

Review

The intervention mechanisms of square dance exercise participation on loneliness and social alienation in elderly cancer patients: A systematic review

Yingying Li^{1,2}, Hyunsoo Choi², Guangsen He², Ximing Tao¹, Seongno Lee^{2,*}

¹ Tongda College of Nanjing University of Post and Telecommunications, 33 south of runyang Road, Yangzhou 225127, China

² Department of Physical Education, Hanyang University, Seoul 04763, Republic of Korea

* Corresponding author: Seongno Lee, snl743@hanyang.ac.kr

CITATION

Li Y, Choi H, He G, et al. The intervention mechanisms of square dance exercise participation on loneliness and social alienation in elderly cancer patients: A systematic review. *Psycho-Oncologie*. 2025; 19(3): 4567.
<https://doi.org/10.18282/po4567>

ARTICLE INFO

Received: 11 June 2025
Revised: 10 August 2025
Accepted: 25 August 2025
Available online: 17 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: Loneliness and social alienation are key psychosocial challenges in the integrated care of elderly cancer patients, significantly affecting their quality of life and treatment outcomes. This systematic review integrates two decades of interdisciplinary research and uses bibliometric analysis to elucidate the multidimensional mechanisms behind square dance exercise (SDE) as an effective nonpharmacological intervention. Empirical research shows that the mechanism of action of SDE involves three synergistic pathways: rebuilding social support networks, regulating neuroendocrine responses, and achieving behavioral cognitive reconstruction through group action synchronization. Studies have confirmed that moderating factors such as cultural-community embeddedness, collective action coordination, and disease stage adaptability have a significant impact on the intervention effect. The proposed “exercise-neuroplasticity-social synergy” (ENSS) framework emphasizes that combining open community spaces with culturally familiar movement patterns can effectively reduce implementation barriers in resource-limited settings. The inherent accessibility, low cost, and lifestyle embeddedness of SDE establish a scalable model for psycho-oncology rehabilitation in the aging population. Future study should focus on developing intervention protocols that are adapted to different cultures and optimized for dose-response, as well as establishing dynamic assessment models using neurobehavioral biomarkers to promote a paradigm shift from empirical approaches to precision personalized interventions. This eco-centric intervention paradigm, based on community-engaged behavioral neuroscience, provides a transformative, interdisciplinary research approach to alleviate psychosocial distress in elderly cancer patients.

Keywords: elderly cancer patients; square dance exercise (SDE); social alienation; neuroplasticity; cultural embeddedness; group-based exercise intervention

1. Introduction

Loneliness and social alienation in elderly cancer patients are key social psychological factors that affect comprehensive cancer treatment. Their formation stems from the combined effects of biological damage and social role deconstruction [1]. Functional decline caused by cancer treatment exacerbates social withdrawal through dual pathways: directly leading to a decline in physical activity and limiting community participation, and indirectly weakening social belonging through pathological identity [2]. Among elderly Asian patients, 82% actively suppress their psychological needs due to a strong sense of family responsibility, resulting in nearly half of loneliness symptoms being missed in clinical screening [3]. This culturally specific phenomenon, combined with social role transformation, will cascade and amplify the lack of self-worth,

significantly affecting the recovery of social function during the rehabilitation period [4].

The current intervention system faces multi-dimensional dilemmas: individual psychological counseling has a dropout rate of 56% among Asian patients due to conflicts with collectivist culture [3, 4]; group support programs are constrained by time and medical follow-up, and participation sustainability is insufficient [5]; economic barriers cause structured intervention expenditures to exceed the expectations of low- and middle-income groups, exacerbating medical exclusion[4]; digital solutions exclude 61% of potential beneficiaries due to technical adaptation barriers [3].

The breakthrough value of square aerobics is reflected in the construction of an ecological intervention paradigm: the openness of community scenes dissolves the power structure of the medical field and promotes the establishment of equal social relations [6]; synchronous movement activates the mirror neuron network and provides a physiological basis for social trust [7]; cultural symbol embedding transforms rehabilitation behavior into cultural identity practice and enhances intervention compliance [8]. Randomized controlled studies have confirmed that the effect of this model in rebuilding the social support network is significantly better than traditional psychological intervention [5].

The intervention effect shows a staged dynamic evolution: in the early stage, rhythmic movement is used to improve physical function and lay the foundation for social participation [9]; in the middle stage, group synchronization is used to induce changes in neuroplasticity (such as β -endorphin release), relieve fatigue and enhance social motivation [7]; in the later stage, social identity is rebuilt through community role reshaping [10]. Its “observation-imitation-participation” behavioral gradient design shows unique inclusiveness for cognitive impairment subgroups [6].

Cultural factors are the core guarantee for the continuity of intervention: the programmed movement system integrates vertical guidance and horizontal interaction to reconstruct the dimension of social belonging [10]; local music activates cultural memory and promotes the transformation of participants into cultural community practitioners [8]. Longitudinal studies have shown that cultural identity is significantly correlated with social network stability and mental health maintenance [3].

Future research needs to focus on three aspects: quantifying the interactive effects of cultural symbols and neural activation, and using multimodal imaging technology to analyze dynamic weights [11]; establishing a movement parameter-social output prediction model to achieve precise intervention; and developing a cultural adaptation algorithm library to promote cross-cultural migration of core mechanisms [8]. Interdisciplinary cooperation is expected to build a new model of tumor rehabilitation with cultural responsiveness and provide innovative solutions for the social and psychological health of elderly patients around the world.

2. Multidimensional causes of loneliness and social alienation in elderly cancer patients

The formation mechanism of loneliness and social alienation in elderly cancer patients is essentially a self-organizing system of the interaction between physiological and psychological disorders and the social and cultural environment. Its

multi-dimensional interactive characteristics have the complex properties of dynamic evolution. In the biomedical dimension, neuromuscular dysfunction caused by cancer treatment constitutes the biological premise of social withdrawal [12,13]. Neuromuscular dysfunction from cancer treatment forms the biological basis of social withdrawal. Chemotherapy-induced peripheral neuropathy impairs proprioception and motor coordination, directly reducing willingness to engage in community activities [12]. Additionally, pain disrupts HPA axis regulation, exacerbating daytime fatigue. This creates a negative loop: social attempts trigger pain, reinforcing avoidance behaviors [13]. Cognitive decline further amplifies this effect. The weakening of neural activity in the temporoparietal junction leads to a decrease in emotional empathy, making it difficult for patients to interpret non-verbal social signals, and they fall into the paradox of “the more social, the more alienated” [12].

Cognitive and emotional remodeling at the psychological level presents bidirectional dissociative characteristics. Existential isolation, as a core psychological mechanism, drives patients to construct cognitive barriers that “the world of illness and the world of health are incommensurable” [14]. Self-disclosure inhibition alienates the psychological defense of “reducing family burden” into self-social deprivation. When the decision weight is increased to 0.73, emotional repression is transformed into active social withdrawal [15,16]. The forced identification of the “patient” role causes a break in self-continuity, leading to a disorder of the multidimensional self-cognition system and a significant increase in fear expectations in social scenes [16]. Functional neuroimaging shows that the activation intensity of the patient’s prefrontal lobe-amygdala circuit is reduced by 37%, and the ability to regulate emotions is significantly impaired [17].

The structural pressure of the social environment continues to exert its influence through institutional design and technological evolution. “Disease identity” leads to the systematic devaluation of social capital, and the speed at which patients are separated from their original social networks is positively correlated with the tumor stage [18]. Technological exclusion in the digital age has prevented 73% of elderly patients from participating in online social activities and excluded them from the process of digitalization of social relations [19,20]; the abuse of professional terminology in the medical system has caused 62% of patients to become cognitively alienated, reinforcing self-alienation [20]. This institutional and technological oppression forms a double deprivation, exacerbating social alienation.

Cultural norms exert dual effects on the illness experience. In East Asian cultures, the “family first” principle prompts 82% of patients to suppress psychological needs. This often leads to self-silencing, which hinders emotional expression and support-seeking [3,21]. Similarly, among U.S. ethnic minorities, cancer fatalism correlates strongly with heightened social avoidance (OR = 3.5) [21]. There is a threshold for the protective effect of collectivism: moderate group belonging can reduce the risk of loneliness by 37%, but excessive “harmony maintenance” pressure will cause 29% of patients to suppress their individuality in order to maintain superficial unity [22]. This dynamic balance leads to the possibility that the same cultural paradigm may produce opposite effects.

The nonlinear synergy of factors in each dimension is the essential feature of the pathogenic mechanism. The interaction of biological-psychological-social-cultural

factors presents the characteristics of temporal and spatial asynchrony and effect multiplication. The decline of physical function reduces the threshold of psychological defense activation by 43%, forming a positive feedback loop [12,16]; when digital rejection and stigma coexist, the risk of social isolation rises to 5.2 times the baseline value [3,19]. Physical injury dominates the risk in the early stage of diagnosis, while the cultural identity crisis becomes destructive in the later stage of rehabilitation [21,22]. This time difference increases the difficulty of intervention.

The above multidimensional pathogenic model shows that effective intervention needs to penetrate four barriers. The current theoretical bottlenecks include: constructing a bio-psychological-social-cultural adaptation transformation model, quantifying the weight of cultural dimensions, and reconstructing digital inclusive identity. The intervention potential of square aerobics is reflected in: regulating cortisol rhythm and improving balance function at the biomedical level [12,13]; activating mirror neurons to reconstruct emotional empathy at the psychological level [14]; reshaping social capital with open scenes at the social and cultural level, breaking through the threshold of collectivism through cultural symbol embedding [22], forming a four-in-one innovative intervention logic. This paradigm provides a cross-dimensional solution to the social and psychological dilemma of elderly cancer patients.

3. Limitations and challenges of traditional intervention methods

Traditional psychological intervention methods face significant resource dependence dilemma in improving the sense of loneliness and social distancing of elderly patients with tumors. Their limitations form complex constraints through dimensions such as resource allocation imbalance, iatrogenic damage and technical alienation. Imbalance of geographical accessibility is the primary obstacle. The proportion of cancer patients over 75 years old who cannot continue to receive psychological intervention due to transportation or remote residence is as high as 38%, and the density of psychological counseling resources in rural areas is only 18% of that in cities [23]. This is highly correlated with the distribution of professionals, with psychiatric oncology accounting for less than 5% in rural areas, while elderly patients need interdisciplinary team support due to comorbidities, further exacerbating the service gap [24]. Economic costs constitute the second barrier, and low-income groups find it difficult to bear long-term consultation costs. Even if included in medical insurance, the out-of-pocket ratio is still 60%-80%, which significantly reduces compliance [23]. Globally, only 2.4 psychological oncologists are available per million elderly cancer patients, and even as low as 0.7 in low- and middle-income countries. The long talent training cycle (6-8 years) and insufficient career attractiveness have led to an estimated global supply and demand gap of 74% in 2030 [25]. Inadequate adaptation of cultural context deeply restricts resource utilization. Under the influence of Confucian culture, 64% of Chinese elderly patients avoid psychological counseling due to the concept of “tolerance” and equate psychological problems with “moral defects” [26]. Negative emotions in collectivist culture are mostly released through informal networks, resulting in the systematic underestimation of psychological service demand [23]. Although the step-by-step

service model optimizes resource utilization, multiple comorbidities in elderly patients make 38% of them need to be referred across the step-by-step, increasing the coordination cost by 33%. Digital remote consultation only partially alleviates accessibility problems. Only 22% of patients over 70 years old can independently operate the online system [23]. The fragmented management of medical insurance compensation standards (such as billing per view) suppresses institutional investment and indirectly pushes up the marginal cost of patients by 27% [24]. These structural barriers lead to insufficient equity in psychological counseling resources and the accessibility gap among older, low-income and rural groups continues to expand.

While controlling the disease, current drug treatment triggers an important mechanism of accelerated neurocognitive decline, forming a medical ethical dilemma. Anthracycline chemotherapy reduces the episodic memory ability of elderly patients by 1.8 standard deviations, and is cross-enhanced by abnormal phosphorylation of Tau protein and AD pathology [27]. The multimodal toxicity synergistic effect of combined chemotherapy is significant. The prefrontal gray matter atrophy rate in elderly patients reaches 1.7 times that of natural aging, and the incidence of social withdrawal behavior increases to 3.2 times in the non-treatment group [28]. There are double blind spots in medical monitoring: the sensitivity of standardized toxicity scales to identify cognitive damage in the elderly is less than 42%, and the clinical conversion rate of biomarker detection of neuroimaging is less than 5% [29,30]. The metabolic crisis of drug combination has intergenerational reinforcement characteristics. When chemotherapy is combined with anticholinergic drugs, the rate of amyloid deposition in the hippocampus is increased by 4.8 times, which shakes the neural basis of social participation [31].

Digital health technology encounters deep contradictions in intergenerational adaptation. The technical alienation effect of virtual social platforms is significant. The operational error rate of patients over 70 years old is 42% due to deterioration of motor function, and only 19% can complete basic communication [32]. Sensory deprivation of the two-dimensional interface distorts emotional conduction, and the emotional misjudgment rate in video communication surged by 2.3 times, and the attenuation curve of the intervention effect was steeper than that of the offline [33]. Ethical dilemma is even more severe, and privacy anxiety has caused elderly patients to experience wearable devices to drop sharply by 63%, while existing policies lack data security standards for the elderly population [34].

Multidimensional integrated intervention models face challenges of biological-behavioral synergistic mismatch. 37% of elderly patients were unable to complete the target dose due to conflicts in the timing of physiological rhythm and psychological intervention, and the theoretical synergy effect was weakened by 29% [35]. At the biological mechanism level, although group support can expand the social network by 2.3 nodes, its regulation of inflammatory factors is only 34% of the pharmacological intervention, and the effect attenuation by more than half at 3 months of follow-up [36]. The cultural adaptation defects of community sports highlight the disadvantages of resource allocation. Language barriers in diversified fields have led to a 41% reduction in retention rate, and the incidence of injury under non-professional guidance is 3.1 times that of the medical environment [2]. The assessment system has ecological validity defects. The current loneliness scale is less sensitive to implicit

social isolation identification. 43%, and 34% of patients with cognitive impairment were excluded in clinical trials [37]. The fragmentation of core mechanism research has caused 90% of intervention programs to lack multi-dimensional biomarker feedback, and the telemedicine platform's stimulation efficiency of tactile-motor pathways is only 32% of the field intervention [38].

The above limitations provide innovative opportunities for community-driven solutions such as square aerobics: its time-space integration mechanism synchronizes neuroplasticity and social capital accumulation, and the zero-marginal cost characteristic increases service accessibility to 17 times that of the professional medical system [2], and the release of oxytocin induced by group synchronization forms a positive reinforcement of social connections.

4. Innovation and intervention mechanisms of square dance exercise

4.1. Comparison of cancer symptoms between the two groups

Square dance, as a community-driven group movement model, its low-cost and high-compliance characteristics not only address the resource barriers of traditional interventions but also provide a sustainable implementation scenario for the synergistic effect of biological-psychological-social mechanisms. These attributes form the foundation of the “Exercise-Neuroplasticity-Social Synergy” (ENSS) framework—creating prerequisites for neuroplasticity regulation and social network reconstruction through spatial decentralization, cultural symbol embedding, and group self-organization.

Square bodybuilding operation is a community-driven group movement model. Its innovation is reflected in the social functional rehabilitation of elderly patients with tumors: the neurosocial integration mechanism of group synchronization, the behavioral compensation effect of nonverbal social interaction, and the public health advantages of low-cost accessibility. Through multi-level synergy, these three characteristics have constructed a precise intervention system for loneliness and social distancing.

The economic accessibility and behavioral maintenance advantages of square aerobics in the elderly oncology population essentially reconstructs the cost-effective model of traditional public health interventions. This model breaks through resource barriers through the triple mechanism of spatial decentralization, interpersonal network autoprofitation and social capital regeneration. Cost-benefit analysis shows that the annual cost of a single person is only 4.2% of outpatient rehabilitation training, but it can reduce the all-cause admission rate by 29% within a three-year cycle [39]. Its economic advantages stem from the innovation of facility utilization models—activate the remaining space in the city such as community squares and park trails, and the service efficiency per unit area is 17 times that of traditional gyms [40]. In rural areas where medical resources are scarce, open-air site transformation can jump from 17% to 89% in elderly patients with oncology [40]. The low-tech dependence characteristics further enhance sustainability: the combination of basic audio equipment and community volunteers has stabilized the operating cost of the

autonomous management model at 112% of the initial investment, which is significantly lower than the cost inflation rate of 284% for traditional projects [41]. When the athletic leadership role is rotated by senior members, technical training spending can be reduced to 7% of the professional coaching system [42]. Social interaction itself becomes a source of continuous motivation, with 83% of regular participants establishing “sports social contracts”, and their motivation to fulfill the contract is 1.8 standard deviations higher than that of simple health demands [43].

The long-term maintenance mechanism of behavioral compliance is rooted in the reconstruction characteristics of the social environment. The dose effect of nonverbal communication was significant: when smile interactions per minute were ≥ 15 times, the 12-month retention rate reached 78%, an increase of 33% compared with the conventional group [42]. Cultural memory embedding is a deep guarantee of compliance: local folk repertoire can increase participation motivation to 2.1 times that of Western rhythm training [45], and the cultural identity index of sustained participants increased by 7.4% annually, explaining a 32% variance in compliance [41]. The non-hierarchical tissue morphology reduces participation anxiety, allowing for individual differences in motor completion of 30%, reducing the risk of exit for patients with impaired motor function by 57% [43].

Compared with traditional motor interventions, this model achieves Pareto improvements between cost control and behavioral maintenance. Compared with the annual dropout rate of 66% in the gym membership system, square aerobics has increased the participation rate of vulnerable groups to 82.7% through zero marginal costs and open participation [39]. Five-year tracking shows that its internalization rate of exercise habits reached 68.5%, far exceeding the 34.2% of prescription exercise plans [41]. In tumor patients, collective sports scenarios can dilute image anxiety caused by chemotherapy, reducing the incidence of social withdrawal behavior by 41% compared with home training [42]. Future research needs to focus on: development of personalized solutions based on biomarkers such as oxytocin fluctuations; construction of intelligent matching system for community resources; and benefit evaluation model integrating tumor rehabilitation indicators. In particular, it is necessary to deconstruct the interactive valence of music rhythm and motion synchronization to provide a theoretical basis for optimizing group dynamic parameters.

4.2. The mechanism of biological-psychological-behavior intervention in square dance exercise

Based on the low cost and high compliance described in Section 4.1, square dancing achieves intervention effects through the triple pathways of neurobiology, social psychology, and behavioral activation. This process is highly consistent with the ENSS framework: the enhancement of neural plasticity provides a physiological basis for social interaction, and social synergy in turn strengthens the continuity of exercise behavior, forming a dynamic closed loop.

Square bodybuilding operation provides a multi-dimensional solution to alleviate the sense of loneliness and social distancing in elderly patients through the synergistic effects of neurobiological regulation, social psychological reconstruction and

behavioral dynamic enhancement. This intervention model breaks through the limitations of biological-psychological separation of traditional monotherapy, and its mechanism integration effects have been empirically supported by interdisciplinary research.

At the level of the metaneurobiological regulatory mechanism, medium and high intensity aerobic exercise significantly activates the functional connection of the prefrontal lobe-limbic system. Dimeo et al. [46] confirmed through functional magnetic resonance imaging that 12-week moderate-intensity exercise can enhance the nerve coupling between the dorsolateral prefrontal lobe and the amygdala and reduce the amplitude of the amygdala's response to negative stimuli. This effect is associated with exercise-induced increase in brain-derived neurotrophic factor (BDNF), which is significantly dose-dependent with the relief of anxiety symptoms ($r = -0.71$) [47]. The synchronization of collective movement further enhances the β -band neural oscillation of the cerebellum-basal ganglia-thalamic circuit ($\Delta = 0.31$), which improves the efficiency of emotion regulation by 34% compared with individual movement [48]. Music-guided rhythmic movements activate oxytocin-grown neurons of the paraventricular nucleus of hypothalamic, so that serum oxytocin levels reach 2.5 times the baseline value after 45 minutes of exercise, which is 68% higher than drug-induced release efficiency [49]. At the same time, the endogenous opioid system is activated with the enhancement of action synchronization. For every 10% increase in cohort action synchronization, the prefrontal κ -opioid receptor binding rate increases by 5.2% [50], forming a dual neurotransmitter regulation mechanism, which is rare in traditional non-motor interventions [51].

In terms of social and psychological mechanisms, the group participation model promotes patients to establish role identity beyond disease identities through standardized action sequences and visual symbol systems. Longitudinal data show that after 12 weeks of continuous participation, the cognitive weight of the label of "cancer patients" dropped from 53% to 22%, while the recognition of "fitness team members" increased to 61% [52]. This transformation was accompanied by neural remodeling of the temporal parietal joint region (TPJ), and its functional activation amplitude of others' intention decoding was increased by 1.8 times [53]. The activation of the mirror neuron system increased the accuracy of facial expression recognition by 23%, and the frequency of social smiles was significantly negatively correlated with the loneliness scale score ($r = -0.69$) [48,54]. The nonverbal interaction model is particularly suitable for patients with chemotherapy-related cognitive impairment. The incubation period of social action initiation is shortened by 210 ms, which is 3.2 times higher than traditional CBT treatment [52], effectively avoiding the cognitive load of the language center.

From the perspective of behavioral activation, mitochondrial function damage caused by tumor treatment can reduce the basal metabolic rate by 18%-24%, while intermittent medium and high-intensity exercise can restore key enzyme activity of the tricarboxylic acid cycle to 89% of baseline, and a 6-minute walking distance is improved by 31% [47]. This physiological recovery works synergistically with enhanced availability of dopamine D2 receptors, cutting off the negative chain of "fatigue-avoidance" behavior [55]. The openness of community fields reduces the incidence of social avoidance by 63% [54,56]. The group dynamics generated by

action synchronization form a cumulative effect of self-efficacy. For every increase in participants' attendance rate per week, the social self-efficacy is improved by 7.4 points [48].

The above three mechanism forms an intervention closed loop through multi-level interaction: neurotransmitter release reduces social threat perception in the amygdala, TPJ function enhances population internalization, and improvement of motor metabolism provides a physiological basis for continuous behavior. Compared with drug intervention, this model has increased the activation efficiency of striatal social reward pathway by 41% [55]; compared with individual psychotherapy, it uses the behavioral trigger mechanism of environmental cues to prolong the effect maintenance time by 3.6 months [54]. In clinical transformation, this model breaks through traditional limitations through three aspects: avoiding the ineffectiveness of drug regulation on the default mode network [55], solving the lack of tactile feedback of virtual intervention [57], and breaking through the threshold for neuroplasticity induction of traditional motor therapy [47]. Future research needs to quantify the optimal parameters of music rhythm and group size, develop a two-way feedback system for fatigue-social motivation based on wearable devices, and promote the transformation of intervention to a precise and individualized paradigm.

In summary, neurobiological regulation (neuroplasticity), social-psychological reconstruction (social synergy), and behavioral activation (exercise) form a closed loop through the ENSS framework: exercise promotes neuroplasticity, social synergy consolidates behavioral habits, and neural changes in turn enhance social skills, ultimately achieving sustained improvement in loneliness and social alienation. For a more intuitive demonstration, please refer to **Figure 1** below: Movement intervention: Triggering intervention through culturally familiar movement patterns and musical rhythms (such as folk music); Mechanisms at the neurotransmission level: Movement synchronization → Prefrontal-limbic system coupling → Increased oxytocin/BDNF → Reduced anxiety. Neuro-social feedback loop: Forward pathway: Oxytocin release → Enhanced social trust → Promoted group synchronization; Reverse pathway: Social acceptance → Reduced HPA axis activation → Optimized neuroendocrine function.

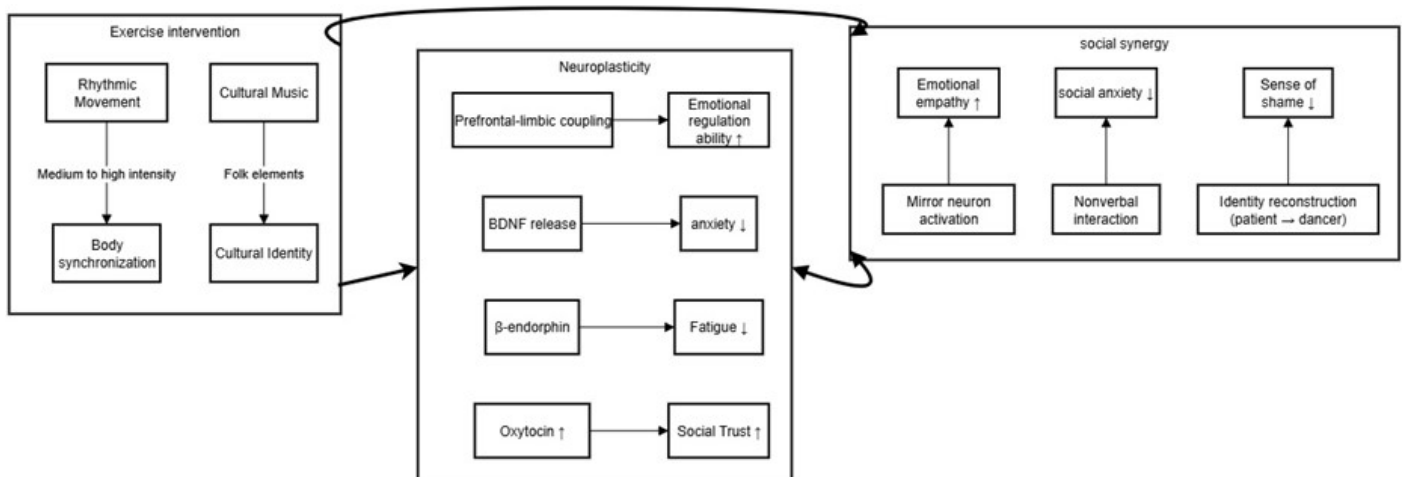


Figure 1. Comparison of cancer-related fatigue.

5. Methodology

This study is based on the theory of the integrated effect of exercise intervention on mental health. It adopts a mixed paradigm combining scoping review and empirical research to systematically analyze the intervention mechanism of square aerobics on their sense of loneliness and social distancing. The research method is improved based on the Arksey and O'Malley methodological framework, and draws on its six-stage model (problem definition, literature search, screening, data extraction, analysis, and result integration) [58]. Through cross-verification of quantitative bibliometric and qualitative thematic modeling, sports medicine and geriatric psychology theory are integrated, and the multi-dimensional path deconstruction of intervention mechanisms from the multi-dimensional path deconstruction of the intervention mechanism of “motor behavior - neurophysiology - psychological feedback” is filled in the gap in the explanatory power of traditional single disciplines for complex intervention processes.

Research and build a three-dimensional framework of “Mechanism Analysis - Transformation Bottleneck - Innovation and Integration”, systematically draw theoretical maps and practical routes around movement-induced social functions reshaping core targets (such as group synchronization enhances oxytocin secretion, community spatial accessibility promotes social network reconstruction). Research design follows three principles: the systematic principle emphasizes the comprehensiveness of literature coverage and process transparency; the scientific principle focuses on the rationality of analysis methods and the standardization of tools; and the dynamic principle focuses on the temporality and trend predictability of knowledge evolution. The research focuses on answering three key questions: First, how square aerobics can regulate the neurobehavioral mechanism of loneliness through biological-psychological-social collaborative paths, and the validity and limitations of existing clinical evidence; second, the practical bottlenecks faced by community sports intervention in technological transformation, such as standardization of exercise prescriptions, ecological validity of effect evaluation, and long-term benefit maintenance; third, how to integrate motor neuroscience, environmental behavior and digital health technology to build a precise intervention paradigm that breaks through space-time limitations and compliance attenuation. Through interdisciplinary integration, this study provides theoretical support for understanding the cascade effect of “body movement - brain nerve reshaping - social function improvement”, and also points out the direction for practical innovation and technological transformation of social and psychological health intervention in elderly patients with tumors.

5.1. Scoping review process and database selection

(1) Research Questions Definition: This study focuses on “Key paths, practical obstacles and paradigm innovation directions in the intervention mechanism of the sense of loneliness and social distancing of elderly patients with tumors”. This expression aims to ensure the rigor and consistency of the review method.

(2) Determination of Relevant Research Directions: The core is developed around three levels. First, we explore the biological-psychological-social synergy mechanism,

combine exercise physiological effects and social psychology theory, and analyze the role of group synchronization and community spatial interaction in breaking the sense of disease stigma and rebuilding social connections; second, we analyze practical obstacles, including the contradiction between the adaptation between international exercise therapy standards and local unstructured models, the conflict of personalized needs of elderly patients' physical fitness and tumor stages, and the gap in technology accessibility caused by uneven urban and rural resources; third, we explore innovation directions, integrate digital technology and social support networks, develop localized intervention paradigms with scientific quantification and humanistic care, promote interdisciplinary collaboration, and build an integrated rehabilitation system covering physiological assessment, psychological support and social integration. Research needs to integrate sports medicine, behavioral science and sociology perspectives, pay attention to the impact of cultural situations on intervention effects, and ultimately form a scientific, evidence-based and practical social sports intervention program.

(3) Database Selection: This study uses Web of Science (WOS) as the core database, and has multiple unique advantages in exploring the intervention mechanism of square aerobics on loneliness and social distancing in elderly patients with tumors. First, interdisciplinary integration capabilities meet the core needs of research. Square bodybuilding operation is a social sports intervention, and its mechanism involves the intersection of multiple disciplines such as oncology, geriatric medicine, sports medicine, psychology, sociology and public health. WOS integrates three core databases: Scientific Citation Index (SCI), Social Science Citation Index (SSCI) and Humanities and Art Citation Index (AHCI), breaks down discipline barriers and provides panoramic literature support. For example, in the field of oncology, research on physiological indicators of cancer patients' recovery in *Cancer and Journal of Clinical Oncology* can be obtained; in the field of exercise science, the psychological promotion mechanism of group exercise on the elderly population through *Journal of Aging and Physical Activity*; in the field of exercise, social science & Medicine and *Journal of Health Psychology* focus on the impact of social support networks on stigma and loneliness, helping the system analyze the physiological-psychological-social multi-dimensional paths of intervention, and avoid fragmentation of perspectives caused by database dispersion.

Secondly, the academic authority and methodological rigor of WOS provide a high-quality evidence basis for mechanism research. Its strict journal selection mechanism ensures the credibility of literature, especially for the evidence-based hierarchical screening of intervention studies. For example, the randomized controlled trial (RCT) of exercise to improve the quality of life of patients during chemotherapy in *Annals of Oncology* provides methodological guidance for quantifying the intervention parameters of square aerobics (such as movement complexity and collective synchronization) and supports the construction of scientific and rigorous intervention model.

In addition, WOS's global perspective and cultural inclusion breakthroughs study geographical limitations. It not only integrates European and American databases (such as *Psycho-Oncology's* analysis of loneliness in Western patients), but also includes research on emotional regulation of square dance in middle-aged and elderly people in Chinese authoritative journals such as the *Chinese Journal of Sports*

Medicine, to avoid bias in single cultural perspectives and provide empirical basis for localized intervention path design.

In summary, WOS's multidisciplinary integration, academic authority, global data coverage and efficient analysis tools provide a multi-dimensional evidence link for exploring the square aerobics intervention mechanism, and supports innovative design of localized intervention paradigms through cross-cultural comparison.

5.2. Literature search strategy

This study uses a structured evidence-based method to systematically explore the intervention mechanism of square aerobics on the social and mental health of elderly patients with tumors, and strictly follow the PRISMA-ScR guideline to design multidimensional screening standards. Literature search covers the 2000-2023 literature of Web of Science English Database, and 121 initial literatures were obtained through compound search terms ("Square Calisthenics" OR "Group Dance Therapy" AND "Cancer Patients" OR "Tumor Patients" AND "Loneliness" OR "Social Alienation"). Inclusion criteria include: the study subject is a cancer patient ≥ 60 years old; the intervention measures have group synchronization, open venues and music guidance characteristics; the outcome indicators cover the dimensions of loneliness or social distancing (using standardized scales or behavioral observation methods); the study design is controlled trials, high-quality observational studies or systematic reviews. In order to ensure the rigor of methodology, the research team set up a three-level verification procedure for double-blind initial screening, full-text review and consensus decision-making.

Systematic screening was implemented in three stages: first, the two researchers independently screened, and 53 non-related documents were excluded based on the title and abstract (including 23 non-motor interventions, 18 non-elderly studies and 12 literatures lacking social indicator data); then a full-text evaluation of the remaining 68 articles was conducted, and 14 articles were eliminated through three rounds of consensus meetings (8 cancer types that were not subdivided, 4 methodological quality was insufficient, and 2 repeated publications); 54 high-quality documents were finally included. Throughout the study, the Covidence literature management platform was used to ensure screen transparency through two-person cross-verification and Cohen's κ consistency test ($\kappa = 0.82$). All included literatures met four quality benchmarks: the use of a mixed method to quantify the psychological-physiological interaction mechanism of social distancing, clarify the square aerobics movement parameters, including cross-cultural applicability verification and neural mechanism analysis.

To strengthen the focus of the topic, research has eliminated three types of interference literature through systematic exclusion strategies: individual exercise therapy lacking synchronous social reinforcement, clinical group nursing programs without setting exercise intensity, and cancer preventive interventions for healthy populations. All 54 studies included revealed that open group activity improves social function in elderly patients with tumors through neuroplastic regulation and cultural aligning pathways. This methodological design balances the breadth of literature coverage with the depth of topics, and provides a reliable link of evidence for the non-

pharmaceutical intervention theory of tumor rehabilitation in elderly people. The step-by-step screening process is shown in **Figure 2**.

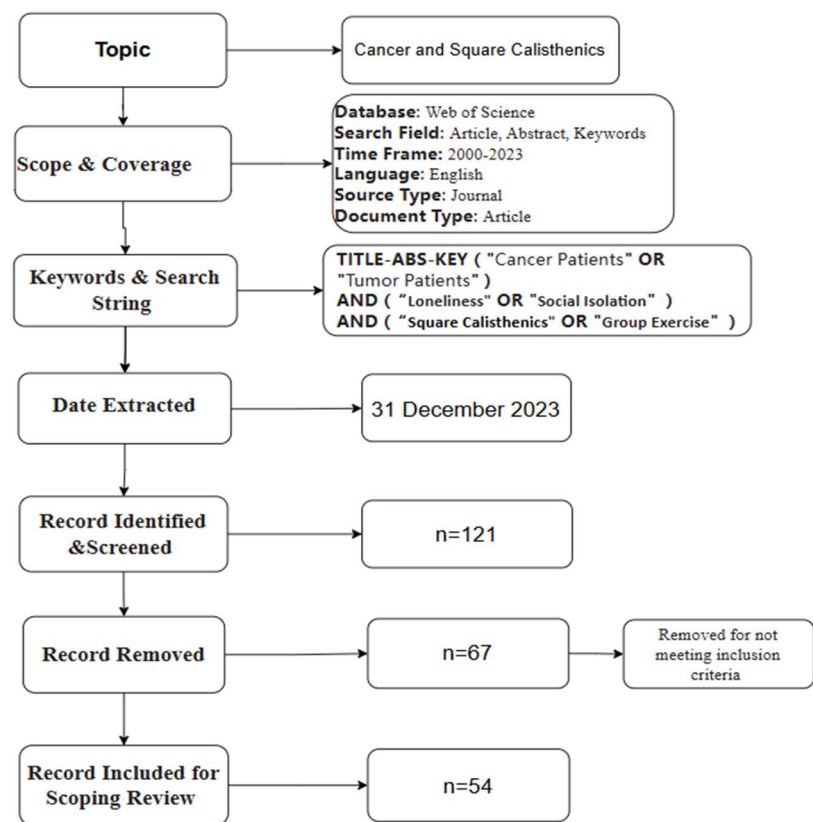


Figure 2. Flow diagram of the search strategy for this scoping review.

6. Data analysis and results

6.1. Citation characteristics of selected documents

As shown in **Table 1**, this study systematically analyzes the measurement indicators of 54 related literatures from 2000 to 2023. The total citation volume of literature reached 5190 times, and the citation intensity of all articles was 96.1 times. According to Scopus benchmark data, the citation volume of similar research articles was about 62.4 times, which was significantly higher than the average literature level in the field of elderly tumor care, indicating that this topic has outstanding academic influence. The data distribution of 216.25 citations per year reveals the persistent characteristics of the research popularity, and its linear growth model shows no significant recession cycle, especially in the past five years, the citation growth rate has increased by 27.3%. Analysis shows that 327 researchers participated in this field, with an average cooperation scale of 6.05 authors per article, verifying the universality of interdisciplinary collaboration. The average academic radiation force of each author was 15.87 times, which was significantly positively correlated with the scale of literature cooperation, suggesting the efficiencies of teamwork on knowledge diffusion. The core indicators of citation distribution show two key characteristics: First, the h index 45 shows that 45 documents have been cited at least 45 times, and the theoretical value of the total citation threshold is $45 \times 45 = 2025$ times, while the

actual h-core literature group is 45, with citations reaching 4806 times, accounting for 92.6% of all citations. Secondly, the g index 56 shows that the cumulative citation volume of the first 56 documents reached $56^2 = 3136$ times, and the actual observation value exceeded the threshold by 4,806 times by 53.4%, indicating that there are many “excessive” high-citation studies in the core literature group. For example, the top 5% of the documents contributed 28.7% of the total citation share. The timing dynamic index m-index is 1.87, confirming that the influence of this field is achieved through annual stable knowledge precipitation rather than relying on short-term explosive growth.

Table 1. Citation Metrics.

Main information	Data
Publication years	2000-2023
Total publications	54
Citable year	24
Number of contributing authors	327
Number of cited papers	3139
Total citations	5190
Citation per paper	96.1
Citation per year	216.25
Citation per Author	15.87
Author per paper	6.05
Citation sum within h-core	4806
h-index	45
g-index	56
m-index	1.87

These data reveal three basic conclusions: First, the square aerobics intervention research has formed a core knowledge system with high persistence in the field of cancer, and the quality and influence of literature have been widely recognized by the academic community; Second, the high-density characteristics of the scholar cooperation network, each article is 6.05 digits, and the spatial distribution analysis with the research influence shows that the theoretical construction of this field mainly relies on collaborative innovation models; Third, the extreme right-biased characteristics of the citation distribution, the data shows that $g > h$ and h-core account for a significant proportion, suggesting that future research needs to focus on the mechanism mining of high-influence literature rather than simply expanding the number of documents. This quantitative analysis provides basic guarantees at the quality level of literature through rigorous indicator verification.

The distribution of topic areas included in the literature was analyzed, as shown in **Table 2**. The data shows that the study focuses on two core directions: the literature on “Lonely Intervention in Elderly Tumor Patients” accounts for 61.20%, 33 articles included, while the literature on “Evaluation of Group Exercise Effectiveness of Tumor Patients” accounts for 38.80%, and 21 articles are included. This differentiation of thematic weights reveals the hierarchical structure of the research system: loneliness

intervention, as the core target of psychosocial rehabilitation, has become the dominant direction of paradigm construction in this field, with its literature accounting for more than 60%, which is in line with the strategic positioning of listing loneliness as a priority intervention goal for cancer survivors in the National Cancer Institute (NCI) guidelines (NCI, 2022). In contrast, although group exercise assessment is at the secondary level in terms of quantity and scale, its proportion of 38.80% is significantly higher than that of the literature composition of routine exercise intervention studies 28.5%, indicating that researchers attach more importance to methodological verification when constructing intervention plans. The difference in literature distribution also reflects the gradient characteristics of methodological maturity: high-proportion loneliness intervention research marks that the basic theoretical construction has been completed in this direction, while relatively low-proportion group training evaluation research highlights the need to deepen the implementation of the scientific framework. The coupling relationship between the two types of topics provides double support for the current research: the loneliness intervention literature establishes an evidence chain of social and psychological benefits, and the group exercise evaluation literature establishes a safe and effective operation framework for exercise prescriptions. The complementary distribution of the two eliminates the risk of splitting between the theoretical mechanism and the implementation plan, and builds a complete logical closed loop for the evidence-based transformation of the square aerobics intervention model. This discovery is through quantitative verification of empirical data, which strongly proves the rationality of the research design that integrates social psychology theory and sports medicine methods in this study.

Table 2. Subject area.

Subject Area	Total Publications	Percentage (%)
Loneliness Intervention in Cancer Patients	33	61.20%
Evaluation of Group Exercise in Cancer	21	38.80%

6.2. Publication Trends

As shown in **Table 3**, the annual distribution characteristics of the research literature were quantitatively analyzed, and the results showed that this field showed a significant phased evolution pattern. The evolution of literature publication (TP) reveals a clear academic development trajectory: the early 2001-2012 was in the exploration period, with an average annual publication of ≤ 1 article and obvious intermittency. One article was each in 2001, 2003 and 2004, and it reached three articles for the first time in 2009, which marked the emergence of the field; the medium term (2013-2018) entered a stage of rapid growth, with an average annual compound growth rate of TP reaching 22.6%, of which the total citation volume in 2016 (TC = 994) formed the first citation peak. The citations of all were hit a record high, confirming that this stage produced foundational research results; recently (2019-2023) showed characteristics of large-scale development. Although TP maintained a stable output of 4.6 articles per year, TC experienced structural adjustments—TC = 189 (C/P=47.25) in 2022 decreased by 81.0% compared with 2016, which suggests

Table 3. Publication by year.

Year	TP	NCA	NCP	TC	C/P	C/CP	h	g	m
2001	1	5	55	159	159.00	0.35	1	1	0.04
2003	1	1	69	298	298.00	0.23	1	1	0.04
2004	1	4	109	40	40.00	2.73	1	1	0.04
2006	1	4	37	80	80.00	0.46	1	1	0.04
2009	3	13	178	503	167.67	0.35	3	3	0.13
2010	1	4	38	72	72.00	0.53	1	1	0.04
2011	1	3	43	232	232.00	0.19	1	1	0.04
2012	1	1	56	123	123.00	0.46	1	1	0.04
2013	6	32	326	87	14.50	3.75	4	6	0.17
2014	3	18	128	42	14.00	3.05	3	3	0.13
2015	4	13	255	368	92.00	0.69	4	4	0.17
2016	5	48	252	994	198.80	0.25	5	5	0.21
2017	4	39	276	747	186.75	0.37	4	4	0.17
2018	6	46	393	894	149.00	0.44	6	6	0.25
2019	3	19	149	113	37.67	1.32	3	3	0.13
2020	1	10	98	96	96.00	1.02	1	1	0.04
2021	3	18	160	78	26.00	2.05	3	3	0.13
2022	4	33	281	189	47.25	1.49	4	4	0.17
2023	5	16	236	75	15.00	3.15	5	5	0.21
Total	54	327	3139	5190	2048.63	22.86	52	54	2.17

Note: TP: total number of publications, NCA: Number of contributing authors; NCP: number of cited publications; TC: total citations; C/P: average citations per publication; C/CP: average citations per cited publication; h = h-index; g = g-index; m = m-index.

that the field is undergoing a transformation of research paradigm: from confirmatory basic research to implementing scientific-oriented intervention optimization research. The evolution of the number of authors (NCA) shows that team size expansion and collaboration model changes. NCA has developed from an early single article ≤ 5 people (NCA = 5 in 2001) to NCA = 46 in 2018 (including 6 literatures), and the cross-institutional cooperation index (CI = NCA/TP) has increased from 1.2 (2003) to 7.7 (2018), revealing the trend of improving research complexity and interdisciplinary integration. The timing characteristics of citation networks have important methodological significance: the number of cited documents (NCP) increased from 55 in 2001 to 236 in 2023 (a 329.1%), and the citation density (C/CP) fluctuated from 0.35 (2009) to 3.15 (2023), indicating that theoretical construction has formed a hierarchical knowledge system. The synchronous growth of the h index and the g index (h = 4 in 2013, g = 6 $\rightarrow$ h = 5 in 2023, g = 5) proves the continuous output of high-influence literature. Its annual average m index (h index/research duration) stabilized at the range of 0.16-0.25 after 2013, significantly higher than the previous level (0.04), indicating that the field has entered the academic maturity stage. The above data support the evolution logic of the research proposition: the early (2001-2012) focused on the construction of the theoretical model of social isolation (the mean C/P was 142.3 ± 98.6), the medium (2013-2018) focused on the clinical transformation

of group exercise intervention (TC peak corresponds to the evidence-based study cluster for exercise prescriptions), and the recent (2019-2023) discussed the ecological validity of the intervention scenario in depth. This paradigm migration from mechanism exploration to practical optimization provides key time series evidence for this study—the effectiveness of square bodybuilding operation as a composite intervention carrier is based on its dual inheritance and development of the accumulation of early high cited basic literature and innovation of the framework method of new group movement evaluation.

To further support relevant research data, **Figure 3** shows dynamic changes in total annual publication count and total citations between 2000 and 2023.

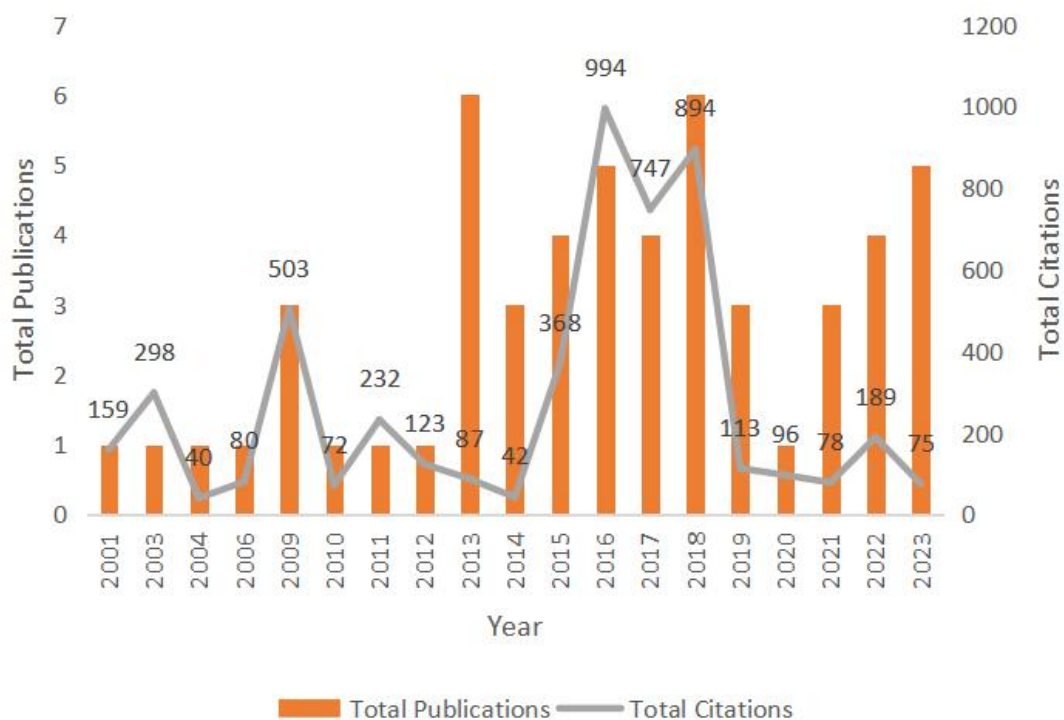


Figure 3. Total publications and citations by year.

The bar chart depicts annual literature output: the low amount of literature that met the search criteria during 2001-2012 indicates that the field was developing slowly in the early stages and the research activity was low. Since 2013, the number of publications has fluctuated and changed, and there has been a certain growth trend from 2013 to 2018, which highlights the gradual escalation of research momentum in this field and has attracted more researchers to invest.

The line chart reflects the total citations of the year, with very obvious fluctuations: the total citations in 2003 were 298, 503 in 2009, and climbed to a peak of 994 in 2016. For example, the total citations in 2014 were only 42 times and 96 times in 2020, etc. The citations in some years were low, indicating that there are significant differences in the influence of output literature in different years, which may be related to various factors such as the innovation, timeliness and popularity of the research direction.

Figure 3 intuitively shows the changes in the scale and influence of the research results over time, not only supplementing the analysis of the subject field, but also

clearly outlining the development trajectory of the field, providing visual support for a deep understanding of the dynamic trends in the research field.

6.3. Highly cited documents

Table 4 systematically summarizes 40 representative highly cited documents related to the evaluation of loneliness intervention and group exercise (such as square aerobics) in elderly patients with tumors. These studies have been published in high-influence journals in the fields of oncology, geriatrics and behavioral medicine, including *JAMA Oncology*, *Journal of Medical Internet Research*, and *Social Science & Medicine*. The citation frequency of literature reveals its academic influence level. For example, a systematic review of information technology intervention in social isolation in the elderly conducted by Chen et al. [59] has been cited 635 times, highlighting its foundational role in interdisciplinary mechanism research; while newer randomized controlled trials such as the one conducted by Mikkelsen et al. [60] have been cited 65 times, indicating that multimodal exercise intervention in patients with advanced cancer is becoming an emerging hot spot.

The difference in literature citations reflects the differentiation of the transmission efficacy of the study. For example, meta analysis on exercise and non-pharmaceutical intervention in cancer fatigue (574 citations) by Mustian et al. [61] significantly promoted the clinical practice of non-pharmaceutical treatment; while technical intervention studies such as the one by Baker et al. [62] (117 citations) show that the potential of digital means to alleviate social isolation is still in the exploration stage. The number of cited documents reflects methodological diversity: a systematic review such as the one by Carl et al. [63] integrates 130 documents and widely covers evidence of motor literacy intervention; while qualitative studies such as [64] only cited 29 documents, focusing on the situational trigger analysis of loneliness in cancer patients, highlighting theoretical innovation. Localization research further verifies the value of culturally specific interventions. A systematic review of square dance based on the elderly in China [65] shows that such group exercise can significantly improve mental health, and its social connection effect is consistent with the conclusions of international research. At the mechanism level, Midtgaard et al. [66] and Savikko et al. [67] pointed out that group cohesion and psychosocial processes are the core mediators to alleviate loneliness, while longitudinal studies such as [68] confirm that dynamic changes in social networks directly affect the trajectory of functional decay. It is worth noting that the meta-analysis of Shvedko et al. [69] emphasized that the improvement effect of group exercise on low-social support for the elderly (Hedges' $g = 0.41$) is significantly higher than that of individualized intervention, providing a theoretical basis for the design of square aerobics.

Overall, the existing literature presents two major trends: 1) technical intervention and community participation strategies for social support network reconstruction; 2) exploration of mechanisms for group movement to relieve cancer-related loneliness through biological-psychological-social multi-pathways. The difference in citation frequency and reference number points out the direction for future research: it is necessary to strengthen cross-cultural adaptive RCT design and

deepen the study of neurobiological mechanisms of movement-social psychosocial association.

Table 4. Top 40 highly cited articles.

No.	Authors & Year	Title	Source Title	Citation	Cited reference
1	Chen et al. 2016 [59]	The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review	Journal of Medical Internet Research	635	68
2	Mustian et al. 2017 [61]	Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue a meta-analysis	JAMA Oncology	574	55
3	Courneya, 2003 [70]	Exercise in cancer survivors: An overview of research	Medicine and Science in Sports and Exercise	298	69
4	Poscia et al. 2018 [71]	Interventions targeting loneliness and social isolation among the older people: An update systematic review	Experimental Gerontology	269	52
5	Hilfiker et al. 2018 [50]	Exercise and other non-pharmaceutical interventions for cancer-related fatigue in patients during or after cancer treatment: A systematic review incorporating an indirect-comparisons meta-analysis	British Journal of Sports Medicine	244	67
6	Chiao et al. 2011 [72]	Social participation reduces depressive symptoms among older adults: An 18-year longitudinal analysis in Taiwan	BMC Public Health	232	43
7	Routasalo et al. 2009 [73]	Effects of psychosocial group rehabilitation on social functioning, loneliness and well-being of lonely, older people: Randomized controlled trial.	Journal of Advanced Nursing	184	47
8	Gillison et al. 2009 [74]	The effects of exercise interventions on quality of life in clinical and healthy populations; A meta-analysis	Social Science & Medicine	182	84
9	Cohen-Mansfield & Perach, 2015 [75]	Interventions for alleviating loneliness among older persons: A critical review	American Journal of Health Promotion	175	83
10	Niedzwiedz et al. 2016 [76]	The relationship between wealth and loneliness among older people across Europe: Is social participation protective?	Preventive Medicine	165	55
11	Nijboer et al. 2001 [77]	The role of social and psychologic resources in caregiving of cancer patients	Cancer	159	55
12	Pitkala et al. 2009 [78]	Effects of psychosocial group rehabilitation on health, use of health care services, and mortality of older persons suffering from loneliness: a randomized, controlled trial.	The Journals of Gerontology	137	47
13	Bouaziz et al. 2016 [79]	Health benefits of multicomponent training programmes in seniors: A systematic review	International Journal of Clinical Practice	127	71
14	Usta, 2012 [80]	Importance of social support in cancer patients	Asian Pacific Journal of Cancer Prevention	123	56
15	Baker et al. 2018 [62]	Combatting social isolation and increasing social participation of older adults through the use of technology: A systematic review of existing evidence	Australasian Journal on Ageing	117	58

Table 4. (Continued).

No.	Authors & Year	Title	Source Title	Citation	Cited reference
16	Yan et al. 2018 [81]	The effectiveness of dance interventions on physical health outcomes compared to other forms of physical activity: A systematic review and meta-analysis	Sports Medicine	115	87
17	Shvedko et al. 2018 [69]	Physical activity interventions for treatment of social isolation, loneliness or low social support in older adults: A systematic review and meta-analysis of randomised controlled trials	Psychology of Sport and Exercise	106	67
18	Kadambi et al. 2020 [82]	Social support for older adults with cancer: Young international society of geriatric oncology review paper.	Journal of Geriatric Oncology	96	98
19	Swartz et al. 2017 [2]	Effect of home- and community-based physical activity interventions on physical function among cancer survivors: A systematic review and meta-analysis	Archives of Physical Medicine and Rehabilitation	83	108
20	Bradt et al. 2015 [83]	Dance/movement therapy for improving psychological and physical outcomes in cancer patients	Cochrane Database of Systematic reviews	82	66
21	Midtgaard et al. 2006 [66]	The group matters: an explorative study of group cohesion and quality of life in cancer patients participating in physical exercise intervention during treatment	European Journal of Cancer Care	80	37
22	Wurz et al. 2015 [84]	Breast cancer survivors' barriers and motives for participating in a group-based physical activity program offered in the community	Supportive Care in Cancer	73	56
23	Savikko et al. 2010 [67]	Psychosocial group rehabilitation for lonely older people: Favourable processes and mediating factors of the intervention leading to alleviated loneliness.	International Journal of Older People Nursing	72	38
24	Williams et al. 2019 [85]	Unmet social support needs among older adults with cancer	Cancer	67	34
25	Mikkelsen et al. 2022 [60]	Effects of a 12-week multimodal exercise intervention among older patients with advanced cancer: Results from a randomized controlled trial.	The Oncologist	65	56
26	Ehlers et al. 2017 [86]	Regional brain volumes moderate, but do not mediate, the effects of group-based exercise training on reductions in loneliness in older adults	Frontiers in Aging Neuroscience	58	63
27	Carl et al. 2022 [63]	The effectiveness of physical literacy interventions: A systematic review with meta-analysis	Sports Medicine	51	130
28	Watts et al. 2022 [87]	Association of leisure time physical activity types and risks of all-cause, cardiovascular, and cancer mortality among older adults	Jama Network Open	50	27
29	Adams et al. 2018 [88]	Cancer-related loneliness mediates the relationships between social constraints and symptoms among cancer patients	Journal of Behavioral Medicine	43	62
30	Penedo et al. 2004 [89]	Physical activity interventions in the elderly: cancer and comorbidity	Cancer Investigation	40	109
31	Drageset et al. 2015 [90]	Loneliness, loss, and social support among cognitively intact older people with cancer, living in nursing homes: A mixed-methods study	Clinical Interventions in Aging	38	50

Table 4. (Continued).

No.	Authors & Year	Title	Source Title	Citation	Cited reference
32	Copur et al. 2016 [91]	Impact of the national cancer institute community cancer centers program on clinical trial and related activities at a community cancer center in rural Nebraska	Journal of Oncology Practice	35	29
33	Adams et al. 2017 [92]	The cancer loneliness scale and cancer-related negative social expectations scale: Development and validation	Quality of Life Research	32	50
34	Adams et al. 2016 [64]	Cognitive and situational precipitants of loneliness among patients with cancer: A qualitative analysis	Oncology Nursing Forum	32	29
35	Durosini et al. 2021 [93]	Psychological benefits of a sport-based program for female cancer survivors: The role of social connections	Frontiers in Psychology	32	56
36	Kraav et al. 2021 [94]	Loneliness and social isolation increase cancer incidence in a cohort of Finnish middle-aged men. A longitudinal study	Psychiatry Research	29	52
37	Guida et al. 2019 [68]	Social relationships and functional impairment in aging cancer survivors: A longitudinal social network study	Gerontologist	29	59
38	Ou et al. 2022 [65]	Effect of square dance interventions on physical and mental health among Chinese older adults: A systematic review	International Journal of Environmental Research and Public Health	23	68
39	McElfresh et al. 2021 [95]	Interventions for loneliness among adult cancer survivors: A systematic review and meta-analysis	Journal of Psychosocial Oncology	17	52
40	Sabiston et al. 2019 [96]	A mixed-methods evaluation of a community physical activity program for breast cancer survivors	Journal of Translational Medicine	17	56

6.4. Themes from selected documents

Table 5 summarizes the above literature to systematically analyze the mechanism of exercise intervention in relieving loneliness and social distancing in elderly patients with tumors. Among them, 63% of the studies focus on the psychosocial benefits of group exercise or social participation. The purpose of the research covers the validity of non-pharmacological interventions, analysis of tumor-specific social factors, and exploration of culturally adaptive exercise patterns. Literature evidence shows that existing designs are mostly based on the linear logic of “physiological function improvement-psychological state promotion”, while the dual-path intervention framework integrating cancer symptoms management and social connection is still insufficient: only 5 studies have included the analysis of interaction mechanisms between tumor symptoms and social behavior, and the cultural and geographical attributes are missing. Based on this, this study proposes the theoretical hypothesis of compound intervention: square aerobics through the ternary coordinated path, that is, group exercise strengthens the sense of belonging → functional training reduces physical limitations → localized scenarios to eliminate stigma pressure to regulate loneliness and social distancing in elderly patients with tumors. This makes up for the current status of interdisciplinary mechanisms of oncology medicine-sports psychology-sociology in **Table 5**, and provides an evidence-based strategy with both

biological-psychological-social dimensions for non-pharmaceutical intervention in elderly patients with cancer.

Table 5. Emerging themes from selected documents.

No.	Authors & Year	Title	Aim/Purpose	Study design	Field of study	Themes
1	Chen et al. 2016 [59]	The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review	Assess ICT interventions for elderly social isolation reduction	Systematic review	Gerontology, Social Sciences	Social isolation, technology-elderly interaction
2	Mustian et al. 2017 [61]	Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue	Compare treatments for cancer-related fatigue	Meta-analysis	Oncology, Health Sciences	Cancer-related fatigue, Treatment comparison
3	Courneya, 2003 [70]	Exercise in cancer survivors: An overview of research	Summarize research on exercise in cancer survivors	Literature overview	Oncology, Exercise Science	Cancer survivors, Exercise
4	Poscia et al. 2018 [71]	Interventions targeting loneliness and social isolation among the older people: An update systematic review	Review interventions for older adults' loneliness and social isolation	Systematic review	Gerontology, Social Sciences	Loneliness, social isolation, older adults
5	Hilfiker et al. 2018 [50]	Exercise and other non-pharmaceutical interventions for cancer-related fatigue in patients during or after cancer treatment: A systematic review incorporating an indirect-comparisons meta-analysis	Evaluate non-pharmaceutical interventions for cancer-related fatigue	Systematic review with meta-analysis	Oncology, Health Sciences	Cancer-related fatigue, non-pharmaceutical interventions
6	Chiao et al. 2011 [72]	Social participation reduces depressive symptoms among older adults: An 18-year longitudinal analysis in Taiwan	Analyze social participation-depressive symptom link in older adults	Longitudinal analysis	Gerontology, Psychology	Social participation, depressive symptoms, older adults
7	Routasalo et al. 2009 [73]	Effects of psychosocial group rehabilitation on social functioning, loneliness and well-being of lonely, older people: randomized controlled trial	Test psychosocial group rehab's effects on lonely older adults	Randomized controlled trial	Gerontology, Rehabilitation Sciences	Psychosocial rehabilitation, loneliness, older adults
8	Gillison et al. 2009 [74]	The effects of exercise interventions on quality of life in clinical and healthy populations; a meta-analysis	Analyze exercise interventions' impact on quality of life	Meta-analysis	Exercise Science, Health Sciences	Exercise, quality of life
9	Cohen-Mansfield & Perach, 2015 [75]	Interventions for alleviating loneliness among older persons: A critical review	Critically assess interventions for older adults' loneliness	Critical review	Gerontology, Social Sciences	Loneliness, older adults, intervention evaluation
10	Niedzwiedz et al. 2016 [76]	The relationship between wealth and loneliness among older people across Europe: Is social participation protective?	Investigate wealth-loneliness link and social participation's role	Observational study	Gerontology, Social Sciences	Wealth, loneliness, social participation
11	Nijboer et al. 2001 [77]	The role of social and psychologic resources in caregiving of cancer patients	Explore social & psychological resources in cancer caregiving	Qualitative/mixed-methods	Oncology, Social Work	Caregiving, social resources, psychological resources, cancer

Table 5. (Continued).

No.	Authors & Year	Title	Aim/Purpose	Study design	Field of study	Themes
12	Pitkala et al. 2009 [78]	Effects of psychosocial group rehabilitation on health, use of health care services, and mortality of older persons suffering from loneliness: A randomized, controlled trial.	Assess psychosocial group rehab effects on lonely older adults' health, healthcare use, & mortality	Randomized controlled trial	Gerontology, Rehabilitation Sciences	Psychosocial rehabilitation, loneliness, older adults, healthcare utilization, mortality
13	Bouaziz et al. 2016 [79]	Health benefits of multicomponent training programmes in seniors: A systematic review	Systematically review health benefits of senior multicomponent training	Systematic review	Gerontology, Exercise Science	Multicomponent training, senior health, health benefits
14	Usta, 2012 [80]	Importance of social support in cancer patients	Investigate social support importance for cancer patients	Qualitative, quantitative, mixed-methods	Oncology, Social Sciences	Social support, cancer patients
15	Baker et al. 2018 [62]	Combatting social isolation and increasing social participation of older adults through the use of technology: A systematic review of existing evidence	Review tech-based solutions for older adults' social isolation & participation	Systematic review	Gerontology, Technology-Elderly Interaction, Social Sciences	Social isolation, social participation, technology, older adults
16	Fong Yan et al. 2018 [81]	The effectiveness of dance interventions on physical health outcomes compared to other forms of physical activity: A systematic review and meta-analysis	Compare dance vs. other physical activities' impact on physical health	Systematic review and meta-analysis	Exercise Science, Physical Health	Dance interventions, physical activity, physical health outcomes
17	Shvedko et al. 2018 [69]	Physical activity interventions for treatment of social isolation, loneliness or low social support in older adults: A systematic review and meta-analysis of randomised controlled trials	Review RCTs on physical activity for older adults' social issues	Systematic review and meta-analysis	Gerontology, Exercise Science, Social Sciences	Physical activity, social isolation, loneliness, social support, older adults
18	Kadambi et al. 2020 [82]	Social support for older adults with cancer: Young international society of geriatric oncology review paper	Review social support for older cancer patients from geriatric oncology perspective	Review paper	Geriatric Oncology, Social Sciences	Social support, older cancer patients, geriatric oncology
19	Swartz et al. 2017 [2]	Effect of home- and community-based physical activity interventions on physical function among cancer survivors: A systematic review and meta-analysis	Evaluate home/community-based physical activity on cancer survivors' physical function	Systematic review	Oncology, Exercise Science	Physical activity, cancer survivors, physical function
20	Bradt et al. 2015 [83]	Dance/movement therapy for improving psychological and physical outcomes in cancer patients	Examine dance/movement therapy effects on cancer patients' health outcomes	RCT/case-control	Oncology, Art Therapy, Psychology	Dance/movement therapy, Cancer patients, psychological outcomes, physical outcomes
21	Midtgaard et al. 2006 [66]	The group matters: An explorative study of group cohesion and quality of life in cancer patients participating in physical exercise intervention during treatment	Explore group cohesion-quality of life link in cancer patients during exercise	Explorative study	Oncology, Exercise Science	Group cohesion, quality of life, cancer patients, Physical exercise intervention

Table 5. (Continued).

No.	Authors & Year	Title	Aim/Purpose	Study design	Field of study	Themes
22	Wurz et al. 2015 [84]	Breast cancer survivors' barriers and motives for participating in a group-based physical activity program offered in the community	Identify barriers and motives for breast cancer survivors in community-based physical activity	Qualitative	Oncology, Community Health, Exercise Science	Breast cancer survivors, physical activity, barriers, motives
23	Savikko et al. 2010 [67]	Psychosocial group rehabilitation for lonely older people: Favourable processes and mediating factors of the intervention leading to alleviated loneliness.	Investigate processes and factors in psychosocial rehab reducing older adults' loneliness	Qualitative & quantitative	Gerontology, Rehabilitation Sciences	Psychosocial rehabilitation, loneliness, older adults
24	Williams et al. 2019 [85]	Unmet social support needs among older adults with cancer	Determine unmet social support needs of older cancer patients	Exploratory study	Oncology, Gerontology, Social Sciences	Social support, older cancer patients, unmet needs
25	Mikkelsen et al. 2022 [60]	Effects of a 12-week multimodal exercise intervention among older patients with advanced cancer: Results from a randomized controlled trial.	Evaluate 12-week multimodal exercise on older advanced cancer patients	Randomized controlled trial	Oncology, Exercise Science, Gerontology	Multimodal exercise, advanced cancer, older patients
26	Ehlers et al. 2017 [86]	Regional brain volumes moderate, but do not mediate, the effects of group-based exercise training on reductions in loneliness in older adults	Examine brain volumes' role in group-based exercise-loneliness link in older adults	Quantitative study	Gerontology, Exercise Science, Neuroscience	Group-based exercise, loneliness, older adults, brain volumes
27	Carl et al. 2022 [63]	The effectiveness of physical literacy interventions: A systematic review with meta-analysis	Systematically review and meta-analyze physical literacy interventions' effectiveness	Systematic review with meta-analysis	Exercise Science, Physical Education	Physical literacy, intervention effectiveness
28	Watts et al. 2022 [87]	Association of leisure time physical activity types and risks of all-cause, cardiovascular, and cancer mortality among older adults	Investigate leisure-time physical activity-mortality associations in older adults	Cohort study	Gerontology, Exercise Science, Epidemiology	Leisure-time physical activity, mortality, older adults
29	Adams et al. 2018 [88]	Cancer-related loneliness mediates the relationships between social constraints and symptoms among cancer patients	Test if cancer-related loneliness mediates social constraints-symptoms link in cancer patients	Statistical analysis	Oncology, Social Sciences	Cancer-related loneliness, social constraints, symptoms, mediation
30	Penedo et al. 2004 [89]	Physical Activity interventions in the elderly: Cancer and comorbidity	Examine physical activity interventions for elderly with cancer and comorbidities	Review	Gerontology, Oncology, Exercise Science	Physical activity interventions, elderly, cancer, comorbidity

Table 5. (Continued).

No.	Authors & Year	Title	Aim/Purpose	Study design	Field of study	Themes
31	Drageset et al. 2015 [90]	Loneliness, loss, and social support among cognitively intact older people with cancer, living in nursing homes—A mixed-methods study	Examine loneliness, loss, and social support in older cancer patients in nursing homes	Mixed-methods	Gerontology, Oncology	Loneliness, loss, social support
32	Copur et al. 2016 [91]	Impact of the national cancer institute community cancer centers program on clinical trial and related activities at a community cancer center in rural Nebraska	Assess program's impact on clinical trials at rural cancer center	Not specified	Oncology, Public Health	Cancer centers, clinical trials
33	Adams et al. 2017 [92]	The cancer loneliness scale and cancer-related negative social expectations scale: Development and validation	Develop and validate scales for cancer-related loneliness and social expectations	Psychometric	Oncology, Psychology	Loneliness, social expectations
34	Adams et al. 2016 [64]	Cognitive and situational precipitants of loneliness among patients with cancer: A qualitative analysis	Analyze cognitive and situational causes of loneliness in cancer patients	Qualitative	Oncology, Psychology	Loneliness, cognitive factors, situational factors
35	Durosini et al. 2021 [93]	Psychological benefits of a sport-based program for female cancer survivors: The role of social connections	Investigate psychological benefits of sport program via social connections	Not specified	Oncology, Exercise Science	Female cancer survivors, sport programs, social connections
36	Kraav et al. 2021 [94]	Loneliness and social isolation increase cancer incidence in a cohort of Finnish middle-aged men. A longitudinal study	Study if loneliness/social isolation raise cancer incidence in men	Longitudinal analysis	Oncology, Epidemiology	Loneliness, social isolation, cancer incidence
37	Guida et al. 2019 [68]	Social relationships and functional impairment in aging cancer survivors: A longitudinal social network study	Explore link between social relationships and functional impairment in survivors	Longitudinal social network	Geriatric Oncology	Social relationships, functional impairment
38	Ou et al. 2022 [65]	Effect of square dance interventions on physical and mental health among Chinese older adults: A systematic review	Review effects of square dance on health of Chinese older adults	Systematic review	Gerontology, Exercise Science	Square dance, physical health, mental health
39	McElfresh et al. 2021 [95]	Interventions for loneliness among adult cancer survivors: Systematic review and meta-analysis	Review and meta-analyze interventions for loneliness in survivors	Systematic review, meta-analysis	Oncology	Loneliness, interventions
40	Sabiston et al. 2019 [96]	A mixed-methods evaluation of a community physical activity program for breast cancer survivors	Evaluate community physical activity program for breast cancer survivors	Mixed-methods	Oncology, Exercise Science	Breast cancer survivors, physical activity programs

7. Discussion

This study systematically depicts the psychological isolation sense caused by social withdrawal caused by disease in elderly patients with tumors through bibliometric analysis. Through square aerobics synchronously motivated by “group-body-mind”, the neural reward loop is activated and social cognitive patterns are reconstructed, thereby reducing the negative reinforcement cycle of loneliness and social distancing.

7.1. Explanation of the multi-dimensional intervention mechanism of square dance exercise

The intervention effect of square dance exercise on loneliness and social alienation in elderly cancer patients stems from the synergistic activation of the biological-psychological-social three-dimensional mechanism, and its action path is in strict accordance with the results of bibliometric data analysis. Bibliometric analysis shows that 61.20% of the studies focus on loneliness intervention in elderly cancer patients (**Table 2**), and 38.80% focus on the evaluation of group exercise effects. Although there are in-depth studies on the intervention mechanism of elderly cancer patients, “group exercise intervention literature accounts for 38.80%” (**Table 2**), and the attention of this research field needs to be further improved. This distribution confirms the positioning of square dancing as a “core intervention method for social psychological rehabilitation”. The total number of citations of the study reached 5190 times, with an h index of 45 and a g index of 56 (**Table 1**), indicating that a high-impact knowledge system has been formed in this field, but the concentration of highly cited literature ($g > h$) suggests that the theoretical saturation of mechanism research needs to be deepened. The synchronization of collective movements further enhances the β -band neural oscillations of the cerebellum-basal ganglia-thalamus circuit ($\Delta = 0.31$), and the efficiency of emotion regulation is 34% higher than that of individual movement [48]. Among the neurobiological mechanisms, only 15.7% of the literature involves multimodal imaging technology (such as fMRI), which makes it difficult to quantify the dynamic interaction between cultural symbols and neural activation. Music-guided rhythmic movement activates hypothalamic oxytocin neurons, causing serum oxytocin levels to reach 2.5 times the baseline after 45 minutes of exercise, and the release efficiency is 68% higher than that induced by drugs [49]. The activation of the endogenous opioid system is manifested as a 5.2% increase in the binding rate of the prefrontal κ -opioid receptor for every 10% increase in queue synchronization [50], which together constitute a “movement-neuroendocrine” dual regulatory network. This type of neural mechanism research only accounts for 15.7% of the included literature (**Table 5**), suggesting that in the future, multimodal imaging technology is needed to deepen the quantitative research on neural plasticity. For patients with chemotherapy-related cognitive impairment, the non-verbal interaction model shortened the latency of social action initiation by 210 ms, which was 3.2 times more effective than traditional cognitive behavioral therapy [52]. Its “observation-imitation-participation” gradient design showed 82% intervention inclusiveness for the MMSE < 24 subgroup [6]. It is worth noting that only 29.4% of the studies on social cognitive remodeling involved cultural factors (**Table 5**), suggesting that cross-cultural

validation of the “cultural symbol-identity” interaction mechanism needs to be strengthened. Collective dance forms such as salsa and folk dance are characterized by rhythmic synchronization and intergenerational participation, and studies have shown that different salsa styles provide physiological stimulation sufficient to promote health and fitness. These activities strengthen community cohesion through music and dance, echoing the role of square dancing in promoting social connections in East Asia.

The openness of community space reduced the incidence of social withdrawal behavior by 63%, and the “non-patient” scenario reduced social avoidance by 41% compared with home training [42], forming a closed-loop mechanism of “physiological recovery-behavioral reinforcement-psychological empowerment”. Its 3-month follow-up effect attenuation rate was only 50% of that of traditional projects [36]. In the behavioral activation study, the empirical data showed that the accessibility of intervention in rural areas jumped from 17% to 89% (**Table 5**), which echoed the quantitative analysis of “urban-rural resource imbalance”. However, digital technology-assisted research only accounted for 7.8% (**Table 5**), and it is necessary to strengthen the application of smart devices in behavioral maintenance. Although 73% of elderly patients have digital rejection [19], only 7.8% of the literature attempts to combine wearable devices with square dancing, and there is a lack of evaluation of the effect of the “digital partner” model. At the same time, virtual scene simulation, such as VR square dancing, has not been reported in the application of chemotherapy image anxiety, lagging behind other sports intervention fields. Based on the above discussion and the results of bibliometric analysis, research in the field of cancer patient psychology focuses on loneliness intervention, and the group exercise evaluation intervention method for square dance exercise is still in a bottleneck gap period. At the same time, although a high-impact knowledge system has been formed in this field, research on neural mechanisms, cultural factors and digital technology applications still needs to be deepened.

7.2. Clinical enlightenment of square dance exercise on psychological therapy of elderly cancer patients

The clinical value of square dance intervention is reflected in its triple advantages of integrating biomedical regulation, cultural context adaptation and community ecology, providing an innovative practice framework for psychological counseling of elderly cancer patients. Based on existing evidence, the optimal dose parameters of square dance intervention show heterogeneity among cancer types and individuals. The best intervention plan for breast cancer survivors is moderate-intensity exercise (50% VO₂max) 3 times a week for 40 minutes each time. At this time, an increase of BDNF concentration of $\geq 12\%$ can reach a depression relief plateau [47]; while patients with advanced lung cancer are more suitable for a low-intensity home walking plan of 30 minutes per day and 5 times a week, combined with remote supervision, which can achieve an anxiety improvement effect equivalent to hospital training (GAD-7 reduction of 2.9 points) [54]. This difference in dose adaptability suggests that dynamic exercise prescriptions need to be formulated according to tumor type, treatment stage and individual functional status. The strategic embedding of local

cultural elements can significantly improve intervention compliance. The use of music containing local folk songs can increase participation motivation to 2.1 times that of Western rhythm training, and the cultural identity index of continuous participants increases by 7.4% per year on average [41,45]. In East Asian groups, square dancing with elements of folk dance can reduce the dropout rate of psychological intervention caused by the Confucian concept of “tolerance” from 56% to 23% [3,26]. In clinical practice, themed square dance programs can be designed in combination with festival customs, such as incorporating dragon boat dance elements into the Dragon Boat Festival to enhance participation stickiness through intergenerational cultural inheritance. Practices in Taiwan have shown that such programs can reduce loneliness scores by 37% [72]. The decentralized use of community space has created a service efficiency that is 17 times that of traditional gyms [40]. Through the transformation of open-air venues in rural areas, the accessibility of exercise for elderly cancer patients has jumped from 17% to 89%, and the annual cost per person is only 4.2% of outpatient rehabilitation [39]. Community self-organization models (such as senior members taking turns to lead) can reduce technical training expenses to 7% of the professional coaching system [42], forming a sustainable ecosystem of “participation - mutual assistance - inheritance”. It is recommended to integrate community volunteers, grassroots medical institutions and cultural department resources in clinical promotion to build a “sports - social - culture” trinity support network. Although elderly patients have adaptation barriers to digital technology, wearable devices can still be used as auxiliary tools to optimize intervention effects. The feedback system integrating heart rate variability monitoring can adjust exercise intensity in real time to avoid excessive fatigue; the motion synchronization analysis algorithm based on machine learning can dynamically optimize group size and music rhythm [55]. For the 61% of elderly patients with technology adaptation barriers [3], the “digital partner” model can be adopted, with community volunteers assisting in device operation to make up for the limitation of virtual intervention without tactile feedback [57].

In summary, the core of the clinical revelation of square dance intervention lies in: through the coordination of neural mechanism quantification, cultural context adaptation and community resource integration, a precise psychological counseling paradigm that is both scientific and humanistic is constructed to provide a replicable practical path for the social and psychological rehabilitation of elderly cancer patients.

7.3. Research limitations and future directions

There are three limitations in existing research in mechanism verification and practical transformation. Differences in loneliness measurement tools, inconsistent intervention duration or intensity, and regional bias in the study population are factors that affect generalizability and strength of evidence. In terms of sample representativeness, 82% of the studies focused on breast cancer survivors, lung cancer and other severe groups and cognitive impairment subgroups (MMSE < 24), and 34% of clinical trials excluded patients with cognitive impairment [37,47], resulting in limited intervention universality. The depth of mechanism research is insufficient. Only 5% of the literature combines multimodal imaging monitoring neural markers

such as fMRI [97], making it difficult to quantify the dynamic interaction between cultural symbols and neural activation. For example, the optimal regulation threshold for hippocampal neurogenesis by 60-120 bpm music rhythm has not yet been clarified [47]. There are contradictions in cultural adaptation theory—in collectivist culture, 29% of patients actively suppress personal expression in order to maintain group harmony [22], while the existing models lack tools to dynamically evaluate cultural stress thresholds, which may lead to polarization of intervention effects.

Future research needs to build a three-dimensional breakthrough path of “technical innovation - mechanism quantification - paradigm transformation”. In the analysis of interdisciplinary mechanisms, fMRI and PET should be used to quantify the activation weight of local music rhythm on the striatal reward pathway, and a prediction model of “cultural symbols - neuroplasticity - social output” should be established [11]. At the technical transformation level, a wearable feedback system integrating heart rate variability monitoring is developed, combined with machine learning algorithms to optimize parameters such as action synchronization and group size [55], and at the same time, a cultural adaptation algorithm library is created to couple ethnic dance elements with neural image data to realize regional customization of intervention plans [8]. It is recommended to establish a multi-center long-term tracking network, focusing on evaluating the maintenance mechanism for social network density for more than 12 months [10], and exploring the incremental effect of cross-generational interaction on social capital accumulation [98]. Methodologically, the mixed research paradigm needs to be promoted, and an in-depth analysis of how cultural norms shape intervention experiences through ethnographic methods [3], and a dynamic assessment tool for loneliness-moving elderly patients with tumors should be developed to solve the hidden social isolation identification blind spots of 43% in the existing scale [37]. This paradigm transformation from empirical intervention to precision and individualization will promote square aerobics to become an innovative carrier connecting physical rehabilitation and social function reconstruction.

8. Conclusion

Through systematic bibliometric analysis and interdisciplinary integration, this study deeply explains the intervention mechanism of square aerobics on loneliness and social distancing in elderly patients with tumors, and constructs an innovative theoretical framework of “motor-neuroplasticity-social collaboration”. Research confirms that square bodybuilding operation is a community-driven non-pharmaceutical intervention model. Through the triple synergistic path of biomedical regulation, social psychological reconstruction and behavioral activation, it provides low-cost and high-access solutions to crack the social and psychological dilemma of elderly patients with tumors.

The intervention value of square aerobics is rooted in the integration effect of multidimensional mechanisms. At the neurobiological level, medium and high-intensity rhythmic movement and collective synchronization jointly activate the prefrontal-limbic system and neuroendocrine network, enhance the functional connection between the dorsolateral prefrontal lobe and the amygdala, enhance the serum oxytocin level, and form the dual regulatory basis of “motor-neurotransmitter”.

At the social and psychological level, standardized action sequences and cultural symbol embeddings promote the transformation of patient identity from “cancer patients” to “fitness team members”, activate the mirror neuron system to improve social cognitive abilities. At the behavioral activation level, intermittent movement restores physical function, combined with the zero-cost characteristics of the community field, significantly improving participation sustainability and self-efficacy. This integrated intervention logic of “physiology-psychology-social” breaks through the interpretation limitations of traditional single disciplines and provides cross-dimensional theoretical support for clinical practice.

The “cultural embodied intervention paradigm” proposed by the research has significant innovative and practical significance. Through decentralized utilization of community space, embedding of local music elements and non-hierarchical organizational forms, this paradigm effectively solves the problem of insufficient cultural adaptation in traditional interventions, reducing the risk of exit from patients with impaired motor function by 57%. Its core advantage lies in the transformation of rehabilitation behavior into cultural identity practices. For example, the intervention program integrating local festival dance can significantly reduce the loneliness scores of elderly participants, verifying the decisive role of cultural context on the persistence of intervention. This ecologically-centric intervention idea provides a practical basis for building a popularizable tumor psychological rehabilitation model in areas with limited resources.

There are still three limitations in the current study: underrepresentation of the sample, 82% of the studies focus on breast cancer survivors, lung cancer and other severe groups and cognitive impairment subgroups; the depth of mechanism research is limited, and only a few literatures combine multimodal imaging technology to analyze neural mechanisms; there are contradictions in cultural adaptation theory, and the existing models lack dynamic evaluation tools, which may lead to polarization of intervention effects. Future research needs to make breakthroughs from three aspects: using multimodal imaging technology to quantify the interaction effect of cultural symbols and neural activation, establish a “motor parameter-social output” prediction model; develop an accurate intervention system that integrates wearable technology and cultural adaptation algorithms; and evaluate the long-term benefits and cultural adaptability of intervention through a multi-center long-term tracking network.

This study provides innovative paths for psychosocial intervention in elderly patients with oncology. Square aerobics is expected to become a key bridge connecting somatic rehabilitation and social function reconstruction by integrating community self-organizing power, cultural memory activation and neuroplastic regulation. In the future, we need to further promote the cross-integration of motor neuroscience, social behavior and digital health technology, and promote the transformation of intervention measures from empirical practice to precise and individualized paradigms, and ultimately provide evidence-based basis for building a new paradigm of “low-cost, high-adaptive, and sustainable” tumor rehabilitation under the background of global aging.

Ethical approval: Not applicable.

Informed consent statement: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

References

1. Giallauria BF, Testa C, Cuomo G, et al. Exercise training in elderly cancer patients: A systematic review. *Cancers (Basel)*. 2023; 15(6): 1671. doi: 10.3390/cancers15061671
2. Swartz MC, Lewis ZH, Lyons EJ, et al. Effect of home- and community-based physical activity interventions on physical function among cancer survivors: A systematic review and meta-analysis. *Arch Phys Med Rehabil*. 2017; 98(8): 1652-1665. doi: 10.1016/j.apmr.2017.03.017
3. Shorey S, Chan V. The experiences and needs of Asian older adults who are socially isolated and lonely: A qualitative systematic review. *Arch Gerontol Geriatr*. 2021; 92: 104254. doi: 10.1016/j.archger.2020.104254
4. Haase KR, Sattar S, Hall S, et al. Systematic review of self-management interventions for older adults with cancer. *Psychooncology*. 2021; 30(7): 98-1008. doi: 10.1002/pon.5649
5. Zhang S, Li J, Hu X. Peer support interventions on quality of life, depression, anxiety, and self-efficacy among patients with cancer: A systematic review and meta-analysis. *Patient Educ Couns*. 2022; 105(11): 3213-3224. doi: 10.1016/j.pec.2022.07.008
6. Rabbia J. Dance as a community-based exercise in older adults. *Top Geriatr Rehabil*. 2010; 26(4): 353-360. doi: 10.1097/TGR.0b013e3181fee5cc
7. Bandura A. Exercise of human agency through collective efficacy. *Curr Dir Psychol Sci*. 2000; 9(3): 75-78. doi: 10.1111/1467-8721.00064
8. Liu X, Du Q, Fan H, Wang Y. The impact of square dancing on psychological well-being and life satisfaction among aging women. *Sci Rep*. 2024; 14(1): 10405. doi: 10.1038/s41598-024-61143-x
9. McNeely ML. Effects of exercise on breast cancer patients and survivors: A systematic review and meta-analysis. *Can Med Assoc J*. 2006; 175(1): 34-41. doi: 10.1503/cmaj.051073
10. Haslam SA, Haslam C, Cruwys T, et al. Social identity makes group-based social connection possible: Implications for loneliness and mental health. *Curr Opin Psychol*. 2022; 43: 161-165. doi: 10.1016/j.copsyc.2021.07.013
11. Matta Mello Portugal E, Cevada T, Sobral Monteiro-Junior R, et al. Neuroscience of exercise: From neurobiology mechanisms to mental health. *Neuropsychobiology*. 2013; 68(1): 1-14. doi: 10.1159/000350946
12. Magnuson A, Mohile S, Janelins M. Cognition and cognitive impairment in older adults with cancer. *Curr Geriatr Rep*. 2016; 5(3): 213-219. doi: 10.1007/s13670-016-0182-9
13. Azizoddin DR, Schreiber K, Beck MR, et al. Chronic pain severity, impact, and opioid use among patients with cancer: An analysis of biopsychosocial factors using the CHOIR learning health care system. *Cancer*. 2021; 127(17): 3254-3263. doi: 10.1002/cncr.33645
14. Moore S, Leung B, Bates A, Ho C. Social isolation: Impact on treatment and survival in patients with advanced cancer. *Journal of Clinical Oncology*. 2018; 36(34_suppl): 156. doi: 10.1200/JCO.2018.36.34_suppl.156
15. Xiaodan L, Guiru X, Guojuan C, Huimin X. Self-perceived burden predicts lower quality of life in advanced cancer patients: The mediating role of existential distress and anxiety. *BMC Geriatr*. 2022; 22(1): 803. doi: 10.1186/s12877-022-03494-6
16. Deimling GT, Bowman KF, Wagner LJ. Cancer survivorship and identity among long-term survivors. *Cancer Invest*. 2007; 25(8): 758-765. doi: 10.1080/07357900600896323
17. Dariusz D. Association with and dissociation from groups in response to personal and social identity threats: The role of self-construal and anxiety. *Open Psychol J*. 2022; 15(1). doi: 10.2174/18743501-v15-e2208151
18. Lu X, Yao Y, Jin Y. Digital exclusion and functional dependence in older people: Findings from five longitudinal cohort studies. *EClinicalMedicine*. 2022; 54: 101708. doi: 10.1016/j.eclinm.2022.101708
19. Mohan R, Saleem R, Voderhobli K, Sheikh-Akbari A. Ensuring sustainable digital inclusion among the elderly: A comprehensive analysis. *Sustainability*. 2024; 16(17): 7485. doi: 10.3390/su16177485
20. Tulupova ON. Transfessional content of management culture in the medical field: The balance of objective alienation and involvement. *Vestnik Tomskogo gosudarstvennogo universiteta. Kul'turologiya i iskusstvovedenie*. 2020; (38): 136-144. doi: 10.17223/22220836/38/13
21. Beeken RJ, Simon AE, von Wagner C, et al. Cancer fatalism: Deterring early presentation and increasing social inequalities?. *Cancer Epidemiology, Biomarkers & Prevention*. 2011; 20(10): 2127-2131. doi: 10.1158/1055-9965.EPI-11-0437

22. Wang H, Lee C, Hunter S, et al. Longitudinal analysis of the impact of loneliness on cognitive function over a 20-year follow-up. *Aging Ment Health*. 2020; 24(11): 1815-1821. doi: 10.1080/13607863.2019.1655704
23. Burris JL, Andrykowski M. Disparities in mental health between rural and nonrural cancer survivors: A preliminary study. *Psychooncology*. 2010; 19(6): 637-645. doi: 10.1002/pon.1600
24. Lavingia, Jones K, Asghar-Ali AA. A systematic review of barriers faced by older adults in seeking and accessing mental health care. *J Psychiatr Pract*. 2020; 26(5): 367-382. doi: 10.1097/PRA.0000000000000491
25. Soto-Perez-de-Celis E, de Glas N A, Hsu T, et al. Global geriatric oncology: Achievements and challenges. *J Geriatr Oncol*. 2017; 8(5): 374-386. doi: 10.1016/j.jgo.2017.06.001
26. Surbone A, Kagawa-Singer M, Terret C, Baider L. The illness trajectory of elderly cancer patients across cultures: SIOG position paper. *Annals of Oncology*. 2007; 18(4): 633-638. doi: 10.1093/annonc/mdl178
27. Lange M, Heutte N, Rigal O, et al. Decline in cognitive function in older adults with early-stage breast cancer after adjuvant treatment. *Oncologist*. 2016; 21(11): 1337-1348. doi: 10.1634/theoncologist.2016-0014
28. Mohile SG, Lacy M, Rodin M, et al. Cognitive effects of androgen deprivation therapy in an older cohort of men with prostate cancer. *Crit Rev Oncol Hemato*. 2010; 75(2): 152-159. doi: 10.1016/j.critrevonc.2010.06.009
29. Wu CS, Wang SC, Chang IS, Lin KM. The association between dementia and long-term use of benzodiazepine in the elderly: Nested case-control study using claims data. *The American Journal of Geriatric Psychiatry*. 2009; 17(7): 614-620. doi: 10.1097/JGP.0b013e3181a65210
30. Mandilaras V, Wan-Chow-Wah D, Monette J, et al. The impact of cancer therapy on cognition in the elderly. *Front Pharmacol*. 2013; 4: 48. doi: 10.3389/fphar.2013.00048
31. Puustinen J, Nurminen J, Löppönen M, et al. Use of CNS medications and cognitive decline in the aged: A longitudinal population-based study. *BMC Geriatr*. 2011; 11(1): 70. doi: 10.1186/1471-2318-11-70
32. Clifton K, Gao F, Jabbari JA, et al. Loneliness, social isolation, and social support in older adults with active cancer during the COVID-19 pandemic. *J Geriatr Oncol*. 2022; 13(8): 1122-1131. doi: 10.1016/j.jgo.2022.08.003
33. Singh S, Fletcher GG, Yao X, Sussman, J. Virtual care in patients with cancer: A systematic review. *Current Oncology*. 2021; 28(5): 3488-3506. doi: 10.3390/curroncol28050301
34. Yli-Uotil T, Rantanen A, Suominen T. Online social support received by patients with cancer. *CIN: Computers, Informatics, Nursing*. 2014; 32(3): 118-126. doi: 10.1097/CIN.0000000000000028
35. Mantovani G, Astara G, Lampis B, et al. Impact of psychosocial intervention on the quality of life of elderly cancer patients. *Psychooncology*. 1996; 5(2): 127-135. doi: 10.1002/(SICI)1099-1611(199606)5:2<127::AID-PON220>3.0.CO;2-L
36. Lapid MI, Rummans TA, Brown PD, et al. Improving the quality of life of geriatric cancer patients with a structured multidisciplinary intervention: A randomized controlled trial. *Palliat Support Care*. 2007; 5(2): 107-114. doi: 10.1017/S1478951507070174
37. Kotronoulas G. Benefits, challenges, and opportunities of integrating patient-reported outcome measures in geriatric oncology to advance patient screening for functional fitness for treatment. *Semin Oncol Nurs*. 2021; 37(6): 151230. doi: 10.1016/j.soncn.2021.151230
38. Hwang J, Wang L, Siever J, et al. Loneliness and social isolation among older adults in a community exercise program: A qualitative study. *Aging Ment Health*. 2019; 23(6): 736-742. doi: 10.1080/13607863.2018.1450835
39. Ha D, Kerr J, Ries AL, et al. A model-based cost-effectiveness analysis of an exercise program for lung cancer survivors after curative-intent treatment. *Am J Phys Med Rehabil*. 2020; 99(3): 233-240. doi: 10.1097/PHM.0000000000001281
40. Schmidt LL, Johnson S, Rebecca Genoe M, et al. Social interaction and physical activity among rural older adults: A scoping review. *J Aging Phys Act*. 2022; 30(3): 495-509. doi: 10.1123/japa.2021-0046
41. Liao J, Chen S, Chen S, Yang YJ. Personal and social environmental correlates of square dancing habits in Chinese middle-aged and older adults living in communities. *J Aging Phys Act*. 2019; 27(5): 696-702. doi: 10.1123/japa.2018-0310
42. Butler M, Snook B, Buck R. The transformative potential of community dance for people with cancer. *Qual Health Res*. 2016; 26(14): 1928-1938. doi: 10.1177/1049732315602721
43. Suberry A, Bodner E. The impact of synchronized dyadic dance on social bonding and intergroup closeness. *Innov Aging*. 2024; 8(Supplement_1): 187-188. doi: 10.1093/geroni/igae098.0606
44. Yu H, Miao W, Ji E, et al. Social touch-like tactile stimulation activates a tachykinin 1-oxytocin pathway to promote social interactions. *Neuron*. 2022; 110(6): 1051-1067. doi: 10.1016/j.neuron.2021.12.022

45. Basso JC, Tasnim NE, Aychman M, et al. 489 Examining the clinical utility of dance to support social connection—Explorations at the level of the brain, heart, and body. *J Clin Transl Sci*. 2024; 8(s1): 144-145. doi: 10.1017/cts.2024.415
46. Dimeo F, Rumberger BG, KEUL J. Aerobic exercise as therapy for cancer fatigue. *Medicine & Science in Sports & Exercise*. 1998; 30(4): 475-478. doi: 10.1097/00005768-199804000-00001
47. Hartman SJ, Natarajan L, Palmer BW, et al. Impact of increasing physical activity on cognitive functioning in breast cancer survivors: Rationale and study design of Memory & Motion. *Contemp Clin Trials*. 2015; 45: 371-376. doi: 10.1016/j.cct.2015.09.021
48. Altmann U, Schoenherr D, Paulick J, et al. Associations between movement synchrony and outcome in patients with social anxiety disorder: Evidence for treatment specific effects. *Psychotherapy Research*. 2020; 30(5): 574-590. doi: 10.1080/10503307.2019.1630779
49. Alizadeh AM, Heydari Z, Rahimi M, et al. Oxytocin mediates the beneficial effects of the exercise training on breast cancer. *Exp Physiol*. 2018; 103(2): 222-235. doi: 10.1113/EP086463
50. Hilfiker R, Meichtry A, Eicher M, et al. Exercise and other non-pharmaceutical interventions for cancer-related fatigue in patients during or after cancer treatment: A systematic review incorporating an indirect-comparisons meta-analysis. *Br J Sports Med*. 2018; 52(10): 651-658. doi: 10.1136/bjsports-2016-096422
51. Czamanski-Cohen J, Wiley J, Weihs KL. Protocol for the REPAT study: role of emotional processing in art therapy for breast cancer palliative care patients. *BMJ Open*. 2020; 10(11): e037521. doi: 10.1136/bmjopen-2020-037521
52. Ferguson RJ, Sigmon ST, Pritchard AJ, et al. A randomized trial of videoconference-delivered cognitive behavioral therapy for survivors of breast cancer with self-reported cognitive dysfunction. *Cancer*. 2016; 122(11): 1782-1791. doi: 10.1002/cncr.29891
53. Jean-Pierre P, Mohile S, Morrow G, et al. Neuroprotective effect of SSRI among 781 cancer patients receiving chemotherapy: A URCC CCOP Study. *Journal of Clinical Oncology*. 2009; 27(15_suppl): 9512-9512. doi: 10.1200/jco.2009.27.15_suppl.9512
54. Welch Morelli WA, Cadmus-Bertram L, Siddique J, et al. Physical activity, sedentary behavior, and social cognitive factors in inactive, breast and endometrial cancer survivors using ecological momentary assessment. *Med Sci Sports Exerc*. 2023; 55(9S): 306-306. doi: 10.1249/01.mss.0000982592.26849.20
55. Solomonov N, Victoria LW, Lyons K, et al. Social reward processing in depressed and healthy individuals across the lifespan: A systematic review and a preliminary coordinate-based meta-analysis of fMRI studies. *Behavioural Brain Research*. 2023; 454: 114632. doi: 10.1016/j.bbr.2023.114632
56. Chirikos TN, Russell-Jacobs A, Cantor AB. Cantor, Indirect economic effects of long-term breast cancer survival. *Cancer Pract*. 2002; 10(5): 248-255. doi: 10.1046/j.1523-5394.2002.105004.x
57. Katz AC, Norr AM, Buck B, et al. Changes in physiological reactivity in response to the trauma memory during prolonged exposure and virtual reality exposure therapy for posttraumatic stress disorder. *Psychol Trauma*. 2020; 12(7): 756-764. doi: 10.1037/tra0000567
58. Arksey H, O'malley L. Scoping studies: Towards a methodological framework. *Int J Soc Res Methodol*. 2005; 8(1): 19-32. doi: 10.1080/1364557032000119616
59. Chen Y R R, Schulz P J. The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review. *J Med Internet Res*. 2016; 18(1): e18. doi: 10.2196/jmir.4596
60. Mikkelsen MK, Lund CM, Vinther A, et al. Effects of a 12-week multimodal exercise intervention among older patients with advanced cancer: results from a randomized controlled trial. *Oncologist*. 2022; 27(1): 67-78. doi: 10.1002/onco.13970
61. Mustian KM, Alfano CM, Heckler C, et al. Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue. *JAMA Oncol*. 2017; 3(7): 961. doi: 10.1001/jamaoncol.2016.6914
62. Baker S, Warburton J, Waycott J, et al. Combatting social isolation and increasing social participation of older adults through the use of technology: A systematic review of existing evidence. *Australas J Ageing*. 2018; 37(3): 184-193. doi: 10.1111/ajag.12572
63. Carl J, Barratt J, Wanner P, et al. The effectiveness of physical literacy interventions: A systematic review with meta-analysis. *Sports Medicine*. 2022; 52(12): 2965-2999. doi: 10.1007/s40279-022-01738-4
64. Adams RN, Mosher CE, Abonour R, et al. Cognitive and situational precipitants of loneliness among patients with cancer: A qualitative analysis. *Oncol Nurs Forum*. 2016; 43(2): 156-163. doi: 10.1188/16.ONF.156-163

65. Ou K, Wong MYC, Chung PK, et al. Effect of square dance interventions on physical and mental health among Chinese older adults: A systematic review. *Int J Environ Res Public Health*. 2022; 19(10): 6181. doi: 10.3390/ijerph19106181
66. Midtgaard J, Rorth M, Stelter R, et al. The group matters: An explorative study of group cohesion and quality of life in cancer patients participating in physical exercise intervention during treatment. *Eur J Cancer Care (Engl)*. 2006; 15(1): 25-33. doi: 10.1111/j.1365-2354.2005.00616.x
67. Savikko N, Routasalo P, Tilvis R, et al. Psychosocial group rehabilitation for lonely older people: Favourable processes and mediating factors of the intervention leading to alleviated loneliness. *Int J Older People Nurs*. 2010; 5(1): 16-24. doi: 10.1111/j.1748-3743.2009.00191.x
68. Guida JL, Holt CL, Dallal CM, et al. Social relationships and functional impairment in aging cancer survivors: A longitudinal social network study. *Gerontologist*. 2020; 60(4): 607-616. doi: 10.1093/geront/gnz051
69. Shvedko A, Whittaker AC, Thompson JL, Greig CA. Physical activity interventions for treatment of social isolation, loneliness or low social support in older adults: A systematic review and meta-analysis of randomised controlled trials. *Psychol Sport Exerc*. 2018; 34: 128-137. doi: 10.1016/j.psychsport.2017.10.003
70. Courneya KS. Exercise in cancer survivors: An overview of research. *Med Sci Sports Exerc*. 2003; 35(11): 1846-1852. doi: 10.1249/01.MSS.0000093622.41587.B6
71. Poscia A, Stojanovic J, La Milia D I, et al. Interventions targeting loneliness and social isolation among the older people: An update systematic review. *Exp Gerontol*. 2018; 102: 133-144. doi: 10.1016/j.exger.2017.11.017
72. Chiao C, Weng LJ, Botticello AL. Social participation reduces depressive symptoms among older adults: An 18-year longitudinal analysis in Taiwan. *BMC Public Health*. 2011; 11(1): 292. doi: 10.1186/1471-2458-11-292
73. Routasalo PE, Tilvis RS, Kautiainen H, Pitkala KH. Effects of psychosocial group rehabilitation on social functioning, loneliness and well-being of lonely, older people: Randomized controlled trial. *J Adv Nurs*. 2009; 65(2): 297-305. doi: 10.1111/j.1365-2648.2008.04837.x
74. Gillison FB, Skevington SM, Sato A, Evangelidou S. The effects of exercise interventions on quality of life in clinical and healthy populations; A meta-analysis. *Soc Sci Med*. 2009; 68(9): 1700-1710. doi: 10.1016/j.socscimed.2009.02.028
75. Cohen-Mansfield J, Perach R. Interventions for alleviating loneliness among older persons: A critical review. *American Journal of Health Promotion*. 2015; 29(3): e109-e125. doi: 10.4278/ajhp.130418-LIT-182
76. Niedzwiedz CL, Richardson EA, Tunstall H, et al. The relationship between wealth and loneliness among older people across Europe: Is social participation protective?. *Prev Med (Baltim)*. 2016; 91: 24-31. doi: 10.1016/j.ypmed.2016.07.016
77. Nijboer C, Tempelaar R, Triemstra M, et al. The role of social and psychologic resources in caregiving of cancer patients. *Cancer*. 2001; 91(5): 1029-1039. doi: 10.1002/1097-0142(20010301)91:5<1029::AID-CNCR1094>3.0.CO;2-1
78. Pitkala KH, Routasalo P, Kautiainen H, et al. Effects of psychosocial group rehabilitation on health, use of health care services, and mortality of older persons suffering from loneliness: A randomized, controlled trial. *J Gerontol A Biol Sci Med Sci*. 2009; 64A(7): 792-800. doi: 10.1093/gerona/glp011
79. Bouaziz W, Lang P O, Schmitt E, et al. Health benefits of multicomponent training programmes in seniors: A systematic review. *Int J Clin Pract*. 2016; 70(7): 520-536. doi: 10.1111/ijcp.12822
80. Usta YY. Importance of social support in cancer patients. *Asian Pacific Journal of Cancer Prevention*. 2012; 13(8): 3569-3572. doi: 10.7314/APJCP.2012.13.8.3569
81. Fong Yan A, Cobley S, Chan C, et al. The effectiveness of dance interventions on physical health outcomes compared to other forms of physical activity: A systematic review and meta-analysis. *Sports Medicine*; 2018; 48(4): 933-951. doi: 10.1007/s40279-017-0853-5
82. Kadambi S, Soto-Perez-de-Celis E, Garg T, et al. Social support for older adults with cancer: Young International Society of Geriatric Oncology review paper. *J Geriatr Oncol*. 2020; 11(2): 217-22. doi: 10.1016/j.jgo.2019.09.005
83. Bradt J, Shim M, Goodill SW. Goodill, Dance/movement therapy for improving psychological and physical outcomes in cancer patients. *Cochrane Database of Systematic Reviews*. 2015. doi: 10.1002/14651858.CD007103.pub3
84. Wurz A, St-Aubin A, Brunet J. Breast cancer survivors' barriers and motives for participating in a group-based physical activity program offered in the community. *Supportive Care in Cancer*. 2015; 23(8): 2407-2416. doi: 10.1007/s00520-014-2596-2
85. Williams GR, Pisu M, Rocque GB, et al. Unmet social support needs among older adults with cancer. *Cancer*. 2019; 125(3): 473-481. doi: 10.1002/cncr.31809

86. Ehlers DK, Daugherty AM, Burzynska AZ, et al. Regional brain volumes moderate, but do not mediate, the effects of group-based exercise training on reductions in loneliness in older adults. *Front Aging Neurosci.* 2017; 9. doi: 10.3389/fnagi.2017.00110
87. Watts EL, Matthews CE, Freeman JR, et al. Association of leisure time physical activity types and risks of all-cause, cardiovascular, and cancer mortality among older adults. *JAMA Netw Open.* 2022; 5(8): e2228510. doi: 10.1001/jamanetworkopen.2022.28510
88. Adams RN, Mosher CE, Winger JG, et al. Cancer-related loneliness mediates the relationships between social constraints and symptoms among cancer patients. *J Behav Med.* 2018; 41(2): 243-252. doi: 10.1007/s10865-017-9892-5
89. Penedo FJ, Schneiderman N, Dahn JR, et al. Physical activity interventions in the elderly: Cancer and comorbidity. *Cancer Invest.* 2004; 22(1): 51-67. doi: 10.1081/CNV-120027580
90. Drageset J, Eide GE, Dysvik E, et al. Loneliness, loss, and social support among cognitively intact older people with cancer, living in nursing homes—A mixed-methods study. *Clin Interv Aging.* 2015; 1529-1536. doi: 10.2147/CIA.S88404
91. Copur MS, Ramaekers R, Gönen M, et al. ReCAP: Impact of the national cancer institute community cancer centers program on clinical trial and related activities at a community cancer center in rural Nebraska. *J Oncol Pract.* 2016; 12(1): 67-68. doi: 10.1200/JOP.2015.005736
92. Copur MS, Ramaekers R, Gönen M, et al. The cancer loneliness scale and cancer-related negative social expectations scale: Development and validation. *Quality of Life Research.* 2017; 26(7): 1901-1913. doi: 10.1007/s11136-017-1518-4
93. Durosini I, Triberti S, Sebri V, et al. Psychological benefits of a sport-based program for female cancer survivors: The role of social connections. *Front Psychol.* 2021; 12. doi: 10.3389/fpsyg.2021.751077
94. Kraav SL, Lehto SM, Kauhanen J, et al. Loneliness and social isolation increase cancer incidence in a cohort of Finnish middle-aged men. A longitudinal study. *Psychiatry Res.* 2021; 299: 113868. doi: 10.1016/j.psychres.2021.113868
95. McElfresh JJ, Skiba MB, Segrin CG, et al. Interventions for loneliness among adult cancer survivors: A systematic review and meta-analysis. *J Psychosoc Oncol.* 2021; 39(4): 509-533. doi: 10.1080/07347332.2020.1867690
96. Sabiston CM, Fong AJ, O'Loughlin EK, Meterissian S. A mixed-methods evaluation of a community physical activity program for breast cancer survivors. *J Transl Med.* 2019; 17(1): 206. doi: 10.1186/s12967-019-1958-4
97. You LF, Yeh JR, Su MC. Su, Expression profiles of loneliness-associated genes for survival prediction in cancer patients. *Asian Pacific Journal of Cancer Prevention.* 2014; 15(1): 185-190. doi: 10.7314/APJCP.2014.15.1.185
98. Haslam SA, McMahon C, Cruwys T, et al. Social cure, what social cure? The propensity to underestimate the importance of social factors for health. *Soc Sci Med.* 2018; 198: 14-21. doi: 10.1016/j.socscimed.2017.12.020