



Effects of cyclic adjustment training delivered via a mobile device on psychological resilience, depression, and anxiety in Chinese post-surgical breast cancer patients

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Abstract

Purpose Psychological resilience is an important ability for women with breast cancer to cope effectively with depression and anxiety. However, the demands of long-term hospital-based psychological rehabilitation interventions are not met in mainland China, where shorter hospital stays and longer home rehabilitation are common. This study examines whether a cyclic adjustment training (CAT) intervention delivered via a mobile device can improve psychological resilience, and reduce depression and anxiety symptoms, in a population of post-surgical women with breast cancer.

Methods Women with breast cancer were recruited through convenience sampling from a general hospital in Xi'an, and randomly allocated to an intervention group ($n = 66$), receiving CAT plus routine nursing care for 12 weeks, or a control group ($n = 66$), receiving only routine nursing care. The primary outcome was psychological resilience. Resilience, anxiety, and depression were measured using the Connor-Davidson Resilience Scale (CD-RISC), Self-Rating Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS), respectively. A linear mixed model was applied to analyze the effects.

Results Patients in the CAT group displayed significantly improved psychological resilience, anxiety, and depression scores ($F = 19.53, P < 0.001$; $F = 31.85, P < 0.001$; $F = 26.32, P < 0.001$), respectively, compared to the control group.

Conclusions The CAT had positive effects on improving psychological resilience and reducing the symptoms of anxiety and depression, supporting its use as an effective psychological management and intervention strategy in the early stages of long-term rehabilitation of post-surgical women with breast cancer.

Trial registration Chictr.org.cn ChiCTR-IOR-16008253, registered 9 April 2016.

Keywords Breast neoplasms · Resilience · Psychological · Anxiety · Depression

Abbreviations

CAT	Cyclic adjustment training
CD-RISC	Connor-Davidson Resilience Scale
SAS	Self-Rating Anxiety Scale
SDS	Self-Rating Depression Scale
RAM	Roy Adaptation Model

Introduction

Breast cancer and its treatment-related adverse effects can negatively influence an individual's physical, psychological, and social functioning [1, 2]. Psychological resilience, defined as the ability with which a person can positively respond and adapt to stress and adversity [3], enables a woman with breast cancer to cope with such a traumatic event. Previous studies have shown that high psychological resilience in breast cancer survivors can reduce the primary caregiver's burden [4], enhance young breast cancer survivors' ability to cope with common negative emotions [5], and improve family functioning and psychological well-being [6]. It also acts as a protective factor for low body image in post-mastectomy women with breast cancer [7] as well as predict positive rehabilitation promotion and improve quality of life [8]. However, postoperative women with breast cancer still have relatively low psychological

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resilience [9], which reduces the success of the long-term rehabilitation process.

A number of published interventions have been developed to enhance the psychological resilience of women with breast cancer [10–12]. Although these programs indicate a high degree of success in terms of satisfaction, healing, and learning [10], significant improvement in resilience and quality of life, and a reduction in perceived stress and anxiety [11, 12], they do not focus on the time and location constraints regarding the intervention and follow-up implementation after the patients are discharged from hospital. Considering the shorter hospital stay and longer home rehabilitation trend common in mainland China, it is vital to develop a program with less time and place constraints for breast cancer survivors, to help them achieve satisfying rehabilitation as early as possible.

With the widespread coverage of mobile internet in China and the use of WeChat (a free communication App which can be installed on a mobile phone), mobile health (mhealth), or WeChat-based intervention programs have become a popular health service model. WeChat-based published reports in international journals include a life review program for cancer patients [13], an intervention to improve the mental health of people living with HIV [14], and a dementia-specific training program for nurses in primary care settings [15]. Findings of studies demonstrate that WeChat-based programs are not only effective non-pharmacological interventions for improving the psychological health of community-dwelling cancer patients [13] but also an effective way to increase knowledge of a specific disease and to change attitudes toward a special population [15]. Additionally, WeChat has been used to collect participant-reported data in pelvic floor disorders via an electronic questionnaire [16], providing evidence for WeChat to develop follow-up systems.

In mainland China, WeChat-based transitional care or continued nursing have been employed in breast cancer care since 2015, managing post-surgery functional exercises and quality of life [17, 18], cancer-related fatigue and negative emotions [19], and peer education programs [20]. However, these applications do not specifically address the problem of low psychological resilience evident in women with breast cancer. A mobile intervention program based on WeChat could provide interactive intervention and follow-up information specific to psychological resilience, with no time and location constraints. As far as the authors are aware, no similar program has been reported in international literature.

Theoretical framework

The theoretical framework of this study is based on the Roy Adaptation Model (RAM), developed to promote theory-based nursing practice [21]. The RAM highlights the

individual as an adaptive system with biological, psychological, and social characteristics, adapting to various stimuli from both the internal and external environments. The aim of nursing care is to improve and support an individuals' adaptation ability and health level, through the process of importing negative stimuli, developing coping mechanisms, adapting and exporting behaviors, and receiving feedback [21]. This framework has been widely used in prenatal education for women with gestational hypertension [22], in the control of maladaptation behaviors in adolescents with asthma [23], in treatment education for hemodialysis patients [24], and in nursing approaches for women undergoing breast-conserving surgery for breast cancer [25]. However, as far as the authors are aware, the RAM framework has never been reported in psychological resilience training for women with breast cancer.

Adapted from the RAM framework, a Cyclic Adjustment Training (CAT) intervention program was developed for women with breast cancer (Fig. 1). Within this theoretical framework, negative stimuli (i.e., the disease and its treatment-related adverse effects, which cause low psychological resilience) are imported to the patient (i.e., adaptation system), who is then trained to confront and cope with the negative stimuli. The use of coping strategies leads to a pre-introspective stage with the patient adapting and adjusting to his/her condition. A further re-introspective stage allows the patient to achieve a new adaptation to their condition through feedback. If the negative stimuli are not well treated, or new negative stimuli are imported to the patient, another adjust cycle begins.

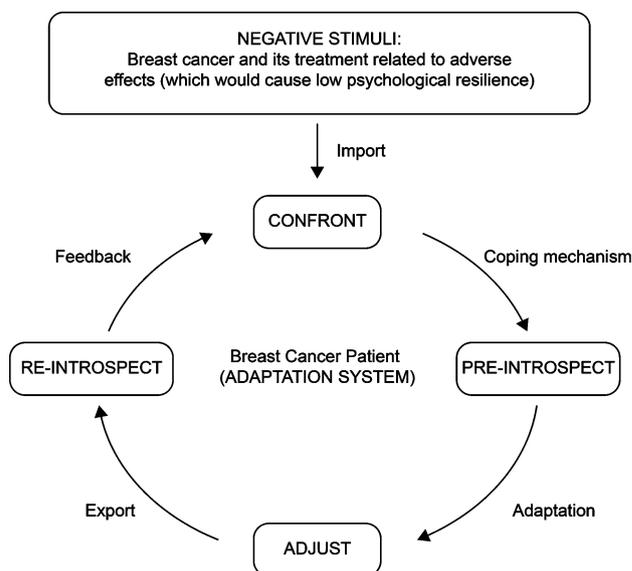


Fig. 1 Theoretical framework of the Cyclic Adjustment Training (CAT) based on the Roy Adaptation Model (RAM)

The purpose of this study is to examine the effects of the CAT in post-surgery women with breast cancer in mainland China and its effect on psychological resilience, anxiety, and depression ratings following surgery. Findings of the study will further inform psychological intervention and management strategies in women with breast cancer at an early stage of long-term rehabilitation.

Materials and methods

Ethical approval

The trial protocol received ethical approval from the Bio-medical Ethics Committee of Xi'an Jiaotong University Health Science Centre. Written informed consent was obtained from each recruited patient before the intervention and questionnaire survey.

Study design and treatment

A clinical randomized controlled trial was conducted in a general hospital in Xi'an, China. Participants were women with breast cancer admitted to hospital, aged 18 years and above, and newly diagnosed with breast cancer. All patients were preparing to receive surgery and other adjuvant therapy. Exclusion criteria were the presence of cognitive and psychiatric disorders (as screened and diagnosed by a psychiatrist not involved in this study and according to the Diagnostic and Statistical Manual of Mental Disorders, 5th ed.), other malignant tumors, and breast disease.

The sample size was estimated based on the Connor-Davidson Resilience Scale (CD-RISC) total score of an eligible intervention study conducted in mainland China [12]. One hundred and ten patients were needed with a power of 80% at a 5% level of statistical significance. The sample size was increased to 132 patients to allow for a 20% drop-out rate. The 132 patients were randomly allocated to the intervention and control groups (66 in each group) via a computer-generated random numbers table.

The intervention group patients received CAT (Table 1) and routine nursing care. The intervention continued from hospital admission to 12 weeks following surgery. The recruited patients were randomly allocated to separate areas of the surgical breast cancer department to avoid between-group contamination. No contact was allowed between the separate areas.

The control group patients received only routine nursing care, including health instruction, vital signs and post-surgery complications monitoring, and post-surgery and drainage tube care.

To avoid bias, the recruited patients and data collectors were unaware of group allocation, and the control group

patients were unaware of the CAT during the trial. Participants in the control group were invited to participate in another WeChat group throughout the process.

Data collection

Data were collected between July 2018 and February 2019 via self-reported questionnaires. If the patient had reading or writing difficulties, the data collector would read the items to the patient and record her responses. Baseline data (i.e., results of the Connor-Davidson Resilience Scale, CD-RISC [26, 27], Self-Rating Anxiety Scale, SAS [28–30], Self-Rating Depression Scale, SDS [28–30], and socio-demographics) were collected before surgery. Follow-up data (i.e., scores on the CD-RISC, SAS, and SDS) were collected at 4, 8, and 12 weeks after surgery. For patients discharged from the hospital, the follow-up data were collected via WeChat through one-to-one communication.

The Chinese CD-RISC has 25 items measured on a 5-point Likert scale (0 = not true at all, 1 = rarely true, 2 = sometimes true, 3 = often true, 4 = true nearly all of the time). The 25 items are categorized into three subscales, tenacity (range 0–52), optimism (range 0–16), and self-improvement (range 0–32). The total score ranges from 0 to 100, with a higher score indicating greater resilience [26]. This scale has been well validated in Chinese populations [26, 27]. In this study, Cronbach's α was 0.75.

The Chinese SAS and SDS consist of 20 items each. The items are rated on a 4-point Likert scale (i.e., 1 = none, 2 = sometimes, 3 = often, 4 = always). A higher score indicates a higher level of anxiety or depression. The Chinese SAS and SDS have been validated in a Chinese population [28–30]. Cronbach's α in this study was 0.90 (SAS) and 0.88 (SDS).

Data analyses

The primary outcome was the CD-RISC score change from baseline to 12 weeks after surgery. The secondary outcomes were CD-RISC score changes at 4 and 8 weeks, and SAS and SDS score changes at 4, 8, and 12 weeks. A linear mixed model was used to analyze the score changes, with CD-RISC, SAS, and SDS baseline measures used as covariates. Group, time, and group \times time interaction were considered as fixed effects, while the patient was considered as a random effect. Missing data owing to loss to follow-up were assumed to be missing at random. The estimated within- and between-group differences were reported along with their 95% confidence intervals. A two-sided *P* value less than 0.05 was regarded as statistically significant. All data analyses were performed using SPSS 23.0 (IBM Corp., Armonk, NY).

Table 1 Cyclic adjustment training (CAT) using WeChat for women with breast cancer

Steps	Content	Implementation
I. Confront	<p>Understand the illness/condition</p> <p>Participate in the decision-making of the treatment modality</p> <p>Understand and accept the potential changes in body image and physical functioning, as well as the long-term rehabilitation process</p> <p>Participate in making the rehabilitation plan as early as possible (including exercises, diet, and rest)</p>	<p>From hospital admission to pre-surgery</p> <p>Nurse-to-patient, face-to-face, once before surgery, 30–60 min per session</p> <p>Inviting the patient to participate in the WeChat group of the CAT, which performed as a mobile intervention and a follow-up system</p>
II. Pre-introspect	<p>The patient is instructed to self-ask the following questions:</p> <p>Do I have negative feelings right now? If yes, what are they?</p> <p>Do I have positive feelings right now? If yes, what are they?</p>	<p>From hospital admission to pre-surgery</p> <p>Nurse-to-patient, face-to-face, once before surgery, 30–60 min per session</p> <p>Answers are recorded by the patient or principal caregiver, and the nurse</p>
III. Adjust	<p>Relaxed deep breath training: slow inhale (5 s) → slow exhale (5 s)</p> <p>Music listening: light music with soothing rhythm and natural sound (e.g., birdsong, the song of running water)</p> <p>Anti-cancer stories reading/listening/watching</p> <p>Adjust experiences and feelings sharing with peers</p>	<p>From hospital admission to 12 weeks follow-up</p> <p>Relaxed deep breath training can be performed with or without music, listening in lying or sitting position: the initial instruction is via nurse-to-patient instruction, once before surgery, 20 min per session</p> <p>After initial instruction, relaxed deep breath training is done three times per day (as time permits), 10 min per session</p> <p>Music (in audio frequency format) and anti-cancer stories (in word, picture, and audio/video frequency format) are provided via WeChat group, 3–5 music or stories per time, and updated every 3 days</p> <p>Listening to music and anti-cancer stories reading/listening/watching is performed three times per day (as time permits), 20–30 min per session</p> <p>Encourage the patient to communicate with other peers (in a one-to-one or one-to-more format) on feelings and experiences during the adjust process, at any time in the WeChat group during the intervention</p> <p>*A star of adjust experiences sharing* is selected once per week in the WeChat group by the recruited intervention group patients, according to the criteria of who shares the most adjust experiences and feelings to other peers during the past week. A small gift is awarded to the selected patient as an encouragement of peer-to-peer communication</p>
IV. Re-introspect	<p>The patient is instructed to self-ask the following questions:</p> <p>Do I address my negative feelings? If yes, what are they? If no, why?</p> <p>Do I keep and strengthen my positive feelings? If yes, what are they? If no, why?</p> <p>Do I have new negative feelings right now? If yes, what are they?</p>	<p>From hospital admission to 12 weeks follow-up</p> <p>Re-introspect was done once per week, 30–60 min per session (<i>Note: the day receiving surgery does not do re-introspect</i>)</p> <p>In hospital: via nurse-to-patient, face-to-face</p> <p>Discharged from hospital: via WeChat nurse-to-patient communication, e.g., audio or video frequency</p> <p>Answers are recorded by the patient or principal caregiver and the nurse, and compared with previous recorded answers</p> <p>Encourage the patient to keep and reinforce positive feelings</p> <p>For the remaining and new negative feelings, turn to confront stage through feedback, then repeat another cycle of pre-introspect, adjust and re-introspect stages, until the remaining and new negative feelings are improved</p>

Results

There were 66 patients in the intervention and control groups, respectively. Figure 2 displays the study's participant flowchart with the numbers of patients remaining in the intervention and control groups and numbers lost to follow-up at each time point of the study. There were no significant between-group differences for all baseline socioeconomic and clinical characteristics ($P > 0.05$; Table 2).

The mixed linear model indicates that individuals in the CAT group had significant improvements in resilience ($F = 32.96$, $P < 0.001$), anxiety ($F = 31.85$, $P < 0.001$), and depression ($F = 26.32$, $P < 0.001$) compared to the control group. Additionally, individuals in the intervention group showed significant improvement on these measures at the three follow-ups. Full details and statistical outcomes are presented in Table 3.

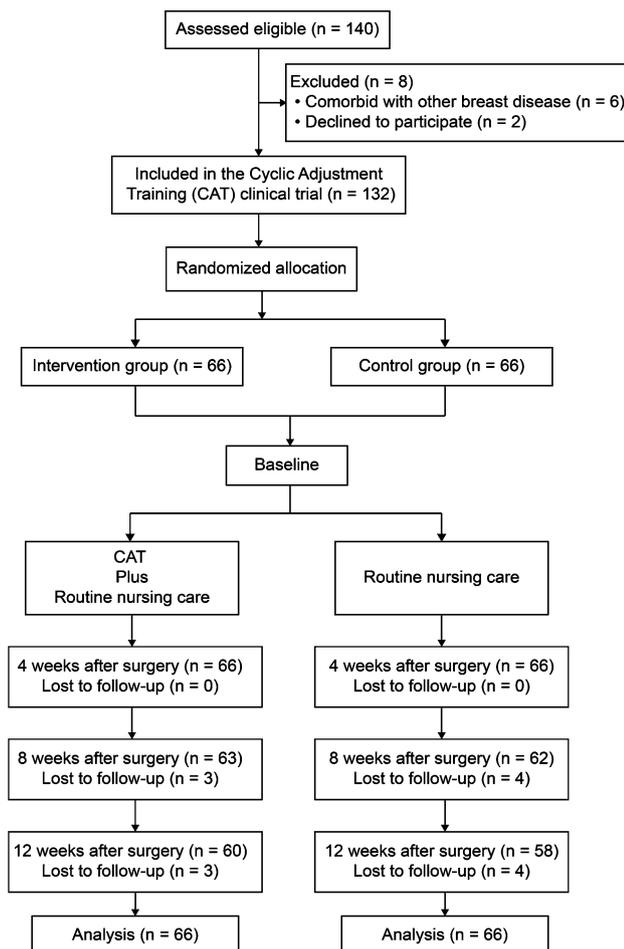


Fig. 2 Flow chart showing patient numbers in the intervention and control groups and numbers lost to follow-up at each time point of the study

Discussion

The clinical randomized controlled trial examined the effects of CAT in women with breast cancer following surgery and found that it produced a significant improvement in the psychological resilience scores, with accompanying reduction in anxiety and depression scores. The findings indicate that the CAT is a promising intervention for psychological rehabilitation in women with breast cancer.

Both the intervention and control group patients showed improvements in the mean resilience total score at 4, 8, and 12 weeks compared to baseline scores, but the changes in the control group patients were not statistically significant. Psychological resilience scores significantly improved only in women with breast cancer who underwent the CAT intervention during the early period after surgery, consistent with other related reports [10–12].

The findings of the study are promising as, in contrast to other related studies [12, 31], the CAT is a dynamic cycle with short intervals (i.e., once per week), from the adjust to the re-introspect stages. This enables the nurse to deal more easily with existing or new problems that may decrease psychological resilience at the early rehabilitation stage. Use of a mobile phone application, WeChat, also makes the process more accessible and convenient for nurse-patient and patient-peer communications, strengthening the intervention and follow-up continuity and completeness.

Similar to the effects of CAT on psychological resilience, both anxiety and depression ratings of the intervention group patients were also reduced significantly compared to scores of the control group. This finding is consistent with the findings of our previous studies [32–34] and other related reports [35–38], which applied music therapy and progressive muscle relaxation training [32], art therapy [33, 34, 36], cognitive behavior therapy [35], group training based on acceptance and commitment therapy [37], and meditation [38] as intervention strategies, supporting the further use of CAT as an alternative psychological intervention in breast cancer patient care at an early stage.

There are some limitations to this study. First, the CD-RISC, SAS, and SDS are self-reported scales and, as such, may be influenced by personal attitudes and misrepresentations. Although the patients reported reduced levels of anxiety and depression, this was not clinically assessed. Second, additional data regarding the patient's perceptions of the methodology and use of technology were not collected. Third, the findings might not necessarily be generalizable to other centers and may be reliant on the technological expertise and interest of individual practitioners and patients. A multicenter study with additional focus groups, practitioner, and patient feedback should be considered in future work.

Table 2 Socio-demographic and clinical characteristics of the patients in the intervention group and control group (*n*, %)

Characteristics	Total (<i>n</i> = 132)	Intervention group (<i>n</i> = 66)	Control group (<i>n</i> = 66)	Statistics	<i>P</i> value
Socio-demographics					
Age (years) (mean ± SD) (range 26–70)	44.56 ± 7.11	44.62 ± 7.89	44.37 ± 7.32	<i>t</i> = −0.05	0.96
Education level					
Primary and below	42 (31.8)	23 (34.8)	19 (28.8)	$\chi^2 = 0.81$	0.73
Secondary	79 (59.8)	37 (56.1)	42 (63.6)		
Tertiary	11 (8.4)	6 (9.1)	5 (7.6)		
Marital status					
Married	120 (90.9)	59 (89.4)	61 (92.4)	$\chi^2 = 1.99$	0.35
Other marital status	12 (9.1)	7 (10.6)	5 (7.6)		
Employment status					
Employed	98 (74.2)	48 (72.7)	50 (75.8)	$\chi^2 = 2.56$	0.20
Unemployed	12 (9.1)	5 (7.6)	7 (10.6)		
Retired	22 (16.7)	13 (19.7)	9 (13.6)		
Average monthly income (Chinese Yuan)					
< 5000	89 (67.4)	46 (69.7)	43 (65.2)	$\chi^2 = 4.12$	0.13
≥ 5000	43 (32.6)	20 (30.3)	23 (34.8)		
Chronic disease					
Yes	38 (28.8)	18 (27.3)	20 (30.3)	$\chi^2 = 3.90$	0.24
No	94 (71.2)	48 (72.7)	46 (69.7)		
Clinical characteristics					
Disease stage					
I	60 (45.5)	29 (43.9)	31 (47.0)	$\chi^2 = 3.01$	0.35
II	57 (43.2)	30 (45.5)	27 (40.9)		
III	15 (11.4)	7 (10.6)	8 (12.1)		
Breast surgery type					
Modified radical mastectomy	63 (47.7)	30 (45.5)	33 (50.0)	$\chi^2 = 3.16$	0.23
Total mastectomy	48 (36.4)	25 (37.9)	23 (34.8)		
Breast-conserving surgery	21 (31.8)	11 (16.7)	10 (15.2)		
Axillary surgery type					
Sentinel lymph node biopsy	119 (90.2)	61 (92.4)	58 (87.9)	$\chi^2 = 2.96$	0.28
Axillary lymph node dissection	13 (9.8)	5 (7.6)	8 (12.1)		
Chemotherapy					
Yes	119 (90.2)	60 (90.9)	59 (89.4)	$\chi^2 = 3.11$	0.20
No	13 (9.8)	6 (9.1)	7 (10.6)		
Radiotherapy					
Yes	46 (34.8)	21 (31.8)	25 (37.9)	$\chi^2 = 0.09$	0.95
No	86 (65.2)	45 (68.2)	41 (62.1)		
Endocrine therapy					
Yes	43 (32.6)	23 (34.8)	20 (30.3)	$\chi^2 = 0.75$	0.32
No	89 (67.4)	43 (65.2)	46 (69.7)		

SD standard deviation

Findings of this study support the positive effects of CAT as an effective psychological management and intervention strategy in women with breast cancer at an early stage of long-term rehabilitation. The study also indicates that the development of mobile phone applications to deliver interactive and practical support in relation to

psychological resilience could be a useful tool in promoting mobile health services in clinical and transitional nursing care.

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Table 3 Changes within group and comparisons between groups of the CD-RISC, SAS, and SDS scores: a linear mixed model analysis

Group	Baseline	4 weeks after surgery		8 weeks after surgery		12 weeks after surgery	
		Score	Change from baseline (95% CI)	Score	Change from baseline (95% CI)	Score	Change from baseline (95% CI)
CD-RISC^a							
Intervention	57.69 ± 9.87	78.21 ± 9.12	20.52 (1.90, 39.14)	83.85 ± 9.56	26.16 (7.11, 45.21)	90.01 ± 10.10	32.32 (12.76, 51.88)
Control	58.20 ± 10.01	59.69 ± 9.57	1.49 (− 17.70, 20.68)	60.62 ± 10.11	2.42 (− 17.30, 22.13)	63.14 ± 9.97	4.94 (− 14.64, 24.52)
MD (95% CI)	− 0.51 (− 19.99, 18.97)	18.52 (0.20, 36.84)		23.23 (3.95, 42.51)		26.87 (7.20, 46.54)	
SAS^b							
Intervention	42.85 ± 3.21	31.02 ± 3.14	− 11.83 (− 18.05, − 5.61)	26.23 ± 2.99	− 16.62 (− 22.71, − 10.54)	22.21 ± 2.87	− 20.64 (− 26.62, − 14.66)
Control	42.53 ± 3.10	41.02 ± 2.89	− 1.51 (− 7.38, 4.36)	38.30 ± 3.24	− 4.23 (− 10.44, 1.98)	34.12 ± 3.05	− 8.41 (− 14.44, − 2.38)
MD (95% CI)	0.32 (− 5.86, 6.50)	− 10.00 (− 15.91, − 4.09)		− 12.07 (− 18.18, − 5.96)		− 11.91 (− 17.71, − 6.11)	
SDS^c							
Intervention	39.96 ± 2.99	31.07 ± 3.09	− 8.89 (− 14.85, − 2.93)	26.02 ± 2.67	− 13.94 (− 19.50, − 8.38)	22.87 ± 2.59	− 17.09 (− 22.59, − 11.59)
Control	39.62 ± 3.07	38.28 ± 3.31	− 1.34 (− 7.60, 4.92)	35.65 ± 3.11	− 3.97 (− 10.03, 2.09)	34.41 ± 3.20	− 5.21 (− 11.35, 0.93)
MD (95% CI)	0.34 (− 5.60, 6.28)	− 7.21 (− 13.49, − 0.93)		− 9.63 (− 15.31, − 3.95)		− 11.54 (− 17.24, − 5.84)	

Sample size of the intervention group: $n=66$ (baseline), $n=66$ (4 weeks after surgery), $n=63$ (8 weeks after surgery), $n=60$ (12 weeks after surgery)

Sample size of the control group: $n=66$ (baseline), $n=66$ (4 weeks after surgery), $n=62$ (8 weeks after surgery), $n=58$ (12 weeks after surgery)

CD-RISC Connor-Davidson Resilience Scale, SAS Self-rating Anxiety Scale, SDS Self-rating Depression Scale. 95% CI 95% confidence interval

^aCD-RISC total score model: (group) $F=32.96$, $P<0.001$; (time) $F=21.31$, $P<0.001$; (group × time) $F=19.53$, $P<0.001$

^bSAS model: (group) $F=31.85$, $P<0.001$; (time) $F=21.06$, $P<0.001$; (group × time) $F=13.15$, $P<0.001$

^cSDS model: (group) $F=26.32$, $P<0.001$; (time) $F=14.31$, $P<0.001$; (group × time) $F=15.62$, $P<0.001$

Author contributions KZ, JL, and XL designed the study and the intervention program. JL and XL performed the intervention. KZ performed data collection, analysis, and interpretation, and manuscript preparation. KZ, JL, and XL revised the manuscript. All authors approved the manuscript before submission.

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Data availability The datasets during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The trial protocol received ethical approval from the Biomedical Ethics Committee of Xi'an Jiaotong University Health Science Centre and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All experiments were performed complying with the current laws of the country.

Informed consent Written informed consent was obtained from each recruited patient before the intervention and questionnaire survey.

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