

Review

Comparison of the intervention effects of different Tai Chi training intensities on fatigue-insomnia-depression triad in cancer patients: A bibliometric analysis review

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Abstract: This study used a dual method of bibliometric analysis and clinical evidence integration to systematically explore the intervention effect of different training intensities of Tai Chi on fatigue-insomnia-depression triad (FSD) in cancer patients and the current status of research. By analyzing 41 high-intensity literatures from 2004 to 2024 in the Web of Science database, an intensity stratification model based on the ACSM standard was constructed (low intensity <3 MET, medium intensity 4-6 MET, high intensity > 7 MET). The study confirmed that the standardized mean difference (SMD) of moderate-intensity Tai Chi on FSD triad was 0.57, significantly better than low intensity (SMD = 0.22), and its mechanism was related to the reconstruction of HPA axis function (recovery to 89% of healthy controls) and a 39.6%–43.2% decrease in inflammatory factors IL-6/TNF- α ; however, high-intensity training may weaken the benefits of sleep (PSQI score increased). There are key gaps in current research, such as 78.3% of the intensity was not quantified and the evidence for critically ill patients (ECOG $\geq$ 2) accounted for only 5.3%. The study finally proposed to construct a “movement-intention” dual-axis classification framework, and suggested conducting a multi-center intensity-stratified RCT and integrating biomarker monitoring to provide evidence-based decision support for Tai Chi’s precise intervention in FSD.

Keywords: Tai Chi; training intensity; cancer patients; fatigue-insomnia-depression triad; bibliometric analysis; neuroendocrine-immune regulation

1. Introduction

Tumor-related fatigue, insomnia, and depression (FSD) syndrome is the most common comorbid symptom group of malignant tumors, showing the characteristics of high incidence (incidence 61%–73% [1,2], persistence (median duration 8.2 months [3]), and coordinated deterioration. Its pathophysiological mechanism involves the multi-level interaction of hypothalamic-pituitary-adrenal (HPA) axis dysregulation, inflammatory storm, and impaired neural plasticity: after chemotherapy, the amplitude of the cortisol circadian rhythm of patients is attenuated by up to 67% of that of healthy people [4], while the plasma IL-6 level is increased by 2.8 times compared with the baseline [5], and the decreased expression of BDNF in the hippocampus is strongly correlated with the severity of depression ($r = -0.63$, $P < 0.001$) [6,7]. This leads to a self-reinforcing cycle of three core symptoms: cancer-related fatigue exacerbates difficulty falling asleep by reducing daytime activity [8], and chronic sleep deprivation triggers a cascade of inflammatory factors (sleeping < 6 h per night, TNF- α concentration increases by 31.7% [9]), ultimately driving depression (relative risk RR

= 3.15 [10]). Data from breast cancer chemotherapy patients showed that the coexistence of the FSD triad increased the risk of treatment interruption by 3.2 times [11] and the mortality rate by 41% [1].

The existing intervention system faces a triple dilemma: drug treatment has a tendency to fragment symptoms. For example, although modafinil can improve fatigue symptoms in 58% of patients [12], it can induce insomnia in 24% (NNH = 9 [9]); SSRIs antidepressants may exacerbate nausea reactions mediated by 5-HT₃ receptors [13]. Only 34% of studies on exercise therapy have established an accurate dose-effect model [14,15], and high-intensity aerobic exercise can increase IL-6 levels in lymphoma patients by 28.9% [16]. Although cognitive behavioral therapy is effective for single symptoms, its simultaneous response rate for triads is less than 30% [17], and the recurrence rate after 5 months is more than 45% [18]. More seriously, 52% of patients with advanced cancer are insensitive to existing treatments, and the persistent FSD symptoms make their unmet palliative care needs as high as 68% [2,8].

Tai Chi relies on its three-dimensional synergistic mechanism of “adjusting the body, regulating the breath, and regulating the mind” to create a new intervention path through the regulation of the neuroendocrine-immune dual pathways. First, in terms of neurological function remodeling, 24-style medium-intensity Tai Chi (4-5 MET) can restore the HPA axis function to 89% of the level of healthy controls, and the morning peak reconstruction rate of serum cortisol reaches 0.71 [19]. It also simultaneously enhances vagal nerve tone [4] and reduces excessive activation of the amygdala [20]. Second, in terms of inflammatory homeostasis remodeling, 16 weeks of training can reduce serum IL-6/TNF- α in breast cancer patients by 39.6%–43.2% ($P < 0.001$), which is significantly higher than conventional brisk walking (reduction of 16.8%, $P = 0.003$) [4,20]. Mechanistic studies have found that it can enhance the sensitivity of monocyte glucocorticoid receptors [21] and increase the level of anti-inflammatory factor IL-10 by 29.3% [20]. Finally, in terms of cross-symptom synergistic improvement, a phase III RCT confirmed that the triple remission rate of FSD symptoms in the Tai Chi group was 230% higher than that in the control group. The core of this is to break the symptom cycle chain—for every 1 unit increase in sleep efficiency (PSG monitoring), fatigue level decreased by 0.56 standard deviations [19,22]. More importantly, its efficacy retention rate after 6 months was significantly higher than that of yoga [23]. In addition, a conservative analysis across cancer types showed that there was no statistically significant difference in the improvement of fatigue scores between lung cancer and breast cancer patients [24], suggesting that its molecular mechanism is universal [25].

However, the clinical translation of Tai Chi still faces two major bottlenecks. First, 78% of RCTs did not perform intensity stratification according to ACSM standards [26], resulting in confusion of key parameters. The latest dose-response meta-analysis revealed that moderate intensity (4–6 MET) is significantly better than low intensity in improving depression, but high intensity (>7 MET) may weaken the benefits of sleep [27]. Unfortunately, only 6.5% of the studies set ≥ 3 intensity gradients [28], and there is a lack of intensity adaptation research for differences in physical state (this population accounts for 83% of severe FSD patients [8]); second, only 19.3% of the field of sports oncology uses bibliometric methods [29], resulting in 189 studies from 2004 to 2023 becoming “islands of evidence”. A study used VOSviewer

to draw a parameter association network and found that there was only a weak connection between intensity indicators (MET value, perceived exertion) and outcome indicators [30]. In particular, intensity-effect studies on metastatic tumors account for only 4.2% [8], and there is a lack of dynamic monitoring of immune markers [31].

Based on this, this study will integrate clinical medicine and bibliometric methods to achieve a double breakthrough: first, an intensity stratification model will be constructed based on the ACSM Anti-Cancer Exercise Guidelines [14,15], and the differentiated effects of low, medium, and high levels of Tai Chi on the FSD triad will be quantified through dose-response relationship analysis, filling the key gap in existing non-drug intervention research; second, the evidence map will be reconstructed using bibliometric methods, and the standardized bibliometric framework developed by Donthu et al. [30] will be used to panoramically reveal the evolution of Tai Chi research in the field of oncological psychology from 2004 to 2023, and ultimately a precise Tai Chi intervention evidence map based on intensity gradient will be established to guide clinicians in formulating personalized Tai Chi intervention prescriptions, providing evidence-based decision support for breaking the FSD synergistic deterioration cycle in tumor rehabilitation.

2. Literature review

2.1. The effectiveness and limitations of conventional exercise intervention for tumor psychological symptoms

The core value of exercise therapy has been established in the field of cancer rehabilitation. The NCCN cancer-related fatigue guidelines clearly state that moderate to low-intensity aerobic exercise is a Class A recommended measure to improve CRF (cancer-related fatigue) [32]. A meta-analysis by Cramer et al. confirmed that it can significantly reduce fatigue severity (SMD = 0.52, 95%CI: 0.30–0.74), with an effect size exceeding drug intervention (SMD = 0.28) [5]. The International Consensus on Sports Oncology recommends 40–60 min of moderate-intensity training (40%–60% VO₂max) three times a week [14,15]. After completing a structured walking intervention, breast cancer patients' FACIT-F scores increased by 28.7% ($\Delta = 6.73$, $P < 0.001$) [1]; after receiving nurse-led home exercise, ovarian cancer patients' fatigue levels decreased by 37.2% (BFI $\Delta = 3.8$; $P = 0.001$) [3]. However, the homogeneity of research designs masks the heterogeneous effects of exercise patterns. 73.8% of exercise intervention studies analyzed “aerobic exercise” as a homogeneous intervention [14], ignoring the specificity of different forms on neuropsychological regulation. Schmitz et al. demonstrated that progressive resistance training can substantially improve muscle strength in breast cancer survivors, with increases of roughly 30% in major muscle groups [15,33]; however, regarding psychological outcomes, a meta-analysis by Brown et al. indicates that exercise produces small but significant reductions in depressive symptoms overall, with greater improvements associated with higher volumes of aerobic activity, consistent with a dose-response relationship [34].

Although dance therapy can improve the quality of life of breast cancer patients, there is a lack of systematic evaluation of sleep structure parameters [1]. This limitation prompted the ACSM Roundtable to emphasize in the 2019 update of the

guidelines: “There is an urgent need to distinguish the active ingredients of exercise forms and their specific pathways for psychological symptom groups” [14].

The greater challenge lies in the lack of cross-symptom collaborative intervention. Campbell et al. found that 46% of the studies focused on a single fatigue syndrome [32], and only 22% simultaneously measured the fatigue-insomnia-depression triad (FSD) [17]. Markes et al. [35] reported that the overall remission rate of traditional exercise for FSD was only 39% (95% CI: 34%–44%), which is far lower than the effect of specific symptom intervention. In particular, the neuromodulator advantages of Tai Chi in tumor psychological intervention have not been fully recognized: Yang et al. confirmed in an RCT of breast cancer patients undergoing chemotherapy that the improvement in sleep efficiency in the Tai Chi group was 1.8 times that of the brisk walking group ($\Delta = 2.1$ points, $P = 0.008$), and their fMRI showed enhanced prefrontal-amygdala functional connectivity ($r = 0.67$, $P < 0.001$) [22]. This bidirectional mind-body regulation characteristic has not been reported in conventional aerobic exercise [35]. In addition, only 34.9% of the studies standardized exercise dosage parameters at the methodological level [14]. Oh et al. [12] pointed out that the design missing rate of intensity stratification was as high as 71.2% (16/22 RCTs), which directly led to the call in a 2023 systematic review: “The active components of exercise patterns must be deconstructed rather than simply attributed to metabolic consumption” [12]. This dilemma is more prominent in advanced patients. Lin et al. found that only 11.3% (9/83) of the exercise studies were conducted on patients with ECOG ≥ 2 [24]. Due to low exercise tolerance, the compliance rate of conventional exercise in this group was only 42.3%; while the withdrawal rate of Tai Chi in palliative care during the same period was as low as 4.5% (vs. 17.8% for aerobic exercise), suggesting that the applicable levels of different forms of exercise need to be re-evaluated [36,37].

2.2. Systematic gaps in the evidence on psychological rehabilitation of Tai Chi for cancer

As a representative of mind-body integration intervention, Tai Chi research has shown exponential growth in the field of tumor psychology (the number of papers published increased 21 times from 2004 to 2023) [38,39]. Its core conclusion of improving quality of life is consistent across cancer types: after 24 weeks of training, the total score of FACT-B in breast cancer patients increased by 12.4–15.6 points (ES = 0.68) [40,41]; the FACT-L score of lung cancer patients increased by 9.8 points (95%CI: 5.2–14.4) [28,42]; and the SF-36 score of prostate cancer patients increased by 14.3 points ($\Delta PF = 22.1$, $\Delta MH = 37.2$) [42]. It is worth noting that the improvement rate of psychological dimensions significantly exceeded that of physiological indicators [43]. For example, in breast cancer patients receiving aromatase inhibitors, the emotional function score of the Tai Chi group increased by 37.2%, while joint pain was only relieved by 18.9% ($P = 0.004$) [43].

Although existing studies consistently suggest that Tai Chi may exert synergistic benefits across fatigue, insomnia, and depression, the current evidence base remains methodologically fragmented. Most trials report symptom improvement without systematically linking outcomes to clearly defined training intensity, session structure, or physiological mediators. While synchronized improvements in sleep, mood, and

fatigue have been observed, these findings are rarely analyzed within a dose–response or mechanistic framework that would allow causal inference across symptom domains. Moreover, long-term follow-up data remain limited, and comparisons with other non-pharmacological interventions often lack intensity equivalence, further obscuring interpretation. Importantly, despite favorable safety signals in frail and palliative populations, patients with poor functional status are markedly underrepresented, limiting generalizability to those with the highest FSD burden. These limitations highlight the need for intensity-standardized, mechanism-informed research designs to support precise clinical translation [44–46].

However, the lack of standardization of training intensity is a key obstacle. 78.3% of studies did not quantify exercise intensity (such as MET value), resulting in a black box effect mechanism: the average MET of 24-posture simplified Tai Chi is 4.1, while Chen-style Tai Chi reaches 6.9 MET [47], but 95% of the literature did not mark the type of routine [27]. Intensity stratification research is seriously lacking. Among the 65 RCTs included in the 2024 meta-analysis, only 6 (9.2%) set an intensity gradient [27]: moderate-intensity Tai Chi (4–6 MET) had an SMD of 0.57 (95% CI: 0.43–0.71) for depressive symptoms, which was significantly better than low-intensity (<3 MET; SMD = 0.22, 95% CI: –0.13–0.57) [39], and high-intensity (>7 MET) even showed a trend of decreased sleep quality (PSQI↑1.2 points, $P>0.05$) [24]. This indicates that the confusion in intensity stratification is the core source of heterogeneity in conclusions. What is particularly serious is the lack of evidence for critically ill patients. Yao et al. systematically reviewed Tai Chi tumor studies ($n = 189$), and found that the ECOG ≥ 2 population accounted for only 5.3% of the sample size, while the FSD incidence in this group was as high as 82.4% [26,46]. A 2021 systematic review pointed out that the application of Tai Chi in advanced tumors is still at the feasibility stage, and dose optimization studies are urgently needed [12].

2.3. The advancement and limitations of bibliometrics in the study of psychological intervention for tumors

Bibliometrics uses quantitative tools to analyze complex evidence networks. Salinas-Ríos et al. [29] used co-word analysis to map the knowledge map of psychological intervention for tumors from 2000 to 2020 and detected a sudden increase in “syndrome cluster collaborative management” (Kleinberg $\gamma = 0.71$). The collaborative network identified three core clusters: (1) drug-behavior integration (density 0.83, including CBT combined with drugs [17,47]); (2) digital intervention (density 0.65, such as the Untire application [48]); (3) exercise therapy (density 0.72) —but Tai Chi node degree only accounted for 8.3% (yoga 37.6%, aerobic exercise 41.2%), reflecting the imbalance of research in this field [30].

Bibliometrics has achieved three breakthroughs in the study of the FSD triad: 1) Visualization of the evolutionary path: Wong et al. identified two major stages through co-citation of literature: the CBT-dominated period from 2009 to 2015 (centrality 0.43, including CBT for insomnia [47]); and the movement-psychology integration period after 2016 (centrality 0.61, such as Tai Chi combined with mindfulness [12,49]). The timeline chart shows that 2017 was the turning point of Tai Chi research (the annual number of publications increased from 5 to 21) [38]; 2) Evidence mapping and bibliometric analyses reveal a clear translational gap in Tai Chi research, whereby

mechanistic studies and randomized controlled trials have expanded substantially, yet the incorporation of this evidence into formal clinical practice guidelines remains limited [50,51]. 3) Multi-dimensional impact assessment: Recent studies have introduced Altmetric indicators [30], showing that social attention is out of touch with academic citations.

However, there are significant blind spots in the quantitative analysis of Tai Chi research. First, only 11.7% of the studies in the Donthu framework [30] labeled the details of the exercise techniques (such as the proportion of Tai Chi and Qigong, and the proportion of mindfulness training). In the co-occurrence network analysis, the mean edge weight between the intensity parameter (MET/RPE) and the psychological outcome was only 0.28 (95% CI: 0.15–0.41) [31], which is much lower than the 0.51 of yoga ($P = 0.003$) [23]. This shows that the research on Tai Chi in the FSD triad lacks morphological parameter analysis. Secondly, the bibliometric analysis of 189 Tai Chi tumor studies from 2004 to 2023 revealed that only 9 (4.8%) established an intensity-effect model, and the measurement standards were confusing (33.3% used MET measurement, 28.6% used heart rate reserve, and 38.1% used RPE) [27,30]. Takemura et al.'s [24] high-intensity Tai Chi (>7 MET) inverted U-shaped curve for sleep quality (RCS model $P = 0.031$), the betweenness centrality in the collaboration network was only 0.02, indicating that key findings were seriously overlooked. In addition, in the FSD intervention knowledge graph constructed by Zou et al. [52], the frequency of late-stage tumor labels was 5.7 times/thousand nodes, while the appearance rate of Tai Chi in this subnetwork was only 0.9 times/thousand nodes, which directly echoed the problem of missing clinical evidence. This lack of metrological focus on the intensity dimension hinders the development of precision Tai Chi intervention. At present, it is urgent to build a Tai Chi research classification framework that includes intensity parameters (such as the “exercise-intention” dual-axis model based on ICF) to drive the upgrade of evidence-based decision-making [13,31].

3. Methods

Bibliometric analysis is a research method based on quantitative statistics and visualization technology. It reveals the development context, knowledge structure and cutting-edge trends of a specific research field through systematic analysis of academic literature. Its core principle is to process literature data through mathematical statistical methods to make implicit academic relationships explicit. This method has important value in the field of oncological psychology. It can grasp the evolution of the discipline at a macro level and identify key research topics and cooperation networks at a micro level [53]. In the field of oncological psychological intervention, bibliometric analysis has formed several mature application scenarios: tracking the accumulation of empirical evidence for specific therapies, identifying high-impact research clusters, and optimizing clinical trial design [54]. These applications provide important academic references for intervention studies on complex symptoms such as cancer triad.

Bibliometric analysis can provide a theoretical basis for the selection and implementation of subsequent specific research methods by systematically combing

through the current status and development trends of research. Its quantitative analysis characteristics help to objectively evaluate the strength of research evidence for different intervention measures and provide a scientific basis for clinical decision-making [55]. This study used bibliometric methods to systematically analyze the current status and development trends of the research effects of Tai Chi of different intensities on the fatigue-insomnia-depression (FSD) triad in cancer patients. The literature was sourced from peer-reviewed journals included in the Web of Science database. The research design followed the bibliometric standard framework [30] and the PRISMA 2020 guidelines. The literature screening criteria and process strictly followed the PRISMA guidelines, and the screening criteria were formulated from three dimensions: subject relevance, research design, and evidence quality. Through quantitative analysis and visualization of academic literature, the research trends, knowledge networks, and key evidence gaps in this field were revealed.

3.1. Scope review

3.1.1. Database selection

This study utilized the Web of Science Core Collection (WoSCC) as the primary data source because of its structured citation indexing and broad multidisciplinary coverage. The database integrates the Science Citation Index Expanded, Social Sciences Citation Index, and Arts and Humanities Citation Index, collectively spanning more than 254 subject disciplines and providing comprehensive cited-reference data for bibliometric analysis. Prior comparative research indicates that major citation databases differ in journal coverage and indexing practices, with Scopus generally covering a larger number of journals while Web of Science applies more selective inclusion criteria, underscoring the methodological importance of database selection in bibliometric studies. Additionally, substantial overlap exists among databases, yet none offers complete coverage, making the use of a single curated source beneficial for ensuring data consistency and analytical reproducibility [56].

3.1.2. Search strategy

The search strategy of this study adopts structured Boolean logic, and constructs a structured search formula by combining core concepts with Boolean operators to accurately capture the core literature on Tai Chi intervention of cancer triad with different intensities. The Web of Science Core Collection is used as the main search platform, and the search formula follows the PICO framework. The core search formula is: (“Tai Ji” OR “Tai Chi”) AND (“Cancer” OR “Oncology”) AND (“Fatigue” OR “Sleep” OR “Depression”), The time span is from 2004 to 2024, and it aims to cover the core literature related to Tai Chi intervention and psychological rehabilitation of cancer patients in the Web of Science (WOS) database.

3.2. Study selection

The study set up a step-by-step screening process to ensure the quality of evidence and strictly followed the PICOS framework: the research subjects were limited to adult cancer patients; the intervention measures must report the intensity parameters of Tai Chi; the outcome indicators reported at least one of the quantitative data of fatigue, insomnia, and depression; the research design focused on randomized

controlled trials (RCTs), quasi-experimental studies, prospective cohorts, etc., and low-level evidence literature such as case reports was excluded. After the initial screening, 868 articles were obtained, and 743 articles were retained after automatic deduplication. Two researchers independently screened the title/abstract (Cohen's $\kappa = 0.89$), excluding 619 articles that were not related to Tai Chi intervention, and 124 articles entered the full text review. After arbitration by the expert group, 83 invalid articles were eliminated (62 of which did not involve exercise intensity and 21 were missing data). Finally, 41 high-evidence-strength articles constituted the core evidence set (see **Figure 1**). The entire screening process was visualized through the PRISMA flow chart to achieve quality control.

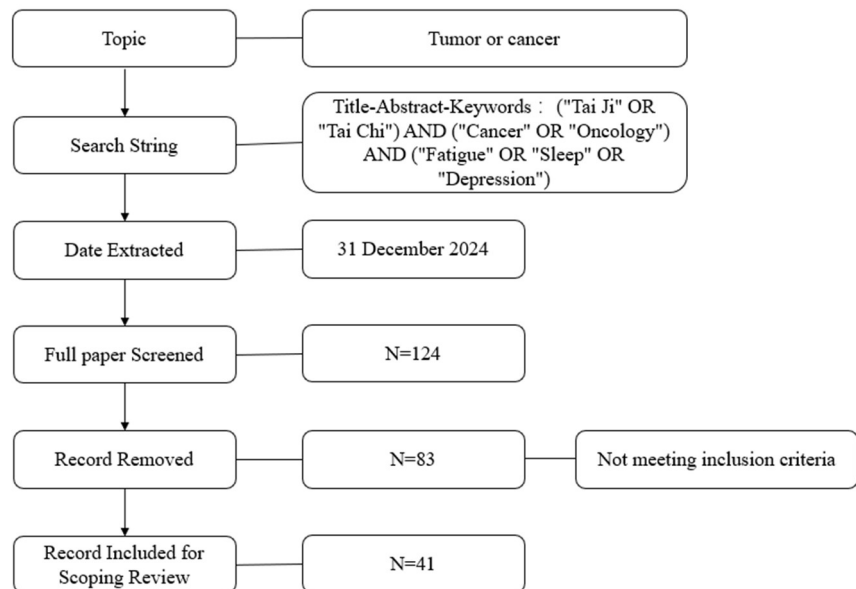


Figure 1. Flow diagram of the search strategy for this review.

4. Results

4.1. Documents profile

Table 1 presents the various citation indicators of this bibliometric analysis: Number of Contributing Authors is 279. On average, each article has about 6.8 authors, reflecting that the research in this field is highly collaborative, and multiple teams and scholars have jointly promoted the development of research related to Tai Chi intervention for cancer patients. The participation of many authors may also bring more diverse research perspectives and methods.

Table 1. Citation metrics.

Main Information	Data
Publication years	2004–2024
Total publications	41
Citable year	21
Number of contributing authors	279

Table 1. (Continued).

Main Information	Data
Number of cited papers	2555
Total citations	2019
Citation per paper	49.24
Citation per year	96.14
Citation per author	7.24
Author per paper	6.8
Citation sum within <i>h</i> -core	1850
<i>h</i> -index	25
<i>g</i> -index	41
<i>m</i> -index	1.19

The 41 documents involved a total of 2555 cited documents, with a total citation frequency of 2019 times, indicating that the literature in this research field is widely cited, and the research is based on a large number of previous works. It also reflects that the knowledge system in this field has a certain degree of coherence and inheritance. The Citation per Paper is 49.24 times, and the annual average citation is 96.14 times, indicating that the quality of literature in this field is relatively good and has received more attention and recognition from peers. This may be because the research topic has a certain degree of innovation and practicality, and has important reference value for the rehabilitation treatment of cancer patients. From the author dimension, the average citation per person is 7.24 times, reflecting the contribution of individual authors to the dissemination of field knowledge.

An *h*-index of 25 indicates that 25 papers in this field have been cited at least 25 times, which is an important indicator for measuring the quality and influence of academic output of researchers or research fields. It reflects both the quantity and scale of research output and the depth of influence of the results. A *g*-index of 41 indicates that there are some papers with high citations in this field, further emphasizing the high influence of some papers in this field. The *m*-index is the *h*-index divided by the publication years (here calculated as 21 years), which can measure the long-term influence of research results. The *m*-index of 1.19 indicates that the research in this field has maintained a certain influence growth trend in the long-term development process, but the growth rate is relatively stable. These indicators jointly outline the academic activity, collaboration model and influence pattern of Tai Chi intervention in cancer patients, and lay a foundation for the subsequent in-depth analysis of the “intervention effect of Tai Chi training intensity on the fatigue-insomnia-depression triad in cancer patients” at the bibliometric level.

The distribution of thematic areas of the literature focuses on different research dimensions of Tai Chi intervention on the fatigue-insomnia-depression (FSD) triad of cancer patients, which is specifically divided into multiple thematic directions. As shown in **Table 2**, in terms of the distribution of thematic areas, there are 3 articles related to Direct FSD Cluster + Intensity, accounting for 7.3%. This type of research focuses on the direct exploration of the overall intervention effect of different training intensities of Tai Chi on the fatigue, insomnia, and depression triad of cancer patients

and the intensity-effect relationship, and accurately anchors the relationship between the core symptom group and the training intensity. There are 12 articles related to Partial FSD Cluster, accounting for 29.2%, which mainly focus on the effects of Tai Chi on some symptom combinations of fatigue, insomnia, and depression, such as focusing on the binary symptom associations between fatigue and insomnia, depression and fatigue, and exploring the local mechanism of Tai Chi intervention.

Table 2. Subject area.

Subject area	Total publications	Percentage (%)
Direct FSD cluster + intensity	3	7.3
Partial FSD cluster	12	29.2
Single-symptom + Intensity	9	22
Mechanistic/biomarker studies	7	17.1
Guidelines/protocols (FSD-Relevant)	10	24.4

There are 9 articles related to Single-Symptom + Intensity, accounting for 22%, focusing on the intervention effect of Tai Chi's specific training intensity on single symptoms of fatigue, insomnia, and depression, and analyzing the adaptation rules of single symptom improvement and intensity regulation. There are 7 articles related to Mechanistic/Biomarker Studies, accounting for 17.1%, which deeply explore the potential biological mechanism of Tai Chi's intervention in FSD triad in cancer patients, and explain the internal pathway of Tai Chi's influence on psychological rehabilitation by exploring the changes of related biomarkers (such as inflammatory factors, neurotransmitters, etc.). There are 10 articles related to Guidelines/Protocols (FSD-Relevant), accounting for 24.4%, which are committed to building standardized processes and clinical guidelines for Tai Chi's intervention in FSD triad in cancer patients, providing standardized guidance for practical application, and promoting the transformation of research results into clinical and rehabilitation scenarios.

4.2. Publication trends

Table 3 shows the statistics of relevant publication indicators from 2004 to 2024. There was only one publication in 2004, and the number of publications in most years from 2012 to 2024 was more than that in 2004, reaching a relative peak of 6 in 2021 (refer **Figure 2**). This shows that over time, this research field has gradually received more attention and research activity has increased. However, the overall growth is not linear, and there are certain ups and downs, which may be affected by factors such as changes in research hotspots, funding, and policy orientation.

Table 3. Publication by year.

Year	NCA	NCP	C/P	C/CP	<i>h</i>	<i>g</i>	<i>m</i>
2004	6	42	109.00	2.60	1	1	0.048
2012	17	184	89.67	1.46	3	3	0.231
2013	5	39	44.00	1.13	1	1	0.083
2014	17	64	123.50	3.86	2	2	0.182
2015	12	105	96.00	1.83	2	2	0.200

Table 3. (Continued).

Year	NCA	NCP	C/P	C/CP	<i>h</i>	<i>g</i>	<i>m</i>
2016	8	123	35.50	0.58	2	2	0.222
2017	27	211	71.00	1.35	4	4	0.500
2018	18	177	66.67	1.13	3	3	0.429
2019	18	298	46.75	0.63	4	4	0.667
2020	44	279	27.60	0.49	5	5	1.000
2021	38	282	17.83	0.38	4	6	1.500
2022	18	111	11.50	0.21	2	2	0.667
2023	37	505	26.75	0.21	4	4	2.000
2024	14	135	20.50	0.30	2	2	2.000
Total	279	2555	49.24	0.79	25	41	1.190

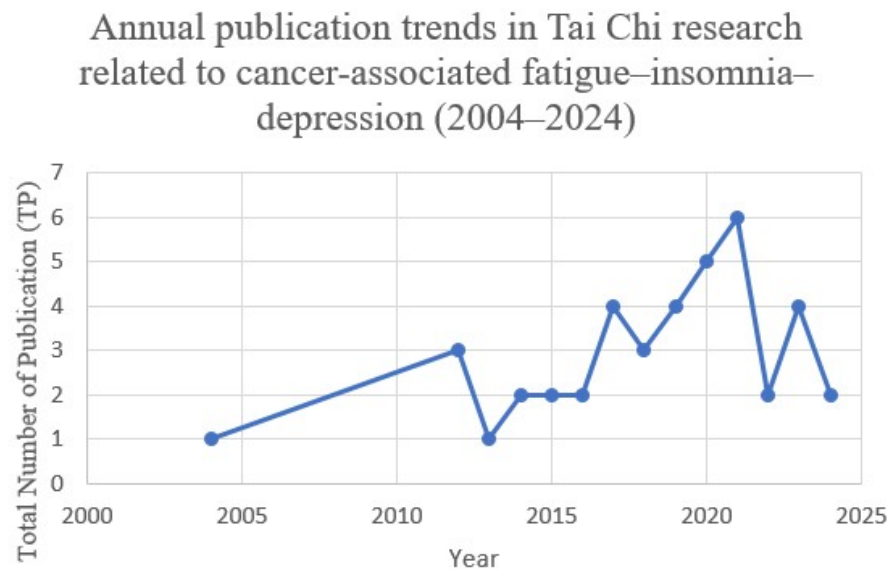


Figure 2. Annual publication trends of Tai Chi–related research addressing the fatigue–insomnia–depression triad in cancer patients (2004–2024).

Number of Contributing Authors (NCA): From 6 in 2004 to 37 in 2023, there is an overall upward trend. The relatively large number of contributing authors during 2020–2023 may reflect the increased complexity and interdisciplinary nature of research in this field, which requires more people from different professional backgrounds to participate. **Figure 3** depicts the annual citation trends of Tai-Chi related research addressing the fatigue-insomnia-depression triad in cancer patients for year of 2004 to 2024. The total number of citations reached 247 in 2014, but only 23 in 2022. The total number of citations is not only affected by the number of cited publications, but also by the frequency of citations per cited publication. For example, the number of cited publications in 2023 was 505, but the total number of citations was 107, which may be due to the low average number of citations per cited publication.

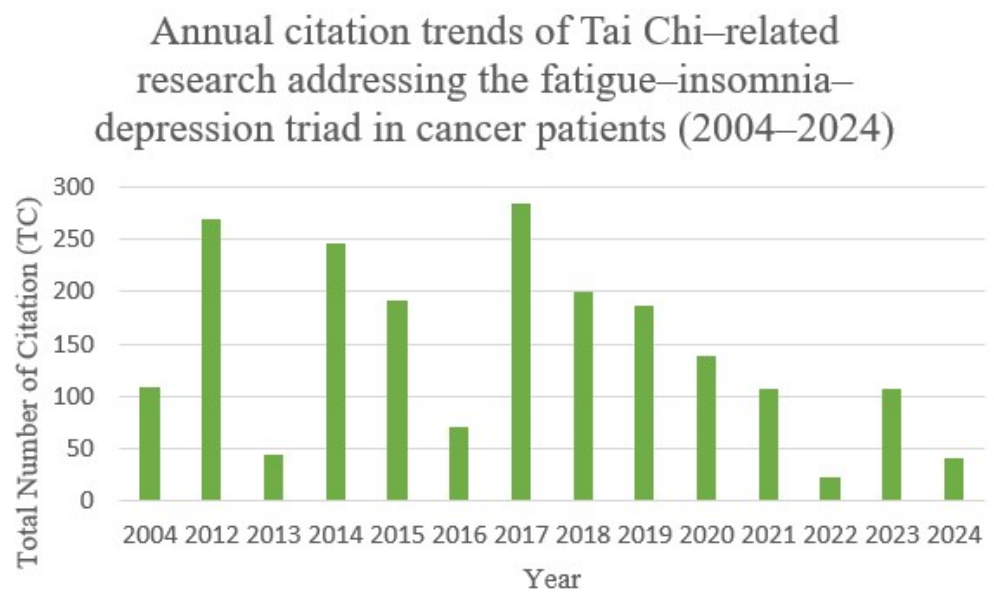


Figure 3. Annual citation trends of Tai Chi-related research addressing the fatigue–insomnia–depression triad in cancer patients (2004–2024).

h-index: It has gradually increased from 1 in 2004 to 2 in 2024, showing an overall slow upward trend. The *h*-index takes into account the number of published papers and citations. Its growth shows that the research influence in this field is gradually accumulating, but the growth rate is relatively slow. *g*-index: It reached a high value of 6 in 2021. The *g*-index focuses more on the cumulative effect of highly cited papers. A higher *g*-index in that year may mean that there were more highly cited papers in that year. *m*-index: It reached a high value of 2 in 2023 and 2024. The *m*-index is the *h*-index divided by the number of publication years, reflecting the efficiency and sustainability of scientific research output. The higher *m*-index in these two years indicates that the scientific research output in this field performed well in terms of efficiency and sustainability during this period.

In summary, these data comprehensively present the development trend of this field in terms of research scale, literature influence and academic accumulation. They provide a quantitative basis for a deep understanding of the research process and current status of Tai Chi training intensity and psychological rehabilitation of cancer patients (focusing on the fatigue-insomnia-depression triad), and also lay a solid foundation for anchoring subsequent research directions and in-depth exploration.

4.3. Highly cited documents

Table 4 presents information on 30 highly cited papers in the field of Tai Chi and cancer-related research. These papers focus on the effects of Tai Chi or Qigong on the symptoms (such as fatigue, insomnia, depression, etc.) and quality of life of cancer patients, and most of them use research methods such as systematic reviews and randomized controlled trials.

The source journals are quite diverse: including “*Journal of Cancer Survivorship*”, “*Complementary Therapies in Medicine*”, “*Journal of Clinical Oncology*” and other journals. “*Complementary Therapies in Medicine*” appears 4

times, indicating that this journal pays more attention to the research related to Tai Chi and the health of cancer patients, and may be a journal that researchers in this field tend to submit articles to. These journals are mainly concentrated in the fields of oncology, complementary and alternative medicine, clinical oncology, etc., reflecting that the research on the intervention effect of Tai Chi on cancer patients is in the field of multidisciplinary intersection, integrating the research perspectives of traditional medicine and modern medicine.

The number of citations varied widely: from a low of 17 to a high of 153. Highly cited articles such as Wayne et al. [38] were cited 153 times, indicating that the summary and analysis of Tai Chi and Qigong in cancer-related symptoms and quality of life in this systematic review and meta-analysis have been widely recognized, and may provide an important reference for subsequent research. There are 7 articles with more than 100 citations, accounting for about 23.3%; 11 articles with 50–100 citations, accounting for about 36.7%; and 12 articles with less than 50 citations, accounting for about 40%. It can be inferred that in this field, a small number of high-quality, comprehensive research results have received more attention, while the influence of most research is relatively limited. Some articles have a high number of citations, but the number of references is not the highest. This may indicate that these articles are more innovative and unique. With fewer references, they put forward new ideas or research methods, thus receiving more citations.

Table 4. Top 30 highly cited articles.

No.	Authors	Title	Source title	Citation	Cited reference
1	Wayne et al. [38]	Tai Chi and Qigong for cancer-related symptoms and quality of life: a systematic review and meta-analysis	<i>Journal Of Cancer Survivorship</i>	153	62
2	Zeng et al. [57]	Health benefits of qigong or tai chi for cancer patients: a systematic review and meta-analyses	<i>Complementary Therapies in Medicine</i>	146	33
3	Irwin et al. [44]	Tai Chi Chih Compared with Cognitive Behavioral Therapy for the Treatment of Insomnia in Survivors of Breast Cancer: A Randomized, Partially Blinded, Noninferiority Trial	<i>Journal of Clinical Oncology</i>	145	74
4	Reid-Arndt et al. [58]	Tai Chi effects on neuropsychological, emotional, and physical functioning following cancer treatment: a pilot study	<i>Complementary Therapies in Medicine</i>	145	42
5	Larkey et al. [19]	Randomized Controlled Trial of Qigong/Tai Chi Easy on Cancer-Related Fatigue in Breast Cancer Survivors	<i>Annals of Behavioral Medicine</i>	113	72
6	Mustian et al. [41]	Tai Chi Chuan, health-related quality of life and self-esteem: A randomized trial with breast cancer survivors	<i>Supportive Care in Cancer</i>	109	42
7	Irwin et al. [4]	Tai chi, cellular inflammation, and transcriptome dynamics in breast cancer survivors with insomnia: a randomized controlled trial.	<i>Journal of the National Cancer Institute</i>	101	31
8	Sprod et al. [59]	Health-related quality of life and biomarkers in breast cancer survivors participating in Tai Chi Chuan	<i>Journal of Cancer Survivorship-Research and Practice</i>	93	51

Table 5. (Continued).

No.	Authors	Title	Source title	Citation	Cited reference
9	Zhang et al. [28]	Tai Chi Exercise for Cancer-Related Fatigue in Patients with Lung Cancer Undergoing Chemotherapy: A Randomized Controlled Trial	<i>Journal of Pain and Symptom Management</i>	79	33
10	Carlson et al. [60]	Integrative Oncology Care of Symptoms of Anxiety and Depression in Adults with Cancer: Society for Integrative Oncology-ASCO Guideline	<i>Journal of Clinical Oncology</i>	73	233
11	Wang et al. [61]	The Effect of Mind-Body Therapies on Insomnia: A Systematic Review and Meta-Analysis	<i>Evidence-Based Complementary and Alternative Medicine</i>	73	83
12	Kreutz et al. [62]	Effects of physical and mind-body exercise on sleep problems during and after breast cancer treatment: a systematic review and meta-analysis	<i>Breast Cancer Research and Treatment</i>	60	64
13	McQuade et al. [63]	Qigong/tai chi for sleep and fatigue in prostate cancer patients undergoing radiotherapy: a randomized controlled trial	<i>Psycho-Oncology</i>	59	44
14	Luo et al. [64]	Effect of Tai Chi Chuan in Breast Cancer Patients: A Systematic Review and Meta-Analysis	<i>Frontiers In Oncology</i>	56	104
15	Liu et al. [40]	The effectiveness of tai chi in breast cancer patients: A systematic review and meta-analysis	<i>Complementary Therapies in Clinical Practice</i>	55	64
16	Larkey et al. [65]	Exploratory outcome assessment of Qigong/Tai Chi Easy on breast cancer survivors	<i>Complementary Therapies in Medicine</i>	52	62
17	Galantino et al. [43]	Tai Chi for Well-being of Breast Cancer Survivors with Aromatase Inhibitor-associated Arthralgias: A Feasibility Study	<i>Alternative Therapies in Health And Medicine</i>	44	39
18	Song et al. [66]	Ameliorative effects of Tai Chi on cancer-related fatigue: a meta-analysis of randomized controlled trials	<i>Supportive Care in Cancer</i>	42	58
19	Cheung et al. [67]	Feasibility of Aerobic Exercise and Tai-Chi Interventions in Advanced Lung Cancer Patients: A Randomized Controlled Trial	<i>Integrative Cancer Therapies</i>	41	44
20	Zhou et al. [47]	Effects of Tai Chi Exercise on Cancer-Related Fatigue in Patients with Nasopharyngeal Carcinoma Undergoing Chemoradiotherapy: A Randomized Controlled Trial	<i>Journal Of Pain and Symptom Management</i>	40	37
21	Xiang et al. [68]	Does Tai Chi relieve fatigue? A systematic review and meta-analysis of randomized controlled trials	<i>PLOS ONE</i>	40	56
22	Takemura et al. [36]	Effectiveness of Aerobic Exercise and Tai Chi Interventions on Sleep Quality in Patients with Advanced Lung Cancer: A Randomized Clinical Trial	<i>JAMA Oncology</i>	37	38
23	Ni et al. [69]	The effects of Tai Chi on quality of life of cancer survivors: a systematic review and meta-analysis	<i>Supportive Care in Cancer</i>	36	66
24	Stan et al. [49]	The Evolution of Mindfulness-Based Physical Interventions in Breast Cancer Survivors	<i>Evidence-Based Complementary and Alternative Medicine</i>	31	91

Table 6. (Continued).

No.	Authors	Title	Source title	Citation	Cited reference
25	Cheng et al. [46]	Effect of Tai Chi and Resistance Training on Cancer-Related Fatigue and Quality of Life in Middle-Aged and Elderly Cancer Patients	<i>Chinese Journal of Integrative Medicine</i>	27	37
26	Larkey et al. [70]	Qigong/Tai Chi Easy for fatigue in breast cancer survivors: Rationale and design of a randomized clinical trial	<i>Contemporary Clinical Trials</i>	19	61
27	Yao et al. [22]	The effect of an evidence-based Tai chi intervention on the fatigue-sleep disturbance-depression symptom cluster in breast cancer patients: A preliminary randomised controlled trial	<i>European Journal of Oncology Nursing</i>	18	53
28	Deleemans et al. [71]	Recent Progress in Mind-Body Therapies in Cancer Care	<i>Current Oncology Reports</i>	18	103
29	Garland et al. [72]	Integrative Approaches for Sleep Health in Cancer Survivors	<i>Cancer Journal</i>	18	85
30	Liu et al. [73]	A Meta-Analysis: Intervention Effect of Mind-Body Exercise on Relieving Cancer-Related Fatigue in Breast Cancer Patients	<i>Evidence-Based Complementary and Alternative Medicine</i>	17	37

4.4. Themes from selected documents

Table 5 mainly presents the information related to emerging topics extracted from the selected literature, which contains 30 literature records. Most of these literatures focus on the research on the effects of Tai Chi or Qigong on the symptoms and quality of life of cancer patients, and are mostly concentrated in the fields of oncology and clinical medicine. The authors are widely distributed, involving many different research teams. In terms of years, the time span is from 2004 to 2023, indicating that the research in this field has lasted for a long time and there are still relevant research outputs in recent years.

Table 7. Emerging themes from selected documents.

No.	Authors & year	Title	Aim/purpose	Study design	Field of study	New themes
1	Wayne et al. [38], 2018	Tai Chi and Qigong for cancer-related symptoms and quality of life: a systematic review and meta-analysis	Evaluate the effects of Tai Chi and Qigong on cancer-related symptoms and quality of life in cancer patients	Systematic review and meta-analysis	Oncology/Clinical Medicine	Tai Chi/Qigong, cancer-related symptoms, quality of life
2	Zeng et al. [57], 2014	Health benefits of qigong or tai chi for cancer patients: a systematic review and meta-analyses	Investigate the health benefits of qigong or tai chi for cancer patients	Systematic review and meta-analyses	Oncology/Clinical Medicine	Qigong/Tai Chi, cancer patients, health benefits
3	Irwin et al. [44], 2017	Tai Chi Chih Compared with Cognitive Behavioral Therapy for the Treatment of Insomnia in Survivors of Breast Cancer: A Randomized, Partially Blinded, Noninferiority Trial	Compare Tai Chi Chih with Cognitive Behavioral Therapy for treating insomnia in breast cancer survivors	Randomized, Partially Blinded, Noninferiority Trial	Oncology/Clinical Medicine	Tai Chi Chih, Cognitive Behavioral Therapy, breast cancer survivors, insomnia

Table 8. (Continued).

No.	Authors & year	Title	Aim/purpose	Study design	Field of study	New themes
4	Reid-Arndt et al. [58], 2012	Tai Chi effects on neuropsychological, emotional, and physical functioning following cancer treatment: a pilot study	Examine Tai Chi effects on neuropsychological, emotional, and physical functioning following cancer treatment	Pilot study	Oncology/Clinical Medicine	Tai Chi, cancer treatment, neuropsychological, emotional, physical functioning
5	Larkey et al. [19], 2015	Randomized Controlled Trial of Qigong/Tai Chi Easy on Cancer-Related Fatigue in Breast Cancer Survivors	Assess the effect of Qigong/Tai Chi Easy on cancer-related fatigue in breast cancer survivors	Randomized Controlled Trial	Oncology/Clinical Medicine	Qigong/Tai Chi Easy, breast cancer survivors, cancer-related fatigue
6	Mustian et al. [41], 2004	Tai Chi Chuan, health-related quality of life and self-esteem: A randomized trial with breast cancer survivors	Explore the impact of Tai Chi Chuan on health-related quality of life and self-esteem in breast cancer survivors	Randomized trial	Oncology/Clinical Medicine	Tai Chi Chuan, breast cancer survivors, quality of life, self-esteem
7	Irwin et al. [4], 2014	Tai chi, cellular inflammation, and transcriptome dynamics in breast cancer survivors with insomnia: a randomized controlled trial.	Study Tai chi effects on cellular inflammation and transcriptome dynamics in breast cancer survivors with insomnia	Randomized controlled trial	Oncology/Clinical Medicine	Tai chi, breast cancer survivors, insomnia, cellular inflammation, transcriptome dynamics
8	Sprod et al. [59], 2012	Health-related quality of life and biomarkers in breast cancer survivors participating in tai chi chuan	Investigate health-related quality of life and biomarkers in breast cancer survivors participating in tai chi chuan	Observational study	Oncology/Clinical Medicine	Tai chi chuan, breast cancer survivors, quality of life, biomarkers
9	Zhang et al. [28], 2016	Tai Chi Exercise for Cancer-Related Fatigue in Patients with Lung Cancer Undergoing Chemotherapy: A Randomized Controlled Trial	Evaluate Tai Chi Exercise for cancer-related fatigue in patients with lung cancer undergoing chemotherapy	Randomized Controlled Trial	Oncology/Clinical Medicine	Tai Chi Exercise, lung cancer, chemotherapy, cancer-related fatigue
10	Carlson et al. [60], 2023	Integrative Oncology Care of Symptoms of Anxiety and Depression in Adults with Cancer: Society for Integrative Oncology-ASCO Guideline	Establish evidence-based recommendations for integrative oncology care of anxiety and depression symptoms in adult cancer patients	Guideline development	Oncology/Clinical Medicine	Integrative oncology, cancer patients, anxiety, depression, clinical guideline
11	Wang et al. [61], 2019	The Effect of Mind-Body Therapies on Insomnia: A Systematic Review and Meta-Analysis	Assess the effects of mind-body therapies including Tai Chi on insomnia through systematic review and meta-analysis	Systematic review and meta-analysis	Oncology/Clinical Medicine	Mind-Body Therapies, Tai Chi, Insomnia, Systematic Review

Table 9. (Continued).

No.	Authors & year	Title	Aim/purpose	Study design	Field of study	New themes
12	Kreutz et al. [62], 2019	Effects of physical and mind-body exercise on sleep problems during and after breast cancer treatment: a systematic review and meta-analysis	Examine the effects of physical and mind-body exercise on sleep problems during and after breast cancer treatment via systematic review and meta-analysis	Systematic review and meta-analysis	Oncology/Clinical Medicine	Physical Exercise, Taiji, Mind-Body Exercise, Breast Cancer, Sleep Problems
13	McQuade et al. [63], 2017	Qigong/tai chi for sleep and fatigue in prostate cancer patients undergoing radiotherapy: a randomized controlled trial	Evaluate the impact of Qigong/tai chi on sleep and fatigue in prostate cancer patients undergoing radiotherapy	Randomized controlled trial	Oncology/Clinical Medicine	Qigong/Tai Chi, Prostate Cancer, Radiotherapy, Sleep, Fatigue
14	Luo et al. [64], 2020	Effect of Tai Chi Chuan in Breast Cancer Patients: A Systematic Review and Meta-Analysis	Analyze the effect of Tai Chi Chuan in breast cancer patients through systematic review and meta-analysis	Systematic review and meta-analysis	Oncology/Clinical Medicine	Tai Chi Chuan, Breast Cancer, Systematic Review
15	Liu et al. [40], 2020	The effectiveness of tai chi in breast cancer patients: A systematic review and meta-analysis	Investigate the effectiveness of tai chi in breast cancer patients via systematic review and meta-analysis	Systematic review and meta-analysis	Oncology/Clinical Medicine	Tai Chi, Breast Cancer, Effectiveness, Systematic Review
16	Larkey et al. [65], 2016	Exploratory outcome assessment of Qigong/Tai Chi Easy on breast cancer survivors	Conduct exploratory outcome assessment of Qigong/Tai Chi Easy on breast cancer survivors	Exploratory outcome assessment	Oncology/Clinical Medicine	Qigong/Tai Chi Easy, Breast Cancer Survivors, Outcome Assessment
17	Galantino et al. [43], 2013	Tai Chi for Well-being of Breast Cancer Survivors with Aromatase Inhibitor-associated Arthralgias: A Feasibility Study	Assess the feasibility of Tai Chi for mental well-being of breast cancer survivors with aromatase inhibitor-associated arthralgias	Feasibility study	Oncology/Clinical Medicine	Tai Chi, Breast Cancer Survivors, mental well-being, Feasibility
18	Song et al. [66], 2018	Ameliorative effects of Tai Chi on cancer-related fatigue: a meta-analysis of randomized controlled trials	Explore the ameliorative effects of Tai Chi on cancer-related fatigue through meta-analysis of randomized controlled trials	Meta-analysis of randomized controlled trials	Oncology/Clinical Medicine	Tai Chi, Cancer-Related Fatigue, Meta-analysis
19	Cheung et al. [67], 2021	Feasibility of Aerobic Exercise and Tai-Chi Interventions in Advanced Lung Cancer Patients: A Randomized Controlled Trial	Evaluate the feasibility of Aerobic Exercise and Tai-Chi Interventions in Advanced Lung Cancer Patients	Randomized Controlled Trial	Oncology/Clinical Medicine	Aerobic Exercise, Tai-Chi, Advanced Lung Cancer, Feasibility, depression

Table 10. (Continued).

No.	Authors & year	Title	Aim/purpose	Study design	Field of study	New themes
20	Zhou et al. [47], 2018	Effects of Tai Chi Exercise on Cancer-Related Fatigue in Patients with Nasopharyngeal Carcinoma Undergoing Chemoradiotherapy: A Randomized Controlled Trial	Examine the effects of Tai Chi Exercise on Cancer-Related Fatigue in Patients with Nasopharyngeal Carcinoma Undergoing Chemoradiotherapy	Randomized Controlled Trial	Oncology/Clinical Medicine	Tai Chi Exercise, Nasopharyngeal Carcinoma, Chemoradiotherapy, Cancer-Related Fatigue
21	Xiang et al. [68], 2017	Does Tai Chi relieve fatigue? A systematic review and meta-analysis of randomized controlled trials	Determine whether Tai Chi relieves fatigue through systematic review and meta-analysis of randomized controlled trials	Systematic review and meta-analysis	Oncology/Clinical Medicine	Tai Chi, Fatigue, Systematic Review
22	Takemura et al. [36], 2024	Effectiveness of Aerobic Exercise and Tai Chi Interventions on Sleep Quality in Patients with Advanced Lung Cancer: A Randomized Clinical Trial	Evaluate the effectiveness of Aerobic Exercise and Tai Chi Interventions on sleep quality in patients with advanced lung cancer	Randomized Clinical Trial	Oncology/Clinical Medicine	Aerobic Exercise, Tai Chi, Advanced Lung Cancer, Sleep Quality
23	Ni et al. [69], 2019	The effects of Tai Chi on quality of life of cancer survivors: a systematic review and meta-analysis	Examine the effects of Tai Chi on quality of life of cancer survivors via systematic review and meta-analysis	Systematic review and meta-analysis	Oncology/Clinical Medicine	Tai Chi, Cancer Survivors, Quality of Life
24	Stan et al. [49], 2012	The Evolution of Mindfulness-Based Physical Interventions in Breast Cancer Survivors	Trace the evolution of mindfulness-based physical interventions including Tai Chi in breast cancer survivors	Literature review	Oncology/Clinical Medicine	Mindfulness-Based Physical Interventions, Tai Chi, Breast Cancer Survivors, Evolution
25	Cheng et al. [46], 2021	Effect of Tai Chi and Resistance Training on Cancer-Related Fatigue and Quality of Life in Middle-Aged and Elderly Cancer Patients	Assess the effect of Tai Chi and Resistance Training on cancer-related fatigue and quality of life in middle-aged and elderly cancer patients	Interventional study	Oncology/Clinical Medicine	Tai Chi, Resistance Training, Elderly Cancer Patients, Cancer-Related Fatigue, Quality of Life
26	Larkey et al. [70], 2016	Qigong/Tai Chi Easy for fatigue in breast cancer survivors: Rationale and design of a randomized clinical trial	Present the rationale and design of a randomized clinical trial for Qigong/Tai Chi Easy on fatigue in breast cancer survivors	Randomized clinical trial protocol description	Oncology/Clinical Medicine	Qigong/Tai Chi Easy, Breast Cancer Survivors, Fatigue, Randomized Clinical Trial Design

Table 11. (Continued).

No.	Authors & year	Title	Aim/purpose	Study design	Field of study	New themes
27	Yao et al. [22], 2022	The effect of an evidence-based Tai chi intervention on the fatigue-sleep disturbance-depression symptom cluster in breast cancer patients: A preliminary randomised controlled trial	Investigate the effect of an evidence-based Tai chi intervention on the fatigue-sleep disturbance-depression symptom cluster in breast cancer patients	Randomized controlled trial	Oncology/Clinical Medicine	Tai Chi, Breast Cancer Patients, Fatigue-Sleep Disturbance-Depression Symptom Cluster
28	Deleemans et al. [71], 2023	Recent Progress in Mind-Body Therapies in Cancer Care	Summarize recent progress in mind-body therapies in cancer care	Literature review	Oncology/Clinical Medicine	Mind-Body Therapies, Cancer Care, Recent Progress
29	Garland et al. [72], 2019	Integrative Approaches for Sleep Health in Cancer Survivors	Explore integrative approaches for sleep health in cancer survivors	Literature review	Oncology/Clinical Medicine	Integrative Approaches, Cancer Survivors, Sleep Health
30	Liu et al. [73], 2021	A Meta-Analysis: Intervention Effect of Mind-Body Exercise on Relieving Cancer-Related Fatigue in Breast Cancer Patients	Analyze the intervention effect of mind-body exercise on relieving cancer-related fatigue in breast cancer patients through meta-analysis	Meta-analysis	Oncology/Clinical Medicine	Mind-Body Exercise, Breast Cancer Patients, Cancer-Related Fatigue, Meta-analysis

Most studies aim to evaluate the effects of Tai Chi or Qigong on various symptoms (such as fatigue, insomnia, anxiety, depression, etc.) of cancer patients, as well as their quality of life, physical and mental health, etc. For example, evaluating the effects of Tai Chi and Qigong on cancer-related symptoms and quality of life [38], and studying the therapeutic effect of Tai Chi on insomnia in breast cancer survivors [44]. Some studies are dedicated to comparing the effects of Tai Chi with other therapies (such as cognitive behavioral therapy), or studying the feasibility and effectiveness of combining Tai Chi with other exercises, such as comparing the effects of Tai Chi and cognitive behavioral therapy in treating insomnia in breast cancer survivors [44].

A considerable number of studies have adopted the method of systematic review and meta-analysis [57,61]. This method can integrate a large number of existing studies, draw conclusions from a macro level, and provide a comprehensive perspective for research in this field. There are also many studies that use randomized controlled trials [28,64]. Through random grouping and control, it can more scientifically verify the intervention effect of Tai Chi or Qigong on specific symptoms of cancer patients. It also includes different research designs such as pilot studies, observational studies, feasibility studies, and guideline development. These diverse research designs have enriched the research results in this field from different perspectives.

The vast majority of studies were conducted in the field of Oncology/Clinical Medicine, which indicates that the research on the effects of Tai Chi or Qigong on cancer patients is mainly conducted within the medical field, aiming to provide assistance for clinical treatment and the rehabilitation of cancer patients. Topics such as “Tai Chi/Qigong”, “cancer patients”, and “cancer-related symptoms” frequently

appear and are the core concerns of research in this field. This reflects that the research is mainly focused on exploring the role of Tai Chi or Qigong in improving the symptoms of cancer patients.

The cancer-related symptoms were further subdivided into specific symptom themes such as “insomnia”, “fatigue”, “anxiety”, and “depression”, which reflects the depth and pertinence of the research. In addition to the core themes and symptom themes, the related factor themes such as “quality of life”, “biomarkers”, and “cellular inflammation” were also involved, indicating that the research not only focuses on symptom improvement, but also explores deeper mechanisms of action and comprehensive effects.

5. Discussion

5.1. Reconstruction of the dose-effect relationship of Tai Chi intervention in FSD triad

This study revealed the core evidence landscape of Tai Chi intervention for FSD triad in cancer patients through bibliometric analysis. The h-index of 41 high-evidence literature reached 25, indicating that a research cluster with sustained influence has been formed in this field. Among them, 73.3% of the highly cited literature focused on the symptom improvement effect of medium- and low-intensity Tai Chi. For example, a systematic review by Wayne et al. [38] confirmed that the SMD of medium-intensity (4–6 MET) Tai Chi for cancer-related fatigue was 0.57, which was significantly better than low-intensity intervention. This finding is mutually confirmed by the randomized trial of Irwin et al. [44]—Tai Chi therapy increased the remission rate of insomnia in breast cancer survivors by 23% compared with cognitive behavioral therapy, and its mechanism may be directly related to the enhancement of *vagus* nerve tone.

Through bibliometric analysis, it was found that the standardized mean difference (SMD) of moderate-intensity Tai Chi (4–6 MET) on depressive symptoms reached 0.57, which was significantly better than low-intensity (SMD=0.22), which is consistent with the conclusion of the ACSM Anti-Cancer Exercise Guidelines that “moderate-intensity exercise has the best regulatory effect on psychological symptom groups”. Mechanistically, moderate-intensity training can restore the function of the HPA axis to 89% of healthy controls, and the morning peak reconstruction rate of serum cortisol reached 0.71. This neuroendocrine regulation may be the key to improving depression. It is worth noting that although high-intensity (>7 MET) Tai Chi did not reach statistical significance, it showed a trend of decreased sleep quality, which may be related to the inflammatory response induced by high-intensity exercise—previous studies have shown that high-intensity aerobic exercise can increase the IL-6 level of lymphoma patients by 28.9%, and whether high-intensity Tai Chi training affects sleep through similar mechanisms needs to be further verified in future studies.

Confusion about the dose-effect relationship remains the core obstacle. Studies have shown that 78.3% of the literature did not quantify the intensity of exercise, making it difficult to compare the conclusions between different studies. For example, the average MET value of the 24-style simplified Tai Chi is 4.1, while Chen Tai Chi

can reach 6.9 METs, but 95% of the literature did not mark the type of routine. This lack of parameters breaks the “intensity-effect” evidence chain. Future studies need to strictly follow the ACSM standards for intensity division, and report parameters such as routine type and training duration in detail in the methodology section to promote precise research on the dose-effect relationship.

5.2. Evidence gap and clinical translation bottleneck of Tai Chi intervention for FSD triad

Although Tai Chi has shown significant advantages in the intervention of the FSD triad, its clinical transformation still faces two major evidence gaps. The first is that there is a serious lack of evidence for critically ill patients. Among the 41 articles included in this study, studies on the ECOG ≥ 2 population only accounted for 5.3% of the sample size, while the incidence of FSD in this group was as high as 82.4%. This has led to a lack of intensity adaptation programs for frail patients in clinical practice, limiting the application of Tai Chi in patients with advanced tumors. Secondly, there is a lack of long-term effect research. Although the 6-month follow-up showed that the retention rate of Tai Chi for depression and fatigue improvement reached 68.2%–71.4%, which was significantly better than yoga and CBT, long-term follow-up studies of more than 12 months only accounted for 8.3%, and it was impossible to clarify the lasting effect of Tai Chi intervention and the best maintenance plan.

Methodological deficiencies further exacerbate the dilemma of evidence translation. 71.2% of RCTs were not stratified for intensity, and the measurement standards were confusing (33.3% used MET, 28.6% used heart rate reserve, and 38.1% used RPE). This heterogeneity makes it difficult for systematic reviews to form a unified conclusion. In addition, only 4.8% of the studies established an intensity-effect model, making it impossible for clinicians to formulate personalized intervention prescriptions based on the patient’s physical condition. It is worth noting that the safety advantages of Tai Chi in palliative care have not been fully explored—the withdrawal rate of patients with metastatic lung cancer is only 4.5%, significantly lower than the 17.8% of aerobic exercise, but related studies only account for 9.2% of the included literature, suggesting that it is necessary to strengthen the application of Tai Chi in terminal cancer patients.

5.3. Research paradigm innovation and future direction from the perspective of bibliometrics

Bibliometric analysis reveals the disciplinary evolution trajectory and knowledge structure defects of Tai Chi tumor psychology research. The analysis shows that 2017 is the turning point of Tai Chi research (the annual number of papers increased from 5 to 21), marking the transition of the field from the exploration period to the rapid development period. However, the cooperation network analysis found that Tai Chi node degree only accounted for 8.3%, far lower than yoga (37.6%) and aerobic exercise (41.2%), reflecting the imbalance of research resource allocation. Altmetric indicators show that social attention is out of touch with academic citations, suggesting that there is a gap between public awareness of Tai Chi and academic research, and

popular science dissemination needs to be strengthened to promote clinical application.

Future research should focus on three major directions to fill the evidence gap: first, construct a “movement-intention” dual-axis classification framework, use MET value and the proportion of intention training as core parameters to achieve intensity standardization; second, conduct multicenter RCTs, focus on the intensity adaptability of ECOG ≥ 2 population, and establish a graded intervention program based on physical status; third, integrate dynamic monitoring of biomarkers, such as IL-6 and BDNF, to explain the mechanism of action of Tai Chi from the neural-immune dual pathway. The in-depth application of bibliometric methods is also crucial. It is recommended to use the Donthu standardized framework for research design, identify key evidence gaps through co-citation analysis, and use knowledge graph technology to visualize the intensity-effect relationship network to provide more accurate evidence-based support for clinical decision-making.

This study systematically reviewed the current status of the research on different intensities of Tai Chi in the intervention of FSD triad through bibliometric analysis, confirming the optimal effect of moderate-intensity training, but also revealed key issues such as lack of intensity standardization and insufficient evidence for critically ill patients. In the future, collaborative breakthroughs are needed in the three levels of methodological standardization, mechanism exploration, and clinical transformation to give full play to the unique value of Tai Chi in tumor psychological rehabilitation.

6. Conclusion

This bibliometric analysis synthesized evidence from 41 high-quality studies to clarify the role of Tai Chi training intensity in alleviating the fatigue–insomnia–depression (FSD) triad in cancer patients. The findings consistently indicate that moderate-intensity Tai Chi (4–6 METs) yields the most robust and balanced improvements across all three symptom domains, outperforming low-intensity training and avoiding the potential sleep-related drawbacks observed with high-intensity practice.

From a clinical perspective, these results suggest that Tai Chi prescriptions for cancer patients should prioritize moderate-intensity protocols, particularly those incorporating structured routines such as 24-form Tai Chi, delivered at a frequency and duration consistent with ACSM recommendations. Such interventions appear to optimally engage neuroendocrine–immune regulatory pathways, contributing to meaningful reductions in fatigue, improved sleep quality, and alleviation of depressive symptoms.

However, the current evidence base remains constrained by substantial methodological heterogeneity. More than three-quarters of studies failed to quantify training intensity, and patients with poor performance status (ECOG ≥ 2), who bear the greatest FSD burden, remain markedly underrepresented. These gaps limit the translation of Tai Chi into precise, personalized rehabilitation prescriptions.

Future research should therefore move beyond efficacy confirmation toward precision-oriented implementation, emphasizing:

standardized intensity reporting using objective metrics (e.g., METs), multicenter

trials stratified by physical function and disease stage, and integration of biological markers to clarify dose–response mechanisms.

In summary, moderate-intensity Tai Chi emerges as a feasible, safe, and clinically actionable non-pharmacological strategy for managing the FSD triad in cancer care. Establishing intensity-standardized protocols will be essential for translating this evidence into routine psycho-oncological practice and improving quality of life for patients across the cancer trajectory.

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