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Evaluating the Impact of Tai Chi and Baduanjin on Cancer-Related Fatigue: A Meta-Analysis

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INTRODUCTION

Review question / Objective This study aims to systematically evaluate the impact of these two types of exercises on CRF through a meta-analysis, to clarify the effects of Tai Chi and Baduanjin on alleviating CRF in cancer patients, and to provide a scientific basis for clinical application.

Rationale Related studies have shown that breast cancer survivors with fatigue exhibit elevated markers of pro-inflammatory cytokine activity and increased numbers of circulating T lymphocytes. Subsequent research has revealed that the hypothalamic-pituitary-adrenal (HPA) axis reactivity is dysregulated in breast cancer patients with fatigue, providing preliminary evidence that HPA axis dysfunction is associated with the behavioral symptoms experienced by cancer patients. Elevated inflammatory biomarkers (e.g., interleukin-6) have been found to play a role in the development of fatigue and other severe

symptoms during chemotherapy in colorectal and esophageal cancer patients. Research has shown that in breast cancer patients undergoing 12 weeks of Tai Chi intervention, the inflammatory cytokines interleukin-1 (IL-1), interleukin-6 (IL-6), and tumor necrosis factor- α (TNF- α) were significantly reduced, effectively alleviating cancer-related fatigue and improving quality of life. Aerobic exercise has been shown to increase the secretion of anti-inflammatory cytokines such as IL-10, IL-6, CD36, and Arginase-1 from skeletal muscle and white blood cells, increase the number of M2 macrophages, activate insulin-sensitive signaling, and promote fatty acid metabolism, thereby improving insulin resistance and regulating the body's metabolism. In October 2016, the Central Committee of the Communist Party of China and the State Council jointly issued the "Healthy China 2030" plan, which clearly stated that efforts should be made to vigorously support and promote the popularization of traditional sports such as Tai Chi and Qigong, build a sports prescription system that covers various populations, environments, and

physical conditions, and promote the development of a disease management model and health services that integrate sports and medicine, highlighting the important role of scientific fitness in enhancing health, preventing, and rehabilitating chronic diseases.

Condition being studied The National Comprehensive Cancer Network defines cancer-related fatigue (CRF) as a distressing, persistent, subjective sense of physical, emotional, and cognitive tiredness or exhaustion related to cancer or cancer treatment, which is not proportional to recent activity and interferes with usual functioning. CRF adversely affects patients' work, social interactions, emotional states, and daily activities, severely compromising their quality of life during and after treatment. It may prevent some patients from undergoing normal treatment and can even shorten survival time. CRF is one of the most troubling symptoms in cancer patients, characterized by persistent fatigue lasting at least two weeks, often accompanied by cognitive dysfunction and low mood, which significantly impacts daily life.

Currently, it is reasonable to encourage all patients to engage in moderate physical activity during and after cancer treatment. Some interventional studies have shown that cancer patients who engage in at least 3 to 5 hours of moderate activity per week may achieve better outcomes with fewer side effects, including fatigue. Traditional Chinese exercises, as a core element of traditional Chinese medicine culture, have demonstrated significant efficacy in disease prevention. Specifically, they can effectively improve hypertension symptoms, optimize the respiratory function of patients with chronic obstructive pulmonary disease (COPD), enhance sleep quality, and play a positive role in alleviating anxiety, providing a unique perspective and practical approach for disease prevention and intervention from traditional Chinese medicine. Chinese Tai Chi, characterized by the integration of movement and stillness as well as internal and external harmony, is increasingly being applied in the rehabilitation treatment of the elderly and has been listed as one of the aerobic exercise therapies suitable for long-term adherence in domestic and international rehabilitation guidelines.

METHODS

Search strategy BaDuanJin, Tai Chi, TaiJiQuan, WuQinXi, YiJinJing, Aerobic Exercise, Neoplasm, Cancer-related Fatigue, Tumor, CRF”.

Participant or population Cancer patients (regardless of gender, race, nationality, or type of cancer).

Intervention Tai Chi and Baduanjin.

Comparator Baduanjin and Tai Chi compared with conventional care and other forms of exercise.

Study designs to be included The statistical analyses were conducted using RevMan 5.4 and Stata-MP17 software. The functions of RevMan 5.4 include the calculation of pooled effect sizes, generation of forest plots and funnel plots, subgroup analyses, and assessment of literature quality. The functions of Stata-MP17 include meta-regression and sensitivity analyses.

Eligibility criteria

Inclusion Criteria. Study Type: Randomized controlled trials (RCTs) only, with the intervention group receiving traditional Chinese exercises (primarily Baduanjin and Tai Chi), and the control group receiving conventional care activities for cancer patients without additional specific exercise interventions.

Participants: Adult cancer survivors undergoing treatment or post-treatment, with no other relevant psychiatric disorders. No restrictions on gender, race, nationality, or type of cancer.

Language: Articles published in Chinese or English.

Outcome Measures: Scales reflecting cancer-related fatigue.

Exclusion Criteria Duplicate publications, conference abstracts, reviews, guidelines, and articles without accessible full-text data.

Intervention groups that used combined exercise interventions or did not apply traditional Chinese exercises on the basis of conventional care activities.

Completely irrelevant articles and animal studies.

Articles with low quality.

Articles related to other diseases.

Articles where the outcome measures were not expressed as mean \pm standard deviation.

Information sources The following databases were utilized in this study: China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform, VIP Chinese Science and Technology Journal Database, Web of Science, PubMed, and EBSCO.

Main outcome(s) The scales reflecting cancer-related fatigue include the Brief Fatigue Inventory (BFI), Piper Fatigue Scale-12, Fatigue Questionnaire, Fatigue Symptom Inventory,

Functional Assessment of Cancer Therapy-Fatigue (FACT-F) , and Multidimensional Fatigue Inventory-20 .

Quality assessment / Risk of bias analysis The quality of the selected studies was assessed using the Cochrane Risk of Bias tool, which evaluates six domains: random sequence generation (1 point), allocation concealment (1 point), blinding of participants and personnel (1 point), completeness of outcome data (1 point), selective reporting (1 point), and other sources of bias (1 point). For statistical purposes, the quality assessment was categorized as follows: studies with 5 or more points were classified as having low risk of bias; those with 3 to 4 points were considered to have moderate risk of bias; and those with fewer than 3 points were deemed to have high risk of bias. In cases of disagreement during the assessment, a third researcher was consulted to make the final decision.

Among the 16 included studies, none were found to have high risk of bias. Specifically, seven studies were classified as having low risk of bias, while the remaining nine were categorized as having moderate risk of bias. Low and moderate risk of bias were denoted by “+,” unknown risk of bias by “?” and high risk of bias by “-.” Figure 4 presents a summary plot of the included studies, showing the specific item ratings for each study. It can be observed that the proportions of studies with adequate random sequence generation, allocation concealment, completeness of outcome data, selective reporting, and other biases all exceeded 50%, with selective reporting and other biases reaching 100%. This indicates that the overall quality of the included studies was high.

Strategy of data synthesis A total of 16 effect size indicators from Tai Chi and Baduanjin interventions for cancer-related fatigue (CRF) were included, involving 1,176 cancer patients. The meta-analysis revealed significant heterogeneity ($I^2 = 75\%$, $P < 0.00001$), prompting the use of a random-effects model. Given the inconsistent units of fatigue scales across studies, the standardized mean difference (SMD) was employed to calculate the pooled statistic. The overall SMD was -1.09, with a 95% confidence interval of [-1.35, -0.84], indicating that the intervention group significantly outperformed the control group in alleviating CRF. This suggests that both Tai Chi and Baduanjin are effective in mitigating CRF in cancer patients.

Subgroup analysis Subgroup analyses revealed that training interventions lasting 3, 4, and 6 months all demonstrated statistically significant effects. The 3-month training period exhibited the

largest absolute value of SMD (-1.12), indicating the most pronounced improvement in the intervention group compared with the control group. However, the 6-month training period, characterized by low heterogeneity, may provide more stable and reliable evidence of effect.

Regarding the frequency of weekly interventions, training sessions occurring ≥ 5 times per week and 2 to 4 times per week both yielded statistically significant results, with ≥ 5 times per week showing a more substantial effect, while 2 to 4 times per week demonstrated greater consistency and reliability.

In terms of daily intervention frequency, twice-daily training sessions were found to be the most effective, whereas once-daily sessions provided more reliable results.

As for the duration of each intervention session, a 40-minute training session was associated with the best outcomes, whereas sessions lasting between 20 and 40 minutes provided more reliable evidence of effect.

In summary, a training intervention consisting of a 3-month duration, with sessions occurring at least 5 days per week, twice daily, and lasting 40 minutes each, appears to be the most effective regimen for alleviating fatigue in cancer patients.

Sensitivity analysis Given the high heterogeneity ($I^2 = 75\%$) in the studies, a sensitivity analysis was conducted by sequentially excluding individual studies to identify potential sources of heterogeneity. The results showed a significant reduction in heterogeneity ($I^2 = 33\%$, $P = 0.11$) when the studies by Yang Liu et al. (2022) and Zhu Jiying et al. (2022) were excluded. Upon further examination, no significant differences were found in the basic patient characteristics or the intervention protocols of traditional exercises in these two studies compared with other studies. Moreover, although the pooled effect size slightly decreased after excluding these studies, the results remained statistically significant ($P < 0.00001$), indicating that these studies should be included in the meta-analysis.

To assess publication bias, both funnel plots and Egger's test were used for qualitative and quantitative analyses of the various scale scores. The results of Egger's test showed no significant publication bias for fatigue scores ($P = 0.147 > 0.05$), and the funnel plot distribution was symmetrical, indicating that the included studies were free from significant publication bias and the results were stable.

Country(ies) involved China.

Keywords Tai Chi; Baduanjin; Cancer-Related Fatigue; CRF; Meta-Analysis.

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