

Review

Low-intensity circuit exercise, psychological resilience, and quality of life in elderly lung cancer: A bibliometric review

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Abstract: This review synthesizes evidence on Low-Intensity Circuit Exercise (LICE), psychological resilience, and quality of life (QOL) among elderly lung cancer populations using bibliometric and scoping methodologies. A search of the Web of Science Core Collection (2005–2025) identified 147 eligible studies after structured screening. Quantitative bibliometric mapping and qualitative thematic analysis were used to characterize publication trends, conceptual frameworks, and interdisciplinary linkages. Across the literature, low-intensity exercise modalities particularly circuit-based and combined aerobic-resistance formats were frequently associated with improvements in muscle strength, functional capacity, and selected cardiopulmonary indicators, while demonstrating favorable safety and adherence profiles in older adults. Psychological resilience emerged as a recurring construct linked to emotional well-being and QOL, with studies describing theoretical pathways involving stress regulation and self-efficacy. However, empirical evidence for resilience as a mediator remains limited and heterogeneous. Gaps identified through the review include a shortage of longitudinal designs, inconsistent reporting of exercise parameters, and variability in resilience measurement tools. Future research should prioritize standardized assessments, stratified analyses of older subgroups, and multidisciplinary approaches to better clarify how low-intensity exercise can be integrated into comprehensive rehabilitation strategies for elderly lung cancer patients. This review provides an updated evidence synthesis and highlights key directions for advancing exercise-based supportive care in psycho-oncology.

Keywords: low-intensity circuit exercise; elderly lung cancer; quality of life; psychological resilience; bibliometric analysis; scoping review

1. Introduction

Lung cancer remains one of the most prevalent and deadly malignancies worldwide, accounting for approximately 18.4% of cancer-related deaths in recent global estimates, with older adults (≥ 65 years) experiencing a 5-year survival rate below 15% [1,2]. This population is particularly vulnerable because standard treatments such as radiotherapy and chemotherapy frequently induce cancer-related fatigue, muscle loss, and heightened psychological burden. Evidence suggests that nearly 70% of elderly lung cancer patients experience moderate to severe fatigue during treatment, muscle mass declines by 3%–8% annually, and the prevalence of depression and anxiety is two to three times higher than in the general population [3–5]. Although pharmacological treatment and psychological counseling can relieve certain symptoms, their effects are often limited and may introduce additional side effects that further compromise quality of life (QOL) [6,7]. These challenges

underscore the need for safe, feasible, and integrative rehabilitation strategies for elderly patients.

Exercise-based interventions have emerged as important non-pharmacological approaches in cancer rehabilitation, yet traditional high-intensity programs pose difficulties for older adults with lung cancer. High-intensity training may improve muscle strength but can exacerbate fatigue, increase the risk of musculoskeletal injury, and generally result in adherence rates below 50% among elderly patients [8,9]. Low-Intensity Circuit Exercise (LICE), which combines aerobic and resistance components at 50%–60% of maximal heart rate for 20–30 min per session, has been proposed as a safer and more acceptable alternative. Reports indicate that LICE reduce adverse event incidence by 62% compared with higher-intensity exercise and achieves a compliance rate of 78% over an eight-week period [10,11]. However, current evidence largely focuses on short-term physiological benefits, and there is limited synthesis of how LICE relate to broader outcomes such as psychological resilience or QOL in elderly lung cancer patients. Moreover, the field lacks consolidated review-based evidence that integrates physiological and psychological perspectives.

Psychological resilience, defined as the capacity to maintain or regain psychological stability when facing adversity, is increasingly recognized as a determinant of clinical adaptation in cancer patients. Higher resilience levels are associated with 30%–40% reductions in anxiety and depressive symptoms and with better overall QOL during treatment [12]. Mechanistically, resilience has been linked to modulation of hypothalamus–pituitary–adrenal (HPA) axis activity and cortisol regulation, contributing to improved immune and inflammatory profiles [13]. Yet gaps remain. First, the extent to which exercise particularly LICE interacts with resilience through neuroendocrine or behavioral pathways is not well established. Second, most existing studies rely on cross-sectional or single-intervention designs and seldom examine resilience as a dynamic construct. Evidence from breast cancer populations suggests that low-intensity resistance exercise may enhance resilience via improved self-efficacy, but its applicability to elderly lung cancer patients has not been confirmed [14,15]. These issues highlight the need for a systematic synthesis of the available literature.

Given these limitations, the present review aims to integrate physiological and psychological evidence to examine how LICE may influence QOL in elderly lung cancer patients, with particular attention to the conceptual mediating role of psychological resilience. Using bibliometric and scoping review approaches, this study summarizes trends, mechanisms, and evidence gaps to support clearer theoretical positioning and future research directions. By drawing on sports science, psychology, and oncology, this review also contributes to multidisciplinary rehabilitation planning, offering insights relevant not only to lung cancer but also to the broader management of chronic disease populations.

2. Multidimensional effects of exercise intervention on the rehabilitation of lung cancer patients

2.1. Intervention mechanism of exercise type and intensity on lung cancer patients

Exercise interventions contribute to physiological and psychological recovery in lung cancer patients through multiple pathways, and their effects vary according to exercise type and intensity. Aerobic exercise and resistance training, the two most commonly studied modalities, differ in their target systems and underlying mechanisms. Aerobic exercise improves cardiopulmonary function and exercise endurance, which are frequently impaired during lung cancer treatment. A meta-analysis reported that moderate-intensity aerobic exercise, such as walking three times per week for 30 min, increased VO_2max by 12.3% and reduced dyspnea scores by 21.5% in lung cancer patients [16]. Given that reduced cardiopulmonary capacity is a major contributor to functional decline in this population, such improvements have practical relevance for daily activity and overall quality of life.

Resistance training, in contrast, primarily addresses muscle function and body composition. Evidence indicates that 12 weeks of resistance training can increase quadriceps strength by 27.8%, elevate lean body mass by 1.2 kg, and reduce body fat percentage by 3.1% among elderly lung cancer patients [17]. Mechanistic research suggests that resistance training may activate the mTOR signaling pathway and promote myosin synthesis. Mikkelsen et al. found that a multimodal resistance program increased lower-limb muscle cross-sectional area by 8.3% in older adults with advanced cancer, an effect associated with elevated IGF-1 levels [18]. Despite these benefits, high-intensity resistance training may not be suitable for many elderly patients, as it can increase blood pressure fluctuations and elevate musculoskeletal injury risk, with adverse event rates reported to be three to five times higher than low-intensity training [19]. These considerations underscore the need to match training intensity to patient tolerance.

Low-Intensity Circuit Exercise (LICE) integrates aerobic and resistance components at a lower physiological load and has attracted interest for its potential suitability in elderly cancer populations. LICE's continuous, low-impact structure can stimulate muscle protein synthesis while minimizing fatigue, making it more acceptable to patients with limited physical reserve. A mixed-methods study among older cancer survivors reported that 82.3% preferred low-intensity, low-impact exercise; participants also increased their 6 min walking distance by 58 meters over 8 weeks and showed a 23.6% reduction in HADS scores, potentially reflecting improved emotional regulation associated with sustained endorphin release [20]. These findings indicate that low-intensity programs may enhance both physical function and psychological well-being.

Exercise interventions may also support psychological resilience, a key determinant of adaptation to cancer-related stress. Lung cancer patients frequently experience anxiety, depression, and disease-related fear, and exercise has been shown to modulate neurotransmitters associated with mood regulation. Neurobiological studies report that regular exercise can increase serum serotonin by

18.3% and norepinephrine by 22.1%, contributing to improved emotional stability [21]. In addition, 150 min of moderate-intensity exercise per week has been associated with a 12.5-point increase in CD-RISC resilience scores, with self-efficacy improvements mediating part of this change [22]. Enhanced mood and coping ability may, in turn, facilitate better engagement in rehabilitation, creating a reinforcing cycle between physical activity and psychological adjustment.

Individual differences in comorbidity, treatment side effects, and exercise preferences highlight the importance of personalized program design. Many elderly patients express a preference for combined aerobic and resistance activities, and adaptive-intensity programs have been associated with higher adherence rates. For example, personalized exercise plans achieved an adherence rate of 89.2% compared with 67.5% for standardized programs [20]. These findings support tailoring exercise prescriptions to patients' functional status, tolerability, and preferences.

In summary, exercise interventions exert multifaceted benefits for lung cancer patients by improving cardiopulmonary capacity, muscle function, body composition, and psychological resilience. Given its low physiological burden and high acceptability, Low-Intensity Circuit Exercise represents a promising approach for elderly patients. Further work is needed to refine its optimal parameters and implementation strategies within clinical rehabilitation.

2.2. Physiological regulation mechanism and clinical value of low-intensity circuit exercise

Low-Intensity Circuit Exercise (LICE) has been described in the literature as a feasible modality capable of influencing several physiological systems relevant to elderly lung cancer patients. Its low mechanical and metabolic demands make it suitable for populations with reduced functional reserve, while its cyclic structure allows simultaneous engagement of muscular, cardiopulmonary, and metabolic pathways. Existing studies indicate that these combined effects may contribute to improved physical function, symptom management, and exercise adherence.

2.2.1. Improve muscle strength, optimize body composition and regulate metabolism

Evidence from low-intensity resistance training in cancer populations suggests that such interventions can improve muscle strength and body composition without imposing excessive physiological stress. For example, Serra et al. reported that 12 weeks of low-intensity resistance training increased quadriceps strength by 18.2% and reduced serum IL-6 levels by 23.4% in elderly breast cancer survivors, suggesting a link between low-load training, inflammation modulation, and muscle protein synthesis [23]. Similarly, a meta-analysis by Metcalfe et al. demonstrated an average 12.7% increase in muscle strength during chemotherapy and highlighted a dose-response relationship between training frequency and reductions in body fat percentage (2.8% reduction ≥ 3 sessions/week versus 1.1% at once weekly) [24].

These observations are relevant for elderly lung cancer patients, who frequently experience muscle atrophy due to tumor burden and treatment-related catabolism. LICE's low-load cyclic structure often organized as 15–20 repetitions per set has been associated with activation of the mTOR pathway and enhanced myosin

synthesis without the soft-tissue strain linked to high-intensity exercise [25]. This provides a mechanistic rationale for exploring LICE as a muscle-preserving strategy in frail populations.

Beyond musculoskeletal benefits, LICE may influence cardiopulmonary parameters. In a randomized trial of lung cancer patients receiving chemotherapy, Chen et al. found that 30 min of low-intensity home walking, five times per week, increased vital capacity by 10.3% and improved 6-minute walk distance by 62 meters, changes associated with elevated vascular endothelial growth factor levels [26]. Fukushima et al. reported similar improvements in patients with hematological malignancies, with high-frequency low-intensity exercise producing 8%–10% increases in VO_2max and reductions in dyspnea [25]. In circuit-based models, combining resistance and aerobic components produced a 25.1% increase in exercise tolerance among advanced lung cancer patients, outperforming single-modality aerobic or resistance training (12.3% and 15.7%, respectively) [27]. These findings suggest that LICE may leverage synergistic effects by activating both muscular and cardiopulmonary systems.

LICE has also been linked to metabolic regulation across multiple organs. Studies report improvements in insulin sensitivity of approximately 22.5%, likely related to enhanced muscular glucose uptake [25]. Additional research suggests that 12 weeks of LICE can reduce visceral fat area by 7.8 cm^2 and increase serum adiponectin by 15.6%, which may support metabolic stability in older adults [23]. Anti-inflammatory effects have also been documented, including reductions in TNF- α of 19.2% through downregulation of NF- κ B activity. This may be clinically meaningful for patients undergoing chemotherapy, where inflammation contributes to symptom burden and treatment intolerance [24]. Comparative work by Cheng et al. further showed that LICE combined with breathing control helped maintain stable C-reactive protein levels (≤ 3 mg/L), while greater fluctuations were observed with resistance training alone [28].

2.2.2. The practical significance of safety advantages and compliance assurance

The safety profile of LICE is a central consideration for elderly lung cancer patients who often present with comorbidities such as COPD, cardiovascular disease, or chemotherapy-related cytopenias. Higher-intensity exercise may increase the risk of dyspnea or musculoskeletal strain, with reports indicating a 3.2-fold increase in dyspnea incidence during high-intensity training. In contrast, LICE typically targets 40%–60% of maximum heart rate and has been associated with a 68% reduction in adverse events [29]. These findings highlight the potential for LICE to provide meaningful physiological stimulus while maintaining a low risk of exacerbating symptoms.

Psychological acceptability also influences adherence. Qualitative evidence suggests that patients with cancer cachexia often feel overwhelmed by high-intensity regimens, while low-intensity formats can increase exercise self-efficacy by 27.3 points [30]. This improvement appears to translate into higher completion rates. For example, Sullivan et al. observed a 92% completion rate in a low-intensity exercise group compared with 68% in moderate- to high-intensity groups among lung cancer patients participating in partner-supported yoga [31]. The adaptability of LICE also

allows integration of diverse modalities such as breathing control, balance training, or strength elements which aligns with patient preferences documented in studies of laughter yoga and Tai Chi–aerobic comparisons [32,33].

2.3. Summary

Taken together, existing evidence indicates that LICE may support improvements in muscle strength, cardiopulmonary capacity, metabolic regulation, and inflammation control while maintaining favorable safety and adherence profiles in elderly cancer populations. Its combination of low physiological load and multidimensional engagement makes it a promising candidate for incorporation into rehabilitation strategies for elderly lung cancer patients. Further research is needed to refine its optimal parameters and clarify its role within comprehensive exercise-based care models.

3. Theoretical basis and mediating effect mechanism of psychological resilience

3.1. Basic theory and dimensional structure of psychological resilience

Psychological resilience has evolved from being viewed as a fixed personality trait to being understood as a dynamic and context-dependent process. Early work in developmental psychology and psychopathology described resilience as an individual's capacity to maintain psychological stability and adapt effectively when facing adversity [34]. Subsequent theoretical developments emphasize resilience as an ongoing adaptive process resulting from continuous interactions between individuals and their environments, with particular attention to how psychological resources are reorganized under stress [35].

Two influential frameworks inform current resilience research. The stress-buffering model highlights the neurobiological and regulatory mechanisms through which resilience mitigates the negative effects of stress, including modulation of the hypothalamus–pituitary–adrenal (HPA) axis [36]. The conservation of resources theory focuses on how individuals acquire, preserve, and utilize internal and external resources to cope with challenges [37]. Clinical observations in lung cancer populations suggest that resource integration through family support, cognitive reappraisal, and access to social networks may play a stabilizing role in managing anxiety and depressive symptoms during treatment [38]. A more comprehensive dynamic development perspective further indicates that resilience is shaped by the interplay of personal characteristics, social support, and cognitive strategies, and may fluctuate as patients progress through different treatment and survivorship stages [39].

Structurally, resilience is often conceptualized as a multi-layered system comprising individual, social, and cognitive components.

(1) Individual trait system: This includes relatively stable characteristics such as optimism, emotion-regulation ability, and perceived self-efficacy. Among lung cancer patients, self-efficacy has been identified as an important determinant of

treatment adherence and overall adjustment, with potential downstream effects on quality of life [36,40].

(2) Social support system: Family support, peer networks, and community-level resources form a critical external buffer. Longitudinal evidence indicates that strong family functioning contributes to higher resilience levels and may reduce the risk of demoralization during illness [39,41].

(3) Cognitive strategy system: Positive reappraisal and problem-focused coping help patients reinterpret their illness experience. Qualitative findings suggest that individuals who successfully navigate postoperative recovery often reconstruct the meaning of cancer as an opportunity for growth rather than a purely threatening event [35,42].

These three systems operate interactively rather than independently. Yin's work illustrates this interdependence, showing that social support may enhance resilience both directly and indirectly by strengthening self-efficacy and encouraging adaptive coping strategies [36]. This interconnected structure highlights why resilience is increasingly regarded as a dynamic, modifiable psychological resource relevant to exercise-based rehabilitation and quality-of-life outcomes in lung cancer patients.

3.2. The mediating role of psychological resilience between exercise intervention and quality of life

Psychological resilience is increasingly discussed as a potential pathway through which exercise may influence the quality of life of elderly lung cancer patients. Theoretically, this mediating role is grounded in the stress-buffering model and the conservation of resources framework, both of which propose that resilience helps individuals manage treatment-related stress and maintain psychological stability [43,44]. Measurement tools such as the 25-item and 10-item versions of the Connor–Davidson Resilience Scale remain widely used and have demonstrated good applicability in cancer populations, making them suitable for evaluating changes in psychological resources in studies examining exercise interventions [45].

Two conceptual pathways are commonly cited to explain the mediating role of resilience. First, resilience may buffer stress by regulating the physiological and psychological responses elicited by cancer and its treatment, thereby reducing symptom burden and emotional distress [44]. Second, resilience may enhance adaptability by facilitating the mobilization and integration of internal and external resources, consistent with the conservation of resources perspective [45]. Empirical studies offer preliminary support for these pathways. For instance, Xu's longitudinal work reported a direct association between resilience and quality of life (effect size = 0.32), with indirect effects accounting for 41% of the total impact through reductions in stigma and self-perceived burden [44].

Exercise-related research also suggests that resilience may help explain variability in quality-of-life outcomes. A prospective study by Ye et al. [43] found that lung cancer patients with higher baseline resilience reported better quality of life at a 6-month follow-up, independent of depressive symptoms. Further, Huang et al.'s [45] chain mediation model indicated that social support may enhance resilience and, in turn, improve self-efficacy before influencing quality of life, underscoring the

broader psychosocial context in which exercise operates. Yang et al. [46] additionally observed that higher resilience levels were associated with lower fear of recurrence after lung cancer surgery, a factor closely tied to quality-of-life outcomes.

Despite these insights, several limitations remain. Resilience is not uniform across patients; latent class analysis by Hong et al. [47] identified marked subgroup differences, suggesting that exercise interventions may need to be tailored according to distinct resilience profiles to achieve optimal benefits. Moreover, trajectories of resilience during treatment may be nonlinear. Seol et al. [48] noted that resilience levels changed dynamically during radiotherapy and were not consistently aligned with concurrent quality-of-life improvements. These findings highlight the need for future studies to employ more rigorous longitudinal designs and multilevel analytic approaches to clarify temporal sequencing, dose–response patterns, and the extent to which resilience mediates exercise–quality-of-life associations in elderly lung cancer populations.

4. Methods

Bibliometric analysis provides a structured approach for examining patterns in academic output through quantitative evaluation of published literature. Its primary purpose is to describe how knowledge develops, disseminates, and evolves within a research field [49]. In studies related to exercise intervention and psychological rehabilitation in cancer, bibliometric techniques have been used to map publication trends, identify influential research themes, and clarify interdisciplinary contributions. These characteristics make bibliometrics an appropriate method for summarizing the scope and development of evidence in this area.

This study combines bibliometric analysis with a scoping review approach to systematically capture and synthesize research concerning exercise interventions, psychological resilience, and quality of life among cancer populations. The methodological framework draws on the six-stage model proposed by Arksey and O'Malley problem identification, literature search, study selection, data extraction, data analysis, and synthesis of findings [50]. This structure enables a comprehensive overview of the literature without imposing the evaluative constraints of a formal systematic review. Quantitative bibliometric mapping was complemented by qualitative topic exploration to highlight emerging themes and interdisciplinary linkages.

Throughout the research process, the study adhered to established standards for bibliometric reporting [51] and followed the PRISMA 2020 guidelines to ensure transparency in literature identification and screening. Inclusion and exclusion criteria were developed based on three core domains: topic relevance (exercise, cancer, psychological outcomes), research design (interventional or observational human studies and review articles), and evidence quality as assessed through reporting completeness. These criteria guided the selection of literature examining how different types and intensities of exercise relate to psychological and quality-of-life outcomes in cancer populations. In addition to mapping the scope of available studies, the analysis also aimed to characterize research trends and interdisciplinary patterns in this field.

4.1. Scoping review process

4.1.1. Database selection

This study used the Web of Science (WOS) Core Collection as the primary data source. WOS integrates the Science Citation Index (SCI), Social Sciences Citation Index (SSCI), and Arts and Humanities Citation Index (AHCI), offering broad disciplinary coverage across oncology, sports medicine, and psychological rehabilitation. Its interdisciplinary structure is suitable for capturing literature related to exercise interventions and psychological outcomes in cancer populations, and previous analyses indicate that WOS provides wider coverage of psychology and sports science journals compared with several biomedical databases [52].

WOS was selected because it provides standardized bibliographic information, stable indexing procedures, and high-quality citation data, which are essential for bibliometric mapping. The database includes peer-reviewed journals with established editorial and publication criteria, thereby supporting consistent retrieval of studies relevant to exercise, cancer, and mental health. Using a single comprehensive database also allowed for a reproducible search strategy and minimized inconsistencies arising from mixed indexing systems.

Overall, WOS provided a coherent and reliable foundation for identifying literature on exercise interventions, psychological resilience, and quality of life, supporting both the bibliometric and scoping components of this review.

4.1.2. Search strategy

A structured search strategy was developed to identify publications related to exercise interventions, psychological resilience, and quality of life in cancer populations. The search was conducted in the Web of Science Core Collection and covered the period from January 2005 to January 2025. Both controlled vocabulary (when available) and free-text terms were used to capture variations in terminology across disciplines.

The search strategy employed Boolean operators and included three main concept blocks:

Exercise and physical activity: (“exercise” OR “physical activity” OR “aerobic training” OR “resistance training” OR “low-intensity exercise” OR “circuit exercise”)

Cancer population: (“cancer” OR “tumor” OR “oncology” OR “lung cancer” OR “cancer survivors”)

Psychological and quality-of-life outcomes: (“psychological resilience” OR “resilience” OR “quality of life” OR “psychological outcomes” OR “mental health”)

An example of the Boolean search string applied was:

TS = (exercise OR “physical activity” OR “low-intensity” OR “circuit training”) AND TS = (cancer OR oncology OR “lung cancer”) AND TS = (“psychological resilience” OR resilience OR “quality of life”)

Filters were applied to limit results to:

- Peer-reviewed journal articles and reviews
- Human studies
- English-language publications

Reference lists of included studies were also screened to identify additional relevant articles. All retrieved records were imported into Covidence for deduplication and screening.

4.2. Studies selection

Study selection followed a structured approach consistent with the PRISMA-ScR guidelines to ensure transparency in identifying literature related to exercise interventions, psychological resilience, and quality-of-life outcomes in cancer populations. Eligible records were limited to peer-reviewed journal articles, clinical trial registrations, and evidence-based reviews indexed in the Web of Science Core Collection. Case reports, technical descriptions, and basic laboratory studies without human participants were excluded to maintain relevance to the review objectives.

A three-stage screening process was applied. First, the predefined search strategy yielded 342 records, of which 239 remained after automatic deduplication. In the second stage, two reviewers independently screened titles and abstracts. Screening consistency was assessed using a cross-validation approach, with a Cohen's κ of 0.82 (95% CI: 0.79–0.85), indicating high agreement. A total of 63 articles were excluded at this stage, primarily because they lacked a defined exercise intervention ($n = 29$), did not involve cancer populations ($n = 18$), or did not report psychological or quality-of-life outcomes relevant to the review ($n = 16$).

Full-text assessment constituted the third stage. Twenty-nine articles were excluded for reasons such as insufficient reporting of exercise parameters, absence of psychological or quality-of-life indicators, or study designs that did not provide enough detail to contribute meaningfully to the review's aims. Following this process, 147 studies met the inclusion criteria and were retained for bibliometric and scoping synthesis.

All screening procedures were managed using the Covidence platform to support traceability and documentation. The overall selection process is summarized in the PRISMA flow diagram (**Figure 1**). This approach ensured systematic identification of literature and provided a consistent evidence base for subsequent analysis.

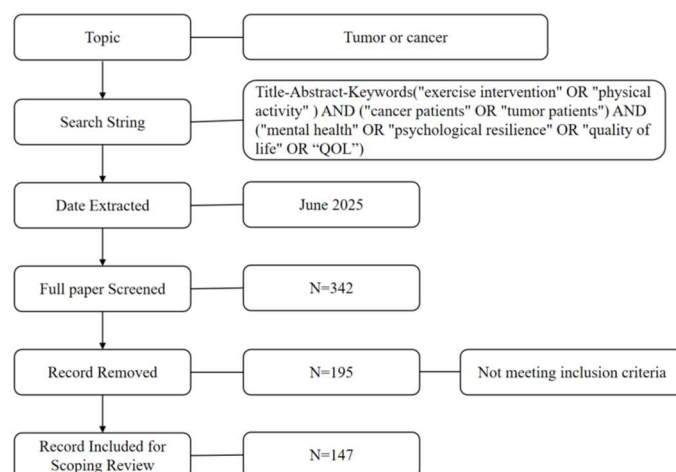


Figure 1. Flow diagram of the search strategy for this review.

5. Results

As shown in **Table 1**, a total of 147 documents published between 2005 and 2025 were included, representing 61 source journals. Most publications were original research articles ($n = 105$, 71.4%) or reviews ($n = 31$, 21.1%). Only three documents were single-authored (2.04%), indicating that publications in this area commonly involve multi-author collaborations. Across all records, 434 author-provided keywords and 524 indexed keywords were identified. The dataset also contained 7744 cited references, reflecting the range of literature incorporated across studies.

Table 1. Documents metrics overview.

Main information	Results
Documents	147
Timespan	2005:2025
Sources (Journals, etc)	61
Authors	816
References	7744
Keywords Plus (ID)	524
Author's Keywords (DE)	434
article	105
review	31
Single-authored docs	3
International co-authorships %	21.77
Document Average Age	6.84
Co-Authors per Doc	6.05
Average citations per doc	32.35
Annual Growth Rate %	11.61

5.1. Publication trends

Figure 2 presents the annual number of publications and annual citation averages. Publication counts showed gradual increases over the two-decade period, with small fluctuations from 2005 to 2012 (range: 1–3.09 publications annually). A rise was observed in 2013 (9.56 publications), followed by variations between 2014 and 2016, and an increase again in the early 2020s, with 2024 recording 17 publications. The annual citation average varied from year to year, with peaks such as 9.56 in 2013 and lower values in other years (e.g. 1.17 in 2014). These data illustrate year-to-year variability in both publication quantity and citation activity.

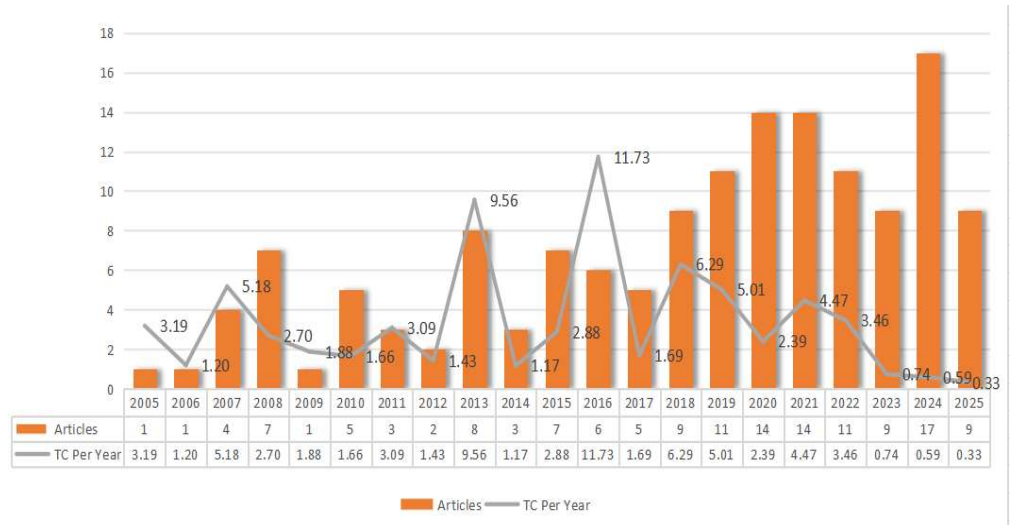


Figure 2. Publications and citations by year.

5.2. Three-field plot (countries–journals–keywords)

Figure 3 summarizes the relationships among countries (AU_CO), journals (SO), and author keywords (DE). In the country–journal domain, the United States, Canada, and the United Kingdom were most frequently linked to journals such as Health Psychology and Frontiers in Psychology. Several Asian countries, including China, appeared in the network with fewer connections.

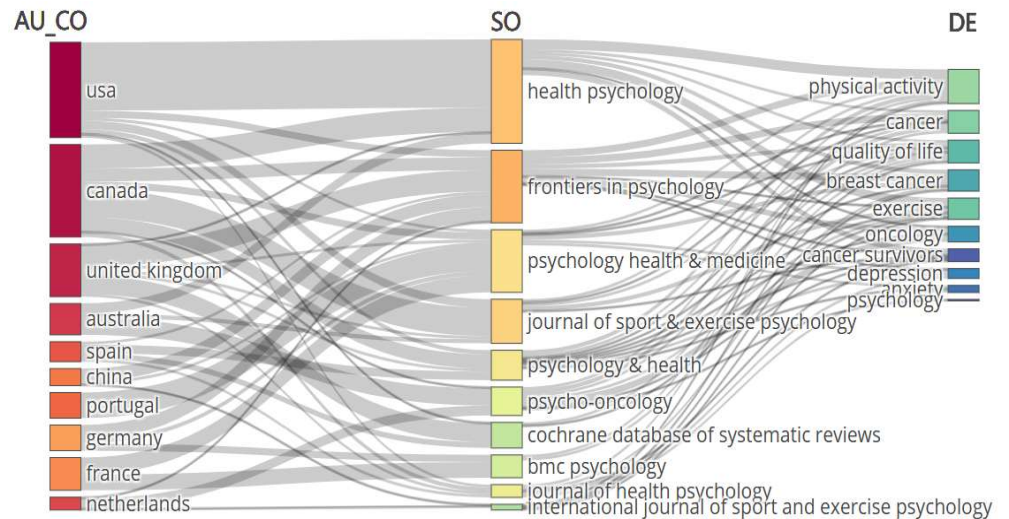


Figure 3. Three-field plot.

In the journal–keyword domain, journals such as Health Psychology, Frontiers in Psychology, and Psycho-Oncology were frequently associated with keywords including “physical activity,” “cancer,” “quality of life,” “breast cancer,” and “oncology.”

In the country–keyword domain, countries in Europe and North America showed connections with keywords such as “physical activity,” “cancer survivors,” “depression,” and “anxiety.” Asian countries showed connections with several exercise- and cancer-related keywords, albeit with smaller node densities in the plot.

5.3. Citation and authorship characteristics

Across all included documents, the total number of citations was 7744, with a mean of 32.35 citations per document. The mean article age was 6.84 years. A total of 816 authors contributed to the dataset, with an average of 6.05 co-authors per publication. The international co-authorship rate was 21.77%.

The annual growth rate of publications was 11.61%, indicating an overall increase in research output across the two-decade period.

5.4. Core journal output trends

Figure 4 displays cumulative publication counts for five representative journals in the psychology domain from 2005 to 2025. All five journals showed upward cumulative trajectories. Health Psychology demonstrated notable increases after 2015, while Frontiers in Psychology displayed steeper growth after 2020.

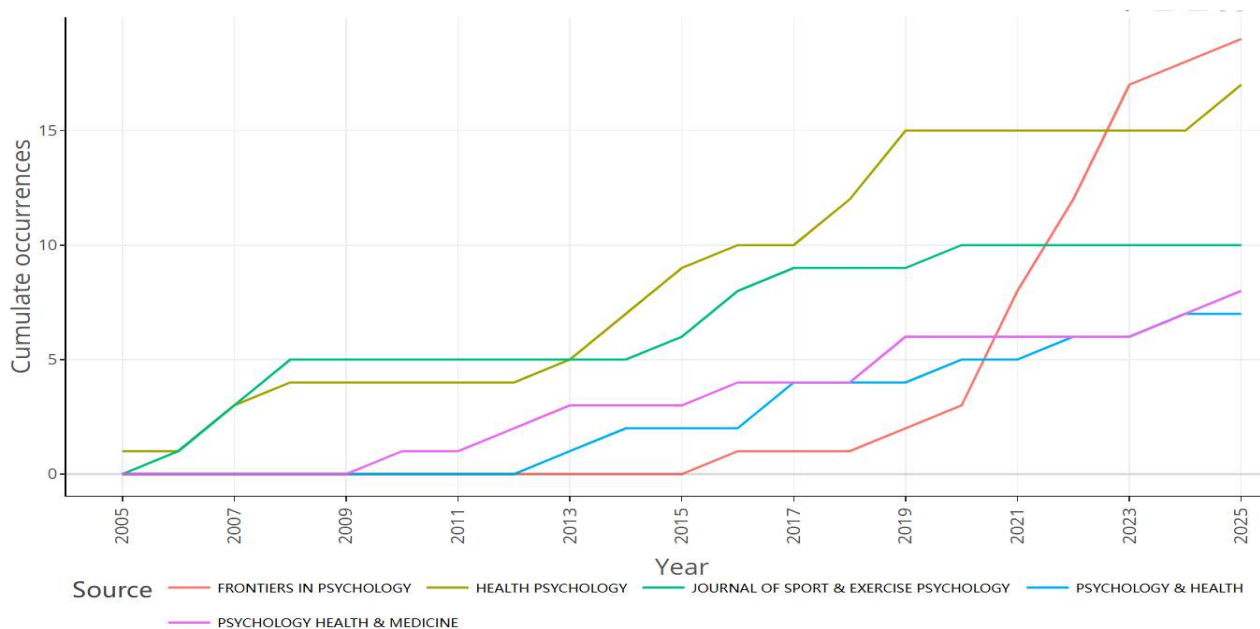


Figure 4. Typical sources production over time.

5.5. Characteristics of highly cited publications

Table 2 summarizes 30 highly cited articles. Study designs included clinical practice guidelines, systematic reviews, randomized controlled trials, and cohort studies. These studies covered a range of exercise modalities, including mind–body exercise, aerobic training, and resistance training. Reported outcomes across highly cited works frequently included fatigue, sleep quality, functional capacity, emotional well-being, and quality of life.

Across these publications, exercise interventions were examined in relation to physiological, psychological, or combined outcomes. While several studies explored associations among exercise, psychological factors, and quality of life, most focused on single-modality interventions, and fewer examined multi-component or stratified approaches.

Table 2. Characteristics and emerging themes of the top 30 highly cited publications (2005–2025).

No	Authors & Year	Title	Total citations	Aim/Purpose	Study design	Field of study	Themes
1	FRIEDENREICH CM,2010 [53]	State of the epidemiological evidence on physical activity and cancer prevention	334	Summarize physical activity - cancer evidence	Literature review	Epidemiology/Cancer Prevention	Physical activity, cancer, epidemiology
2	BROWN JC,2012 [54]	Cancer, Physical Activity, and Exercise	254	Examine cancer - activity - exercise connections	Narrative review	Oncology/Rehabilitation	Cancer, physical activity, exercise
3	JACOBSEN PB, 2007 [55]	Systematic review and meta-analysis of psychological and activity-based interventions for cancer-related fatigue	218	Evaluate interventions for cancer - related fatigue	Systematic review , meta - analysis	Oncology/Behavioral Medicine	Cancer, fatigue, interventions
4	ZHANG ZJ, 2019 [56]	A Systematic Review of the Relationship Between Physical Activity and Happiness.	213	Explore physical activity - happiness relationship	Systematic review	Sports Psychology/Public Health	Physical activity, happiness, correlation
5	Hsin-Yu An, 2020 [57]	The Relationships between Physical Activity and Life Satisfaction and Happiness among Young, Middle-Aged, and Older Adults	210	Compare age - group activity - satisfaction links	Cross - sectional study	Developmental Psychology/Epidemiology	Physical activity, life satisfaction, age
6	CHAMBERS SK,2011 [58]	A systematic review of the impact of stigma and nihilism on lung cancer outcomes	179	Assess stigma impact on lung cancer outcomes	Systematic review	Oncology/Psychoncology	Lung cancer, stigma, outcomes
7	MARKER AM, 2018 [59]	Physical activity and health-related quality of life in children and adolescents: A systematic review and meta-analysis	160	Analyze activity - QOL in youth	Systematic review , meta - analysis	Pediatrics/Public Health	Physical activity, quality of life, youth
8	GRANGER CL,2013 [60]	Low physical activity levels and functional decline in individuals with lung cancer	134	Study lung cancer - activity - decline link	Cohort study	Oncology/Respiratory Medicine	Lung cancer, physical activity, decline
9	TREANOR C, 2018 [61]	An international review and meta-analysis of prehabilitation compared to usual care for cancer patients	101	Compare prehabilitation - usual care for cancer	Systematic review , meta - analysis	Oncology/Rehabilitation	Cancer, prehabilitation, care

Table 2. (Continued).

No	Authors & year	Title	Total citations	Aim/purpose	Study design	Field of study	Themes
10	MILNE HM, 2008 [62]	Self-determination theory and physical activity among breast cancer survivors	99	Test self - determination theory on survivors	Theoretical application	Oncology/Health Psychology	Breast cancer, physical activity, theory
11	BADE BC, 2015 [63]	Increasing Physical Activity and Exercise in Lung Cancer Reviewing Safety, Benefits, and Application	98	Evaluate safety and benefits of lung cancer exercise	Literature review	Oncology/Rehabilitation Medicine	Lung cancer, physical activity, safety
12	PEDDLE CJ, 2008 [64]	Associations between exercise, quality of life, and fatigue in colorectal cancer survivors	94	Explore exercise - QOL - fatigue links in CRC survivors	Observational study	Oncology/Public Health	Colorectal cancer, exercise, quality of life
13	DHILLON HM, 2017 [65]	Impact of physical activity on fatigue and quality of life in people with advanced lung cancer: a randomized controlled trial	87	Test activity impact on advanced lung cancer fatigue	Randomized controlled trial	Oncology/Clinical Research	Lung cancer, physical activity, fatigue
14	BRADT J, 2015 [66]	Dance/movement therapy for improving psychological and physical outcomes in cancer patients	83	Assess dance therapy on cancer patients' outcomes	Clinical trial	Oncology/Complementary Medicine	Cancer, dance therapy, psychological outcomes
15	NAKANO J, 2018 [67]	Effects of Aerobic and Resistance Exercises on Physical Symptoms in Cancer Patients: A Meta-analysis	78	Analyze exercise effects on cancer patients' symptoms	Meta - analysis	Oncology/Rehabilitation	Cancer, aerobic exercise, resistance training
16	PINTO BM, 2015 [68]	Peers promoting physical activity among breast cancer survivors: A randomized controlled trial	78	Study peer - led activity in breast cancer survivors	Randomized controlled trial	Oncology/Behavioral Science	Breast cancer, peer support, physical activity
17	LYNCH J, 2011 [69]	Screening for psychological distress in patients with lung cancer: results of a clinical audit evaluating the use of the patient Distress Thermometer	74	Audit Distress Thermometer usage in cancer care	Clinical audit	Oncology/Psychoncology	Cancer, distress assessment, clinical tool
18	RUEDA JR, 2011 [70]	Non-invasive interventions for improving well-being and quality of life in patients with lung cancer	73	Examine non-invasive interventions for lung cancer	Literature review	Oncology/Palliative Care	Lung cancer, well-being, quality of life

Table 2. (Continued).

No	Authors & year	Title	Total citations	Aim/purpose	Study design	Field of study	Themes
19	JONES LW, 2005 [71]	Does the theory of planned behavior mediate the effects of an oncologist's recommendation to exercise in newly diagnosed breast cancer survivors? Results from a randomized controlled trial	67	Investigate exercise recommendation in breast cancer	Randomized controlled trial	Oncology/Behavioral Medicine	Breast cancer, exercise recommendation, behavior
20	PARK CL, 2008 [72]	Positive and negative health behavior changes in cancer survivors: a stress and coping perspective	67	Understand health behavior changes in cancer survivors	Qualitative study	Oncology/Health Psychology	Cancer survivors, health behavior, stress coping
21	CLARK MM, 2008 [73]	Motivational readiness for physical activity and quality of life in long-term lung cancer survivors	64	Explore physical activity motivation in lung survivors	Cross - sectional study	Oncology/Rehabilitation	Lung cancer, physical activity, quality of life
22	HUANG YN, 2019 [74]	Psychological resilience of women after breast cancer surgery: a cross-sectional study of associated influencing factors	56	Identify factors of breast cancer patients' resilience	Cross - sectional study	Oncology/Psychology	Breast cancer, psychological resilience, surgery
23	BASEN-EK, 2013 [75]	Social-cognitive theory predictors of exercise behavior in endometrial cancer survivors	53	Predict exercise behavior in endometrial survivors	Observational study	Oncology/Behavioral Science	Endometrial cancer, exercise, social - cognitive theory
24	GOSAIN R, 2020 [76]	Stress reduction strategies in breast cancer: review of pharmacologic and non-pharmacologic based strategies	50	Review stress reduction in breast cancer	Literature review	Oncology/Palliative Care	Breast cancer, stress, management strategies
25	BADE BC, 2018 [77]	Assessing the Correlation Between Physical Activity and Quality of Life in Advanced Lung Cancer	47	Correlate activity and QOL in advanced lung cancer	Observational study	Oncology/Clinical Research	Lung cancer, physical activity, quality of life
26	UNGAR N, 2016 [78]	Physical Activity Enjoyment and Self-Efficacy As Predictors of Cancer Patients' Physical Activity Level	43	Predict physical activity via enjoyment/self - efficacy	Predictive study	Oncology/Rehabilitation	Cancer, physical activity, self - efficacy

Table 2. (Continued).

No	Authors & year	Title	Total citations	Aim/purpose	Study design	Field of study	Themes
27	GRANGER CL,2013 [79]	Functional capacity, physical activity and muscle strength assessment of individuals with non-small cell lung cancer: a systematic review of instruments and their measurement properties	37	Review instruments for NSCLC assessment	Systematic review	Oncology/Clinical Research	NSCLC, assessment, instruments
28	SUN JY,2012 [80]	Physical Activity and Risk of Lung Cancer: A Meta-Analysis of Prospective Cohort Studies	34	Analyze activity - lung cancer risk link	Meta - analysis	Oncology/Epidemiology	Lung cancer, physical activity, risk
29	GRANGER L,2016 [81]	Deterioration in physical activity and function differs according to treatment type in non-small cell lung cancer - future directions for physiotherapy management	32	Guide physiotherapy for NSCLC treatment	Review	Oncology/Rehabilitation	NSCLC, physiotherapy, treatment
30	DHILLON HM,2012 [82]	The impact of physical activity on fatigue and quality of life in lung cancer patients: a randomised controlled trial protocol	29	Test activity impact on lung cancer fatigue	Randomized controlled trial	Oncology/Clinical Research	Lung cancer, physical activity, fatigue

6. Discussion

6.1. Main findings and theoretical verification

The present review synthesizes existing evidence on Low-Intensity Circuit Exercise (LICE), psychological resilience, and quality-of-life outcomes among elderly lung cancer patients, integrating findings from bibliometric mapping and scoping analysis. Rather than providing empirical verification, the review highlights how published studies collectively describe the physiological and psychological pathways through which exercise may influence rehabilitation.

With respect to physiological effects, prior research indicates that low-intensity resistance or circuit-based training can contribute to improvements in muscle strength and body composition. Studies have reported increases in quadriceps strength ranging from 18.2% to 27.8% and reductions in body fat of approximately 2.8%–3.1% among older cancer populations engaged in low-intensity or multimodal training programs [23,24]. Improvements in cardiopulmonary capacity have also been documented, such as increases in vital capacity of 10.3% and gains of 62 meters in 6-minute walking distance following low-intensity aerobic interventions

[26]. Combined aerobic–resistance models appear to provide additional benefits, with circuit training improving exercise tolerance more than single-modality programs [27]. These findings, when viewed alongside bibliometric evidence showing sustained research interest in exercise-based cancer rehabilitation, illustrate how frequently physiological outcomes are emphasized in existing research [53].

In relation to psychological mechanisms, published studies describe resilience as an important factor associated with emotional well-being and quality of life. Existing evidence suggests that resilience may mitigate anxiety and depressive symptoms through regulation of stress-response pathways, including the HPA axis, and may exert indirect effects by strengthening self-efficacy [12,36]. Bibliometric trends further show that resilience-related publications have maintained notable citation activity, with a peak in 2013 and a sizable proportion of highly cited articles examining resilience in the context of exercise or psychosocial intervention [55,74]. Conceptual models discussed in the literature, such as those proposed by Huang et al. (2024), suggest that social support may enhance resilience and self-efficacy before influencing quality of life, offering one possible pathway by which exercise could exert psychological benefits [45].

Overall, the review identifies converging descriptions across the literature regarding the physiological benefits of low-intensity exercise and the potential mediating role of resilience; however, these patterns should be interpreted as synthesized evidence rather than empirical validation, consistent with the scope of a bibliometric and scoping review.

6.2. Clinical practice significance and application value

The literature reviewed suggests several potential areas in which Low-Intensity Circuit Exercise (LICE) may support clinical rehabilitation for elderly lung cancer patients, particularly regarding safety, adherence, and suitability for multidisciplinary care models. Low-intensity exercise formats generally operate at 50%–60% of maximum heart rate and have been associated with fewer adverse events compared with higher-intensity regimens. Reported adherence rates of approximately 78% after eight weeks of intervention indicate that low-intensity approaches may be more acceptable for older adults, including those with COPD or treatment-related bone marrow suppression [11,29]. Preference data from Cheung et al. further show that 82.3% of older cancer survivors favored low-intensity or low-impact activities, and individualized programming was associated with higher adherence (89.2%) [20]. These patterns suggest that LICE align well with the functional capabilities and preferences of many elderly patients, although direct evidence in lung cancer–specific cohorts remain limited.

Bibliometric findings also highlight consistent international engagement in research on low-intensity exercise, with an international co-authorship rate of 21.77%. While not a measure of clinical effectiveness, this trend reflects the growing interest in low-intensity approaches across disciplines and research settings.

Integration of LICE within multidisciplinary rehabilitation frameworks is a theme noted across several studies. Exercise interventions that incorporate principles from sports science, psychology, and oncology may offer opportunities to address

physiological decline alongside emotional and functional challenges. Research on interactions among exercise, psychological factors, and immune responses for example, work by Mavropalias et al. on inflammation-related adaptations illustrates potential pathways through which low-intensity exercise might contribute to broader rehabilitation strategies [13,24]. Complementary modalities such as breathing exercises or balance-focused activities have also been explored, with some studies reporting stable inflammatory markers, including C-reactive protein, when combined with low-intensity programs [28].

Overall, while the literature provides encouraging indications that LICE may be a feasible and well-tolerated option within multimodal rehabilitation, the evidence base remains heterogeneous. Further clinical studies specific to lung cancer populations are needed to clarify the extent to which LICE can be systematically integrated into multidisciplinary care pathways.

6.3. Analysis of study limitations

The findings synthesized in this review should be interpreted in light of several limitations observed within the existing body of literature. First, the proportion of longitudinal follow-up studies is limited, which restricts the ability to examine temporal changes in psychological resilience and quality of life. As Seol et al. (2021) noted, trajectories of resilience during radiotherapy may be nonlinear, and reliance on cross-sectional or single-time-point assessments makes it difficult to understand how resilience functions as a potential mediator across different phases of treatment [48]. Similarly, although some studies discuss neurobiological correlates of resilience, evidence on how low-intensity exercise influences these pathways such as through neuroendocrine responses or monoamine regulation remains preliminary, and dynamic monitoring of biomarkers like serotonin is sparse [21].

Second, sample heterogeneity poses challenges for interpretation. Older adults represent a key clinical subgroup, yet bibliometric results indicate that only 29.3% of studies explicitly distinguished participants aged ≥ 65 years. Comorbidity patterns common in elderly lung cancer populations were inconsistently reported, and few studies conducted subgroup analyses based on pathological type, treatment modality, or functional status. Granger et al. (2013), for example, reported that functional decline in non-small cell lung cancer varied by treatment type, but similar stratified analyses are uncommon in studies examining low-intensity exercise interventions [60,81].

Third, variability in assessment tools for psychological resilience complicates cross-study comparisons. Different studies employ different scales and measurement dimensions, which limits the ability to draw consistent conclusions regarding resilience-related outcomes [43,74]. This methodological inconsistency underscores the need for standardized measurement approaches in future work.

Taken together, these limitations highlight the need for more robust longitudinal designs, clearer subgroup definitions, and greater methodological consistency to advance understanding of how low-intensity exercise relates to psychological resilience and quality-of-life outcomes in elderly lung cancer populations.

6.4. Future research directions and prospects

Several gaps identified in the current literature point to opportunities for future research. First, further work is needed to clarify the mechanisms linking low-intensity exercise to psychological resilience and quality of life. While some studies have examined physiological markers and inflammatory pathways, evidence regarding neuroendocrine or neurobiological responses remains limited. Techniques such as neuroimaging or biomarker profiling may help to elucidate how exercise influences processes related to stress regulation, cognitive functioning, and emotional well-being, building on preliminary findings regarding factors such as IGF-1, IL-6, and fear-of-recurrence outcomes [18,23,46].

Second, the development of more personalized exercise programs represents an important direction. Existing studies highlight the association between exercise preference, perceived burden, and adherence, suggesting that individualized approaches may improve engagement and outcomes [20]. Incorporating elements that address social support such as partner-assisted or low-intensity group-based formats may also strengthen psychological resilience, as explored in interventions like laughter yoga and partner-supported yoga [31,32]. Future studies could examine how individual characteristics, including baseline resilience and functional status, inform tailored exercise prescriptions.

Finally, broader interdisciplinary collaboration may support more comprehensive investigation of exercise-based rehabilitation in cancer populations. Integrating insights from sports science, psychology, oncology, and rehabilitation medicine may enable more coordinated approaches to study design, data collection, and implementation. Real-world evidence from prospective registries could contribute to understanding the feasibility and effectiveness of low-intensity exercise in routine care settings. Bibliometric trends showing growth in research on combined exercise and medical interventions suggest increasing interest in multidisciplinary approaches, although more rigorous empirical work is needed to determine their clinical relevance.

7. Conclusion

This review synthesized 147 publications (2005–2025) using bibliometric and scoping methods to examine existing evidence on Low-Intensity Circuit Exercise (LICE), psychological resilience, and quality-of-life outcomes among elderly lung cancer populations. The literature collectively suggests that low-intensity exercise modalities may support improvements in muscle strength, body composition, exercise tolerance, and selected cardiopulmonary indicators. Studies also describe psychological resilience as a potentially important factor associated with emotional well-being and quality-of-life outcomes, with theoretical models proposing links to stress-regulation pathways and self-efficacy. Bibliometric trends showing sustained citation activity and growing international collaboration indicate increasing scholarly attention to research at the intersection of exercise, psychological health, and cancer rehabilitation.

At the same time, several limitations in the current evidence remain. Longitudinal studies are relatively scarce, constraining understanding of how

resilience and quality-of-life trajectories evolve over time. Mechanistic investigations are still preliminary, with limited biomarker or neurobiological data available to clarify how low-intensity exercise influences stress-related or inflammatory pathways. Heterogeneity in sample characteristics—including age distributions, treatment stages, and comorbidity profiles further limits generalizability, and resilience assessment tools vary substantially between studies.

Future research would benefit from more rigorous longitudinal designs, clearer reporting of exercise parameters, and standardized psychological measures to better characterize the relationships among exercise, resilience, and quality-of-life outcomes. Tailored interventions that consider patient preferences, functional status, and social support may also enhance adherence and effectiveness. Strengthening interdisciplinary collaboration and expanding real-world, multicenter research particularly in underrepresented regions and among older age groups such as those aged ≥ 75 years may help address current evidence gaps and inform more personalized rehabilitation practices.

Overall, this review provides a consolidated overview of the existing literature and identifies key areas where further empirical work is needed. While low-intensity exercise shows promise as a feasible and potentially beneficial component of supportive care in elderly lung cancer populations, additional research is required to refine its role within comprehensive, multidisciplinary rehabilitation strategies.

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