019 and January 2021. Eligible patients were identified at a cancer hospital in Guangzhou and invited into the study by 4 master's degree students who had been trained as research assistants. The study inclusion criteria were as follows: (1) female sex; (2) aged  $\geq 18$  years old; (3) first diagnosis of breast cancer; (4) underwent modified radical mastectomy; and (5) had the ability to communicate

verbally with the research assistants and to complete the written informed consent form. Patients were excluded if they had a history of other malignant tumors, mental illness, or cognitive impairment.

During hospitalization, females who met the inclusion criteria were invited to participate in the study. Participants were asked to supply their informed consent and contact details; then, after informed consent was obtained, all participants were asked to complete socio-demographic and clinical profile-baseline forms. After discharge, all participants were also invited to complete follow-up questionnaires in the first (T1), third (T2), and sixth (T3) months post-surgery. At each of the follow-up assessments, we invited participants to return to the hospital to complete the questionnaires independently. For patients who could not return to the hospital, we sent the questionnaires to them through the social media platform WeChat (Tencent Holdings Ltd., Shenzhen, China) or asked for answers by telephone.

## Measures

### Socio-Demographic and Clinical Characteristics

In the present study, socio-demographic variables included age, geographic residence, education level, marital status, employment status, and monthly family income per person. Clinical variables obtained from medical records included tumor stage and dominant limb affected. These variables were collected at baseline using a socio-demographic and clinical characteristics list designed by the authors.

### BCRL Risk-Management Behaviors

The Lymphedema Risk-Management Behavior Questionnaire (LRMBQ)<sup>13</sup> was revised from the Lymphedema Risk-Reduction Behavior Checklist developed by Wang<sup>23</sup> to assess BCRL risk-management behaviors based on internationally accepted guidelines.<sup>14–16</sup> The LRMBQ consists of 18 items divided into four dimensions, as follows: “Skin care” (5 items), “Avoidance of compression and injury” (4 items), “Lifestyle” (5 items), and “Other matters requiring attention” (4 items). Each item is rated on a five-point Likert scale ranging from 1 (never) to 5 (always) points. LRMBQ has good content validity (scale content validity index=0.86) and the Cronbach’s  $\alpha$  of the total scale and each subscale range from 0.65–0.79, respectively.

In the LRMBQ, only one item (item 22, “Perform appropriate functional exercises of the affected arm every day”) mentioned functional exercise. Considering the significance of functional exercise among BCS, the Functional Exercise Adherence Scale (FEAS) was also used. The FEAS<sup>24</sup> consists of 18 items divided into three subscales, as follows: “Adherence to physical exercise” (9 items), “Adherence to actively seeking advice” (4 items), and “Adherence to following the precautions” (5 items). Each item is rated on a four-point Likert scale ranging from 1 (cannot do it at all) to 4 (completely achievable) points. For the reliability of the scale, the Cronbach’s alpha coefficients for these subscales range from 0.75–0.88. After discharge, study participants completed both the LRMBQ and the FEAS at T1, T2, and T3.

## Data Analysis

All data were analyzed using the Statistical Package for the Social Sciences version 25.0 for Windows (SPSS Inc., Chicago, IL, USA). A  $p < 0.05$  was considered to be statistically significant in all analyses. Categorical variables were described by frequencies and percentages, and continuous variables were presented using mean  $\pm$  standard deviation (SD) values. To examine the changes in BCRL risk-management behaviors from T1 to T3, a repeated-measures analysis of variance (ANOVA) was conducted. Paired  $t$ -tests were used to examine the mean difference in BCRL risk-management behaviors between all pairs of time points.

To determine socio-demographic and clinical factors associated with LRMBQ and FEAS, generalized linear mixed model (GLMM) analyses were performed with time as the repeated factor. The GLMM, an extension of the widely used repeated-measures ANOVA model, provides greater flexibility for modelling within-subject correlation and for handling random errors both within and between subjects. Further, the GLMM has no strict requirements regarding the type of data distribution in which the outcome variable is a continuous variable. In this study, we entered all of the socio-demographic and clinical variables into the GLMM.

## Results

A total of 198 females were recruited and completed the T1 assessment in this study. During follow-up, 10 participants did not complete the T2 assessment, and 22 did not complete the T3 assessment, leaving 166 participants who completed all three assessments (retention rate of 83.8%). Reasons for dropout included withdrawal of consent, an inability to complete the questionnaires, significant travel distance, and an inability to contact participants due to outdated contact information. In this study, we used the final 166 participants' complete data for analysis.

### Participants' Socio-Demographic and Clinical Characteristics

The socio-demographic and clinical characteristics of the participants are profiled in Table 1. Participants ranged between 25–71 years, with a mean age of 47.5 years (SD = 10.48). Only 29.5% of the participants had a college education or higher. Most participants were married (86.1%) and unemployed (53.6%), and more than half of them had a monthly family income per person of more than 4000 RMB (56.6%). More than 70% of the participants were in the early stages of breast cancer (stage I = 19.9%, stage II = 53.6%); among 60.2% of the respondents, the affected limb was the dominant limb.

### Changes in BCRL Risk-Management Behaviors

As for LRMBQ, repeated-measures ANOVA analyses indicated that the “Total LRMBQ” score did not change over time ( $F=1.75$ ,  $p=0.176$ ; Table 2). Among the four subscales, repeated-measures ANOVA analyses showed significant time effects on both “Avoidance of limb compression and injury” ( $F=10.46$ ,  $p<0.001$ ) and “Other matters requiring attention” ( $F=9.17$ ,  $p<0.001$ ), suggesting significant mean differences existed in these two subscales between the three study time periods. The scores of the “Skin care” ( $F=2.84$ ,  $p=0.063$ ) and “Lifestyle” ( $F=3.05$ ,  $p=0.051$ ) subscales did not change over time.

For FEAS, repeated-measures ANOVA analyses revealed a time effect, indicating significant mean differences in “Total FEAS” scores between the three study time periods ( $F=5.57$ ,  $p=0.004$ ; Table 2). Among the three subscales, repeated-measures ANOVA analyses showed significant time effects on both “Adherence to actively seeking advice” ( $F=3.96$ ,  $p<0.020$ ) and “Adherence to following the precautions” ( $F=25.02$ ,  $p<0.001$ ), indicating significant mean differences existed in these two subscales between the three study time periods. In contrast, the “Adherence to physical exercise” subscale score did not change over time ( $F=0.91$ ,  $p=0.404$ ).

### Socio-Demographic and Clinical Factors Associated with BCRL Risk-Management Behaviors

As shown in Table 3, the GLMM of the LRMBQ revealed that there were three significant predictors correlated with the LRMBQ results, as follows: geographic residence, education level, and tumor stage.

In the model, participants who lived in rural areas were associated with a greater reduction in scores for “Total LRMBQ”, “Skin care”, and “Other matters requiring attention”. Higher education level was associated with a greater increase in the “Skin care” score. Finally, a positive correlation was found between the tumor stage and the scores for “Total LRMBQ”, “Skin care”, “Avoidance of limb compression and injury”, “Lifestyle”, and “Other matters requiring attention”.

As shown in Table 4, the GLMM of the FEAS revealed that there were two significant predictors correlated with the FEAS results, as follows: education level and tumor stage.

In the model, a higher education level was associated with a greater increase in the scores for “Total FEAS”, “Adherence to physical exercise”, and “Adherence to actively seeking advice”. Separately, a positive correlation was found between the tumor stage and the scores for “Total FEAS”, “Adherence to actively seeking advice” and “Adherence to following the precautions”.

**Table I** Socio-Demographic and Clinical Characteristics of the Sample (N=166)

Variable	N	%
Age (years) <sup>a</sup>		
<40	44	26.5
≥40	122	73.5
Geographic residence		
Urban	104	62.7
Rural	62	37.3
Education level		
Primary school	36	21.7
Middle school	81	48.8
College degree or above	49	29.5
Marital status		
Married	143	86.1
Single/divorced/widowed	23	13.9
Employment status		
Employed	77	46.4
Unemployed (housewife, retired)	89	53.6
Monthly family income per person (yuan)		
<4000	72	43.4
≥4000	94	56.6
Stage of tumor		
I	33	19.9
II	89	53.6
≥III	44	26.5
Dominant limb affected		
Yes	100	60.2
No	66	39.8

Notes: <sup>a</sup>Age: the mean score was 47.5 years with a standard deviation of 10.48.

## Discussion

To our knowledge, this study is the first in China to report changes in BCRL risk-management behaviors at three different time points after breast cancer surgery (the first, third, and sixth months post-surgery). The results of this study reveal the dynamic nature of BCRL risk-management behaviors over three time periods and elucidate the relationship between socio-demographic and clinical factors and BCRL risk-management behaviors.

As for the LRMBQ, the scores of the “Avoidance of limb compression and injury” and “Other matters requiring attention” subscales were highest at the first month post-surgery. They then dropped down to their lowest at the third month post-surgery and remained stable during the third and sixth months after surgery (Table 2, Figure 1). A possible

**Table 2** The Changes in BCRL Risk-Management Behaviors Over Three Time Periods (N=166)

Variable	T1		T2		T3		Repeated-Measures ANOVA		Pairwise Comparison
	Mean	SD	Mean	SD	Mean	SD	F	P	
<b>LRMBQ</b>									
Total LRMBQ	4.08	0.55	3.97	0.65	4.04	0.67	1.75	0.176	–
Skin care	3.77	0.86	3.83	0.80	3.95	0.78	2.84	0.063	–
Avoidance of limb compression and injury	4.85	0.30	4.54	0.81	4.58	0.80	10.46	<0.001**	①③
Lifestyle	3.45	1.01	3.94	0.89	3.64	0.95	3.05	0.051	–
Other matters requiring attention	4.24	0.66	3.94	0.89	4.00	0.92	9.17	<0.001**	①③
<b>FEAS</b>									
Total FEAS	2.98	0.58	2.96	0.55	2.83	0.68	5.57	0.004*	②③
Adherence to physical exercise	2.71	0.75	2.75	0.68	2.67	0.79	0.91	0.404	–
Adherence to actively seeking advice	2.77	0.91	2.55	0.84	2.62	0.91	3.96	0.020*	①
Adherence to following the precautions	3.46	0.42	3.57	0.47	3.20	0.74	25.02	<0.001**	①②③

**Notes:** ①T1 vs T2 significant difference; ②T2 vs T3 significant difference; ③T1 vs T3 significant difference; \* $p < 0.05$ , \*\* $p < 0.001$ .

**Abbreviations:** T1, the first month post-surgery; T2, the third month post-surgery; T3, the sixth month post-surgery; repeated-measures ANOVA, repeated-measures analysis of variance; SD, standard deviation; LRMBQ, Lymphedema Risk-Management Behaviors Questionnaire; FEAS, Functional Exercise Adherence Scale.

**Table 3** Results of Generalized Linear Mixed Model Analysis: Associations Between Socio-Demographic and Clinical Factors and LRMBQ (N=166)

Variable	Total LRMBQ	Skin Care	Avoidance of Limb Compression and Injury	Lifestyle	Other Matters Requiring Attention
	Estimate Mean	Estimate Mean	Estimate Mean	Estimate Mean	Estimate Mean
Geographic residence					
Urban	Ref.	Ref.	Ref.	Ref.	Ref.
Rural	-0.146*	-0.179*	-0.084	-0.113	-0.205*
Education level					
Primary school	Ref.	Ref.	Ref.	Ref.	Ref.
Middle school	0.134	0.125	0.034	0.163	0.138
College degree or above	0.172	0.288*	-0.033	0.280	0.195
Stage of tumor					
I	Ref.	Ref.	Ref.	Ref.	Ref.
II	0.270***	0.203*	0.191**	0.282*	0.385***
≥III	0.312***	0.232*	0.098	0.335*	0.460***
Time					
T1	Ref.	Ref.	Ref.	Ref.	Ref.
T2	-0.101	0.057	-0.307***	0.148	-0.301**
T3	-0.034	0.177*	-0.267***	0.192	-0.239***

Notes: \* $p < 0.05$ , \*\* $p < 0.001$ , \*\*\* $p < 0.0001$ .

Abbreviations: LRMBQ, Lymphedema Risk-Management Behaviors Questionnaire; T1, the first month post-surgery; T2, the third month post-surgery; T3, the sixth month post-surgery.

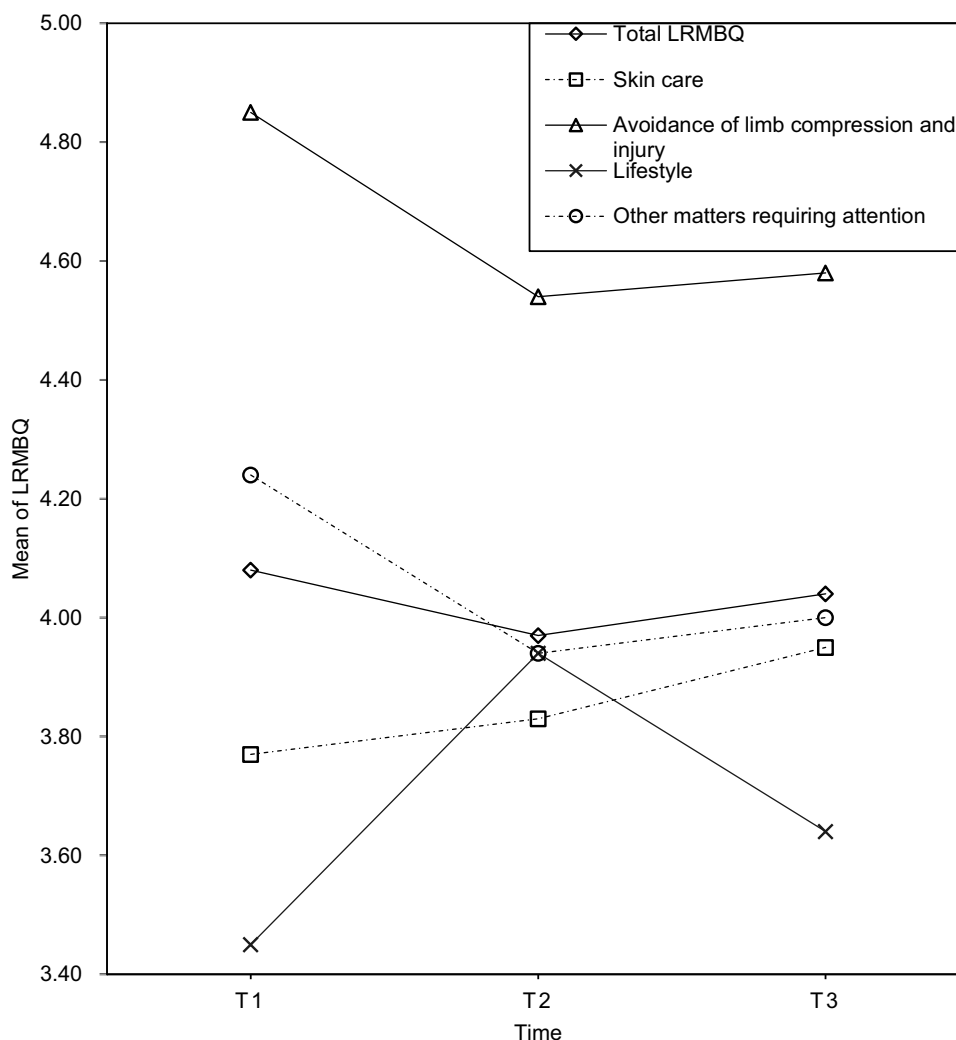
**Table 4** Results of Generalized Linear Mixed Model Analysis: Associations Between Socio-Demographic and Clinical Factors and FEAS (N=166)

Variable	Total FEAS	Adherence to Physical Exercise	Adherence to Actively Seeking Advice	Adherence to Following the Precautions
	Estimate Mean	Estimate Mean	Estimate Mean	Estimate Mean
Education level				
Primary school	Ref.	Ref.	Ref.	Ref.
Middle school	0.059	0.096	0.017	0.034
College degree or above	0.254**	0.333**	0.360**	0.069
Stage of tumor				
I	Ref.	Ref.	Ref.	Ref.
II	0.183**	0.144	0.161	0.207**
≥III	0.217**	0.143	0.254*	0.190**
Time				
T1	Ref.	Ref.	Ref.	Ref.
T2	-0.022	0.038	-0.212*	0.107*
T3	-0.150*	-0.044	-0.143	-0.264***

Notes: \* $p < 0.05$ , \*\* $p < 0.001$ , \*\*\* $p < 0.0001$ .

Abbreviations: FEAS, Functional Exercise Adherence Scale; T1, the first month post-surgery; T2, the third month post-surgery; T3, the sixth month post-surgery.

explanation for these findings might be that behaviors in these two aspects depend both on past habits and current rehabilitation needs. In the early stage after surgery, BCS usually felt uncomfortable on the side of the affected limb (eg, pain, numbness, weakness) because of the breast cancer treatment. This experience could encourage them to avoid limb compression and injury, pay attention to BCRL prevention, and attach significant importance to rehabilitation. However,



**Figure 1** The changes in LRMBQ over three time periods.

**Abbreviations:** LRMBQ, Lymphedema Risk-Management Behaviors Questionnaire; T1, the first month post-surgery; T2, the third month post-surgery; T3, the sixth month post-surgery.

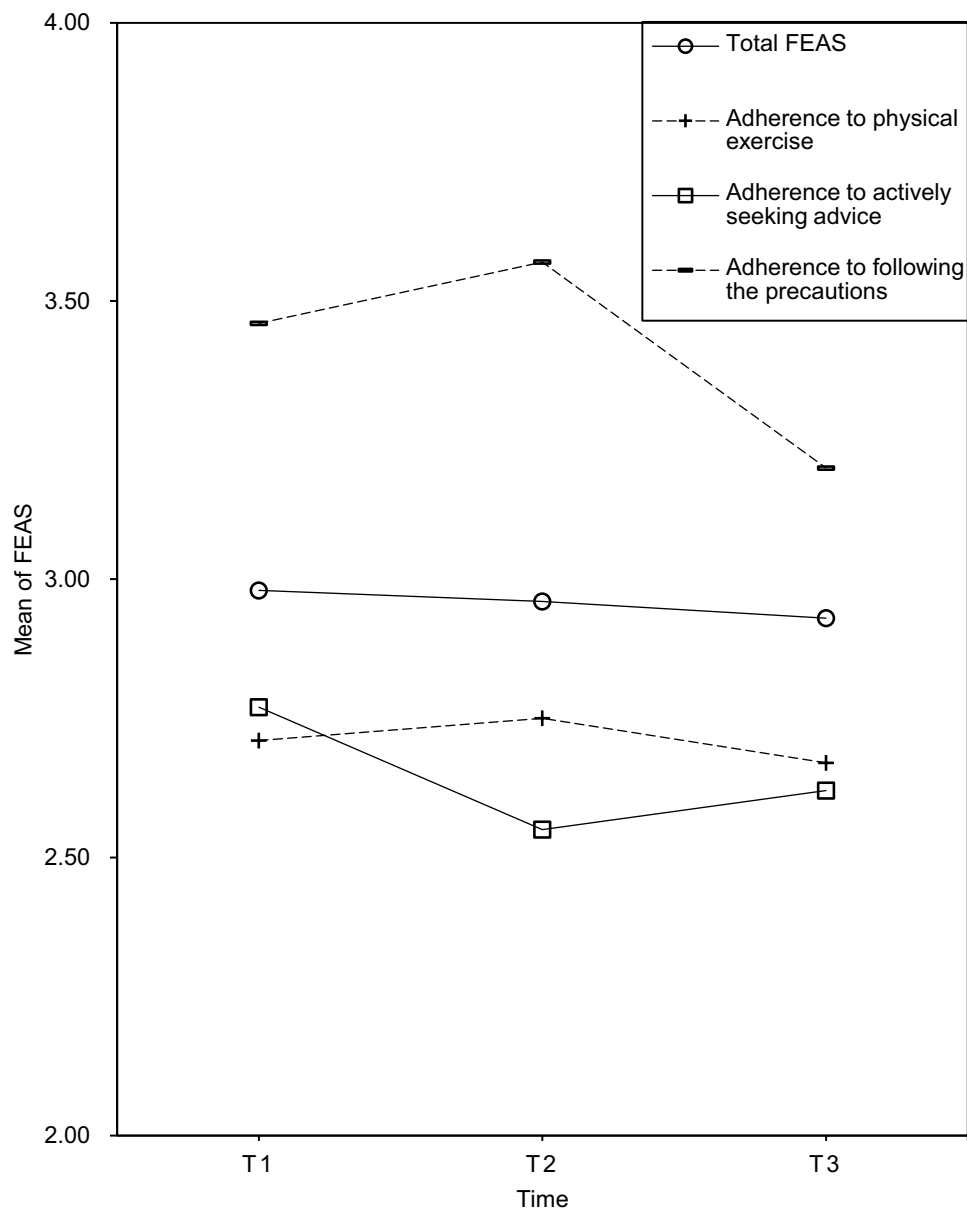
over time, an individual's pre-existing habits, affected limb recovery, or completion of breast cancer treatment can lead to a decrease in compliance with these behaviors. In addition, the findings may be due to the fact that practicing BCRL risk-management behaviors require BCS to spend much time and energy in their daily life, making them feel troubled and annoyed.<sup>22</sup> In China, patient education for the prevention of BCRL is mainly conducted by nurses during hospitalization. With the passage of time, BCS gradually forget the details and importance of preventing BCRL and may fail to implement these behaviors strictly. Meanwhile, BCRL risk management often is not paid adequate attention in subsequent visits and treatment sessions. It has been suggested that the provision of adequate information on BCRL risk-management behaviors positively affects and enables adoption and maintenance of BCRL risk-management behaviors,<sup>25–27</sup> and a positive nurse–physician collaboration is key to achieving quality patient outcomes.<sup>28</sup> Therefore, long-term BCRL educational programs conducted by both nurses and physicians should be offered to BCS after discharge. Our findings indicate that the duration of BCRL educational programs should preferably extend beyond 3 months, focusing especially on avoidance of limb compression and injury, and the other matters requiring attention.

With regard to the FEAS, the score for “Adherence to actively seeking advice” was highest at the first month post-surgery. It dropped to its lowest at the third month post-surgery and remained stable during the third and sixth months after surgery (Table 2, Figure 2). In the early stage after surgery, BCS have a strong focus on rehabilitation and treatment.



However, in traditional Chinese culture, patients are supposed to remain passively obedient in the treatment and rehabilitation process rather than seeking help actively. Additionally, this score trend may be related to the lack of convenient and fast communication channels between physicians and BCS. Chinese BCS mainly consult physicians when returning to the hospital for re-examination or treatment. In this situation, the amount of communication between BCS and physicians regarding functional exercise is relatively limited. Our finding suggests that healthcare providers need to assist BCS to seek more professional support to enhance their functional exercise related to BCRL risk-management behaviors, particularly before the third month after surgery.

In this study, the scores of the “Lifestyle” and “Adherence to following the precautions” subscales rose from the first month post-surgery to the third month post-surgery, and then dropped to their lowest at the sixth month post-surgery (Table 2, Figures 1 and 2). Fear of recurrence is one of the most commonly reported problems among cancer survivors.<sup>29</sup> This fear stems from the inherent uncertainty of outcomes associated with the disease,<sup>30</sup> the side effects of treatment, and the fear of death. The fear of recurrence may lead to developing the habits of a healthy lifestyle and closely following the



**Figure 2** The changes in FEAS over three time periods.

**Abbreviations:** FEAS, Functional Exercise Adherence Scale; T1, the first month post-surgery; T2, the third month post-surgery; T3, the sixth month post-surgery.

precautions. However, over time, the complex lifelong requirements and the time-consuming attributes of BCRL risk-management behaviors may result in lower adherence to adopting a healthy lifestyle and following precautions among BCS.<sup>26,31</sup> Additionally, the findings may be due to the fact that most participants in this study were >40 years old and married. In China, women who have undergone surgery are usually well cared for by their partners or other family members. They have plenty of time to practice these behaviors. However, with improvement in their physical condition, BCS would gradually assume family obligations based on their traditional gender-specific roles as wives, mothers, and homemakers, and they would spend less and less time on these behaviors as they increasingly prioritize caring for family members and doing housework instead. Therefore, health care professionals should regularly evaluate patients' BCRL risk-management behaviors and provide more targeted and reliable intervention programs. Intervention programs need to be developed and implemented to improve the lifestyle and adherence to the precautions between the third and sixth months following surgery.

In this study, we found that geographic residence, education level, and tumor stage related to some subscale scores of the two questionnaires (Tables 3 and 4). Specifically, this study found that a higher level of education was associated with a greater increase in FEAS scores, and participants living in rural areas were associated with a greater decrease in LRMBQ scores. Similar to our findings, the literature suggests that BCS with high education levels may have a better understanding of the benefits and skills associated with BCRL risk-management behaviors, leading to better adherence to BCRL risk-management behaviors.<sup>21</sup> Compared to urban patients, it is more difficult for rural patients to obtain disease-related information and support from health care professionals to a degree that will enable them to believe in the benefits of BCRL risk-management behaviors. It has been suggested that a lack of available information and not believing in the perceived benefits of BCRL risk-management behaviors can lead to reduced adoption of BCRL risk-management behaviors.<sup>32,33</sup> Our findings suggest that health care professionals should provide more educational programs to BCS in rural areas and BCS with low levels of education, and assist them in seeking more resources to enhance their BCRL risk-management behaviors.

Meanwhile, a higher tumor stage was associated with a greater increase in scores of LRMBQ and FEAS. A possible explanation for this finding might be that BCS with higher tumor stages are aware of the severity of their disease and then adopt better BCRL risk-management behaviors in response. This finding suggests that health care professionals should pay more attention to BCS with lower tumor stages.

There were several limitations in this study. First, our participants were recruited from only one cancer hospital, thus limiting the generalization of our findings. Second, BCRL risk-management behaviors were self-reported by study participants. Possible sources of bias in this study include the tendency of participants to respond in a socially desirable manner or to exaggerate their BCRL risk-management behaviors. Third, our measurement approach is not a widely used method to assess BCRL risk-management behaviors among BCS, which makes it difficult to compare results between studies.

## Conclusion

The present study highlighted changes in BCRL risk-management behaviors among BCS from the first to the sixth month after breast cancer surgery. BCRL risk-management behaviors were assessed by LRMBQ and FEAS questionnaires. LRMBQ scores for the "Avoidance of limb compression and injury" and "Other matters requiring attention" subscales changed over the three study time periods. For the FEAS, the scores of the "Total FEAS", "Adherence to actively seeking advice" and "Adherence to the following precautions" subscales changed over the three study time periods. In addition, geographic residence, education level, and tumor stage were found to be associated with BCRL risk-management behaviors. Health care providers should understand the dynamic nature of BCRL risk-management behaviors and should consider the patient characteristics highlighted in this study with the goal of helping patients to improve their BCRL risk-management behaviors. Future research is expected to provide further replication in a longer follow-up study with a more diverse sample.

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## Disclosure

The authors report no conflicts of interest in this work.

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