

Article

Effects of basic badminton training on psychological recovery and sense of social belonging in female cancer survivors during rehabilitation

Zitong Qin, Annisaa Basar*

Department of Educational Foundations and Humanities Faculty of Education, Universiti Malaya, Kuala Lumpur, 50603, Malaysia

* Corresponding author: Annisaa Basar, annisaa@um.edu.my

CITATION

Qin Z, Basar A. Effects of basic badminton training on psychological recovery and sense of social belonging in female cancer survivors during rehabilitation. *Psycho-Oncologie*. 2025; 19(3): 4494. <https://doi.org/10.18282/po4494>

ARTICLE INFO

Received: 15 May 2025

Revised: 29 August 2025

Accepted: 5 September 2025

Available online: 28 September 2025

COPYRIGHT



Copyright © 2025 by author(s). *Psycho-Oncologie* is published by PiscoMed Publishing Pte. Ltd. This work is licensed under the Creative Commons Attribution (CC BY) license. <https://creativecommons.org/licenses/by/4.0/>

Abstract: This study aimed to examine the effects of fundamental badminton training on psychological recovery and sense of belonging in female cancer survivors during rehabilitation. There was a randomized controlled trial of 80 women cancer survivors (25-65 years) who had completed their initial cancer treatment in the past 6-24 months. Participants were assigned to a 12-week structured badminton training program ($n = 40$) or to usual care ($n = 40$). Bi-weekly sessions of 60 min of badminton intervention were conducted in small groups. Measurements were taken at baseline and following the intervention and at a 3-month follow-up with standardized measures of anxiety, depression, cancer-related fatigue, social connectedness, and quality of life. Results showed statistically significant improvement in the intervention group compared with controls in all markers of psychological recovery of anxiety ($F[2,156] = 9.43$, $p < 0.001$, $\eta^2p = 0.11$), depression ($F[2,156] = 8.67$, $p < 0.001$, $\eta^2p = 0.10$), and cancer-related fatigue ($F[2,156] = 10.24$, $p < 0.001$, $\eta^2p = 0.12$). In addition, significant gains in measures of social connectedness ($F[2,156] = 11.24$, $p < 0.001$, $\eta^2p = 0.13$) and quality of life were seen in the intervention group and were maintained at 3-month follow-up. Strong correlations were seen between gains in markers of psychological recovery and measures of social connectedness ($r = -0.64$ to -0.71 , $p < 0.001$). These findings provide preliminary evidence that badminton training may enhance psychological recovery and social belonging in female cancer survivors during rehabilitation. However, the absence of active control groups and cultural specificity of findings limit generalizability, warranting further research in diverse populations before clinical implementation.

Keywords: badminton training; cancer rehabilitation; psychological recovery; social belonging; female cancer survivors

1. Introduction

Cancer poses a serious risk to the health of individuals affected and also to their mental health and social lives. In women who survive cancer, the process of physical recovery is accompanied by complex psychological adaptations and challenges in reintegration into society [1]. Even though cancer treatments in the advanced form are available, survivors often suffer from long-term psychological challenges in the form of depression, anxiety, and withdrawal from society during the recovery process [2]. It is observed that around 20%-30% of cancer survivors experience long-term challenges in the form of anxiety, depression, and other psychosocial and emotional challenges [3]. These psychosocial challenges can critically affect the quality of life and may also negatively impact long-term health outcomes, which justifies the need for overall rehabilitation measures that promote physical recovery and also psychosocial recovery and reintegration into society [4].

The theoretical understanding of psychological recovery in cancer survivors benefits from multiple complementary frameworks that address different aspects of the rehabilitation process. Post-traumatic growth theory, developed by Marziliano, provides a comprehensive framework for understanding how individuals can experience positive psychological change following traumatic life events such as cancer diagnosis and treatment [5]. Cancer survivors frequently experience post-traumatic growth across multiple domains including appreciation of life, deeper relationships with others, increased personal strength, awareness of new possibilities, and spiritual development [6]. Post-traumatic stress and post-traumatic growth in cancer patients demonstrate a modestly positive and robust relationship, suggesting that the struggle with cancer-related distress can facilitate meaningful psychological development when appropriate support is provided [7]. Physical activity serves as a significant moderator in this process, with exercise interventions enhancing post-traumatic growth by providing mastery experiences, social connection, and opportunities for meaning-making [8].

Self-Determination Theory (SDT) offers another essential theoretical lens for understanding motivation and psychological well-being in cancer survivors, particularly regarding engagement in rehabilitation activities such as exercise interventions. SDT identifies three fundamental psychological needs—autonomy, competence, and relatedness—that are crucial for optimal human functioning and well-being [9]. Research with breast cancer survivors demonstrates that autonomous motivation, perceived competence, and autonomy support from healthcare providers are strong predictors of sustained physical activity engagement and improved psychological well-being [10]. The social context of group-based interventions may be particularly effective in meeting the relatedness need while simultaneously supporting autonomy and competence development through peer modeling and shared experience [11].

Cancer-induced fatigue and the fear of relapse are among the most common and most bothersome problems facing cancer survivors and affect their general life quality [12]. Physical activity has been shown to be a useful method of improving multiple aspects of cancer survivorship. Physical activity may attenuate cancer-induced symptoms of fatigue, anxiety, and depression and enhance the survivors' general life quality and mental health simultaneously [13]. In spite of the cancer type and treatment modality heterogeneity and rehabilitation duration, physical activity is described by cancer survivors to be improving their physical function and mental health and serving as a medium of positive interpersonal interaction and injecting confidence into their lives [14].

Group-based physical activity interventions offer unique advantages over individual approaches by capitalizing on social cognitive mechanisms and peer support processes. Yoga interventions in cancer patients demonstrate significant improvements in physical and psychosocial outcomes, with group-based programs showing particular promise for addressing isolation and enhancing social connectedness [15]. Cultural dance interventions have similarly shown efficacy in promoting sustained physical activity among cancer survivors, with participants experiencing improvements in physical function, biomarker profiles, and psychosocial well-being that persisted beyond the intervention period [16]. Comparisons between

group versus individual exercise interventions for breast cancer survivors indicate that while both approaches are beneficial, group interventions may provide additional psychological benefits through shared experience, collective identity formation, and peer support, particularly when group cohesion and social processes are explicitly facilitated [17].

From a theoretical perspective, Social Cognitive Theory (SCT) provides a framework for understanding how badminton training might benefit psychological recovery and social belonging, emphasizing the interplay between personal factors, environmental influences, and behavior [18]. Physical activity contexts facilitate relationships that form a foundation for supportive behaviors that both enable physical activity and assist with coping with cancer [19]. Participating in group physical activities, e.g., badminton, can impact substantially these constructs by providing mastery experiences, providing modeling, and promoting social persuasion in a supportive environment. Research suggests that exercise interventions for cancer survivors are most effective when they incorporate both individual and group components [20]. In sports-based interventions for improving health and quality of life in chronic patients, participants develop meaningful social relationships that affect their well-being as much as the intervention activities themselves [21]. This social dimension appears particularly valuable for female cancer survivors, who often report that peer support and shared experiences are crucial aspects of their recovery process [22]. Physical activity plays a crucial role in transitioning from surviving to thriving post-cancer, supporting not only physical health but also psychological resilience and social connection [23].

Despite the growing evidence for group-based physical activity interventions, little research exists that evaluates the effects of particular physical activities on cancer survivors' psychosocial recovery and sense of belongingness. Out of the endless variety of physical activities, badminton with its high accessibility and interpersonal interaction may be of particular use in cancer rehabilitation [24]. Badminton is among the most popular sports in the world; however, empirical research on its health benefits to participants is relatively scarce [25]. The lack of equipment and the flexible intensity of badminton make it potentially adaptable to cancer survivors with varying physical capacities. In addition to that, the interactive nature of the game ensures interpersonal contact that may help in attenuating the cancer rehabilitation-induced social isolation [26].

Group exercise interventions can advance the level of understanding among patients and thus counteract problems linked with illness and the management of treatment. By interacting with peers during exercise sessions, individuals can reconstruct their own identity [27]. Such social relationships can promote the construction of a cancer-related identity that incorporates the cancer experience and fosters resilience and a reformed sense of purpose. Involvement in physical activity with social interaction may enhance the psychological benefits linked with exercise and offer a support group and a sense of belonging that is so important in individuals with anxiety [28]. In spite of the theoretical backing and initial evidence of beneficial effects of exercise in cancer survivors, there is a gap in research that specifically addresses the role of badminton in rehabilitative intervention. Recent research has set out to determine the impact of badminton teaching on health and health-related

outcomes in specific populations and has uncovered evidence of potential gains in both physiological and psychosocial functioning [29]. However, there is a large research gap that specifically addresses the novel psychological and social benefits of badminton in cancer survivors in the process of rehabilitation.

The current study attempts to explore the impact of core badminton training on the psychological recuperation and social reintegration of female cancer survivors during the process of rehabilitation. From the implementation of a systematic badminton training program and the evaluation of psychological and social outcomes, the study aims to provide evidence of the effectiveness of badminton as a holistic rehabilitative intervention that addresses not only physical dimensions of recuperation but also psychological and social aspects of recovery. The findings can be used to develop more unified and efficient rehabilitation plans for female cancer survivors and improve the overall quality of life and successful reintegration into society after cancer treatment.

2. Methods

2.1. Research design

This research used a randomized controlled trial study design to investigate the impact of a 12-week badminton training program on psychological recovery and sense of social belonging in female cancer survivors undergoing rehabilitation. The experiment was conducted using a parallel-group design at an allocation ratio of 1:1 for both intervention and control groups. The study was conducted between March 2023 and December 2023. The data were collected at three time points: baseline (T0), post-intervention (T1, 12 weeks later), and follow-up (T2, 3 months after the intervention). The study employed a comprehensive methodology to minimize the risk of bias, including computer-generated randomization sequences, allocation concealment, and blinded outcome assessment. **Figure 1** illustrates the general study process from recruitment through data analysis.

2.2. Participants and intervention

Participants were female cancer survivors who had completed their primary cancer treatment within the past 6-24 months. Eligible participants were between 25-65 years of age with medical clearance from their oncologists to participate in moderate physical activity. Of the 120 potential participants screened, 90 met the eligibility criteria and provided written informed consent. Following baseline assessment, 10 participants were excluded due to medical concerns or withdrawal of consent. The remaining 80 participants were randomly assigned to either the intervention ($n = 40$) or control group ($n = 40$).

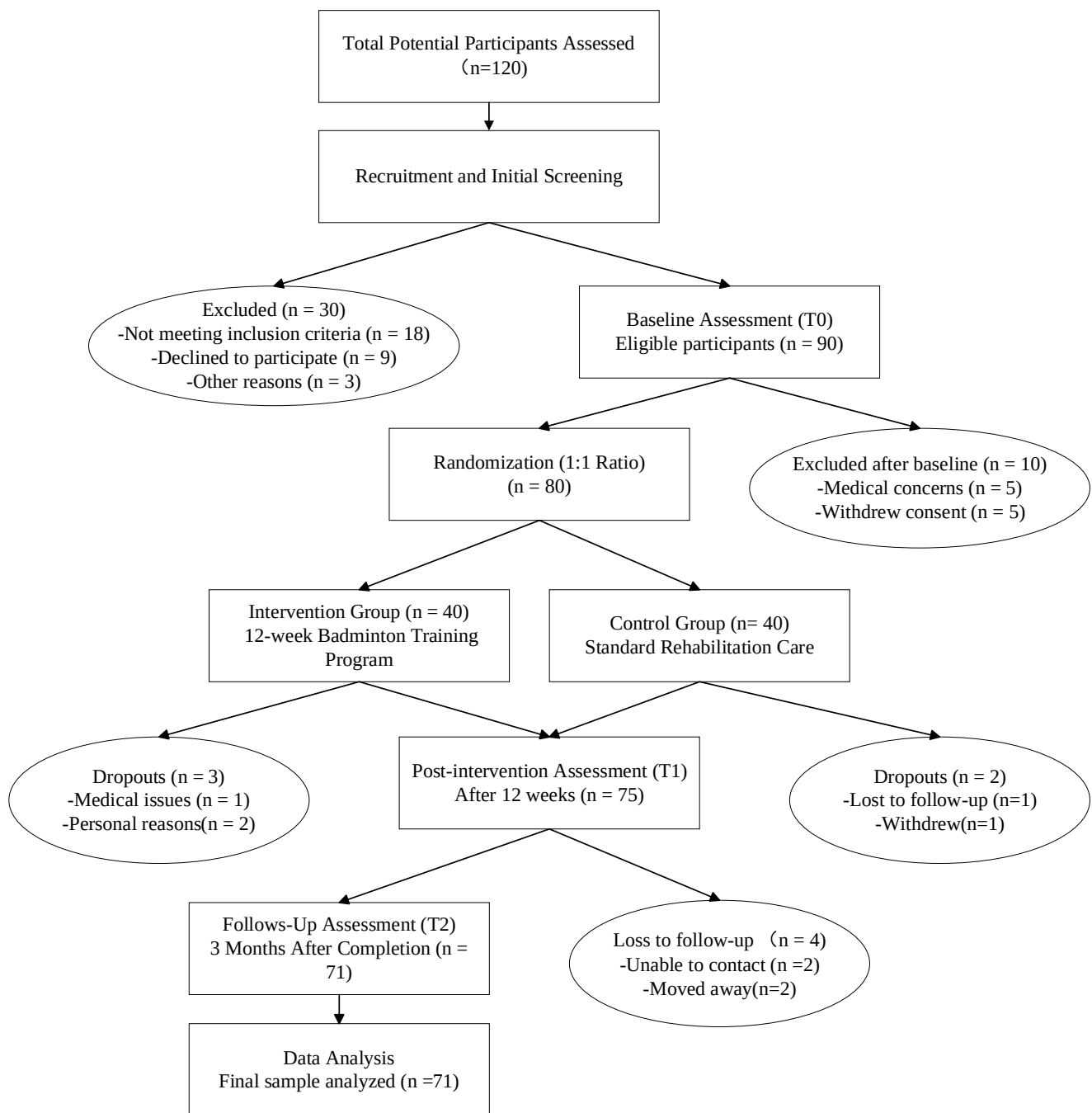


Figure 1. Participant flow diagram for badminton intervention trial.

The intervention group participated in a 12-week structured badminton training program specifically designed for cancer survivors, while the control group received standard rehabilitation care. The badminton program consisted of two 60-min sessions per week, conducted by certified badminton coaches with experience in adaptive physical activity. Sessions were held in small groups of 8-10 participants to facilitate social interaction while ensuring adequate individual instruction. The key characteristics of participants and details of the intervention program are summarized in **Table 1**.

Table 1. Study participants and intervention characteristics.

Category	Details
Participant inclusion criteria	Age 25-65 years Histologically confirmed diagnosis of primary cancer Completed primary treatment (except hormone therapy) Medical clearance for moderate physical activity Ability to understand and follow instructions No previous regular badminton experience
Participant exclusion criteria	Cancer recurrence or metastasis Severe cardiovascular conditions Cognitive impairment affecting consent Ongoing severe treatment side effects Regular exercise (>60 min/week) in past 6 months
Intervention structure	Duration: 12 weeks Frequency: 2 sessions per week Duration: 60 min per session Group size: 8-10 participants Supervision: Certified badminton coaches with adaptive physical activity training
Progressive skill development	Weeks 1-4 (Foundation Phase): Basic grip techniques and racquet handling Fundamental footwork patterns and court movement Simple underhand serve practice Introduction to clear stroke technique Weeks 5-8 (Skill Building Phase): Advanced stroke techniques (drop shot, smash) Court positioning and movement strategies Partner-based rally practice Introduction to doubles play concepts Weeks 9-12 (Integration Phase): Game strategy and tactical awareness Competitive modified games Skill refinement and individual feedback Tournament-style friendly matches
Session components	Warm-up (10 min): Light cardiovascular exercises, dynamic stretching, joint mobility Technical training (20 min): Skill-specific drills and technique development Game activities (20 min): Modified games promoting social interaction and skill application Cool-down (10 min): Static stretching, relaxation techniques, group reflection

Table 1. (Continued).

Category	Details
Intensity management	Heart rate monitoring: 50-70% of age-predicted maximum (220-age) Perceived exertion: 11-14 on Borg RPE scale (light to somewhat hard) Individual progression based on baseline fitness and weekly assessments Continuous monitoring by certified instructors Immediate intensity adjustments for safety
Social interaction facilitation	Structured Social Elements: Systematic partner rotations every 10 min during practice Team-building activities at session start Guided sharing sessions (5 min) at session end Peer encouragement and mutual support strategies Environment Design: Non-competitive, supportive atmosphere Emphasis on collective progress over individual performance Group problem-solving activities Celebration of group achievements and milestones
Control group	Standard oncology rehabilitation care General physical activity recommendations (written materials) Educational brochures about exercise benefits Maintained usual activities and medical follow-up

2.3. Outcome measures

Assessments were conducted at three time points: baseline (T0), post-intervention (T1, after 12 weeks), and follow-up (T2, 3 months after intervention completion). All assessments were performed by trained researchers who were blinded to group allocation. Psychological recovery was primarily assessed using the Hospital Anxiety and Depression Scale (HADS), a validated 14-item self-report questionnaire with two subscales measuring anxiety (HADS-A) and depression (HADS-D). Each subscale consists of 7 items scored on a 4-point Likert scale (0-3), with higher scores indicating greater symptom severity (Cronbach's $\alpha = 0.83$ and 0.79 for HADS-A and HADS-D, respectively). The HADS maintains excellent psychometric properties in cancer populations across diverse cultural contexts [30].

Cancer-related fatigue was measured using the Cancer-Related Fatigue Scale (CRFS), a widely used 15-item instrument with demonstrated reliability in cancer populations (Cronbach's $\alpha = 0.85$). Cancer-related fatigue scales, including the CRFS, maintain strong psychometric properties across diverse cancer populations and treatment phases [31]. Sense of social belonging, the second primary outcome, was evaluated using the Social Connectedness Scale-Revised (SCS-R), which consists of 20 items rated on a 6-point Likert scale, with higher scores reflecting a stronger sense of social connectedness (Cronbach's $\alpha = 0.88$). The SCS-R and related social connectedness measures have been extensively validated and applied in cancer

survivor populations, demonstrating strong psychometric properties and clinical relevance for measuring social isolation and connectedness [32].

Quality of life was assessed as a secondary outcome using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30), which incorporates functional scales, symptom scales, and a global health status scale. The EORTC QLQ-C30 remains the gold standard for quality of life assessment in cancer research with continued validation demonstrating robust psychometric properties and clinical utility [33]. The transformation of raw scores to the 0-100 scale was calculated using:

$$\text{Score} = \left(\frac{\text{Raw Score} - \text{Minimum score}}{\text{Range}} \right) \times 100 \quad (1)$$

Physical activity levels outside the intervention were monitored using the International Physical Activity Questionnaire-Short Form (IPAQ-SF) to account for potential confounding effects. Participants also completed a demographic and medical history questionnaire at baseline, including age, education level, cancer type, treatment modalities, and time since treatment completion.

2.4. Statistical analysis

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Sample size was determined a priori using G*Power 3.1, with calculations based on detecting a moderate effect size (Cohen's $d = 0.50$) for the primary outcomes (psychological recovery and social belonging) with 80% power at $\alpha = 0.05$, accounting for an anticipated 15% attrition rate. Normality of data distribution was assessed using the Shapiro-Wilk test. Baseline characteristics were compared between groups using independent t-tests for continuous variables and chi-square tests for categorical variables.

The primary analysis employed a mixed-model repeated measures analysis of variance (ANOVA) with time (baseline, post-intervention, follow-up) as the within-subject factor and group (intervention, control) as the between-subject factor. The F-statistic for the group $\times$ time interaction effect was calculated as:

$$F = \frac{MS_{\text{group} \times \text{time}}}{MS_{\text{error}}} \quad (2)$$

Effect sizes were calculated using partial eta squared (η_p^2):

$$\eta_p^2 = \frac{SS_{\text{effect}}}{SS_{\text{effect}} + SS_{\text{error}}} \quad (3)$$

where values of 0.01, 0.06, and 0.14 represent small, medium, and large effects, respectively.

Post-hoc comparisons were performed using Bonferroni correction to adjust for multiple comparisons. Additionally, clinical significance was determined by calculating the proportion of participants in each group demonstrating meaningful improvement, defined as a change of ≥ 4 points on the HADS and ≥ 5 points on the SCS-R, based on previous validation studies.

The relationship between changes in psychological recovery indicators and social belonging measures was assessed using Pearson correlation coefficients:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad (4)$$

An intention-to-treat approach was used for all analyses, with missing data handled using multiple imputation techniques. Sensitivity analyses were conducted to assess the robustness of findings under different assumptions about missing data. A p -value <0.05 was considered statistically significant for all analyses.

2.5. Ethical considerations

This study was approved by the University of Malaya Research Ethics Committee—Non-Medical (UMREC-NM). The ethics approval number is UMREC/2024/EDU/0021, granted on 21 December 2024. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent prior to enrollment. The consent process included detailed information about the study purpose, procedures, potential risks and benefits, and the voluntary nature of participation. Participants were informed of their right to withdraw from the study at any time without facing any adverse effects on their usual care. All personal and clinical information was anonymized and stored in a secure fashion, with access limited to approved research personnel only. Participants' confidentiality and privacy were maintained during the study duration. Due regard was taken of cancer survivors' vulnerability with the offer of counseling in response to participants' need during the study duration. Safety factors were of paramount importance in designing the badminton intervention with adaptations in place to allow participation by those with physical limitations resulting from cancer treatment. In addition to that, the control group was invited to participate in the badminton program after the study to promote fair access to the potential benefits from the intervention.

3. Results

3.1. Participant characteristics and adherence

A total of 80 female cancer survivors were randomly assigned to either the badminton intervention group ($n = 40$) or the control group ($n = 40$). The demographic and clinical characteristics of participants at baseline are presented in **Table 2**. There were no significant differences between groups in terms of age, education level, cancer type, treatment modalities, time since treatment completion, or baseline outcome measures, indicating successful randomization. Of the 80 randomized participants, 75 (93.8%) completed the post-intervention assessment (T1) at 12 weeks, with 3 dropouts from the intervention group and 2 from the control group. At the 3-month follow-up (T2), 71 participants (88.8%) completed all assessments. **Figure 1** illustrates the complete participant flow through the trial.

Table 2. Baseline demographic and clinical characteristics of study participants.

	Characteristic	Intervention group (n = 40)	Control group (n = 40)	p-value
Demographic characteristics	Age (years), mean ± SD	52.6 ± 8.3	51.4 ± 9.1	0.54
	Education level, n (%)			0.68
	- Primary school	5 (12.5)	4 (10.0)	
	- Secondary school	18 (45.0)	16 (40.0)	
	- College/university	17 (42.5)	20 (50.0)	
	Employment status, n (%)			0.72
	- Employed	15 (37.5)	17 (42.5)	
	- Unemployed	7 (17.5)	8 (20.0)	
	- Retired	12 (30.0)	10 (25.0)	
Clinical characteristics	- Medical leave	6 (15.0)	5 (12.5)	
	Cancer type, n (%)			0.83
	- Breast	22 (55.0)	24 (60.0)	
	- Gynecological	10 (25.0)	9 (22.5)	
	- Colorectal	6 (15.0)	5 (12.5)	
	- Other	2 (5.0)	2 (5.0)	
	Treatment received, n (%)			
	- Surgery	36 (90.0)	35 (87.5)	0.72
	- Chemotherapy	31 (77.5)	30 (75.0)	0.79
	- Radiation therapy	27 (67.5)	29 (72.5)	0.63
Baseline outcome measures	- Hormone therapy*	19 (47.5)	21 (52.5)	0.65
	Time since treatment completion (months), mean ± SD	14.3 ± 5.2	13.8 ± 4.9	0.65
	Hospital Anxiety and Depression Scale-Anxiety, mean ± SD	8.2 ± 3.1	7.9 ± 3.3	0.68
	Hospital Anxiety and Depression Scale-Depression, mean ± SD	7.6 ± 3.4	7.4 ± 3.2	0.78
	Cancer-Related Fatigue Scale, mean ± SD	31.5 ± 8.7	30.9 ± 9.1	0.76
	Social Connectedness Scale-Revised, mean ± SD	72.4 ± 15.6	73.1 ± 14.9	0.84
	European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 Global health status, mean ± SD	62.8 ± 13.4	63.5 ± 14.2	0.82
	International Physical Activity Questionnaire-Short Form (MET-minutes/week), mean ± SD	458.3 ± 211.4	472.6 ± 198.5	0.75

Note: *Ongoing at study enrollment; SD = Standard Deviation; MET = Metabolic Equivalent of Task.

Detailed analysis of participant attrition revealed that the three dropouts from the intervention group were due to cancer recurrence ($n = 1$), family relocation ($n = 1$), and scheduling conflicts with work commitments ($n = 1$). The two dropouts from the control group were attributed to loss of interest ($n = 1$) and medical complications unrelated to the study ($n = 1$). Comparison between completers and non-completers showed no significant differences in baseline demographic characteristics, cancer type, or initial outcome measures (all $p > 0.05$), suggesting that attrition was not systematic.

Adherence to the badminton intervention was high, with participants attending an average of 20.4 ± 3.6 out of 24 planned sessions (85% attendance rate). Attendance patterns remained consistent throughout the intervention period: weeks 1-4 averaged 87.2% attendance, weeks 5-8 averaged 84.8% attendance, and weeks 9-12 averaged 83.1% attendance. The primary reasons for missed individual sessions included minor illness not related to cancer (32%), family obligations (28%), medical appointments (25%), and transportation difficulties (15%). Participants who attended fewer than 18 sessions ($n = 4$) still demonstrated significant improvements in primary outcomes, suggesting that the intervention effects were robust across varying levels of adherence.

No serious adverse events related to the intervention were reported during the study period. Minor issues reported included muscle soreness ($n = 5$), minor ankle sprains ($n = 2$), and wrist discomfort ($n = 3$), all of which resolved without medical intervention. The control group maintained their standard rehabilitation activities throughout the study period, with no significant changes in physical activity levels as measured by the IPAQ-SF ($p = 0.78$ for between-group differences in change from baseline to post-intervention).

3.2. Effects on psychological recovery

Analysis of psychological recovery outcomes revealed significant improvements in the intervention group compared to the control group. Regarding anxiety symptoms, the mixed-model ANOVA showed a significant group $\times$ time interaction effect for Hospital Anxiety and Depression Scale-Anxiety scores ($F[2,156] = 9.43$, $p < 0.001$, $\eta^2p = 0.11$, Cohen's $d = 1.2$). Post-hoc analyses indicated that the badminton intervention group demonstrated significant reductions in anxiety from baseline (8.2 ± 3.1) to post-intervention (5.3 ± 2.5 , $p < 0.001$, Cohen's $d = 1.0$) and maintained these improvements at 3-month follow-up (5.5 ± 2.7 , $p < 0.001$, Cohen's $d = 0.9$), while the control group showed minimal changes across time points (baseline: 7.9 ± 3.3 ; post-intervention: 7.5 ± 3.1 ; follow-up: 7.3 ± 3.2).

Similarly, depression symptoms measured by Hospital Anxiety and Depression Scale-Depression showed a significant group $\times$ time interaction ($F[2,156] = 8.67$, $p < 0.001$, $\eta^2p = 0.10$, Cohen's $d = 1.1$), with the intervention group exhibiting greater improvements (baseline: 7.6 ± 3.4 ; post-intervention: 4.9 ± 2.6 , Cohen's $d = 0.9$; follow-up: 5.1 ± 2.8 , Cohen's $d = 0.8$) compared to the control group (baseline: 7.4 ± 3.2 ; post-intervention: 7.0 ± 3.3 ; follow-up: 6.8 ± 3.1). Cancer-related fatigue also showed significant between-group differences over time ($F[2,156] = 10.24$, $p < 0.001$, $\eta^2p = 0.12$, Cohen's $d = 1.3$), with the intervention group reporting substantial reductions in fatigue scores (baseline: 31.5 ± 8.7 ; post-intervention: 23.6 ± 7.4 , Cohen's $d = 1.0$; follow-up: 24.2 ± 7.9 , Cohen's $d = 0.9$) compared to modest changes

in the control group (baseline: 30.9 ± 9.1 ; post-intervention: 29.5 ± 8.8 ; follow-up: 28.7 ± 8.6).

A detailed comparison of psychological recovery outcomes across assessment points for both groups is presented in **Table 3**. As shown in the table, the intervention group demonstrated consistent and substantial improvements in all psychological recovery indicators from baseline to post-intervention, with these benefits largely maintained at follow-up.

Table 3. Psychological recovery outcomes at baseline, post-intervention, and follow-up.

Outcome measure	Group	Baseline (Mean $\pm$ SD)	Post-intervention (Mean $\pm$ SD)	Follow-up (Mean $\pm$ SD)	Group $\times$ time interaction	Cohen's <i>d</i>
Hospital Anxiety and Depression Scale-Anxiety	Intervention	8.2 ± 3.1	$5.3 \pm 2.5^{***}$	$5.5 \pm 2.7^{***}$	$F[2,156] = 9.43$	1.0
	Control	7.9 ± 3.3	7.5 ± 3.1	7.3 ± 3.2	$p < 0.001, \eta^2 p = 0.11$	
Hospital Anxiety and Depression Scale-Depression	Intervention	7.6 ± 3.4	$4.9 \pm 2.6^{***}$	$5.1 \pm 2.8^{***}$	$F[2,156] = 8.67$	0.9
	Control	7.4 ± 3.2	7.0 ± 3.3	6.8 ± 3.1	$p < 0.001, \eta^2 p = 0.10$	
Cancer-Related Fatigue Scale	Intervention	31.5 ± 8.7	$23.6 \pm 7.4^{***}$	$24.2 \pm 7.9^{***}$	$F[2,156] = 10.24$	1.0
	Control	30.9 ± 9.1	29.5 ± 8.8	28.7 ± 8.6	$p < 0.001, \eta^2 p = 0.12$	

Note: *** indicates significant difference from baseline ($p < 0.001$); SD = Standard Deviation; Cohen's *d* represents effect size for intervention group changes from baseline.

Analysis of clinical significance revealed that 65% of participants in the intervention group achieved meaningful improvement in anxiety symptoms (≥ 4 point reduction in HADS-Anxiety) compared to 22.5% in the control group ($\chi^2 = 15.21, p < 0.001$). For depression, 62.5% of the intervention group versus 20% of the control group achieved clinically meaningful improvement ($\chi^2 = 14.82, p < 0.001$). As shown in **Figure 2**, the trajectory of psychological recovery indicators across the three assessment points clearly demonstrates the sustained beneficial effects of the badminton intervention on psychological well-being in female cancer survivors.

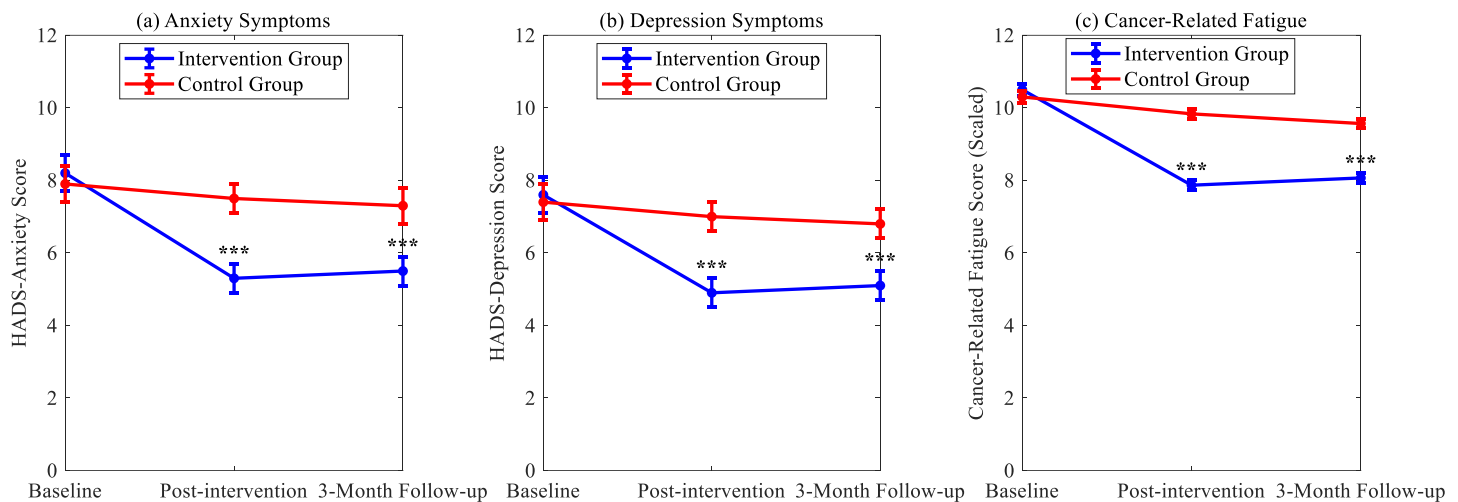


Figure 2. Changes in psychological recovery outcomes over time.

Note: Error bars represent standard errors of the mean. *** indicates $p < 0.001$ compared to baseline for intervention group. Cancer-Related Fatigue scores were scaled for visualization purposes.

3.3. Effects on social belonging

The analysis of social belonging outcomes revealed significant improvements in the intervention group compared to the control group. The mixed-model ANOVA showed a significant group $\times$ time interaction effect for the Social Connectedness Scale-Revised (SCS-R) scores ($F[2,156] = 11.24$, $p < 0.001$, $\eta^2p = 0.13$, Cohen's $d = 1.4$). Post-hoc analyses demonstrated that the badminton intervention group experienced significant increases in social connectedness from baseline (72.4 ± 15.6) to post-intervention (86.8 ± 13.2 , $p < 0.001$, Cohen's $d = 1.0$), representing a 19.9% improvement. These enhanced social connection levels were largely maintained at 3-month follow-up (85.3 ± 14.1 , $p < 0.001$, Cohen's $d = 0.9$), indicating the durability of the intervention effects. In contrast, the control group showed only minimal changes across time points (baseline: 73.1 ± 14.9 ; post-intervention: 75.2 ± 15.1 ; follow-up: 76.5 ± 14.7), with just a 2.9% improvement from baseline to post-intervention and a 4.7% improvement at follow-up.

The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 global health status scores also showed significant group $\times$ time interaction ($F[2,156] = 9.89$, $p < 0.001$, $\eta^2p = 0.11$, Cohen's $d = 1.1$), with the intervention group demonstrating substantial improvements from baseline (62.8 ± 13.4) to post-intervention (76.9 ± 12.1 , $p < 0.001$, Cohen's $d = 1.1$), representing a 22.5% increase. These quality of life enhancements were sustained at follow-up (75.2 ± 12.8 , $p < 0.001$, Cohen's $d = 0.9$), with only a slight decrease from the post-intervention peak. The control group, however, showed considerably more modest changes across the study period (baseline: 63.5 ± 14.2 ; post-intervention: 65.7 ± 13.8 ; follow-up: 66.2 ± 14.1), with just a 3.5% improvement from baseline to post-intervention and a 4.3% improvement at follow-up.

A comprehensive summary of social belonging and quality of life outcomes across all assessment points is presented in **Table 4**. As shown in the table, the intervention group demonstrated significant improvements in both social

connectedness and quality of life measures, with benefits largely maintained at the 3-month follow-up assessment.

Table 4. Social belonging and quality of life outcomes at baseline, post-intervention, and follow-up.

Outcome measure	Group	Baseline (Mean $\pm$ SD)	Post-intervention (Mean $\pm$ SD)	Follow-up (Mean $\pm$ SD)	Group $\times$ time interaction	Cohen's <i>d</i>
Social Connectedness Scale-Revised	Intervention	72.4 $\pm$ 15.6	86.8 $\pm$ 13.2***	85.3 $\pm$ 14.1***	F[2,156] = 11.24	1.0
	Control	73.1 $\pm$ 14.9	75.2 $\pm$ 15.1	76.5 $\pm$ 14.7	$p < 0.001$, $\eta^2 p = 0.13$	
European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 Global Health Status	Intervention	62.8 $\pm$ 13.4	76.9 $\pm$ 12.1***	75.2 $\pm$ 12.8***	F[2,156] = 9.89	1.1
	Control	63.5 $\pm$ 14.2	65.7 $\pm$ 13.8	66.2 $\pm$ 14.1	$p < 0.001$, $\eta^2 p = 0.11$	

Note: *** indicates significant difference from baseline ($p < 0.001$); SD = Standard Deviation; Cohen's *d* represents effect size for intervention group changes from baseline.

Analysis of clinical significance showed that 67.5% of participants in the intervention group achieved meaningful improvement in social connectedness (≥ 5 point increase in SCS-R) compared to only 25% in the control group ($\chi^2 = 14.58$, $p < 0.001$). As shown in **Figure 3**, the trajectory of social belonging indicators across the three assessment points demonstrates the sustained beneficial effects of the badminton intervention on social integration and quality of life in female cancer survivors.

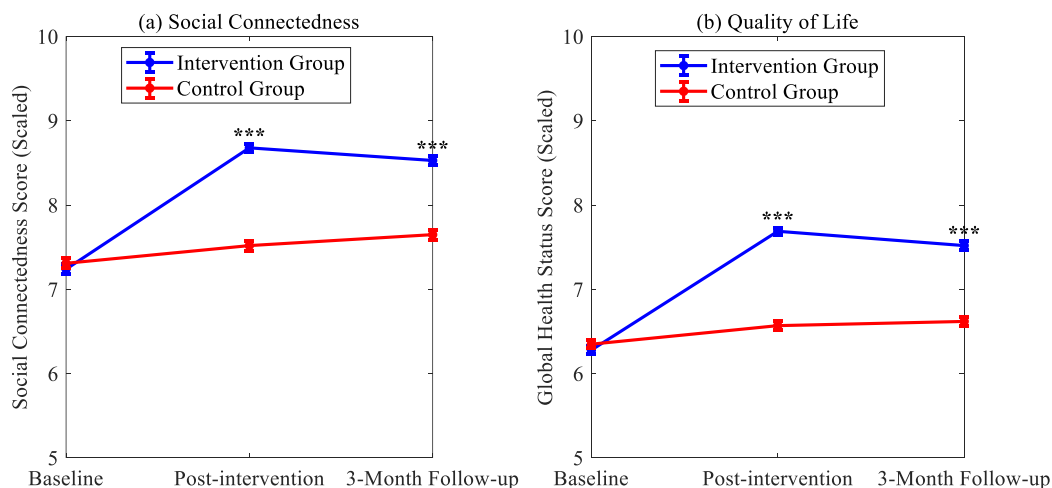


Figure 3. Changes in social belonging and quality of life over time.

Note: Error bars represent standard errors of the mean. *** indicates $p < 0.001$ compared to baseline for intervention group. Both measures were scaled for visualization purposes.

3.4. Correlations between psychological recovery and social belonging

Correlation analyses were conducted to examine the relationships between changes in psychological recovery indicators and social belonging measures from baseline to post-intervention. Significant correlations were observed between

improvements in psychological outcomes and enhancements in social connection, as presented in **Table 5**. Changes in Hospital Anxiety and Depression Scale-Anxiety scores were strongly correlated with changes in Social Connectedness Scale-Revised scores ($r = -0.68$, $p < 0.001$), indicating that greater reductions in anxiety were associated with greater improvements in social connectedness. Similarly, changes in Hospital Anxiety and Depression Scale-Depression scores demonstrated a strong negative correlation with changes in social connectedness ($r = -0.71$, $p < 0.001$). Improvements in cancer-related fatigue also showed a significant association with enhanced social connectedness ($r = -0.64$, $p < 0.001$). When examining these correlations separately by group, the intervention group exhibited consistently stronger associations between psychological recovery and social connectedness than the control group. The correlation between Hospital Anxiety and Depression Scale-Depression and social connectedness was particularly robust in the intervention group ($r = -0.71$, $p < 0.001$), suggesting that the badminton program may have simultaneously addressed both depressive symptoms and feelings of social isolation.

Table 5. Correlations between changes in psychological recovery indicators and social belonging measures.

	Variable pairs	Intervention group	Control group	Overall sample
Correlations with social connectedness	Hospital Anxiety and Depression Scale-Anxiety	-0.68***	-0.38*	-0.64***
	Hospital Anxiety and Depression Scale-Depression	-0.71***	-0.41**	-0.68***
	Cancer-Related Fatigue Scale	-0.64***	-0.34*	-0.59***
Correlations with quality of life	Hospital Anxiety and Depression Scale-Anxiety	-0.59***	-0.29	-0.52***
	Hospital Anxiety and Depression Scale-Depression	-0.63***	-0.33*	-0.55***
	Cancer-Related Fatigue Scale	-0.65***	-0.35*	-0.58***

Note: Changes calculated as difference between baseline and post-intervention scores. Negative correlations indicate inverse relationships between variables. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

When examining the relationship between psychological recovery indicators and quality of life measures, improvements in Hospital Anxiety and Depression Scale-Anxiety, Hospital Anxiety and Depression Scale-Depression, and Cancer-Related Fatigue Scale scores were all significantly correlated with enhancements in European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 global health status ($r = -0.59$, $r = -0.63$, and $r = -0.65$, respectively, all $p < 0.001$). These correlation patterns were consistent across both intervention and control groups, although the magnitude of changes was notably greater in the intervention group. As shown in **Figure 4**, the intervention group demonstrated consistently stronger correlations between psychological recovery indicators and outcome measures compared to the control group.

The stronger correlations observed in the intervention group suggest that badminton training may facilitate a synergistic improvement across both

psychological and social domains. This integrated enhancement could be attributed to the dual nature of the badminton intervention, which combines physical activity with structured social interaction in a supportive environment. The findings highlight the importance of holistic rehabilitation approaches that simultaneously address multiple dimensions of well-being in female cancer survivors.

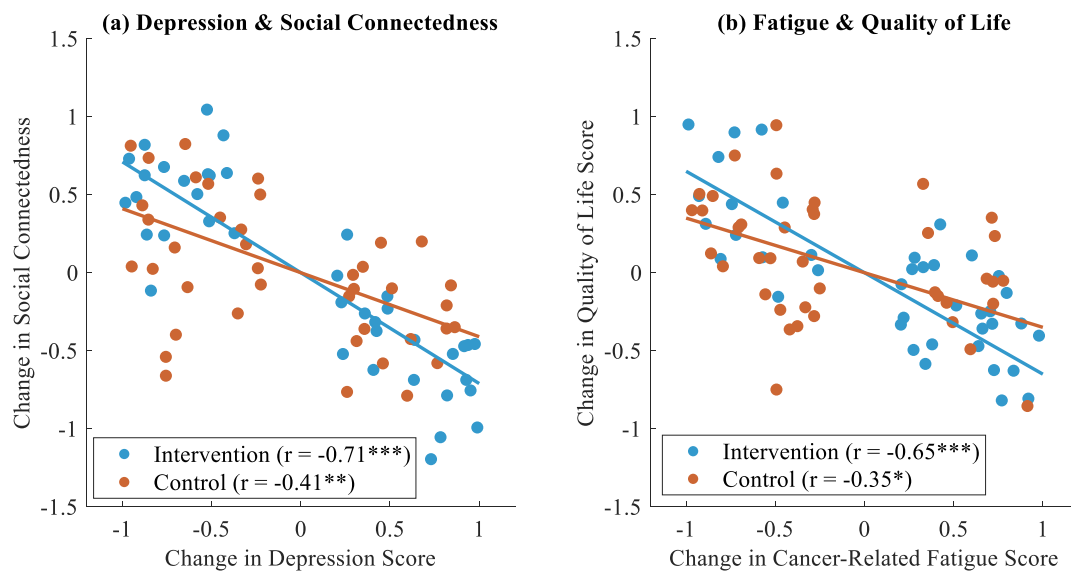


Figure 4. Correlations between psychological recovery and outcome measures.

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Negative correlations indicate that improvements in psychological measures are associated with improvements in outcome measures.

4. Discussion

This study demonstrates that structured badminton training significantly enhances psychological recovery and social belonging among female cancer survivors during rehabilitation. These findings align with established theoretical frameworks that explain positive adaptation following traumatic experiences. The observed improvements support post-traumatic growth theory [7], which suggests that individuals can experience meaningful psychological development through deliberate engagement with trauma-related challenges when appropriate support is provided. Furthermore, the effectiveness can be understood through self-determination theory [9], which identifies autonomy, competence, and relatedness as fundamental psychological needs crucial for optimal human functioning. Autonomous motivation and perceived competence are strong predictors of sustained physical activity engagement and improved psychological well-being among cancer survivors [34]. The badminton program addressed these needs through skill progression that enhanced competence, participatory choice that supported autonomy, and structured social interactions that fostered relatedness.

The relationship between badminton participation and psychological recovery aligns with emerging evidence on physical activity benefits for cancer survivors. Eather et al. found that sports participation is linked to “lower levels of perceived stress, and improved vitality, social functioning, mental health, and life satisfaction in adults” [35]. The interactive nature of badminton may have provided optimal combinations of

physical exertion and social engagement, addressing multiple recovery aspects simultaneously. Zanghi et al. found physical activity interventions “generally improve the physical, mental, and social spheres of breast-cancer survivors”, though they noted heterogeneity in intervention protocols [36]. Murray et al. demonstrated that connecting women diagnosed and treated for breast cancer to engage in physical activity shows promising results in improving both physical and psychological outcomes [37]. The psychological mechanisms underlying these benefits likely include mastery experiences through skill acquisition, social support through peer interactions, attentional distraction from cancer-related concerns, and meaning-making opportunities that facilitate post-traumatic growth. The structured partner rotations and collaborative activities created supportive environments where participants could experience both individual achievement and collective belonging.

However, several important limitations must be acknowledged regarding our study design. The control group did not receive equivalent social engagement activities, making it unclear whether observed benefits stem specifically from badminton training, general physical activity, group interaction, or attention effects. This limitation is common in behavioral interventions and underscores the complexity of determining causative factors in multifaceted interventions. Future research should consider active control groups involving other group activities to isolate specific mechanisms contributing to therapeutic outcomes. The efficacy of the intervention may be partly explained by the implementation approach combining physical activity with social support elements. Tyrus Korecki et al. found that structured group-based programs can effectively reduce depressive symptoms, particularly for those who “feel least prepared for cancer survivorship” [38], suggesting that comprehensive interventions addressing both physical and psychological aspects of recovery are particularly effective.

The generalizability of these findings faces significant constraints related to cultural context and participant characteristics. This study included only female cancer survivors in a predominantly Chinese cultural setting, and results may not translate to male survivors, different cultural groups, or various cancer types. Cultural differences in attitudes toward group activities, physical expression, and social interaction may substantially influence intervention effectiveness [39]. Cross-cultural validation studies indicate that measurement instruments may perform differently across ethnic groups, potentially affecting the accuracy of our findings [40]. Additionally, while the scales used have international recognition, cultural differences in psychological symptom reporting and social connectedness expression may affect measurement accuracy, as cross-cultural validation of these instruments in Chinese cancer populations remains limited.

Despite these limitations, the strong correlations between psychological recovery indicators and social connectedness measures suggest synergistic relationships warranting further investigation. Hardcastle et al. found that physical activity interventions for cancer survivors produced “significant net increase of 50 min/week of moderate-to-vigorous physical activity” and demonstrated “preliminary effectiveness of a low-intensity, distance-based intervention” [41]. Although our intervention was facility-based rather than distance-based, similar principles of accessibility and participation were crucial. Friedenreich et al. demonstrated that

physical activity is linked to reduced mortality in cancer survivors, indicating relevance not only for quality of life but potentially for survival [42]. The intervention group demonstrated consistently stronger associations between psychological and social domains compared to controls, suggesting that badminton training may facilitate integrated improvements across multiple aspects of well-being. However, structured badminton programs should be implemented as components of comprehensive cancer rehabilitation with careful consideration of individual preferences, cultural background, and physical capabilities, recognizing that not all patients may respond positively to group-based physical activities.

Future research should prioritize randomized controlled trials with active control groups, extended intervention periods, longer follow-up assessments, and diverse participant populations. Investigation of optimal intervention characteristics, including duration, frequency, and social components, would inform evidence-based program development. Cross-cultural validation studies of measurement instruments and exploration of cultural adaptations necessary for different populations would enhance global applicability. Additionally, studies examining mechanisms through which different types of group-based physical activities influence psychological and social outcomes could guide more targeted intervention design. Until such research is completed, these promising results suggest that structured badminton programs may serve as valuable components of comprehensive cancer rehabilitation when appropriately adapted to local contexts.

5. Conclusion

This study provides preliminary evidence that structured badminton training may enhance psychological recovery and social connectedness in female cancer survivors during rehabilitation. While the 12-week intervention demonstrated statistically significant improvements in anxiety, depression, cancer-related fatigue, and social belonging with benefits maintained at three-month follow-up, several important limitations constrain the interpretability and generalizability of these findings. The absence of an active control group limits our ability to determine whether benefits stem specifically from badminton training or from general group interaction and attention effects. Furthermore, the study's restriction to female survivors in a predominantly Chinese cultural context raises questions about applicability to male survivors, different cultural groups, or various cancer types. The strong correlations observed between psychological and social outcomes suggest interconnected recovery processes that warrant further investigation. Although badminton's adjustable intensity and minimal equipment requirements make it potentially suitable for rehabilitation contexts, healthcare providers should exercise caution in clinical application until these findings are replicated in larger, more diverse samples with robust control group designs. Future research incorporating active control groups, extended follow-up periods, and cross-cultural validation is essential before broad clinical implementation can be recommended. These preliminary results suggest potential value for group-based physical activity interventions in cancer rehabilitation when appropriately adapted to individual and cultural contexts, contributing to the

growing evidence base for holistic approaches that address both physical and psychosocial dimensions of cancer survivorship.

Author contributions: Conceptualization, ZQ and AB; methodology, ZQ; investigation and data curation, ZQ; formal analysis, ZQ; writing—original draft preparation, ZQ; writing—review & editing, AB; supervision, AB. Both authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Ethical approval: This study was approved by the University of Malaya Research Ethics Committee—Non-Medical (UMREC-NM) under protocol number UMREC/2024/EDU/0021, approved on 21 December 2024. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent statement: Written informed consent was obtained from all participants prior to enrollment in the study. The consent process included detailed information about the study purpose, procedures, potential risks and benefits, confidentiality, and the right to withdraw from the study at any time without any consequences to their usual care.

Conflict of interest: The authors declare no conflict of interest. The study was conducted independently without any financial or non-financial competing interests that could have influenced the research process or outcomes.

References

1. Wang YH, Li JQ, Shi JF, et al. Depression and anxiety in relation to cancer incidence and mortality: a systematic review and meta-analysis of cohort studies. *Molecular Psychiatry*. 2020; 25: 1487-1499. doi: 10.1038/s41380-019-0595-x
2. Niedzwiedz CL, Knifton L, Robb KA, et al. Depression and anxiety among people living with and beyond cancer: A growing clinical and research priority. *BMC Cancer*. 2019; 19: 943. doi: 10.1186/s12885-019-6181-4
3. Philip EJ, Merluzzi TV. Psychosocial issues in post-treatment cancer survivors: Desire for support and challenges in identifying individuals in need. *Journal of Psychosocial Oncology*. 2016; 34(3): 223-239. doi: 10.1080/07347332.2016.1157716
4. Schmitz KH, Campbell AM, Stuver MM, et al. Exercise is medicine in oncology: Engaging clinicians to help patients move through cancer. *CA: A Cancer Journal for Clinicians*. 2019; 69(6): 468-484. doi: 10.3322/caac.21579
5. Marziliano A, M. Tuman M, Moyer A. The relationship between post-traumatic stress and post-traumatic growth in cancer patients and survivors: A systematic review and meta-analysis. *Psycho-Oncology*. 2020; 29(4): 604-616. doi: 10.1002/pon.5314
6. Huang S, Huang M, Long F, Wang F. Post-traumatic growth experience of breast cancer patients: A qualitative systematic review and meta-synthesis. *PLoS One*. 2025; 20(1): e0316108. doi: 10.1371/journal.pone.0316108
7. Love C, Sabiston CM. Exploring the links between physical activity and posttraumatic growth in young adult cancer survivors. *Psycho-Oncology*. 2011; 20(3): 278-286. doi: 10.1002/pon.1733
8. Cafaro V, Rabitti E, Artioli G, et al. Promoting post-traumatic growth in cancer patients: A randomized controlled trial of guided written disclosure. *Frontiers in Psychology*. 2024; 15: 1285998. doi: 10.3389/fpsyg.2024.1285998
9. Patrick H, Williams GC. Self-determination theory: Its application to health behavior and complementarity with motivational interviewing. *International Journal of Behavioral Nutrition and Physical Activity*. 2012; 9: 18. doi: 10.1186/1479-5868-9-18

10. Milne HM, Wallman KE, Guilfoyle A, et al. Self-determination theory and physical activity among breast cancer survivors. *Journal of Sport and Exercise Psychology*. 2008; 30(1): 23-38. doi: 10.1123/jsep.30.1.23
11. Wilson PM, Blanchard CM, Nehl E, Baker F. Predicting physical activity and outcome expectations in cancer survivors: An application of Self-Determination Theory. *Psycho-Oncology: Journal of the Psychological, Social and Behavioral Dimensions of Cancer*. 2006; 15(7): 567-578. doi: 10.1002/pon.990
12. Lee YH, Lai GM, Lee DC, et al. Promoting physical and psychological rehabilitation activities and evaluating potential links among cancer-related fatigue, fear of recurrence, quality of life, and physiological indicators in cancer survivors. *Integrative Cancer Therapies*. 2018; 17(4): 1183-1194. doi: 10.1177/1534735418805149
13. Frikkel J, Götte M, Beckmann M, et al. Fatigue, barriers to physical activity and predictors for motivation to exercise in advanced Cancer patients. *BMC Palliative Care*. 2020; 19: 43. doi: 10.1186/s12904-020-00542-z
14. Liska TM, Kolen AM. The role of physical activity in cancer survivors' quality of life. *Health and Quality of Life Outcomes*. 2020; 18: 197. doi: 10.1186/s12955-020-01448-3
15. Niu N, Huang R, Zhao J, Zeng Y. Health benefits of yoga for cancer survivors: an updated systematic review and meta-analysis. *Asia-Pacific Journal of Oncology Nursing*. 2024; 11(3): 100316. doi: 10.1016/j.apjon.2023.100316
16. Loo LW, Nishibun K, Welsh L, et al. Using a cultural dance program to increase sustainable physical activity for breast cancer survivors—A pilot study. *Complementary Therapies in Medicine*. 2019; 47: 102197. doi: 10.1016/j.ctim.2019.102197
17. Leach HJ, Potter KB, Hidde MC. A group dynamics-based exercise intervention to improve physical activity maintenance in breast cancer survivors. *Journal of Physical Activity and Health*. 2019; 16(9): 785-791. doi: 10.1123/jpah.2018-0667
18. Bandura A. Social cognitive theory of mass communication. In: *Media Effects*. Routledge; 2009. pp. 110-140.
19. McDonough MH, Beselt LJ, Kronlund LJ, et al. Social support and physical activity for cancer survivors: A qualitative review and meta-study. *Journal of Cancer Survivorship*. 2021; 15: 713-728. doi: 10.1007/s11764-020-00963-y
20. Mercier J, Ivers H, Savard J. A non-inferiority randomized controlled trial comparing a home-based aerobic exercise program to a self-administered cognitive-behavioral therapy for insomnia in cancer patients. *Sleep*. 2018; 41(10): zsy149. doi: 10.1093/sleep/zsy149
21. Durosini I, Triberti S, Sebrì V, et al. Psychological benefits of a sport-based program for female cancer survivors: The role of social connections. *Frontiers in Psychology*. 2021; 12: 751077. doi: 10.3389/fpsyg.2021.751077
22. Soriano-Maldonado A, Carrera-Ruiz A, Díez-Fernández DM, et al. Effects of a 12-week resistance and aerobic exercise program on muscular strength and quality of life in breast cancer survivors: Study protocol for the EFICAN randomized controlled trial. *Medicine*. 2019; 98(44): e17625. doi: 10.1097/MD.00000000000017625
23. Lirola MJ, Hernández-Rodríguez AI, Cuenca-Piqueras C, Prados-Megías ME. Resilience and renewal: The personal impact of physical activity in breast cancer survivors. *BMC Women's Health*. 2025; 25: 257. doi: 10.1186/s12905-025-03791-3
24. Lassandro G, Trisciuzzi R, Palladino V, et al. Psychophysical health and perception of well-being between master badminton athletes and the adult Italian population. *Acta Bio Medica: Atenei Parmensis*. 2021; 92(4): e2021253. doi: 10.23750/abm.v92i4.9857
25. Cabello-Manrique D, Lorente JA, Padial-Ruz R, Puga-Gonzalez E. Play badminton forever: A systematic review of health benefits. *International Journal of Environmental Research and Public Health*. 2022; 19(15): 9077. doi: 10.3390/ijerph19159077
26. Patterson S, Pattison J, Legg H, et al. The impact of badminton on health markers in untrained females. *Journal of Sports Sciences*. 2017; 35(11): 1098-1106. doi: 10.1080/02640414.2016.1210819
27. Missel M, Borregaard B, Schoenau MN, Sommer MS. A sense of understanding and belonging when life is at stake—Operable lung cancer patients' lived experiences of participation in exercise. *European Journal of Cancer Care*. 2019; 28(5): e13126. doi: 10.1111/ecc.13126
28. Bianco T, Eklund RC. Conceptual considerations for social support research in sport and exercise settings: The case of sport injury. *Journal of Sport and Exercise Psychology*. 2001; 23(2): 85-107. doi: 10.1123/jsep.23.2.85
29. Chen CC, Ryuh YJ, Donald M, Rayner M. The impact of badminton lessons on health and wellness of young adults with intellectual disabilities: A pilot study. *International Journal of Developmental Disabilities*. 2022; 68(5): 703-711. doi: 10.1080/20473869.2021.1882716
30. Annunziata MA, Muzzatti B, Bidoli E, et al. Hospital Anxiety and Depression Scale (HADS) accuracy in cancer patients. *Supportive Care in Cancer*. 2020; 28: 3921-3926. doi: 10.1007/s00520-019-05244-8

31. Fisher MI, Cohn JC, Harrington SE, et al. Screening and assessment of cancer-related fatigue: A clinical practice guideline for health care providers. *Physical Therapy*. 2022; 102(9): pzac120. doi: 10.1093/ptj/pzac120
32. Fox RS, Armstrong GE, Gaumond JS, et al. Social isolation and social connectedness among young adult cancer survivors: A systematic review. *Cancer*. 2023; 129(19): 2946-2965. doi: 10.1002/cncr.34934
33. Giesinger JM, Kieffer JM, Fayers PM, et al. Replication and validation of higher order models demonstrated that a summary score for the EORTC QLQ-C30 is robust. *Journal of Clinical Epidemiology*. 2016; 69: 79-88. doi: 10.1016/j.jclinepi.2015.08.007
34. Rodrigues B, Encantado J, Franco S, et al. Psychosocial correlates of physical activity in cancer survivors: A systematic review and meta-analysis. *Journal of Cancer Survivorship*. 2025; 19: 1385-1402. doi: 10.1007/s11764-024-01559-6
35. Eather N, Wade L, Pankowiak A, Eime R. The impact of sports participation on mental health and social outcomes in adults: A systematic review and the 'Mental Health through Sport' conceptual model. *Systematic Reviews*. 2023; 12: 102. doi: 10.1186/s13643-023-02264-8
36. Zanghi M, Petrigna L, Maugeri G, et al. The practice of physical activity on psychological, mental, physical, and social wellbeing for breast-cancer survivors: An umbrella review. *International Journal of Environmental Research and Public Health*. 2022; 19(16): 10391. doi: 10.3390/ijerph191610391
37. Murray RM, O'Loughlin E, Smith-Turchyn J, et al. Connecting women who are diagnosed and treated for breast cancer to engage in physical activity: A two-arm randomized controlled trial. *BMC Sports Science, Medicine and Rehabilitation*. 2025; 17: 96. doi: 10.1186/s13102-025-01131-4
38. Tyrus Korecki JR, Ganz PA, Partridge AH, et al. Moderators of intervention efficacy in the pathways to wellness trial of survivorship education and mindfulness meditation for younger breast cancer survivors. *JCO Oncology Practice*. 2024; 20(10): 1410-1419. doi: 10.1200/OP.23.00617
39. Bedi M, Devins GM. Cultural considerations for South Asian women with breast cancer. *Journal of Cancer Survivorship*. 2016; 10: 31-50. doi: 10.1007/s11764-015-0449-8
40. León-Salas B, Bilbao-González A, y Medina AM, et al. Cross-cultural adaptation, reliability and validity of the Spanish version of the long-term quality of life questionnaire. *Frontiers in Oncology*. 2024; 14: 1375125. doi: 10.3389/fonc.2024.1375125
41. Hardcastle SJ, Maxwell-Smith C, Cavalheri V, et al. A randomized controlled trial of promoting physical activity in regional and remote cancer survivors (PPARCS). *Journal of Sport and Health Science*. 2024; 13(1): 81-89. doi: 10.1016/j.jshs.2023.01.003
42. Friedenreich CM, Stone CR, Cheung WY, Hayes SC. Physical activity and mortality in cancer survivors: A systematic review and meta-analysis. *JNCI Cancer Spectrum*. 2020; 4(1): pkz080. doi: 10.1093/jncics/pkz080