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Original Article

Relationship between kinesiophobia and quality of life among patients with breast cancer–related lymphedema: Chain-mediating effect of self-care and functional exercise compliance

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ABSTRACT

Objective: Breast cancer–related lymphedema (BCRL) significantly impacts the quality of life (QoL) of breast cancer survivors following treatment. This study explores the association between kinesiophobia (fear of pain caused by movement) and QoL in postsurgical BCRL survivors and examines whether self-care and compliance with functional exercise act as mediators between these variables.

Methods: This cross-sectional study surveyed 274 BCRL patients at three tertiary hospitals in Shenyang City, China, from May 2020 to October 2022. The participants completed self-reported questionnaires on self-care, functional exercise compliance, kinesiophobia, and QoL. Medication analysis was conducted using the PROCESS macro (Model 6).

Results: Kinesiophobia was found to have negative association with self-care ($P < 0.001$), functional exercise compliance ($P < 0.001$), and QoL ($P < 0.001$). Kinesiophobia indirectly affected QoL through three mediating pathways: self-care (effect = −0.132), functional exercise compliance (effect = −0.390), and a combination of self-care and functional exercise compliance (effect = −0.220), collectively accounting for 7.9%, 23.3%, and 13.1% of the total effect, respectively.

Conclusions: This study highlights the substantial chain-mediating role of self-care and functional exercise compliance in the relationship between kinesiophobia and QoL. It provides valuable evidence supporting the protective effects of self-care and functional exercise compliance in mitigating kinesiophobia and enhancing the QoL of BCRL survivors.

Introduction

Breast cancer (BC) is recognized as the most prevalent malignancy affecting women in China.[1] The primary treatment for clinical BC often involves modified radical mastectomy (MRM) combined with chemoradiotherapy. However, BC survivors frequently endure a substantial burden of postoperative symptoms in the long term. Among these complications, breast cancer–related lymphedema (BCRL) is one of the most common, affecting around 5%–50% of BC patients.[2] BC surgical procedures can disrupt the normal functioning of the lymph system, leading to the accumulation of excess fluid in the affected upper extremity. This condition is typically associated with severe swelling, pain, stiffness, and even limitations in shoulder and arm mobility.[3] Consequently, previous research has shown that the persistent upper extremity impairments caused by BCRL not only severely impact patients' daily physical activities but also exacerbate their psychological distress, ultimately diminishing their overall quality of life (QoL).[4]

QoL is a crucial index for assessing the multidimensional aspects of patients' health outcomes in their daily lives during long-term rehabilitation of cancer survivors.[5] Kwan et al. verified that nearly 30%–70% of BC patients experienced at least mild shoulder or arm symptoms after BC treatment, and 12.5% of patients developed lymphedema, as revealed through a survey of 744 BC patients. Furthermore, both symptomatic patients and BC patients with lymphedema had significantly worse QoL scores than asymptomatic patients.[6] In addition, a cross-sectional study conducted by Bulley et al. found that the prevalence of lymphedema peaked at 28% in the third year among 473 women who had undergone BC treatment. Moreover, the study revealed that persistent arm problems seriously impaired patients' upper limb function and led to a decline in their QoL over time.[7] A recent review has shown that patients with BCRL

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and poor QoL often experience feelings of weakness, financial burden, concerns about disease progression, changes in body image, and reduced limb function.[8] Therefore, considering that the essential aspects of QoL such as physical functioning, psychological health, social support, and spiritual well-being experienced by BC patients are strongly associated with lymphedema, QoL is widely perceived as a particularly significant factor in measuring symptom relief and prognosis among BC survivors.[9]

Kinesiophobia refers to a situation where individuals have an irrational and intense fear of physical activity to avoid painful reinjury.[10] Based on the fear avoidance model, this fear of pain leads kinesiophobic patients to reduce their daily activities and physical movements, ultimately resulting in the degradation of somatic functions and deterioration of mental health.[11] Notably, Gencay et al. discovered that 76% of patients with kinesiophobia also had upper extremity lymphedema among 81 BC patients who had undergone cancer–related surgery. This suggests that those who develop lymphedema are more likely to limit the use and movement of their upper extremities due to the fear of excessive pain, which can worsen the severity of the edema.[12] Similarly, Karadibak et al.[13] found that the severity of edema in upper extremity lymphedema was positively correlated with a high level of kinesiophobia but negatively correlated with better QoL among 62 BC patients (all $P < 0.01$). Furthermore, a cross-sectional study of 54 BC survivors reported that a high incidence (66.7%) of kinesiophobia was significantly correlated with poorer QoL scores among these patients.[14] Therefore, kinesiophobia is considered to play an essential role in predicting QoL in patients with chronic disorders.[15] However, the impact of kinesiophobia on QoL in BC patients with lymphedema remains rarely studied.

Self-care may play a role in the interaction between kinesiophobia and QoL in BC patients with lymphedema. Self-care ability is recognized as a series of conscious activities that can assist cancer survivors in returning to their normal lives after surgery or chemoradiotherapy by enhancing proactive attitudes and voluntarily modifying health-related behaviors.[16] A prior study revealed that low adherence to BCRL self-care modalities could accelerate the development and progression of BCRL into more advanced stages. Therefore, it is imperative to enhance the self-care abilities of these survivors to promote their QoL.[17] Additionally, according to the Health Belief Model, individuals with kinesiophobia tend to subjectively amplify obstacles they may encounter; consequently, they restrict their health-related behaviors, such as self-care.[18] From this perspective, BC patients with postoperative upper extremity lymphedema are advised to acquire adequate self-care practices from health care professionals or nurses to enhance their management skills for BCRL and improve their QoL.[19]

Notably, previous researchers have suggested that BC survivors should actively engage in postoperative functional exercise programs to prevent the progression of lymphedema in the upper extremities.[20] However, it is a great challenge for the majority of patients to adhere to long-term functional exercise programs after discharge.[21] Comparable studies have illustrated that the adherence rate to functional exercise gradually decreases after discharge, especially from the 105th day after operation, which directly hinders the recovery of normal upper limb function.[22] Accordingly, increasing numbers of scholars have demonstrated that the fear of pain and movement is the major barrier for BC survivors to utilize rehabilitation exercise.[23] Interestingly, a randomized controlled trial study revealed that BC patients who underwent 8 weeks of rehabilitative exercise intervention following surgery showed a significant improvement in kinesiophobia scores compared to those in the control group.[24] Moreover, Keradibak et al. reported that adherence to a 12-week home-based exercise program had significantly positive effects on improving kinesiophobia and QoL in patients with BCRL following BC surgery.[13] However, the correlation between kinesiophobia, postoperative exercise adherence, and QoL among survivors with BCRL has not yet been fully determined.

Self-care and adherence to functional exercises are closely interconnected, especially in cases of chronic illnesses. Warehime et al. conducted a qualitative study that substantiated the importance of confidently participating in self-care activities in patients with heart failure. The study found that 59.1% of patients who engaged in self-care activities experienced improved health outcomes and long-term excise adherence, suggesting that self-care might play a pivotal role in adherence to functional exercise programs.[25] Interestingly, a randomized controlled study confirmed that BC patients in the intervention group who participated in a 10-min holistic BCRL self-care program including gentle arm functional exercises for 6 months exhibited higher improvements in BCRL-related symptoms, self-care scores, and exercise frequency (all $P < 0.05$) than those in the control group, highlighting the beneficial effects of the BCRL self-care program among BC patients.[26] Additionally, a small sample feasibility study confirmed that patients with BCRL who followed daily home-based exercise combining with standard lymphedema self-care measures for 26 weeks experienced a clinically meaningful improvement in the management of BCRL, adherence to the exercise program, and QoL, compared to the control group that only practiced self-care measures.[27]

Currently, there has been no evidence regarding the evaluation of the underlying mechanisms of self-care ability, compliance with functional exercise, kinesiophobia, or QoL in patients with BCRL. Therefore, this study aimed to determine the correlation between kinesiophobia and QoL, as well as the underlying mechanical roles of self-care ability and functional exercise compliance among BC patients with lymphedema. We hypothesized that (1) kinesiophobia would negatively predict and directly affect QoL; (2) self-care would act as a mediator in the relationship between kinesiophobia and QoL; (3) functional exercise compliance would play an intermediary role between kinesiophobia and QoL; and (4) both self-care and functional exercise compliance would serve as chain mediators in the correlation between kinesiophobia and QoL. The hypothesized framework is shown in Fig. 1 and provides valuable evidence for the establishment of targeted interventions to improve the QoL of BC survivors with lymphedema.

Methods

Participants and design

A cross-sectional study was conducted by surveying 300 patients with BCRL from three tertiary hospitals in Shenyang City, China, between May

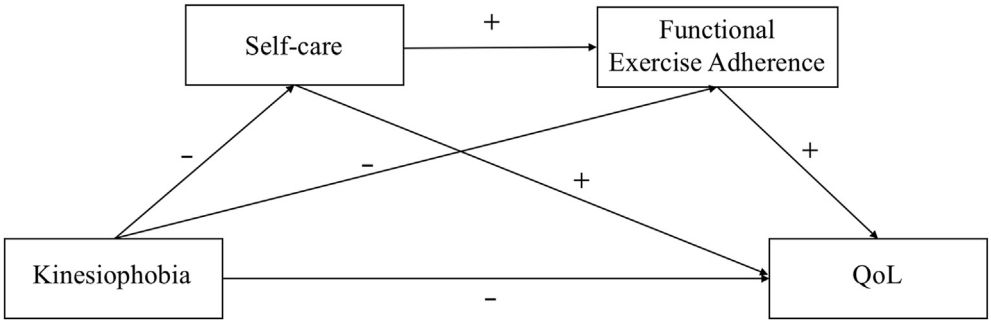

Fig. 1. Hypothesized model. QoL, quality of life.

2020 and October 2022. The inclusion criteria were as follows: (1) female patients diagnosed with BCRL; (2) at least 60 days after completing their cancer–related treatments (including surgical procedures and postoperative chemotherapy or radiotherapy); (3) had clear cognition and normal communication ability; (4) aged > 18 years; and (5) no pre-existing upper extremity dysfunction before surgery. The exclusion criteria were as follows: (1) psychiatric disorders and poor cooperation; (2) other malignancies or breast diseases; (3) liver, heart, or kidney failure; and (4) had undergone bilateral axillary lymphadenectomy.

Data collection and procedure

This study was conducted by qualified researchers who had received professional training at each outpatient oncology clinic in the three tertiary hospitals. The participants were enrolled using convenience sampling. To avoid potential response bias, all participants were individually invited to participate in the survey in a private and quiet area within the nurses' station without the companionship of family members or friends. At the outset, the purpose and methodology of this investigation were thoroughly explained to each patient, and the participants were assured that they could withdraw from the survey at any time without any impact on their treatment. The paper-based Chinese version of the questionnaires was distributed to participants by the researchers. Each respondent completed the questionnaire both anonymously and independently. During the investigation, the researchers were alongside the participants to help them understand any confusing survey items. It took the participants approximately 10–15 min to complete all the self-reported questionnaires. After the survey, trained researchers immediately checked each participant's responses to guarantee that all the required data were filled out. All the participants were informed that the collected data would be confidential and would only be used for research purposes.

Sample size

The sample size was estimated by applying a metric of 5–10 respondents per item in a validated survey to ensure sufficient statistical power.[28,29] The instrument used in this study with the largest number of items was the Chinese Functional Assessment of Cancer Therapy-Breast version 4.0 (FACT-Bv4.0), which consists of 36 items. The required sample size was 180 participants. Considering a sample loss of 20%, a final sample size of 225 participants was required. We approached 315 patients with BCRL, of whom 300 patients met the inclusion criteria and agreed to participate in the study (response rate: 95.2%). Among the 300 eligible participants, 26 were excluded because of withdrawal (7 cases) or missing data (19 cases). Ultimately, 274 completed questionnaires were collected for the final analysis, with a valid recovery rate of 91.3% (Fig. 2).

Measurements

Demographic and clinical characteristics

The demographic data of the participants, including age, body mass index, educational level, marital and employment status, monthly family income, number of children, and clinical data, such as disease duration, BC stage, treatment type, tumor location, and comorbidities (e.g., hypertension, diabetes, thyroid, osteoporosis, or dyslipidemia), were obtained from either self-designed surveys or available medical records in the hospitals by the responsible nursing staff.

Measurement of self-care ability

Self-care ability was evaluated by the Appraisal of Self-Care Agency Scale-Revised, which contains 15 items and is classified into three dimensions: having self-care capacity, developing self-care capacity, and lack of self-care capacity, of which the lack of self-care capacity was adversely

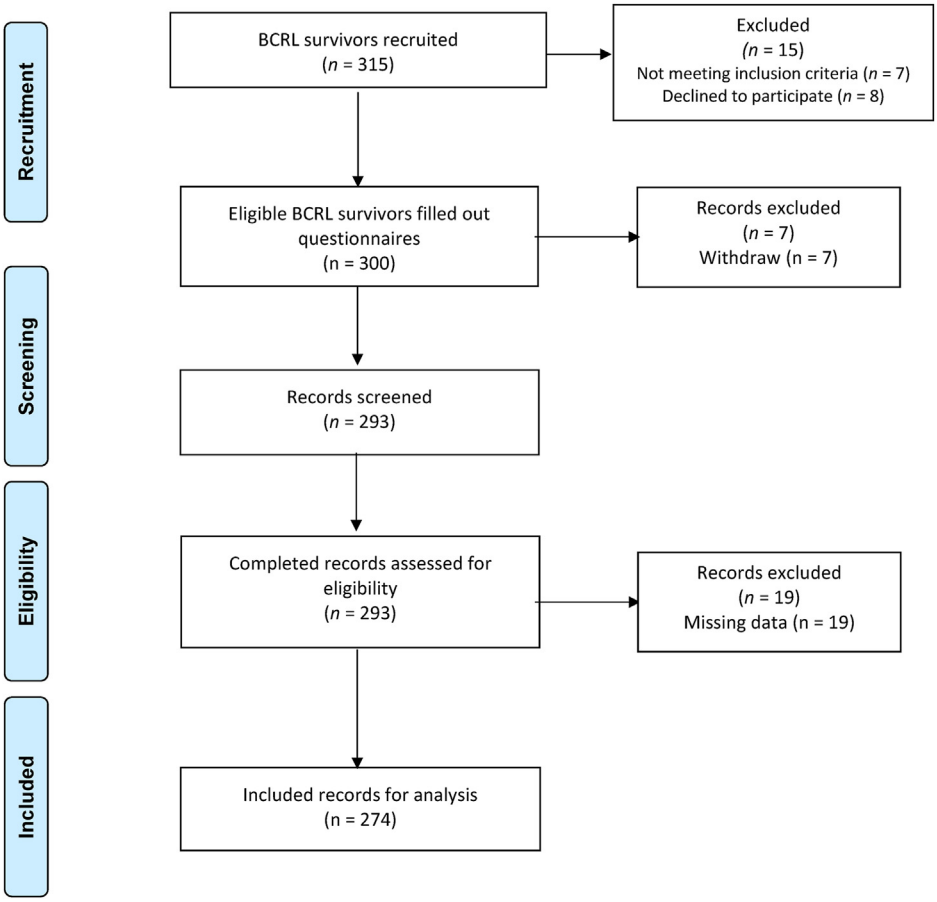

Fig. 2. Flow diagram of study recruitment process. BCRL, breast cancer–related lymphedema.

recorded. Total scores range from 15 to 75 using a 5-point Likert-type scale from 1 (totally disagree) to 5 (totally agree). Higher scores indicate better self-care. The Cronbach's α coefficient in this study was 0.80.

Evaluation of functional exercise adherence

The Postoperative Functional Exercise Adherence Scale was used to measure functional exercise adherence according to previous Chinese researchers.[30] This self-report scale consists of 18 items on a 4-point Likert scale, ranging from 1 (unable to accomplish) to 4 (competent to accomplish). The scale is divided into three domains: postoperative precautionary adherence, physical exercise adherence, and actively seeking advice adherence. The total score ranges from 18 to 72, with higher scores indicating higher levels of adherence. The Cronbach's α coefficient in this study was 0.87.

Measurement of Kinesiophobia

Kinesiophobia was measured using the Tampa Scale for Kinesiophobia-11 (TSK-11). It comprises 11 items rated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), to assess the patients' fear of movement or reinjury related to pain. The total score ranged from 11 to 44, with a higher score indicating a higher level of kinesiophobia: a score of $\leq$ 17 indicated no fear of movement, a score of 18–24 indicated mild fear, a score of 25–31 indicated moderate fear, a score of 32–38 indicated severe fear, and a score of 39–44 indicated extreme fear. The Cronbach's α coefficient in this study was 0.82.

Assessment of quality of life

The FACT-Bv4.0 was used to evaluate the QoL, which consists of 36 items rated on a 5-point Likert scale from 0 (totally disagree) to 4 (totally agree), with total scores ranging from 0 to 144. The assessment comprises five subscales: a general cancer subscale (FACT-G), including physical well-being (PWB, seven items), emotional well-being (EWB, six items), social/family well-being (SWB, seven items), and functional well-being (FWB, seven items); and a Breast Cancer Subscale for additional concerns (BCS, nine items). Higher scores indicate better QoL. In this study, the Cronbach's α for the aforementioned subscales was 0.82 (PWB), 0.83 (EWB), 0.87 (SWB), 0.80 (FWB), and 0.87 (BCS), and the Cronbach's α for the overall scale was 0.91.

Data analysis

All data were analyzed using SPSS Statistics software version 25 (IBM, Inc., Chicago, IL, USA). The normal distribution of the variables was tested using the Kolmogorov–Smirnov method. Continuous variables were expressed as mean ± standard deviation (SD), while categorical data were presented as frequencies with percentages (%). Independent *t*-test and one-way analysis of variance were performed to determine the statistical significance of the different demographic and clinical groups. Harman's single-factor test was used to mitigate the possibility of common method bias underlying the observed results, which could be attributed to the single source of data collection in our study.[31] Pearson's correlation analysis was performed to examine the relationships between kinesiophobia, self-care, functional exercise compliance, and QoL. Model 6 of the PROCESS macro was used to estimate the chain-mediating effect of self-care and functional exercise adherence (two mediators) in the relationship between kinesiophobia (one independent variable) and QoL (one dependent variable). Demographic and clinical characteristics, including age, marital status, BC duration, BC stage, chemotherapy, radiotherapy, and comorbidities that had a significant impact on kinesiophobia, self-care, functional exercise adherence, and QoL (Table 1) were incorporated into the model as control variables. Bootstrapping was performed using 5000 random samples to determine the significance of the mediating effect. If the corresponding 95% bias-corrected confidence interval (CI) did not contain zero, the mediating effect was considered statistically significant. A value of $P < 0.05$ (two-tailed) was considered statistically significant.

Ethical considerations

This study was approved by the Human Research Ethical Committee of Shengjing Hospital of China Medical University (IRB No. EC-2020-HS-030) and was conducted in accordance with the Declaration of Helsinki. This study adhered to the Strengthening the Reporting of Observation Studies in Epidemiology. Written informed consent was obtained from each respondent before they participated in the study.

Results

Common method bias test

Harman's single-factor test was used to detect possible common methodological biases. The results showed that there were 22 factors with characteristic values greater than 1, and the amount of variance explained by the first factor was 21.6%, which was less than the critical criterion of 40%. Thus, the influence of common methodological deviations was excluded from this study.

Different variable scores according to characteristics of participants

As shown in Table 1, the mean age of the participants was 48.76 ± 8.78 years, ranging from 27 to 76 years. More than half of the patients (55.1%) had been diagnosed with BC for more than 4 years. Most patients were married (84.3%) and had children (86.9%). Nearly 44.2% were employed, and 35.4% had obtained a high school education degree or a higher degree. The majority of patients (77.4%) had T1 and TII stages, and approximately 62.4% of patients underwent MRM therapeutic operation, while 30.7% underwent breast-protective surgery. Approximately 55.8% of the patients received chemotherapy, and 50.4% underwent radiotherapy. The other demographic and clinical characteristics are presented in Table 1. Moreover, age ($P = 0.038$), marital status ($P = 0.007$), BC duration ($P = 0.015$), BC stage ($P = 0.003$), chemotherapy ($P = 0.008$), radiotherapy ($P = 0.006$), and comorbidities ($P = 0.040$) were significantly associated with kinesiophobia (Table 1). Furthermore, older adult patients ($P = 0.002$), those with prolonged BC duration ($P = 0.004$), and those who underwent radiotherapy ($P = 0.019$) exhibited lower self-care scores than those who did not (Table 1). Additionally, older adult patients ($P = 0.001$) who underwent chemotherapy ($P = 0.013$) were less likely to adhere to postoperative functional exercises (Table 1). Regarding QoL, patients who were older ($P = 0.004$), were single ($P = 0.035$), had a prolonged BC duration ($P = 0.021$), had an advanced BC stage ($P = 0.010$), received chemotherapy ($P = 0.006$) or radiotherapy ($P < 0.001$), and had comorbidities ($P = 0.042$) displayed worse QoL among these participants (Table 1).

Correlation analyses among the investigated variables

As shown in Table 2, the total scores of kinesiophobia, self-care, functional exercise adherence, and QoL were 29.27 ± 4.49, 40.95 ± 5.03, 43.09 ± 7.29, and 79.52 ± 11.93, respectively (Table 2). Pearson's correlation analysis showed that kinesiophobia was negatively associated with self-care ($r = -0.481$, $P < 0.001$), functional exercise adherence ($r = -0.564$, $P < 0.001$), and QoL ($r = -0.680$, $P < 0.001$; Table 2). Additionally, self-care exhibited a significantly positive correlation with functional exercise adherence ($r = 0.614$, $P < 0.001$) and QoL ($r = 0.569$, $P < 0.001$; Table 2). A strong positive correlation was observed between adherence to functional exercise and QoL ($r = 0.713$, $P < 0.001$; Table 2).

Mediating effect of self-care and functional exercise adherence

Considering QoL as the dependent variable, kinesiophobia as the independent variable, and self-care and functional exercise adherence as the intermediary variables, the chain mediation model of the mediating

Table 1
Participants' characteristics and different variable scores ($N = 274$).

Variables	*n* (%)	Kinesiophobia score			Self-care score			PFEA score			QoL score		
		Mean	SD	Significant[a]	Mean	SD	Significant[a]	Mean	SD	Significant[a]	Mean	SD	Significant[a]
Age													
< 50 years	155 (56.6)	28.77	4.39	0.038*	41.78	5.02	0.002**	44.32	7.19	0.001**	81.32	12.19	0.004**
≥ 50 years	119 (43.4)	29.91	4.55		39.86	4.85		41.49	7.12		77.17	11.21	
BMI													
< 23 kg/m^2	92 (33.6)	28.99	4.33	0.468	40.98	5.06	0.918	42.48	7.57	0.323	79.20	12.29	0.751
≥ 23 kg/m^2	182 (66.4)	29.41	4.57		40.92	5.03		43.40	7.14		79.68	11.77	
Education level													
< senior high school	177 (64.6)	29.41	4.34	0.396	40.55	4.92	0.082	42.97	7.39	0.702	79.06	11.81	0.394
≥ senior high school	97 (35.4)	29.01	4.76		41.66	5.18		42.32	7.13		80.35	12.17	
Marital status													
Married/partner	231 (84.3)	28.95	4.39	0.007**	41.05	5.00	0.436	43.30	7.30	0.266	80.17	11.91	0.035*
Single	43 (15.7)	30.95	4.65		40.40	5.21		41.96	7.19		76.00	11.56	
Monthly income													
< 2000 yuan	89 (32.5)	29.28	4.59	0.994	40.47	5.23	0.260	42.10	7.27	0.173	78.83	12.83	0.654
2000–5000 yuan	166 (60.6)	29.27	4.47		41.01	4.96		43.38	7.37		79.66	11.61	
> 5000 yuan	19 (6.9)	29.16	4.32		42.53	4.57		45.21	6.17		81.53	10.61	
Have children													
Yes	238 (86.9)	29.16	4.56	0.331	41.17	4.96	0.059	43.05	7.24	0.812	79.74	12.03	0.431
No	36 (13.1)	29.94	3.94		39.47	5.28		43.36	7.71		78.06	11.28	
Employment													
Unemployed	153 (55.8)	29.14	4.60	0.612	41.38	4.91	0.109	43.52	7.24	0.271	80.25	12.70	0.255
Employed	121 (44.2)	29.42	4.34		40.40	5.14		42.55	7.33		78.60	10.86	
BC duration													
< 4 years	123 (44.9)	28.54	4.71	0.015*	41.91	5.43	0.004**	43.72	7.49	0.195	81.36	12.01	0.021*
≥ 4 years	151 (55.1)	29.86	4.22		40.16	4.55		42.58	7.10		78.02	11.69	
Chemotherapy													
Yes	153 (55.8)	29.90	4.74	0.008**	40.56	4.85	0.157	42.12	6.99	0.013**	77.77	12.13	0.006**
No	121 (44.2)	28.46	4.02		41.43	5.23		44.32	7.50		81.73	11.34	
Radiotherapy													
Yes	138 (50.4)	30.01	4.46	0.006**	40.24	5.13	0.019*	42.33	7.38	0.080	76.80	10.56	<0.001***
No	136 (49.6)	28.51	4.40		41.66	4.84		43.87	7.13		82.27	12.63	
Tumor location													
Left	143 (52.2)	28.78	4.01	0.115	40.76	4.90	0.066	43.15	6.82	0.131	80.10	11.68	0.068
Right	126 (46.0)	29.72	4.93		41.34	5.14		43.28	7.83		79.33	12.16	
Bilateral	5 (1.8)	31.60	4.56		36.20	3.56		36.60	2.51		67.60	7.64	
BC stages													
Stage I-II	212 (77.4)	28.84	4.48	0.003**	41.24	5.15	0.077	43.57	7.40	0.044*	80.51	11.95	0.010*
Stage III-IV	62 (22.6)	30.73	4.24		39.95	4.47		41.45	6.70		76.11	11.31	
Surgery type													
MRM	171 (62.4)	29.16	4.41	0.714	41.28	5.00	0.364	43.60	7.34	0.288	80.20	11.98	0.209
BPS	84 (30.7)	29.30	4.58		40.37	5.17		42.42	7.16		79.11	12.06	
Others[b]	19 (6.9)	30.05	4.88		40.47	4.64		41.47	7.29		75.21	10.42	
Comorbidities[c]													
Yes	195 (71.2)	29.62	4.49	0.040*	40.71	5.10	0.230	42.67	7.12	0.130	78.59	11.70	0.042*
No	79 (28.8)	28.39	4.39		41.52	4.83		44.14	7.63		81.82	12.25	

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.
BC, breast cancer; BMI, body mass index; BPS, breast-protective surgery; MRM, modified radical mastectomy; PFEA, postoperative functional exercise adherence; QoL, quality of life; SD, standard deviation.
[a] One-way analysis of variance test/independent *t*-test.
[b] Lumpectomy and axillary dissection or total mastectomy.
[c] Hypertension, diabetes, thyroid, osteoporosis, or dyslipidemia.

Table 2
Correlation between kinesiophobia, self-care, functional exercise adherence, and QoL in patients with BCRL (*r*).

Variables	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Kinesiophobia	29.27	4.49	1								
2. Self-care	40.95	5.03	−0.481***	1							
3. PFEA	43.09	7.29	−0.564***	0.614***	1						
4. QoL	79.52	11.93	−0.680***	0.569***	0.713***	1					
5. PWB	14.82	2.69	−0.194***	0.198***	0.230***	0.464***	1				
6. EWB	13.80	2.96	−0.520***	0.366***	0.508***	0.749***	0.241***	1			
7. SWB	15.31	3.49	−0.441***	0.476***	0.492***	0.696***	0.155***	0.383***	1		
8. FWB	13.46	3.01	−0.355***	0.317***	0.341***	0.586***	0.700***	0.379***	0.342***	1	
9. BCS	18.78	4.88	−0.569***	0.447***	0.629***	0.802***	0.176***	0.538***	0.372***	0.311**	1

**$P < 0.01$, ***$P < 0.001$.
BCRL, breast cancer–related lymphedema; BCS, Breast Cancer Subscale for additional concerns; EWB, emotional well-being; FWB, functional well-being; PFEA, postoperative functional exercise adherence; PWB, physical well-being; QoL, quality of life; SD, standard deviation; SWB, social/family well-being.

effects of self-care and functional exercise adherence between kinesiophobia and QoL is shown in Fig. 3 and Table 3. Demographic and clinical characteristics such as age, marital status, BC duration, BC stage, chemotherapy, radiotherapy, and comorbidities were included as control variables. The regression analysis showed that the total effect of kinesiophobia on QoL was significant ($\beta = -0.630$, $t = -13.276$, $P < 0.001$; Fig. 3 and Table 3). Furthermore, there was a significantly direct effect of kinesiophobia on QoL ($\beta = -0.351$, $t = -7.407$, $P < 0.001$; Fig. 3 and Table 3), indicating that the higher levels of kinesiophobia were associated with worse QoL among BC patients with lymphedema. Moreover, kinesiophobia had a significant negative predictive effect on self-care ($\beta = -0.441$, $t = -7.751$, $P < 0.001$), and self-care positively predicted QoL ($\beta = 0.113$, $t = 2.322$, $P < 0.05$; Fig. 3 and Table 3), suggesting the mediating role of self-care played between kinesiophobia and QoL. Meanwhile, kinesiophobia had a negative impact on functional exercise adherence ($\beta = -0.349$, $t = -6.598$, $P < 0.001$), while functional exercise adherence had a positive effect on QoL ($\beta = 0.420$, $t = 8.237$, $P < 0.001$; Fig. 3 and Table 3), implying that functional exercise adherence acted as a mediator between kinesiophobia and QoL. Furthermore, self-care exhibited a positive correlation with functional exercise adherence ($\beta = 0.446$, $t = 8.650$, $P < 0.001$; Fig. 3 and Table 3), indicating that self-care and functional exercise adherence played a chain-mediating role between kinesiophobia and QoL of BC survivors with lymphedema.

Bootstrap examination

We validated the mediating effect using a Bootstrap approach. The 95% CI for the mediating effect was calculated based on a randomly selected sample of 5000 individuals to assess the mediating role of self-care and functional exercise adherence as mediators between kinesiophobia and QoL. As shown in Table 4, the direct effect pathway was as follows: kinesiophobia → QoL, with a direct effect value of −0.933 (Bootstrap 95% CI: −1.181 to −0.685), which accounted for 55.7% of the total effect (Table 4). The total indirect effect was −0.742 (Bootstrap 95% CI: −0.915 to −0.592), accounting for 44.3% of the total effect (Table 4). The lower and upper Bootstrap 95% CIs did not contain a value of zero, indicating that the effect was significant. Meanwhile, there were three mediating effect pathways: kinesiophobia → self-care → QoL, with an indirect effect value of −0.132 (Bootstrap 95% CI: −0.267 to −0.007), accounting for 7.9% of the total effect (Table 4); kinesiophobia → functional exercise adherence → QoL, with an indirect effect value of 0.390 (Bootstrap 95% CI: −0.516 to −0.269), accounting for 23.3% of the total effect (Table 4); and kinesiophobia → self-care → functional exercise adherence → QoL, with an indirect effect value of −0.220 (Bootstrap 95% CI: −0.320 to −0.142), accounting for 13.1% of the total effect (Table 4). Hence, Hypotheses 1, 2, 3, and 4 are verified.

Discussion

The majority of BC survivors tend to avoid using their affected arms after treatment because of kinesiophobia, which results in an increased risk of developing BCRL in the upper extremity.[12] An accumulating stream of studies has demonstrated that sufficient self-care capacity and adherence to functional exercises can help improve edema and have a potent effect on the QoL of women with lymphedema.[26,27] Nevertheless, the relationship between kinesiophobia and QoL has rarely been examined in detail. Therefore, the present study aimed to explore this hypothesized association, which may be connected to self-care and adherence to functional exercise.

Relationship between kinesiophobia and quality of life

Kinesiophobia is rather frequent and is strongly correlated with lymphedema in BC survivors after mastectomy.[32] In the current study, we found that all 274 patients with BCRL included in this study exhibited varying degrees of kinesiophobia (TSK-11 score: ≥ 18 points). Similarly, Altas and Demirdel[32] found that among 70 female patients with post-mastectomy lymphedema, kinesiophobia was presented in 70% of these patients, as measured using the TSK. These findings highlight the high prevalence of kinesiophobia among patients with BCRL after undergoing BC surgery.[12] Furthermore, our study confirmed a correlation between fear of movement and impaired QoL in patients with BCRL. We also discovered that kinesiophobia served as a direct predictor of QoL in BC survivors with lymphedema as higher kinesiophobia scores were negatively associated with better QoL among patients with BCRL (Hypothesis 1 was confirmed). These findings were consistent with those of several previous studies. For instance, a cross-sectional study conducted by Sunar[14] found a significant correlation between a high score of kinesiophobia and worse QoL, and fatigue was found among BC patients from Turkey. Moreover, Gencay et al.[12] confirmed that kinesiophobic patients had a significantly lower physical QoL score in BC patients, although no significant correlation between kinesiophobia and QoL scores was found. Therefore, it is imperative for patients with BCRL to receive appropriate training to help them promote pain management and overcome the fear of movement, as well as improve their QoL. For example, a longitudinal cohort study conducted by Velthuis et al. found that a high level of kinesiophobia was negatively associated with the perceived global health status (QoL). However, this negative association was significantly reduced by a 12-week graded-activity rehabilitation program among

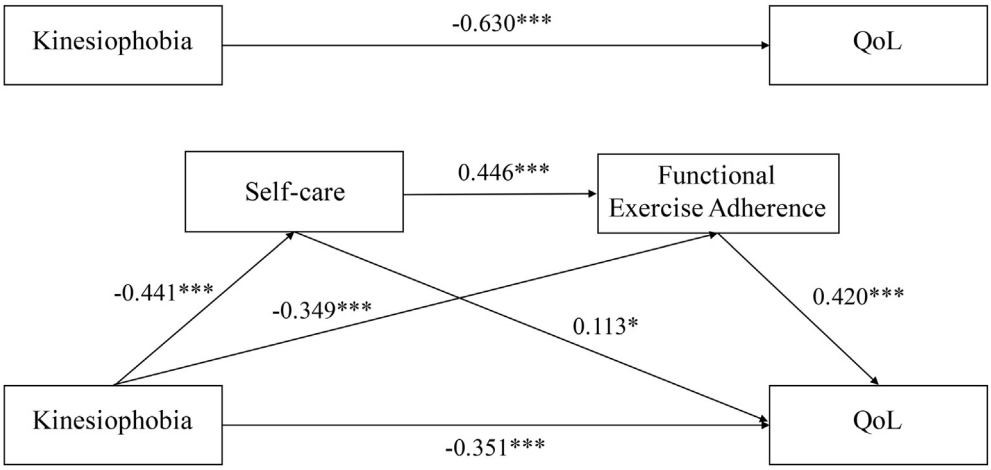

Fig. 3. The chain-mediating model of self-care and functional exercise adherence in the correlation between kinesiophobia and QoL. $^{**}P < 0.01$, $^{***}P < 0.001$ was considered statistically significant. QoL, quality of life.

Table 3
Regression model of the relationship between factors ($N = 274$).

Variables	QoL		Self-care		PFEA		QoL	
	β (95% CI)	*t*	β (95% CI)	*t*	β (95% CI)	*t*	β (95% CI)	*t*
Age	−0.084 (−0.233, 0.004)	−1.896	−0.115 (−0.126, −0.006)	−2.160*	−0.063 (−0.126, 0.022)	−1.394	−0.023 (−0.132, 0.069)	−0.619
Marital status	−0.019 (−3.507, 2.294)	−0.412	0.040 (−0.911, 2.021)	0.746	0.010 (−1.596, 1.977)	0.210	−0.035 (−3.558, 1.292)	−0.920
BC duration	−0.031 (−0.806, 0.389)	−0.689	−0.124 (−0.651, −0.047)	−2.276*	0.062 (−0.118, 0.624)	1.341	−0.020 (−0.640, 0.371)	−0.523
BC stage	−0.024 (−3.232, 1.885)	−0.518	−0.001 (−1.307, 1.279)	−0.021	−0.013 (−1.796, 1.352)	−0.278	−0.018 (−2.648, 1.626)	−0.471
Chemotherapy	−0.038 (−3.045, 1.242)	−0.828	−0.002 (1.103, −1.064)	−0.035	−0.053 (−2.102, 0.536)	−1.169	−0.015 (−2.143, 1.446)	−0.383
Radiotherapy	−0.113 (−4.808, −0.567)	−2.495*	−0.067 (−1.749, 0.395)	−1.243	0.031 (−0.857, 1.760)	0.680	−0.106 (−4.294, −0.739)	−2.787**
Comorbidities	−0.030 (−3.107, 1.511)	−0.680	−0.004 (−1.207, 1.127)	−0.068	−0.011 (−1.591, 1.250)	−0.236	−0.025 (−2.580, 1.277)	−0.666
Kinesiophobia	−0.630 (−1.923, −1.427)	−13.276***	−0.441 (−0.620, −0.369)	−7.751***	−0.349 (−0.736, −0.398)	−6.598***	−0.351 (−1.181, −0.685)	−7.407***
Self-care					0.446 (0.500, 0.794)	8.650***	0.113 (0.041, 0.493)	2.322*
PFEA							0.420 (0.524, 0.853)	8.237***
R^2	0.488		0.264		0.483		0.646	
F	31.584***		11.895***		27.355***		47.946***	

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.
BC, breast cancer; CI, confidence interval; PFEA, postoperative functional exercise adherence; QoL, quality of life.

cancer survivors.[33] Therefore, professional medical staff should provide more practical and effective support to help survivors overcome kinesiophobia and enhance their QoL.

Mediating role of self-care on kinesiophobia and quality of life

The present study confirms Hypothesis 2, which states that self-care partially mediates the relationship between kinesiophobia and QoL. The self-care ability of the patients with BCRL in our study was relatively low, with a total score of 40.95 ± 5.03. These findings were also confirmed by Jiang and Chen,[34] who developed factor-based models to demonstrate that the severity of lymphedema was associated with decreased limb activity and lower self-care ability in patients with BCRL. Therefore, it is necessary for patients with BCRL to adhere to lymphedema self-care behaviors to improve lymph drainage capacity and enhance their QoL. Unfortunately, the overall self-care capacity of patients at risk of lymphedema is considerably poor, and the reasons for non-adherence to self-care consist of symptom burden, complicated treatment regimens, and insufficient educational support.[35] Therefore, Tsuchiya et al.[36] suggested that in addition to providing basic instructions on self-care skills, it was essential to implement continuous psychoeducational programs to encourage female cancer survivors to engage in self-care behaviors after discharge. Specifically, to improve the QoL of BC survivors with lymphedema, enhancing patients' awareness by educating them about the risk of lymphedema and knowledge about proper self-care behaviors for BC cancer survivors is warranted.[37]

Mediating role of functional exercise adherence on kinesiophobia and quality of life

The mediation model also showed that functional exercise adherence exhibited a significant indirect effect on the relationship between kinesiophobia and QoL (Hypothesis 3 was verified). After reviewing several papers on health-related QoL in BC published in the last decade, scholars have summarized that appropriate physical activity interventions are effective in managing symptoms of BCRL and improving QoL in BC survivors.[38] Nevertheless, previous studies have suggested that women with BC often hold misconceptions that physical activity can accelerate the spread of tumor cells and aggravate cancer metastases. Consequently, most BC survivors refuse to adhere to the physical exercise recommendations provided by medical professionals after treatment, which exacerbates the severity of BCRL.[39] In addition, it is essential to provide proper education and implement a scientifically designed exercise program to assist patients with BCRL in overcoming their fear of movement during rehabilitation. A systematic review conducted by Baumann et al.[20] found that various types of exercise programs, such as aerobic exercise, resistance exercise, aqua lymph training, yoga, and gravity-resistive exercise, demonstrated a marked improvement in the severity of BCRL status, mood, and QoL. Cormie et al. conducted a randomized trial study in Australia to evaluate the safety and efficacy of a prescribed resistance exercise program on 62 women with BCRL. They discovered that patients who received appropriate upper-body resistance exercise intervention for three months demonstrated significantly improved lymphedema management and higher scores in the physical functioning domain of QoL than those in the usual care group (all $P < 0.05$).[40]

Chain-mediated role of self-care and functional exercise adherence on kinesiophobia and quality of life

Regarding the relationship between kinesiophobia and QoL in patients with BCRL, this study is the first to find that self-care and adherence to functional exercise have a chain-mediating effect on the interaction between kinesiophobia and QoL in patients with BCRL. The indirect effect ratio was 13.13%, supporting Hypothesis 4. These findings imply that the fear of movement caused by a high level of kinesiophobia could impair self-care behaviors among patients with BCRL. Their limited

Table 4
Bootstrap analysis of the mediating effect of kinesiophobia and QoL ($N = 274$).

Paths	Effect	BootSE	BootLLCI	BootULCI	Effect ratio
Total effect	−1.675	0.126	−1.923	−1.427	
Direct effect	−0.933	0.126	−1.181	−0.685	55.7%
Total indirect effect	−0.742	0.082	−0.915	−0.592	44.3%
Ind 1: Kinesiophobia → self-care → QoL	−0.132	0.065	−0.267	−0.007	7.9%
Ind 2: Kinesiophobia → PFEA → QoL	−0.390	−0.064	−0.516	−0.269	23.3%
Ind 3: Kinesiophobia → self-care → PFEA → QoL	−0.220	−0.046	−0.320	−0.142	13.1%
Comparison 1 (Indirect 1–Indirect 2)	0.258	0.104	0.053	0.457	
Comparison 2 (Indirect 1–Indirect 3)	0.088	0.088	−0.081	0.273	
Comparison 3 (Indirect 2–Indirect 3)	−0.170	0.077	−0.313	−0.009	

CI, confidence interval; PFEA, postoperative functional exercise adherence; QoL, quality of life.

self-care abilities further prevent them from actively participating in rehabilitative regimens, thereby resulting in low adherence to functional exercise and decreased QoL. Conversely, patients with BCRL would benefit from adopting adequate self-care behaviors as this could assist them in overcoming the psychological obstacles associated with kinesiophobia. Proper self-care behaviors also promote subjective initiatives and perceived awareness of functional exercise adherence, thereby positively influencing all dimensions of QoL among patients with BCRL. Recent randomized controlled studies have emphasized the effectiveness of implementing proper self-care programs to alleviate symptoms related to BCRL, promote exercise adherence, and improve QoL in patients with BCRL.[26,27] Given the hypothesized framework used in our study, we found a positive association between self-care and functional exercise adherence, suggesting that individuals with higher self-care abilities are more likely to comply with functional exercise. This finding was consistent with prior clinical studies conducted by Li et al.,[41] who demonstrated that the implementation of self-controlled exercise programs could sustainably enhance the mobility of the affected shoulder joints and have a positive effect on the postoperative recovery process in BC patients. Furthermore, our findings confirmed the positive correlation between functional exercise adherence and QoL, a relationship supported by other researchers. Kim et al.[42] found that participation in physical activity for self-care showed a significant positive correlation with increased mobility, reduced mental burden, and improved QoL among Korean patients with BC.

Notably, the chain-mediating pathway of "self-care → functional exercise adherence" acted as an essential bridge between kinesiophobia and QoL. Therefore, the results of the present study extend our understanding of the potential variables that impact kinesiophobia and uncover the pathways through which QoL can be promoted. These findings provide valuable information for the development of effective clinical intervention strategies. Understanding the psychological mechanisms in patients with BCRL contributes to promoting QoL by emphasizing high-quality self-care practices and interventions that enhance adherence to functional exercise. For instance, when addressing the challenges of kinesiophobia, nursing staff should educate patients with BCRL on appropriate self-care practices that can improve their health outcomes. Health care practitioners should provide tailored functional exercise interventions during rehabilitation to enhance patient adherence. Moreover, effective interventions that target the reduction of kinesiophobia can also improve patients' self-care abilities and enhance their motivation to engage in rehabilitative programs, ultimately resulting in improved QoL among patients with BCRL. Additionally, when considering the chain-mediating effects of self-care and functional exercise adherence, it is critical for oncology nursing staff to develop comprehensive interventions that address this pathway: diminish kinesiophobia → enhance self-care ability → promote functional exercise adherence → improve QoL, which would be more effective in improving the health benefits of patients with BCRL than interventions that target only one factor.

Limitations

This study has some limitations. First, the data were collected from only three urban hospitals in the city, which may challenge the generalizability of the results. Extended surveys are required to investigate patients with BCRL in rural regions and other cities in China. Second, this study was conducted during the COVID-19 pandemic, which might have affected the patients' self-estimated QoL and generated a response bias. Third, this study was cross-sectional using self-reported data; thus, a longitudinal study should be conducted to further identify the causal relationships of this framework and track changes in patients' attitudes toward the aforementioned variables over the course of long-term cancer treatment. Fourth, this study focused only on exploring the mechanism underlying the chain-mediating effects of self-care capacity and functional exercise adherence on the relationship between kinesiophobia and QoL in patients with BCRL. There may be other factors that affect QoL through different mechanisms. Thus, a more comprehensive study should be conducted to further explore the impact of kinesiophobia on the QoL of patients with BCRL.

Conclusions

To the best of our knowledge, the current study is the first to elucidate that kinesiophobia has a negative impact on QoL in survivors of BCRL and the sequential mediating effect of self-care and functional exercise adherence on the relationship between kinesiophobia and QoL in patients with BCRL. The chain-mediating effect of self-care and adherence to functional exercise represents potential practical significance in promoting the QoL of survivors with BCRL. Therefore, clinical intervention programs that focus on improving self-care ability should be developed and implemented to help diminish the detrimental impact of kinesiophobia on QoL and expand the protective effects of adhering to functional exercise for survivors with BCRL in the future.

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CRediT author statement

Qi Wang: Methodology, Software, Data curation, Data analysis, Writing – Original draft preparation; **Na Du:** Research conceptualization, Validation, Supervision, Writing – Reviewing and Editing. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Declaration of interest

The authors declare no conflict of interest.

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Ethics statement

This study was approved by the Research Ethics Committee of Shengjing Hospital Affiliated to China Medical University (IRB No. EC-2020-HS-030) and in accordance with the Declaration of Helsinki. All participants provided written informed consent.

Data availability statement

The data that support the findings of this study are available from the corresponding author ND, upon reasonable request.

Declaration of Generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this manuscript.

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