

Article

Structured dance course intervention for psychological rehabilitation in cancer patients

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Abstract: Cancer patients undergoing active treatment face significant psychological burdens, including anxiety, depression, and elevated perceived stress. However, accessible and scalable non-pharmacological interventions for these issues remain limited. This study explored the impact of a twelve-week structured group dance program on anxiety, depression, health-related quality of life, and perceived stress in cancer patients who were undergoing or had recently completed active cancer treatment. A quasi-experimental pre-post design was employed, with participants assigned to an intervention or control group and assessed at baseline and immediately after the intervention. A total of 136 patients with a confirmed malignant cancer diagnosis, recruited from oncology outpatient clinics, were allocated to either the dance program (twice-weekly 60-minute sessions) or standard care. Outcomes were measured using the Hospital Anxiety and Depression Scale (HADS), the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 (EORTC QLQ-C30), and the Perceived Stress Scale, and the group-by-time interaction effect was analyzed using generalized estimating equations under the intention-to-treat principle. The intervention group showed significantly greater improvements than the control group across all primary outcomes. HADS anxiety scores declined from the borderline range to the normal range, and HADS depression scores, which were already below the borderline threshold at baseline, decreased further within the normal range. The EORTC QLQ-C30 Global Health status score increased by 8.5 points, falling within the 5–10 point range recommended as a minimal important difference, with significant improvements in emotional, social, and role functioning. Perceived Stress Scale-10 (PSS-10) scores decreased by 3.4 points in the intervention group, versus a negligible change in controls. Effect sizes were mild to moderate across outcomes. Session attendance was high, with 87.0% of intervention participants completing at least 80% of scheduled sessions. These preliminary findings suggest that a structured dance course is a feasible adjunct intervention for psychological rehabilitation in cancer patients, associated with improvements in affective, functional, and stress-related outcomes. As the control group received standard care only, the dance-specific component cannot be isolated from non-specific effects of attention, social interaction, music, and generic physical activity. Multi-centre randomised controlled trials with attention-matched active control groups and long-term follow-up are warranted to confirm and contextualise these effects.

Keywords: dance intervention; cancer rehabilitation; anxiety; quality of life; perceived stress

1. Introduction

Cancer accounted for nearly 20 million new cases and 9.7 million deaths globally in 2022, and as survival rates continue to rise, the number of individuals living with and beyond a diagnosis is steadily increasing [1]. Psychological burden is a persistent aspect of this trend. Survivors of the 20 most prevalent cancers remain at a markedly increased risk for depression and anxiety compared to cancer-

free individuals, a risk that persists for more than five years post-diagnosis [2]. Depression strikes one-third of survivors globally, and anxiety strikes 30.55% of this patient group [3]. Depression and anxiety have a wide array of consequences that go beyond emotional symptoms. Patients with comorbid depression and anxiety have the most pronounced decline in both physical and mental quality of life compared to patients with cancer alone [4]. Depression is associated with several problems in the cancer journey, such as low adherence to treatment, increased inflammation, reduced immune response, and decreased survival [5]. Preventable unmet psychosocial needs pose a significant issue among patients with cancer, negatively impacting their quality of life and health outcomes [6].

Psychotropic drugs can interact with other concurrent treatments for cancer, and patients tend to be reluctant to take another pharmacological agent while already undergoing a taxing regimen [7]. Regular physical activity has a moderate impact on depression, anxiety, and mental well-being in chronically ill adults, contributing to the rising prominence of movement-based interventions as an increasingly important part of supportive oncology [8]. Exercise interventions have been shown to substantially reduce depression and anxiety and to improve health-related quality of life among older adults with cancer [9]. Dance is one such intervention, particularly because it combines rhythmic physical activity, music, and social interaction, each of which independently enhances mental well-being and, when combined, can produce effects greater than their sum [10].

Dance/movement therapy requires a credentialed therapist for treatment delivery, making it difficult to scale up in general rehabilitation settings [11]. This problem can be addressed through formalized dance interventions led by qualified instructors, thereby increasing accessibility. Controlled trials of dance/movement therapy in cancer patients found no significant pooled effects on depression, stress, anxiety, or fatigue [12]. In contrast, community-based dance interventions with instructors have shown more promising results. A community-based dance intervention is associated with significant improvements in quality of life and depression in comparison to no intervention, with evidence pointing toward positive effects across multiple psychological outcomes in people with cancer [13]. In a group of breast cancer patients with adjuvant chemotherapy, a 16-week dance intervention reduced the incidence of depression and slowed the rate of decline in quality of life versus controls [14]. A dance intervention has also been associated with reduced anxiety and stress in cancer patients, although the evidence is predominantly from breast cancer patients and is heterogeneous in terms of intervention protocols [13, 15].

The simultaneous effects of a structured dance intervention on anxiety, depression, health-related quality of life, and perceived stress in a broader cancer population have yet to be comprehensively investigated. Therefore, this study employed a quasi-experimental pre-post design to examine whether participation in a structured dance course is associated with improvements in these outcomes among cancer patients undergoing or having recently completed active treatment, thereby providing preliminary evidence to inform future randomized controlled trials.

2. Methodology

2.1. Study design, ethics, and participants

This study employed a quasi-experimental pre-post design comprising an intervention group and a control group. Outcome measures were collected at baseline (T0) and immediately after the 12-week intervention (T1). The study is reported in

accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement [16]. The study protocol was reviewed and approved by the Ethics Committee of Shanghai University (approval number: ECSHU 2026-023). All participants provided written informed consent prior to enrollment. Data collection and handling were conducted in accordance with the Declaration of Helsinki.

Subjects who met the eligibility requirements were adults 18 years or older diagnosed with malignant cancer, currently undergoing or having recently completed active treatment within the past six months, and with an Eastern Cooperative Oncology Group (ECOG) performance status of 0–2. To meet the criteria for participation, patients had to be able to comprehend and complete self-report measures and to have not engaged in any structured dance or movement programme over the past year. Subjects were not eligible for participation in case of severe psychiatric disorders requiring specialist inpatient care, significant physical contraindications to moderate exercise as deemed appropriate by their treating physician, or a low probability of attending at least 80% of sessions.

For the sample size calculation, a medium effect size (Cohen's $d = 0.50$) was assumed, based on estimates from previous dance intervention studies conducted in similar populations [14]. The statistical power was set at 0.80, and the two-tailed alpha level at 0.05, giving a minimum sample size of 52 participants per group. Taking the expected dropout rate of approximately 20% into account, the target sample size was increased to 68 participants per group, totaling 136 participants. Recruitment was conducted at the oncology outpatient clinics of Fudan University Shanghai Cancer Center, through physician referral and posted notices. After screening, eligible patients were allocated to the intervention or control group according to their scheduled clinic attendance day: those whose routine clinic visits fell on the days designated for intervention sessions were assigned to the intervention group, while those attending on the remaining days were assigned to the control group. Allocation was determined solely by the pre-existing clinic schedule rather than by the participants, recruiting staff, or investigators, and group assignment was not concealed. Because allocation was not randomised, systematic differences between groups in treatment timing, disease status, or motivation cannot be excluded. The participant flow throughout the study is shown in **Figure 1**.

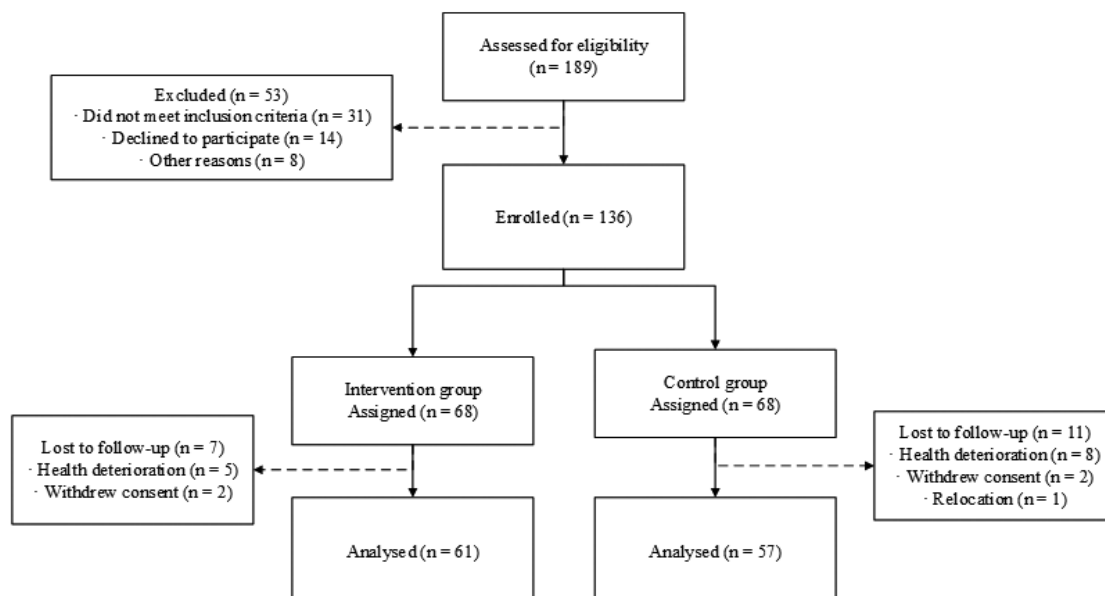


Figure 1. Participant flow diagram.

2.2. Dance course intervention

The description of the intervention is presented according to the TIDieR checklist [17]. The dance course was a structured, progressive intervention delivered over 12 weeks, including two 60-minute sessions per week (24 sessions in total). Every session followed a standardized three-phase structure. Phase 1 (warm-up) lasted about 10 minutes and included gentle joint movements and low-intensity rhythmic exercises. Phase 2 (dance movements) lasted about 40 minutes and included training led by instructors on familiar folk and social dances, specifically Chinese folk dances and ballroom-style social dances. Movement sequences were introduced progressively in line with participants' increasing capacity and interest. Movement intensity was kept at a low-to-moderate level appropriate for patients undergoing oncological treatment and was monitored in every session using the Borg Rating of Perceived Exertion (RPE) scale to keep exertion within a tolerable range. Recorded music accompanied each session and matched the rhythm and tempo of the corresponding dance style. Movements were individually adaptable: participants experiencing cancer-related fatigue or physical limitations were permitted to reduce the range or pace of movement, perform movements while seated, or rest as needed under instructor supervision. Phase 3 (cool-down and relaxation) lasted about 10 minutes and included slow stretching, deep breathing, and guided relaxation.

Sessions were conducted in small groups of 10–15 participants by two qualified dance instructors, each with at least three years of experience in clinical exercise settings, who were briefed on cancer-related fatigue and participant safety prior to programme commencement. Intervention fidelity was supported by delivering every session according to the standardized three-phase protocol, monitored using a standardized session checklist completed by the instructors after each session. No home-based practice was prescribed, and the intervention was delivered exclusively in supervised group sessions. Attendance at each session was recorded by the instructors. Adverse events were monitored throughout the programme, and no intervention-related adverse events were reported. Participants in the control group received standard care only, comprising routine medical follow-up and general health education without any structured physical activity programme.

2.3. Outcome measures

Psychological outcomes were assessed using three scales, which were administered at T0 and T1, questionnaire completion requiring approximately 20–25 minutes per assessment.

The Hospital Anxiety and Depression Scale is a 14-item scale comprising two subscales: anxiety (HADS-A) and depression (HADS-D). Each subscale contains seven items, with scores ranging from 0 to 21. A total score of 8–10 is indicative of borderline caseness, whereas a score of 11 or higher is indicative of probable clinical disorders. Cronbach's alpha for HADS-A ranges from 0.68 to 0.93 (mean = 0.83), and for HADS-D from 0.67 to 0.90 (mean = 0.82). At a cutoff score of 8, sensitivity and specificity are approximately 0.80 in somatic and primary care populations [18].

The EORTC QLQ-C30 version 3.0 assesses health-related quality of life in five functional domains: physical, role, emotional, cognitive, and social functioning. It also has three scales for symptoms and one for global health status. Additionally, it has six single items. Scoring for all scales involves linear transformation onto a scale ranging from 0 to 100. For the functional and global health scales, higher scores represent a better quality of life. On the other hand, for the scales measuring symptoms, higher scores represent more symptoms. For the multi-item scales, the

reliability coefficient of Cronbach's alpha is above 0.70. There is also satisfactory discriminant validity among patient groups with varying clinical states [19].

The Perceived Stress Scale (PSS-10) has ten questions that measure the degree to which the respondent perceives life events as stressful in the past month. The PSS-10 has a total score ranging from 0 to 40. For the PSS-10, Cronbach's alpha has consistently been reported to exceed 0.70 across studies. Furthermore, satisfactory test-retest reliability has been shown for the PSS-10 for time periods ranging from two days to six weeks [20].

2.4. Statistical analysis

Descriptive statistics were used for analyzing the baseline demographic and clinical characteristics of the participants. The baseline characteristics were compared using an independent samples t-test for continuous variables and a chi-square test for categorical variables. To estimate the effect of the dance course on each outcome, generalized estimating equations (GEE) were fitted assuming a Gaussian distribution, with an identity link, an unstructured working correlation, and robust (sandwich) variance estimators. The fixed-effect part of each model included group, time and their interaction; the group $\times$ time term captures how the two groups changed differently from T0 to T1. Baseline age, sex, cancer type and treatment status entered the models as covariates. Following the intention-to-treat principle, all 136 enrolled participants were retained in the analysis regardless of how many sessions they attended [21]. Because GEE uses every available observation and handles missingness under a missing-at-random assumption, no imputation was performed. Cohen's d was calculated by dividing the adjusted between-group difference (the group $\times$ time interaction coefficient, β) by the square root of the model-based residual variance (σ_{residual}) from the GEE model: $d = \beta / \sigma_{\text{residual}}$. The five EORTC QLQ-C30 functional subscales were not pre-specified primary outcomes; the alpha level was therefore not adjusted for multiple comparisons, and the subscale results are treated as exploratory. For interpreting the QLQ-C30 changes, a minimal important difference of 5 to 10 points was used, following established guidelines [22]. Robustness to attrition was checked in three ways: (i) baseline differences between completers and non-completers were tested, (ii) a complete-case analysis was run on those with both T0 and T1 data, and (iii) a per-protocol analysis was restricted to intervention participants with $\geq 80\%$ attendance. All tests were two-tailed and performed at an alpha level of 0.05 using SPSS version 26.0.

3. Results

3.1. Participant characteristics and adherence

Of the 136 enrolled participants, 61 in the intervention group and 57 in the control group completed the post-intervention assessment, making a total of 118 participants included in the completer analysis (**Figure 1**). In the intervention group, seven participants were lost to follow-up due to health deterioration, and two due to withdrawal of consent. In the control group, eleven participants were lost to follow-up, attributable to health deterioration ($n = 8$), withdrawal of consent ($n = 2$), and relocation ($n = 1$). The dropout rate was 10.3% in the intervention group and 16.2% in the control group. All 136 enrolled participants were included in the intention-to-treat analysis, irrespective of their attendance at the sessions. Missing outcome data were analyzed through the Generalized Estimating Equations (GEE), which allows for incomplete data to be analyzed under a missing at random assumption without imputation.

The two cohorts were comparable at baseline across all demographic and clinical characteristics, with no statistically significant differences observed between groups, as shown in **Table 1**. The average age of the entire sample was 51.4 years, with a standard deviation of 9.7 years. Female participants accounted for 68.4% of the cohort. The most common types of cancer were breast cancer (34.6%), colorectal cancer (18.4%), lung cancer (14%), and gynecologic cancers (12.5%), while other types comprised the remainder. About 61.8% were under active treatment at the time of study, while 38.2% were within six months after completion of treatment. In addition, disease stage was evenly distributed between both cohorts, with 57.4% and 55.9% in Stage I-II in the intervention and control groups, respectively. To assess potential attrition bias, baseline characteristics of completers ($n = 118$) and non-completers ($n = 18$) were compared. Non-completers were on average slightly older (53.6, $SD = 10.2$ vs 51.1, $SD = 9.5$ years) and presented with marginally higher HADS-A (8.8 vs 8.1), HADS-D (8.2 vs 7.6) and PSS-10 (23.8 vs 22.8) scores and lower QLQ-C30 Global Health (51.6, $SD = 17.9$ vs 55.6, $SD = 16.8$), consistent with the predominance of health-related dropouts; none of these differences reached statistical significance (all $p > 0.10$), supporting the plausibility of the missing-at-random assumption underlying the primary analysis. In the intervention group, the average attendance rate was 79.6%, with a standard deviation of 11.3%, and 87.0% were able to attend at least 80% of sessions, with the remaining 13.0% attending 60–79% of sessions (9.0%) or fewer than 60% (4.0%).

Table 1. Baseline characteristics of participants.

Characteristic	Intervention (n = 68)	Control (n = 68)	p value
Age, mean (SD), years	51.2 (9.4)	51.6 (10.1)	0.812
Sex, female, n (%)	47 (69.1)	46 (67.6)	0.858
Cancer type, n (%)			0.743
Breast	24 (35.3)	23 (33.8)	
Colorectal	12 (17.6)	13 (19.1)	
Lung	10 (14.7)	9 (13.2)	
Gynaecological	9 (13.2)	8 (11.8)	
Other	13 (19.1)	15 (22.1)	
Treatment status, n (%)			0.694
Active treatment	43 (63.2)	41 (60.3)	
Post-treatment	25 (36.8)	27 (39.7)	
Disease stage, n (%)			0.781
Stage I–II	39 (57.4)	38 (55.9)	
Stage III–IV	29 (42.6)	30 (44.1)	
HADS-A, mean (SD)	8.3 (2.6)	8.1 (2.7)	0.664
HADS-D, mean (SD)	7.6 (2.4)	7.8 (2.5)	0.618
EORTC QLQ-C30 Global Health, mean (SD)	55.4 (17.3)	54.8 (16.9)	0.831
PSS-10, mean (SD)	22.7 (5.1)	23.1 (4.9)	0.621

3.2. Effects of the intervention on anxiety and depression

At baseline, the HADS-A scores of both groups fell within the borderline caseness range (8–10), indicating subclinical but heightened levels of anxiety, whereas the HADS-D scores of both groups were just below the borderline threshold of 8 (means of 7.6 and 7.8), within the upper end of the normal range. After the twelve-week intervention, the HADS-A and HADS-D scores of the intervention group decreased substantially, while those of the control group remained stable. For the intervention group, the mean HADS-A score decreased from 8.3 (SD = 2.6) to 6.2 (SD = 2.4), moving from the borderline caseness range into the normal range (< 8). Similarly, the mean HADS-D score decreased from 7.6 (SD = 2.4) to 5.8 (SD = 2.3), reflecting a further movement to a clearly lower level within the normal range. In contrast, the control group's score changes were negligible, with the HADS-A score decreasing from 8.1 (SD = 2.7) to 7.9 (SD = 2.6), and the HADS-D score from 7.8 (SD = 2.5) to 7.6 (SD = 2.4). After adjusting for baseline age, sex, cancer type, and treatment status, the GEE analysis confirmed statistically significant group $\times$ time interaction effects for both anxiety ($\beta = -2.14$, SE = 0.45, 95% CI: -3.02 to -1.26 , $p < 0.001$, Cohen's $d = 0.47$) and depression ($\beta = -1.87$, SE = 0.43, 95% CI: -2.71 to -1.03 , $p < 0.001$, Cohen's $d = 0.43$), reflecting mild-to-moderate effect sizes. The scores of both groups are shown in **Table 2**, and the temporal trends of HADS-A and HADS-D are shown in **Figure 2**.

Table 2. HADS scores at baseline and post-intervention.

Outcome	Intervention		Control		β	SE	95% CI	p value	Cohen's d
	Baseline mean (SD)	Post mean (SD)	Baseline mean (SD)	Post mean (SD)					
HADS-A	8.3 (2.6)	6.2 (2.4)	8.1 (2.7)	7.9 (2.6)	-2.14	0.45	-3.02 to -1.26	< 0.001	0.47
HADS-D	7.6 (2.4)	5.8 (2.3)	7.8 (2.5)	7.6 (2.4)	-1.87	0.43	-2.71 to -1.03	< 0.001	0.43

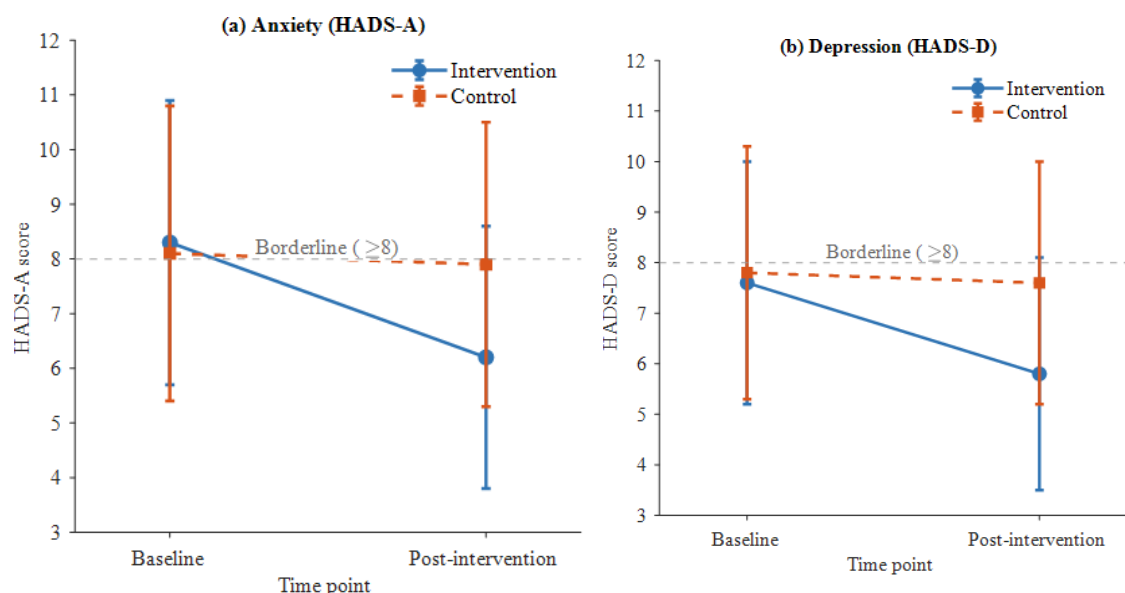


Figure 2. Anxiety and depression scores over time by group. Changes in anxiety (a) and depression (b) scores were measured by the Hospital Anxiety and Depression Scale (HADS). Participants in the intervention group demonstrated significant reductions in both HADS-A and HADS-D scores following the 12-week dance program, whereas scores in the control group remained largely unchanged. The dashed horizontal line indicates the clinical borderline threshold (HADS score ≥ 8). Post-intervention, anxiety scores in the intervention group decreased from the borderline range to the normal range, while depression scores, already below the threshold at baseline, showed further improvement within the normal range.

3.3. Effects of the intervention on quality of life

The global health status scores were comparable between both groups at baseline. For the intervention group, the scores were a mean of 55.4 (SD 17.3), while those of the control group were a mean of 54.8 (SD 16.9), with $p = 0.831$. After completing the twelve-week program, the intervention group demonstrated improvements in global health status and across various functional subscales, whereas the control group remained stable in all aspects. There was a significant increase in global health status scores in the intervention group, whose mean score improved from 55.4 (SD 17.3) to 63.9 (SD 16.1). This indicates a difference of about 8.5 points, which falls within the 5–10 point range recommended as a minimal important difference for the EORTC QLQ-C30 and is therefore consistent with a small-to-moderate clinically meaningful change. In contrast, the control group did not show any significant differences, with scores increasing from 54.8, SD 16.9, to 55.2, SD 17.4, within the same period. GEE confirmed a significant group-time interaction effect for global health status ($\beta = 8.62$, $SE = 1.61$, 95% CI: 5.47 to 11.77, $p < 0.001$).

As the five EORTC QLQ-C30 functional subscales were analysed in addition to the primary outcomes without formal correction for multiple comparisons, the subscale findings reported below are interpreted as exploratory. Of the functional subscales, the greatest gains were seen in those areas most directly affected by the group-oriented and expressive aspects of the dance intervention program. Emotional functioning had the largest gains, showing a score increase in the intervention group from 57.3 (SD = 19.8) to 66.4 (SD = 18.2) ($\beta = 9.14$, $SE = 1.88$, 95% CI: 5.45 to 12.83, $p < 0.001$), followed by social functioning, which improved from 58.1 (SD = 21.4) to 64.9 (SD = 19.7) ($\beta = 6.83$, $SE = 2.04$, 95% CI: 2.82 to 10.84, $p = 0.003$). A smaller but statistically significant improvement was also seen in role functioning, which improved from 59.7 (SD = 22.6) to 65.1 (SD = 21.3) ($\beta = 5.47$, $SE = 2.15$, 95% CI: 1.26 to 9.68, $p = 0.012$), with the magnitude of these three subscale improvements falling within or close to the lower bound of the 5–10 point MID range. Improvements in physical functioning ($\beta = 3.21$, $SE = 1.76$, 95% CI: -0.24 to 6.66, $p = 0.087$) and cognitive functioning ($\beta = 2.76$, $SE = 1.71$, 95% CI: -0.58 to 6.10, $p = 0.134$) did not reach statistical significance and remained below the lower bound of the MID range, consistent with the program's focus on expressive rather than physical or cognitive conditioning. Scores for each subscale are presented in **Table 3**, and the trend of improvement is shown in **Figure 3**.

Table 3. EORTC QLQ-C30 scores at baseline and post-intervention.

Scale	Intervention		Control		β	SE	95% CI	p value
	Baseline mean (SD)	Post mean (SD)	Baseline mean (SD)	Post mean (SD)				
Global Health Status	55.4 (17.3)	63.9 (16.1)	54.8 (16.9)	55.2 (17.4)	8.62	1.61	5.47 to 11.77	< 0.001
Physical Functioning	68.2 (18.4)	71.4 (17.6)	67.5 (19.1)	67.1 (18.8)	3.21	1.76	-0.24 to 6.66	0.087
Role Functioning	59.7 (22.6)	65.1 (21.3)	58.9 (23.1)	58.4 (22.7)	5.47	2.15	1.26 to 9.68	0.012
Emotional Functioning	57.3 (19.8)	66.4 (18.2)	56.8 (20.3)	57.1 (19.9)	9.14	1.88	5.45 to 12.83	< 0.001
Cognitive Functioning	66.4 (17.9)	69.2 (17.1)	65.8 (18.4)	65.4 (18.1)	2.76	1.71	-0.58 to 6.10	0.134
Social Functioning	58.1 (21.4)	64.9 (19.7)	57.6 (22.1)	57.9 (21.8)	6.83	2.04	2.82 to 10.84	0.003

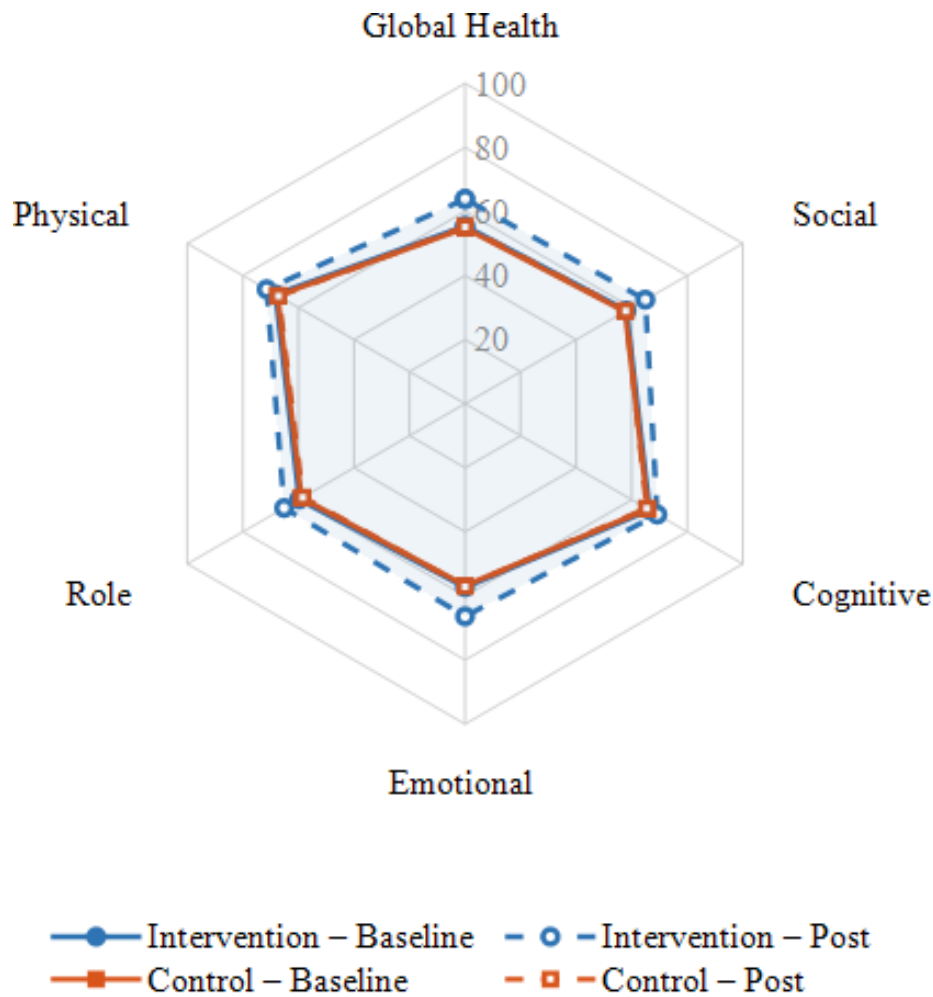


Figure 3. EORTC QLQ-C30 functional scores at baseline and post-intervention by group.

3.4. Effects of the intervention on perceived stress

At baseline, both groups' PSS-10 scores fell within the moderate range of stress (14-26), with no significant intergroup differences (intervention group: $M = 22.7$, $SD = 5.1$; control group: $M = 23.1$, $SD = 4.9$; $p = 0.621$). For the intervention group, a reduction to a mean of 19.3 ($SD = 4.8$) was observed post-intervention, a reduction of 3.4 points but still within the moderate range, albeit significantly further away from the upper end of this range than at baseline. For the control group, a small increase to 23.6 ($SD = 5.2$) was observed, also within the moderate range but showing a small tendency towards increased levels of perceived stress. GEE revealed a statistically significant interaction between group and time ($\beta = -3.47$, $SE = 0.72$, 95% CI -4.89 to -2.05, $p < 0.001$), corresponding to a moderate effect size (Cohen's $d = 0.51$). Moreover, the mean in the intervention group remained above 14, which is the low and moderate threshold, indicating that despite a statistically robust reduction, participants had not transitioned into the low stress category at the end of the twelve-week intervention. The trend in PSS-10 scores for both groups at both assessment points is shown in **Figure 4**.

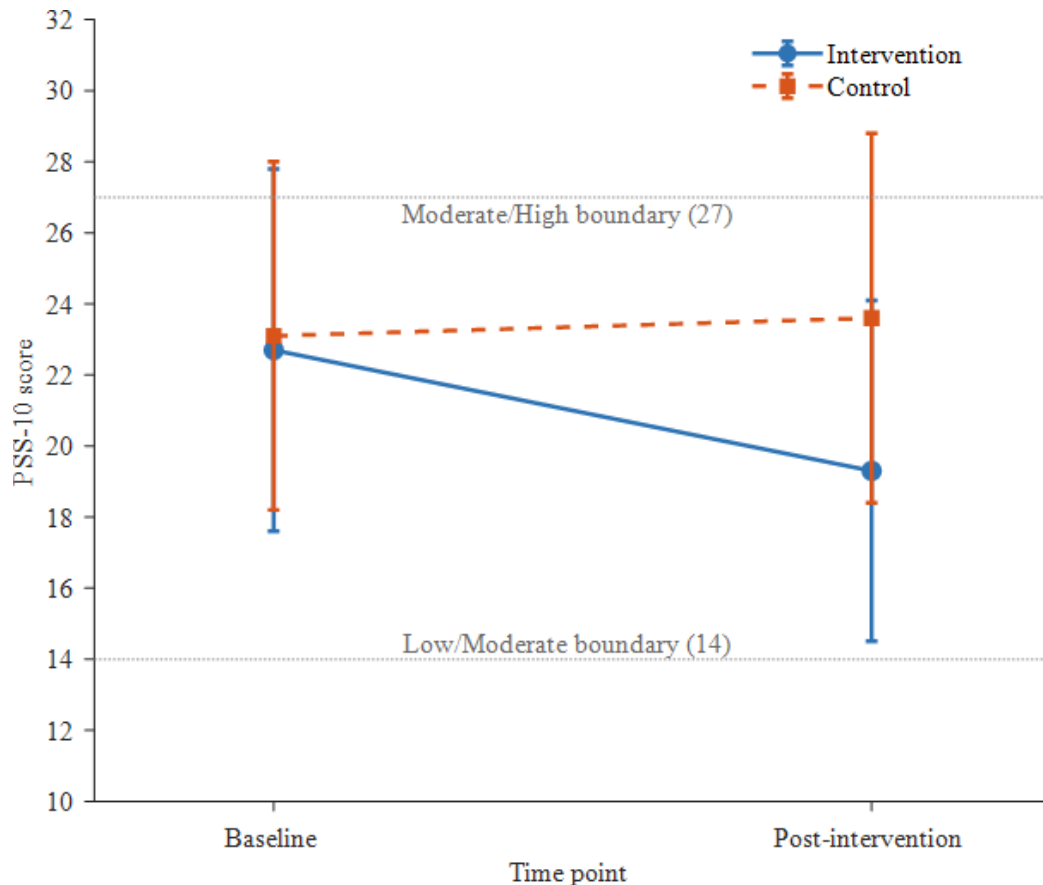


Figure 4. Perceived stress scores over time by group.

3.5. Sensitivity Analyses

To examine the robustness of the primary findings to attrition, complete-case analyses (restricted to participants with both baseline and post-intervention assessments, $n = 118$) and per-protocol analyses, which included intervention participants who attended at least 80% of sessions ($n = 59$) and control participants who completed both baseline and post-intervention assessments ($n = 57$), for a total sample of 116 participants. Control participants were not subject to the attendance criterion and were included based on having complete outcome data. were conducted alongside the intention-to-treat (ITT) analyses described above. Across all four primary outcomes, the direction, statistical significance, and approximate magnitude of the group $\times$ time interaction effects were consistent across the three analytic approaches, with all interactions remaining statistically significant at $p < 0.001$. For HADS-A, the per-protocol estimate was $\beta = -2.35$ (95% CI: -3.31 to -1.40) and the complete-case estimate was $\beta = -2.20$ (95% CI: -3.15 to -1.26), compared with the ITT estimate of $\beta = -2.14$ (95% CI: -3.02 to -1.26); for HADS-D, the corresponding per-protocol and complete-case estimates were -2.06 (95% CI: -2.97 to -1.15) and -1.93 (95% CI: -2.83 to -1.02); for EORTC QLQ-C30 Global Health status, $+9.48$ (95% CI: 6.07 to 12.89) and $+8.88$ (95% CI: 5.50 to 12.26); and for PSS-10, -3.82 (95% CI: -5.35 to -2.28) and -3.57 (95% CI: -5.10 to -2.05). The slightly larger effects observed in the per-protocol analysis are consistent with a dose-response pattern in which participants attending a greater proportion of sessions derived modestly larger benefits, while the close agreement between ITT and complete-case estimates supports the robustness of the findings to the level of attrition observed. Full numerical results are summarised in **Table 4**.

Table 4. Sensitivity analyses of group $\times$ time interaction effects on primary outcomes.

Outcome	Analysis (n)	β (95% CI)	ITT β (95% CI)	Comparison to ITT	p
HADS-A	CC (118)	-2.20 (-3.15, -1.26)	-2.14 (-3.02, -1.26)	Within 3% of ITT	< 0.001
	PP (116)	-2.35 (-3.31, -1.40)	-2.14 (-3.02, -1.26)	~10% larger than ITT	< 0.001
HADS-D	CC (118)	-1.93 (-2.83, -1.02)	-1.87 (-2.71, -1.03)	Within 3% of ITT	< 0.001
	PP (116)	-2.06 (-2.97, -1.15)	-1.87 (-2.71, -1.03)	~10% larger than ITT	< 0.001
GH	CC (118)	8.88 (5.50, 12.26)	8.62 (5.47, 11.77)	Within 3% of ITT	< 0.001
	PP (116)	9.48 (6.07, 12.89)	8.62 (5.47, 11.77)	~10% larger than ITT	< 0.001
PSS-10	CC (118)	-3.57 (-5.10, -2.05)	-3.47 (-4.89, -2.05)	Within 3% of ITT	< 0.001
	PP (116)	-3.82 (-5.35, -2.28)	-3.47 (-4.89, -2.05)	~10% larger than ITT	< 0.001

Note. Per-protocol analysis included intervention participants who attended $\geq 80\%$ of scheduled sessions and completed the post-intervention assessment (n = 59), together with control participants who completed the post-intervention assessment (n = 57), resulting in a total sample of 116 participants.

4. Discussion

This study found that a 12-week structured dance course was associated with significant improvements in anxiety, depression, health-related quality of life, and perceived stress in cancer patients undergoing or having recently completed active treatment, compared with standard care alone.

Why did HADS-A and HADS-D drop in the intervention arm? Prior work points to a combination of physiological and social pathways involved in group rhythmic movement. Moving in time to music has been reported to engage the endogenous opioid system and to modulate dopaminergic and serotonergic signalling, both of which feature in models of low mood and anxious arousal [23, 24]. Synchronous exertion in particular appears to raise endorphin levels above what is seen with non-synchronous activity of comparable intensity [25]. These pathways are plausible candidates for what was observed in this study, but they remain candidates only: blood biomarkers, autonomic indices, and neurotransmitter measures were not collected, so the mechanistic links above are imported from the literature and should not be read as a finding of the present trial. Cancer patients often experience social isolation and impairment in social networks due to diagnosis and treatment [26, 27]. However, the group-based intervention may have offset these tendencies by providing a sense of community and social support that is often diminished in cancer patients [28]. Social mechanisms have been identified as important mechanisms through which group physical activity reduces emotional distress in oncology patients [29]. The mild-to-moderate effect sizes for anxiety ($d = 0.47$) and depression ($d = 0.43$) are consistent with ranges reported for mind-body interventions in cancer patients [20]. Indeed, mind-body exercises have been identified as one of the most effective interventions in reducing anxiety and depression in cancer patients [21]. Dance has been identified as one of the most effective forms of exercise in reducing depression in cancer patients [12].

The significant improvement observed in the EORTC QLQ-C30 Global Health status, which fell within the 5–10 point range recommended as a minimal important difference [12], along with improvements in the emotional, social, and role functioning subscales, is consistent with a clinically meaningful quality-of-life benefit

associated with the intervention. Comparable improvements in the emotional and social subscales have been reported in previous dance-based interventions, particularly among breast cancer patient population [29], with significant improvements observed in the domains of emotional and social well-being despite the attenuated improvements in physical capacity. Similar improvements in fatigue and quality of life have been reported with community-based dance interventions in cancer patients [13]. Mind-body interventions have been demonstrated to reliably improve quality of life in cancer patients regardless of cancer type [24]. The absence of significant improvements in the physical and cognitive subscales may also be explained by the study design rationale for the current study, as the dance-based intervention was designed as a psychological rehabilitation tool and not a physical training program. Additionally, 12 weeks may be insufficient to elicit changes in domains more closely tied to physical capacity. Similar findings have been reported with home-based dance programs for breast cancer patients, where improvements in quality of life outcomes were observed alongside attenuated gains in physical capacity [25]. The group-based format of the current study may also have contributed to the improvements observed in the quality-of-life domains by the enhanced perceived social support and self-efficacy experienced by the patients with cancer [26], as these are well-established mediators of quality of life in cancer patients [6].

The perceived stress level in the intervention group also decreased: it dropped by 3.4 points on the PSS-10, while there was almost no change in the control group. For patients within the moderate-stress range of the scale, a shift of this size is clinically meaningful. Previous dance-based studies have suggested that such reductions are related to both psychological mechanisms (greater acceptance of illness, a renewed sense of personal resources) and physiological mechanisms (parasympathetic activation through rhythmic entrainment) [23]. Exercise has been associated with changes in autonomic nervous system reactivity and reductions in physiological stress in cancer patients [27, 28]. Autonomic balance, cortisol output, and related indicators were not measured in the present study; the explanation is therefore interpretive rather than demonstrated in the data. Dance and mind-body interventions have also been found to reduce perceived stress in cancer patients undergoing active treatment [11, 23].

These findings are different from the results of the previous Cochrane review on the efficacy of dance/movement therapy for cancer patients, which concluded that there is insufficient evidence to suggest that this therapy has a significant impact on depression, anxiety, or stress [12]. This difference may be attributed to two factors: first, the Cochrane review was based on the limited evidence available at that time; second, the review evaluated dance/movement psychotherapy delivered by professionals, while the present study used a structured dance course led by qualified instructors, which does not require specialized therapeutic credentials. This format may enhance clinical accessibility, in line with guidelines that increasingly support the role of group physical activity within supportive cancer care [5]. The session attendance rate was as high as 87.0%, and the dropout rate was comparable to those in similar studies [10, 13], indicating the feasibility of this modality.

A number of limitations should be highlighted. The quasi-experimental design does not allow making any cause-and-effect conclusions, and lack of allocation concealment may result in possible performance and detection biases. Allocation based on the clinic's visit schedule can, theoretically, lead to the creation of systematic differences between groups regarding the treatment timing, disease state, or

motivation which have not been controlled for in baseline variables, and unmeasured confounding is therefore possible. In addition, while the control group received standard care only, the intervention group received physical activities, music, social interactions, instructor attention, and group support concurrently, hence the current study is unable to determine whether the obtained positive results are caused by specific effects of dance or by nonspecific effects of attention, socialization, music, or physical activity. The above mentioned mechanisms underlying the effect of dancing have not been tested, hence they should be considered only as hypotheses supported by previous research. While attrition was mainly determined by the deteriorated health state of patients, the sensitivity analysis showed similar findings to intention-to-treat, yet the possibility of non-random missingness due to disease progression cannot be totally ruled out. The current study had a single center sample, including different types of cancer, which might decrease generalizability [22, 24], and lack of follow-up did not allow assessing the sustainability of results [9, 13].

Future studies should include an attention-matched control condition of equal attention, duration, and social structure—such as a supervised exercise programme or another group activity—to establish the unique effect of dance. Multi-centre randomized clinical trials utilizing attention-matched active control groups, stratification by cancer type, longer intervention durations, direct assessment of putative biological and autonomic mechanisms, and long-term follow-up assessments would strengthen the evidence base and inform the optimization of dance-based programming in oncological psychological rehabilitation.

5. Conclusion

The results of this study show that involvement in a 12-week structured group dancing program was associated with improvements in anxiety, depression, health-related quality of life, and perceived stress of cancer patients undergoing or having recently completed active treatment. The effect sizes are mild to moderate and are in line with other effect sizes from the literature on mind–body treatments in similar populations. The high attendance and low attrition rates in the study are consistent with those found in other similar interventions. The results of this study are in line with other existing literature postulating that the combination of rhythmic group movements, music and social interactions might be responsible for achieving psychological effects, but these assumptions have not been tested in this study and need further research. Given the quasi-experimental design, the single-center recruitment, and the use of a usual care comparison group in the study, the results should be considered preliminary. The structured dancing programs can be seen as a feasible complement to usual cancer treatment, pending confirmation in multi-center randomized controlled trials using attention-matched active control groups, long-term follow-up, and direct measurement of putative biological mechanisms.

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