

A Scoping Review on Exercise Therapy for Lower Limb Lymphedema after Cervical Cancer Surgery

Ting XU¹, Xiaoyan SHI^{2*}

1. Taihe Hospital of Shiyan City of Hubei Province, Affiliated Hospital of Hubei University of Medicine, Shiyan 442000, China; 2. Sinopharm Dongfeng Maojian Hospital, Shiyan 442000, China

Abstract [Objectives] To explore the effectiveness of exercise therapy for lower limb lymphedema after cervical cancer surgery, and to inform future research and clinical practice in developing evidence-based nursing interventions. [Methods] Using the JBI scoping review guidelines as a methodological framework, relevant studies were retrieved from PubMed, Embase, Web of Science, Cochrane Library, CINAHL, CNKI, Wanfang Data, and Chinese Biomedical Literature Database from their inception to December 2024. [Results] The findings of included 18 studies showed that exercise therapy, mainly including progressive resistance training, aerobic exercise, aquatic exercise, and mixed exercise modalities, could effectively alleviate lower limb lymphedema symptoms in patients after cervical cancer surgery and improve quality of life. Progressive resistance training has been proven to be a safe and feasible preventive intervention; aerobic exercise and aquatic exercise have certain relieving effects on established lymphedema; mixed exercise interventions can improve patients' functional activity capacity. [Conclusions] Exercise therapy is a feasible, safe, and effective intervention for lower limb lymphedema after cervical cancer surgery. Future high-quality randomized controlled trials are required to validate the effectiveness of different exercise modalities and to develop individualized exercise prescriptions that enhance patient adherence and reduce complications.

Key words Cervical cancer, Lower limb lymphedema, Exercise therapy, Progressive resistance training, Aerobic exercise, Scoping review

1 Introduction

Cervical cancer remains one of the most common malignant tumors among women. According to the GLOBOCAN 2022 database from the International Agency for Research on Cancer (IARC), the global annual incidence of cervical cancer has reached 662 044 cases (age-standardized incidence rate: 14.12 per 100 000), with 348 709 related deaths (age-standardized mortality rate: 7.08 per 100 000)^[1]. Advances in medical technology have significantly improved survival rates and survival duration for cervical cancer patients, but treatment-related complications are increasingly drawing attention^[2]. Lower limb lymphedema is a common complication after cervical cancer treatment, primarily caused by impaired lymphatic drainage due to pelvic lymph node dissection during surgery and/or radiotherapy^[3]. Studies indicate that the incidence of postoperative lower limb lymphedema in cervical cancer patients ranges from 2.4% to 41.0%^[4]. It is characterized by unilateral or bilateral lower limb swelling, heaviness, pain, itching, numbness, skin changes, and infections^[5]. Lower limb lymphedema not only impairs patients' ability to perform activities of daily living but also significantly reduces their quality of life^[6-7]. Once developed, lower limb lymphedema is often difficult to completely cure, making prevention and early intervention particularly crucial^[8].

At present, therapeutic options for lower-extremity lymphedema include pharmacologic treatment, surgical intervention, intermittent pneumatic compression, and complex decongestive therapy (CDT)^[9]. Among these, exercise therapy as an integral compo-

ment of CDT has attracted growing attention from clinical researchers^[10]. However, evidence regarding the effectiveness of exercise therapy on lower-extremity lymphedema following cervical cancer surgery remains inconsistent and scattered^[11]. Therefore, this study adopted the Joanna Briggs Institute (JBI) scoping review methodology^[12] to systematically search and synthesize existing evidence. Through this review, we intended to clarify the current application, therapeutic effects, and limitations of exercise therapy for managing postoperative in cervical cancer patients, thereby providing a reference for developing evidence-based exercise interventions in clinical nursing practice.

2 Materials and methods

2.1 Inclusion criteria The inclusion criteria were formulated according to the PCC (Participants, Concept, Context) framework; Participants (P): surgical cervical cancer patients, with no age restrictions; Concept (C): exercise therapy measures, including but not limited to progressive resistance training, aerobic exercise, and aquatic exercise; Context (C): prevention or management of lower limb lymphedema.

2.2 Exclusion criteria Studies were excluded if they met any of the following conditions: non-Chinese and English literature; conference abstracts and review articles; the full text cannot be obtained; the research content is inconsistent with the purpose; literature with incomplete data.

2.3 Data retrieval A systematic computer-based search was conducted in PubMed, Embase, Web of Science, Cochrane Library, CINAHL, China Knowledge Net, Wanfang Data, and China Biomedical Literature Database. The search time limit is from database establishment to December 31, 2024. The search strategy combining subject terms and free words were adopted.

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Ting XU, master's degree candidate, senior nurse and trainer at the Taihe Skills Training Center. *Corresponding author. Xiaoyan SHI, senior nurse, master of science in nursing.

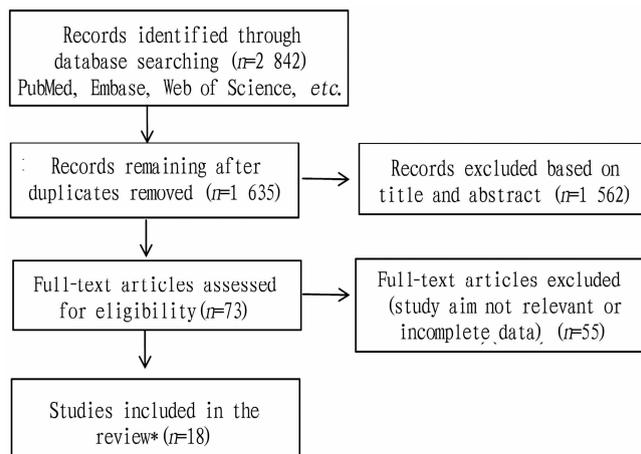
English and Chinese counterpart search terms included: "cervical cancer", "cervical carcinoma", "cervical neoplasm", "uterine cervical cancer", "lymphedema", "lymphoedema", "limb swelling", "edema"; "exercise", "physical activity", "resistance training", "aerobic exercise", "aquatic exercise", "progressive resistance exercise"; "lower extremity", "lower limb" and "Lymphedema of lower limbs".

2.4 Data extraction and analysis All retrieved articles were imported into EndNote X9 and duplicates were removed. Two reviewers independently screened the literature and extracted data. Initial screening involved reviewing titles and abstracts, followed by full-text reading to determine final inclusion. A pre-designed data extraction form was used to collect the following information: first author, publication year, country, study design, sample size, intervention measures (exercise type, frequency, intensity, duration), outcome measures, and primary study results. Any disagreements were resolved through discussion with a third reviewer. Results were summarized using a narrative approach, with data presented in tables and figures.

3 Results and analysis

3.1 Literature search results The initial search identified 2 842 records. After the removal of duplicates, 1 635 records remained. Screening of titles and abstracts excluded 1 562 records, and subsequent full-text review resulted in the inclusion of 18 studies^[13–30]. The study selection process is illustrated in Fig. 1.

3.2 Basic characteristics of included studies Among the 18 included studies, 15 were published in English and 3 in Chinese; publication years ranged from 2015 to 2024. Study designs comprised 10 randomized controlled trials, 5 single-arm before-and-after studies, 2 cross-sectional studies, and 1 qualitative study. All studies involved postoperative cervical cancer patients, with sample sizes ranging from 10 to 261 cases. Basic characteristics of the included studies are summarized in Table 1.



NOTE * Prospective controlled trial ($n = 10$), randomized controlled trial ($n = 5$), cross-sectional study ($n = 2$), and qualitative study ($n = 1$).

Fig. 1 Flow diagram of study screening

Table 1 Basic characteristics of included studies

Author (year)	Country	Study design	Sample size (n)	Intervention	Primary outcomes	Main conclusions
Zhang J (2021) ^[13]	China	Single-arm before-after study	24	Progressive resistance training, twice daily, for 24 weeks	Feasibility, safety, satisfaction, adherence	Progressive resistance training is safe and feasible for postoperative cervical cancer patients, with high patient satisfaction
Zhang J (2023) ^[14]	China	Randomized controlled trial (RCT)	120	Progressive resistance training, twice daily, for 24 weeks	Incidence of lower limb lymphedema, limb circumference difference, symptom scores	The intervention group had a significantly lower incidence of lymphedema than the control group (8.3% vs 21.7%, $P < 0.05$)
Hsu YY (2024) ^[15]	Taiwan	Systematic review and meta-analysis	261	Active exercise, aerobic exercise, aquatic exercise, and weight training	Limb volume, pain, heaviness, symptom improvement	Exercise significantly improved symptoms of lower limb lymphedema; adherence ranged from 77% to 100%
Wang Li (2020) ^[16]	China	Randomized controlled trial (RCT)	86	Comprehensive exercise (including resistance and aerobic training), 5 times/week, 30 min/session, for 12 weeks	Lower limb circumference, edema severity, quality of life, activities of daily living	The intervention group showed reduced limb circumference and significant improvements in quality of life and activities of daily living ($P < 0.01$)
Cormie P (2016) ^[17]	Australia	Randomized controlled trial (RCT)	62	Supervised whole-body resistance training, twice weekly, for 12 weeks	Lower limb lymphedema severity, symptoms, muscle strength	Resistance training did not exacerbate existing lymphedema and enhanced muscle strength and symptoms
Kendrová L (2020) ^[18]	Slovakia	Single-arm before-after study	35	Complete decongestive therapy (including an exercise component), once daily, for 2 weeks	Lower limb circumference, quality of life	Complete decongestive therapy effectively reduced lower limb lymphedema and improved quality of life ($P < 0.05$)
Oliveira MMF (2018) ^[19]	Brazil	Randomized controlled trial (RCT)	40	Aquatic exercise, 3 times/week, 50 min/session, for 8 weeks	Lower limb circumference, functional mobility, pain score	Aquatic exercise significantly reduced lower limb lymphedema ($P < 0.05$) and improved functional mobility
Brown JC (2017) ^[20]	USA	Single-arm before-after study	10	Progressive weightlifting, twice weekly, for 5 months	Limb volume difference, functional mobility, quality of life	Weightlifting was feasible, but infection risk requires attention; two cases of cellulitis occurred

(To be continued)

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Author (year)	Country	Study design	Sample size (n)	Intervention	Primary outcomes	Main conclusions
Liu Min (2021) ^[21]	China	Randomized controlled trial (RCT)	90	Early exercise intervention (starting on postoperative day 1), three times daily, for 4 weeks	Incidence of lower limb lymphedema, lower limb circumference, pain score	Early exercise significantly reduced the incidence of lymphedema (6.7% vs 26.7%, $P < 0.05$)
Katz E (2019) ^[22]	USA	Randomized controlled trial (RCT)	40	Unsupervised home-based exercise program, once daily, for 6 months	Adherence, feasibility, quality of life, limb circumference	The home program was feasible but had lower adherence (65%) and positively affected quality of life
Jiang Shou (2022) ^[23]	China	Randomized controlled trial (RCT)	80	Progressive resistance training plus usual care, twice daily, for 8 weeks	Lower limb circumference, lower-limb function score, quality of life	The intervention group had significant improvements in lower-limb function ($P < 0.01$) and quality of life
Jeffs E (2016) ^[24]	UK	Qualitative study	15	Self-management exercise program including progressive resistance and flexibility training	Patient experience, determinants of adherence, implementation barriers	Key factors affecting adherence were identified: motivation, self-efficacy, social support, and time constraints
Kim DS (2019) ^[25]	South Korea	Randomized controlled trial (RCT)	45	Aerobic exercise, 3 times/week, 40 min/session, for 10 weeks	Lower limb circumference, pain, heaviness, functional mobility	Aerobic exercise reduced pain and heaviness ($P < 0.05$) and improved functional mobility
Loudon A (2017) ^[26]	Australia	Single-arm before-after study	15	Yoga, once weekly, 90 min/session, for 8 weeks	Lower limb lymphedema symptom score, quality of life, mental health	Yoga improved lymphedema symptoms, quality of life, and mental health status
Mizrahi D (2020) ^[27]	Australia	Cross-sectional study	85	Association of different exercise modalities with lymphedema severity	Correlations of exercise type, frequency, and intensity with lymphedema severity	Moderate-intensity aerobic exercise was associated with reduced symptoms ($r = -0.42$, $P < 0.01$)
Nelson S (2016) ^[28]	USA	Cross-sectional study	213	Association between exercise participation and lymphedema self-management	Exercise participation rate, lymphedema self-management behaviors, quality of life	Regular exercisers demonstrated stronger lymphedema self-management abilities ($P < 0.05$)
Singh B (2016) ^[29]	Australia	Single-arm before-after study	10	Supervised combined resistance and aerobic training, twice weekly, for 12 weeks	Safety, feasibility, patient satisfaction, biomarker changes	Mixed training was safe and feasible, with high patient satisfaction (95%) and reductions in inflammatory markers
Yeung W (2018) ^[30]	Hong Kong	Randomized controlled trial (RCT)	60	Early progressive exercise beginning 24 h postoperatively, three times daily during hospitalization and for 4 weeks after discharge	Incidence of lower limb lymphedema, postoperative recovery time, quality of life	Early progressive exercise promoted postoperative recovery and reduced lymphedema incidence ($P < 0.05$)

3.3 Types and implementation of exercise therapy

3.3.1 Progressive resistance training. The 6 included studies^[13–14,17,20,23,29] reported the application of progressive resistance training. The feasibility study and randomized controlled trial conducted by Zhang *et al.*^[13–14] showed that progressive resistance training can be used as a preventive measure for lower limb lymphedema after cervical cancer surgery. The training program consisted of two daily exercises for 24 weeks (2 weeks of hospital-supervised training, 22 weeks of home-based training). Specific exercises include sitting rowing, chest press, lateral raise, biceps curls, triceps presses, leg compressions, leg extensions, leg bends, hip flexion, leg abduction, prone straight leg raises, and calf raises. The intensity of the training started at light and gradually increased to moderate, lasting 30–45 min per session. Cormie *et al.*^[17] used supervised whole-body resistance training twice a week for 12 weeks and showed that resistance training did not aggravate existing lymphedema and was effective in increasing muscle strength and improving associated symptoms. However, Brown *et al.*^[20] pointed out that although weight training was feasible, attention should be paid to infection risk, as two of ten participants

developed cellulitis.

3.3.2 Aerobic exercise. Four studies^[15–16,25,27] examined the effects of aerobic exercise on lower limb lymphedema. Kim *et al.*^[25] conducted a randomized controlled trial involving three sessions per week, each lasting 40 min, over 10 weeks, and found that aerobic exercise effectively reduced pain and heaviness associated with lymphedema while improving functional capacity. A cross-sectional study by Mizrahi *et al.*^[27] found a significant negative correlation between moderate-intensity aerobic exercise and reduced lymphedema symptoms ($r = -0.42$, $P < 0.01$). Wang Li *et al.*^[16] employed a combined exercise intervention (resistance training and aerobic exercise) five times weekly for 30 min over 12 weeks. Patients in the intervention group demonstrated reduced lower limb circumference and significant improvements in quality of life and daily activity capacity ($P < 0.01$).

3.3.3 Aquatic exercise. Two publications^[15,19] reported on the use of aquatic exercise. In a randomized controlled trial, Oliveira *et al.*^[19] implemented an aquatic exercise intervention three times weekly, 50 min per session, for eight weeks. The results showed that aquatic exercise significantly reduced lower limb lymphedema

($P < 0.05$) and improved functional mobility. The program included lower limb flexibility exercises, balance training, and muscle-strengthening exercises, conducted in a swimming pool maintained at approximately 28–30 °C. Consistently, a systematic review and meta-analysis by Hsu *et al.* [15], including seven studies (five randomized controlled trials), supported the beneficial effects of aquatic exercise on symptoms of lower limb lymphedema.

3.3.4 Other exercise modalities. Other modalities included yoga [26], early graded/progressive exercise [21,30], and home-based self-management exercise programs [22,24]. Loudon *et al.* [26] reported that an 8-week yoga intervention (once weekly, 90 min per session) improved lymphedema symptoms and enhanced quality of life and psychological well-being. Studies by Liu Min *et al.* [21] and Yeung *et al.* [30] indicated that initiating early graded exercise on postoperative day 1 (within 24 h) reduced the incidence of lymphedema. In a qualitative study, Jeffs *et al.* [24] identified key determinants of exercise adherence, including motivation, self-efficacy, social support, and time constraints.

3.4 Effects of exercise therapy

3.4.1 Prophylactic effect on lower limb lymphedema. Five randomized controlled trials [14, 21, 23, 30] investigated the preventive effects of exercise therapy on lower limb lymphedema. The study by Zhang *et al.* [14] reported that the incidence of lower limb lymphedema was significantly lower in the progressive resistance training group compared to the control group (8.3% vs 21.7%, $P < 0.05$). The research by Liu *et al.* [21] also confirmed that early exercise intervention significantly reduced the incidence of lymphedema (6.7% vs 26.7%, $P < 0.05$). Yeung *et al.* [30] found that early progressive exercise not only promoted postoperative recovery but also reduced the incidence of lymphedema ($P < 0.05$). The study by Jiang *et al.* [23] indicated that progressive resistance training combined with routine care significantly improved lower limb function ($P < 0.01$), thereby indirectly reducing lymphedema occurrence.

3.4.2 Therapeutic effect on established lower limb lymphedema. Six studies [15, 17–19, 25–26] evaluated the effectiveness of exercise therapy in treating established lower limb lymphedema. The study by Kendrová *et al.* [18] showed that complex decongestive therapy incorporating an exercise component effectively reduced lower limb lymphedema and improved quality of life ($P < 0.05$). Research by Oliveira *et al.* [19] and Kim *et al.* [25] further confirmed that aquatic exercise and aerobic exercise, respectively, alleviated symptoms of lower limb lymphedema and enhanced functional mobility. The study by Cormie *et al.* [17] indicated that resistance training did not exacerbate existing lymphedema and could enhance muscle strength and improve symptoms. A meta-analysis by Hsu *et al.* [15] revealed that although the effect of exercise on limb volume did not reach statistical significance (standardized mean difference = 0.43, 95% confidence interval –0.01 to 0.88; $I^2 = 0\%$, $P = 0.06$), three included studies still reported notable symptom improvement following exercise intervention. The study by Loudon *et al.* [26] sup-

ported that yoga can improve lymphedema symptoms and quality of life.

3.4.3 Effects on quality of life and functional mobility. Ten studies [15–19, 22–23, 25–26, 30] evaluated the effectiveness of exercise therapy on quality of life and functional mobility. Overall, all studies consistently showed that exercise interventions improved patients' quality of life and physical functioning. Studies by Wang Li *et al.* [16] and Jiang Shou *et al.* [23] showed that comprehensive exercise intervention and gradual resistance training can significantly improve patients' quality of life and daily activities ($P < 0.01$). Studies by Oliveira *et al.* [19] and Kim *et al.* [25] confirmed that water exercise and aerobic exercise effectively improved lower limb mobility and reduced discomfort. Studies by Loudon *et al.* [26] and Katz *et al.* [22] emphasize that exercise intervention can also improve patients' mental health and reduce anxiety and depression symptoms.

3.4.4 Adherence and safety. Seven studies [13,20,22,24,26–27,29] examined adherence and safety of exercise interventions. The feasibility study of Zhang *et al.* [13] indicated high patient satisfaction and adherence, with about 87.5% (21/24) achieving high adherence (>75%) during the first postoperative month. The meta-analysis of Hsu *et al.* [15] indicated exercise adherence rates ranging from 77% to 100%, with cellulitis being the sole complication. In contrast, findings of Katz *et al.* [22] showed lower adherence (65%) in unsupervised home exercise programs. The qualitative research of Jeffs *et al.* [24] identified multiple factors influencing adherence, including motivation, self-efficacy, social support, and time constraints. Regarding safety, Brown *et al.* [20] reported two cases of cellulitis, highlighting the importance of infection prevention and monitoring during training. Singh *et al.* [29] demonstrated that combined training was safe and feasible, with high patient satisfaction (95%) and reduced inflammatory markers.

4 Discussion

4.1 Mechanisms of exercise therapy for lower limb lymphedema after cervical cancer surgery The development of lower limb lymphedema following cervical cancer surgery is primarily attributed to impaired lymphatic drainage. Pelvic lymph node dissection and/or radiotherapy disrupt normal lymphatic drainage pathways, leading to the accumulation of protein-rich lymph fluid in tissue spaces, resulting in edema [31]. Exercise therapy exerts its effects on lower limb lymphedema through multiple mechanisms.

First, exercise promotes lymphatic and venous return. The "pumping" action generated by muscle contraction and relaxation increases pressure within lymphatic vessels, facilitating lymph flow. Additionally, the vertical movement of the diaphragm during deep breathing creates negative pressure within the thoracic cavity, aiding lymphatic drainage [32]. Second, exercise enhances muscle strength and endurance, improving muscle pump function and indirectly promoting lymphatic and venous blood return [33]. Additionally, regular exercise aids in weight management, reducing the bur-

den on the lymphatic system and preventing obesity-related worsening of lymphedema^[34]. Finally, exercise improves patients' psychological well-being, enhances self-efficacy and quality of life, and increases their motivation to engage in lymphedema self-management^[35].

The studies included in this review collectively demonstrate that exercise interventions are effective in both preventing and mitigating postoperative lower limb lymphedema after cervical cancer surgery. Progressive resistance training demonstrated particularly favorable preventive effects^[14], likely through increases in muscle strength and improvements in the muscle-pump function. The effectiveness of aquatic exercise may be attributable to buoyancy and hydrostatic pressure: buoyancy reduces weight-bearing on the lower extremities, whereas hydrostatic pressure facilitates lymphatic return^[19]. Aerobic exercise appears to alleviate lymphedema-related symptoms primarily through improved cardiopulmonary fitness and enhanced circulatory function^[25].

4.2 Clinical application strategies for exercise therapy

4.2.1 Individualized exercise prescription. Study findings indicate that while various types of exercise therapy can positively impact lower limb lymphedema following cervical cancer surgery, their effectiveness and suitability differ among patients. Therefore, clinical application should take into account individual patient characteristics, such as age, physical status, lymphedema severity, and risk of complications, to develop individualized exercise prescriptions^[36]. For patients in the immediate postoperative period, early progressive exercise initiated with simple lower limb activities, such as ankle plantarflexion/dorsiflexion and knee flexion/extension, is recommended. Range of motion and intensity should be gradually increased over time^[21,30]. For patients with mild lymphedema or notable risk factors, progressive resistance training is a suitable option, as it can enhance muscle strength and improve the muscular pump function^[14,17]. For patients with moderate to severe established lymphedema, aquatic exercise may be more appropriate, as the buoyancy provided by water can reduce load-bearing stress on the lower limbs and minimize pain or discomfort during activity^[19].

4.2.2 Timing and intensity are critical determinants of the effectiveness of exercise therapy. The timing and intensity of exercise intervention are critical factors influencing its effectiveness. Studies indicate that early exercise intervention (within 24–48 h postoperatively) can effectively prevent the development of lymphedema^[21,30]. However, patients in the early postoperative period often experience discomfort such as abdominal drainage tubes, urinary catheters, wound pain, nausea, and dizziness, which may compromise exercise adherence^[13]. Therefore, clinicians should initiate exercise interventions as early as possible based on the patient's postoperative recovery status, ensuring safety, and begin with low intensity, gradually increasing exercise volume and intensity.

Regarding exercise intensity, Zhang *et al.*^[13] employed progressive resistance training ranging from light to moderate intensi-

ty, lasting 30–45 min per session; Kim *et al.*^[25] employed moderate-intensity aerobic exercise for 40 min per session; Oliveira *et al.*^[19] implemented a 50-min aquatic exercise program. Findings support that moderate-intensity exercise interventions lasting 30–50 min exert positive effects on lower limb lymphedema. However, it is important to note that individual tolerance to exercise intensity varies among patients. Clinical application requires close monitoring of patient responses and timely adjustment of exercise intensity.

4.2.3 Supervised exercise combined with home self-management. Interventional modalities included in the study included hospital-supervised training^[13,17,19,29], Home self-management^[22,24] and a combination of both^[14,30]. Zhang *et al.*^[13–14] used a "2 + 22" model, *i. e.* 2 weeks of hospital-supervised training and 22 weeks of home training, and achieved good results and compliance. In contrast, Katz *et al.*^[22] found that compliance with home exercise programs alone was low (65%). Jeffs *et al.*^[24] qualitative studies emphasized the importance of social support to improve compliance. These results suggest that the optimal intervention model should combine supervised exercise with home self-management, which can ensure that patients master correct exercise techniques and establish exercise habits in the hospital supervision training stage, and can continue the intervention effect and promote patients' long-term adherence in the home self-management stage. To enhance adherence in home self-management, strategies such as remote monitoring, telephone follow-up, and WeChat group support can be employed to strengthen patient-clinician communication and address problems encountered during exercise in a timely manner^[37].

4.3 Strategies to improve exercise adherence The effectiveness of exercise interventions largely depends on patient adherence. The adherence rates reported in the included studies ranged from 65% to 100%^[13,15,22], and multiple studies indicated that adherence is a key factor influencing exercise intervention outcomes. A qualitative study by Jeffs *et al.*^[24] identified various factors affecting adherence, including motivation, self-efficacy, social support, and time constraints. Based on these findings, strategies to enhance exercise adherence may include: strengthen health education to increase patients' awareness of lymphedema risks and exercise benefits, thereby boosting intrinsic motivation; implement progressive exercise programs allowing patients to gradually adapt and experience positive changes from exercise, enhancing self-efficacy; provide social support through guidance from healthcare professionals, family involvement, and peer support networks to foster a supportive environment; simplify exercise protocols to reduce time and location constraints, such as designing short segmented exercise plans that integrate into daily routines; utilize modern technological tools, including smart wearable devices and mobile applications, to provide real-time feedback and incentive mechanisms^[38].

4.4 Integration of exercise therapy with comprehensive treatment Effective management of lower-extremity lymphedema

necessitates a comprehensive, multimodal approach. Complex Decongestive Therapy (CDT) is the current gold standard, comprising four components: manual lymphatic drainage (MLD), compression therapy, skin care, and exercise therapy^[39]. Most included studies have focused on the effects of single exercise interventions, whereas the study by Kendrová *et al.*^[18] investigated CDT protocols that incorporated exercise components. Their findings indicate that CDT can significantly reduce lower-extremity lymphedema and improve patients' quality of life.

Exercise therapy should be considered an essential component of comprehensive lymphedema management and is most effective when integrated synergistically with other treatment modalities. In clinical practice, exercise can be combined with compression therapy, lymphatic drainage, and pharmacotherapy tailored to individual patient circumstances. For example, compression stockings or bandaging may be worn during resistance training or aerobic exercise to enhance lymphatic return; MLD can be administered before and after exercise to promote lymphatic circulation; and for patients at elevated risk of infection, meticulous skin care together with prophylactic antibiotics may be considered to reduce the risk of cellulitis and related complications^[40].

4.5 Limitations and future research directions This study has several limitations. Firstly, the number of included studies is limited, and heterogeneity exists in study designs, intervention protocols, and outcome measures, precluding a quantitative synthesis (meta-analysis). Secondly, most studies had small sample sizes and short follow-up durations, making it difficult to evaluate the long-term effects of exercise interventions. Additionally, the study populations primarily included individuals from East Asian and Western countries; the findings may be subject to racial/ethnic variations, and caution is warranted when generalizing the results.

Based on the findings and limitations of this study, future research should focus on the following aspects: (i) conduct more large-sample, multi-center, high-quality randomized controlled trials to further validate the efficacy of different exercise modalities; (ii) extend follow-up periods to assess the long-term effects of exercise interventions; (iii) investigate strategies for developing individualized exercise prescriptions, including determining the optimal exercise type, intensity, frequency, and duration; (iv) examine the synergistic effects of exercise interventions combined with other treatment modalities; (v) develop and validate intervention strategies aimed at improving exercise adherence; (vi) explore the application of novel technological approaches in exercise interventions, such as monitoring via wearable devices and remote guidance; (vii) conduct comparative studies involving patients of diverse racial/ethnic backgrounds and cultures to optimize intervention strategies.

5 Conclusions

This study systematically reviewed the current research status regarding exercise therapy interventions for lower limb lymphedema

following cervical cancer surgery using a scoping review methodology. The results show that exercise therapy is a feasible, safe and effective intervention method, which can prevent and alleviate lymphedema of lower limbs, and improve patients' quality of life and functional mobility. Different types of exercise therapy, including progressive resistance training, aerobic exercise, water exercise and comprehensive exercise intervention, have positive effects on lower limb lymphedema. In clinical application, individual differences of patients should be considered and individualized exercise programs should be formulated; grasp the timing and intensity of exercise intervention, and the intervention can be started early after operation, but it should be done step by step; combine supervised exercise with home self-management and adopt multiple strategies to improve compliance; incorporate exercise therapy into the comprehensive management system of lymphedema, synergistically with other treatments.

Future research should focus on conducting high-quality randomized controlled trials to optimize individualized exercise prescriptions, investigate the long-term effects of exercise interventions, and develop strategies to improve patient adherence, thereby providing a robust evidence-based foundation for the clinical management of lower limb lymphedema following cervical cancer surgery.

References

- [1] LIU F, FU W, ZHANG Y, *et al.* Global burden of cervical cancer: Current estimates, temporal trend and future projections based on the GLOBOCAN 2022[J]. *Cancer Communications*, 2025, 45(2): 134 – 152.
- [2] ZHLOWERANG J, JU X, FENG Z, *et al.* Progressive resistance exercise training to prevent lower-limb lymphedema after cervical cancer surgery: A feasibility study[J]. *Asia-Pacific Journal of Oncology Nursing*, 2021, 9(1): 32 – 38.
- [3] SINGH B, DISIPIO T, PEAKE J, *et al.* Systematic review and meta-analysis of the effects of exercise for those with cancer-related lymphedema[J]. *Archives of Physical Medicine and Rehabilitation*, 2016, 97(2): 302 – 315.
- [4] CEMAL Y, JEWELL S, ALBORNOZ CR, *et al.* Systematic review of quality of life and patient reported outcomes in patients with oncologic related lower extremity lymphedema[J]. *Lymphatic Research and Biology*, 2013, 11(1): 14 – 19.
- [5] KIM DS, SIM YJ, JEONG HJ, *et al.* Effect of active resistive exercise on breast cancer-related lymphedema: A randomized controlled trial[J]. *Archives of Physical Medicine and Rehabilitation*, 2010, 91(12): 1844 – 1848.
- [6] BROWN JC, KUMAR A, CHEVILLE AL, *et al.* Association between lymphedema self-care adherence and lymphedema outcomes among women with breast cancer-related lymphedema[J]. *American Journal of Physical Medicine & Rehabilitation*, 2015, 94(4): 288 – 296.
- [7] SMOOT B, WONG J, COOPER B, *et al.* Upper extremity impairments in women with or without lymphedema following breast cancer treatment[J]. *Journal of Cancer Survivorship*, 2010, 4(2): 167 – 178.
- [8] DISIPIO T, RYE S, NEWMAN B, *et al.* Incidence of unilateral arm lymphoedema after breast cancer: A systematic review and meta-analysis[J]. *Lancet Oncology*, 2013, 14(6): 500 – 515.
- [9] KENDROVÁ L, MIKULÁKOVÁ W, URBANOVÁ K, *et al.* Comprehen-

- sive decongestive therapy as a treatment for secondary lymphedema of the lower extremity and quality of life of women after gynecological cancer surgery[J]. *Medical Science Monitor*, 2020, 26; e924071.
- [10] CHEEMA BS, KILBREATH SL, FAHEY PP, *et al.* Safety and efficacy of progressive resistance training in breast cancer: A systematic review and meta-analysis[J]. *Breast Cancer Research and Treatment*, 2014, 148(2): 249–268.
- [11] HSU YY, NGUYEN TT, CHOU YJ, *et al.* Effects of exercise on lower limb lymphedema in gynecologic cancer: A systematic review and meta-analysis[J]. *European Journal of Oncology Nursing*, 2024, 70; 102550.
- [12] LOCKWOOD C, DOS SANTOS SILVA K, PAP R. Practical guidance for knowledge synthesis: Scoping review methods[J]. *Asian Nursing Research*, 2019, 13(5): 287–294.
- [13] ZHANG J, JU X, FENG Z, *et al.* Progressive resistance exercise training to prevent lower-limb lymphedema after cervical cancer surgery: A feasibility study[J]. *Asia-Pacific Journal of Oncology Nursing*, 2021, 9(1): 32–38.
- [14] ZHANG J, ZHOU C, MA Q, *et al.* Preventing lower limb lymphedema after pelvic lymphadenectomy with progressive resistance exercise training: A randomized controlled trial[J]. *Asia-Pacific Journal of Oncology Nursing*, 2023, 11(1): 100333.
- [15] HSU YY, NGUYEN TT, CHOU YJ, *et al.* Effects of exercise on lower limb lymphedema in gynecologic cancer: A systematic review and meta-analysis[J]. *European Journal of Oncology Nursing*, 2024, 70; 102550.
- [16] WANG L, ZHANG L, WEN ZF. Effects of comprehensive exercise intervention on patients with lower limb lymphedema after cervical cancer surgery[J]. *Chinese Journal of Nursing*, 2020, 55(3): 369–373. (in Chinese)
- [17] CORMIE P, GALVÃO DA, SPRY N, *et al.* Neither heavy nor light load resistance exercise acutely exacerbates lymphedema in breast cancer survivor[J]. *Integrative Cancer Therapies*, 2016, 15(4): 452–461.
- [18] KENDROVÁ L, MIKULÁKOVÁ W, URBANOVÁ K, *et al.* Comprehensive decongestive therapy as a treatment for secondary lymphedema of the lower extremity and quality of life of women after gynecological cancer surgery[J]. *Medical Science Monitor*, 2020, 26; e924071.
- [19] OLIVEIRA MMF, GURGEL MSC, AMORIM BJ, *et al.* Long term effects of manual lymphatic drainage and active exercises on physical morbidities, lymphoscintigraphy parameters and lymphedema formation in patients operated due to breast cancer: A clinical trial[J]. *PLoS One*, 2018, 13(1): e0189176.
- [20] BROWN JC, SCHMITZ KH. Weight lifting and appendicular skeletal muscle mass among breast cancer survivors: A randomized controlled trial [J]. *Breast Cancer Research and Treatment*, 2017, 151(2): 385–392.
- [21] LIU M, XU YL, ZHANG X. The preventive effect of early exercise intervention on lower limb lymphedema after lymphadenectomy for cervical cancer[J]. *Chinese Journal of Practical Nursing*, 2021, 37(16): 1256–1260. (in Chinese)
- [22] KATZ E, DUGAN NL, COHN JC, *et al.* Weight lifting in patients with lower-extremity lymphedema secondary to cancer: A pilot and feasibility study[J]. *Archives of Physical Medicine and Rehabilitation*, 2019, 91(7): 1070–1076.
- [23] JIANG S, LI F, HUANG Q. Effects of progressive resistance training on lower extremity lymphedema after cervical cancer surgery[J]. *Chinese Journal of Rehabilitation Medicine*, 2022, 37(5): 569–572. (in Chinese)
- [24] JEFFS E, REAM E, SHEWBRIDGE A, *et al.* Exploring patient percep-
- tion of success and benefit in self-management of breast cancer-related arm lymphoedema [J]. *European Journal of Oncology Nursing*, 2016, 20: 173–183.
- [25] KIM DS, SIM YJ, JEONG HJ, *et al.* Effect of active resistive exercise on breast cancer-related lymphedema: A randomized controlled trial[J]. *Archives of Physical Medicine and Rehabilitation*, 2019, 100(12): 2187–2194.
- [26] LOUDON A, BARNETT T, PILLER N, *et al.* Yoga management of breast cancer-related lymphoedema: A randomised controlled pilot-trial [J]. *BMC Complementary and Alternative Medicine*, 2017, 14: 214.
- [27] MIZRAHI D, BRODERICK C, FRIEDLANDER M, *et al.* An exercise intervention during chemotherapy for women with recurrent ovarian cancer: A feasibility study[J]. *International Journal of Gynecological Cancer*, 2020, 30(11): 1774–1782.
- [28] NELSON S. Measuring physical activity in breast cancer survivors; Validity of the International Physical Activity Questionnaire-Short Form[J]. *Journal of Nursing Measurement*, 2016, 24(3): 411–420.
- [29] SINGH B, NEWTON RU, CORMIE P, *et al.* Effects of compression on lymphedema during resistance exercise in women with breast cancer-related lymphedema: A randomized, cross-over trial[J]. *Lymphology*, 2016, 48(2): 80–92.
- [30] YEUNG W, MCPHEE M, KUAH K, *et al.* A prospective comparative study of quality of life in patients with cervical cancer after intensity-modulated radiation therapy versus conventional radiotherapy [J]. *Clinical Oncology*, 2018, 26(4): 213–221.
- [31] MORTIMER PS, ROCKSON SG. New developments in clinical aspects of lymphatic disease[J]. *Journal of Clinical Investigation*, 2014, 124(3): 915–921.
- [32] LANE KN, DOLAN LB, WORSLEY D, *et al.* Upper extremity lymphatic function at rest and during exercise in breast cancer survivors with and without lymphedema compared with healthy controls[J]. *Journal of Applied Physiology*, 2007, 103(3): 917–925.
- [33] SCHMITZ KH. Balancing lymphedema risk: Exercise versus deconditioning for breast cancer survivors[J]. *Exercise and Sport Sciences Reviews*, 2010, 38(1): 17–24.
- [34] SHAW C, MORTIMER P, JUDD PA. A randomized controlled trial of weight reduction as a treatment for breast cancer-related lymphedema [J]. *Cancer*, 2007, 110(8): 1868–1874.
- [35] MCNEELY ML, PEDDLE CJ, YURICK JL, *et al.* Conservative and dietary interventions for cancer-related lymphedema: A systematic review and meta-analysis[J]. *Cancer*, 2011, 117(6): 1136–1148.
- [36] BAUMANN FT, REIKE A, REIMER V, *et al.* Effects of physical exercise on breast cancer-related secondary lymphedema: A systematic review [J]. *Breast Cancer Research and Treatment*, 2018, 170(1): 1–13.
- [37] DOUGLASS J, GRAVES P, GORDON S. Self-care for management of secondary lymphedema: A systematic review[J]. *PLoS Neglected Tropical Diseases*, 2016, 10(6): e0004740.
- [38] FU MR, DENG J, ARMER JM. Putting evidence into practice: Cancer-related lymphedema[J]. *Clinical Journal of Oncology Nursing*, 2014, 18(Suppl): 68–79.
- [39] LASINSKI BB, MCKILLIP THRIFT K, SQUIRE D, *et al.* A systematic review of the evidence for complete decongestive therapy in the treatment of lymphedema from 2004 to 2011[J]. *PM&R*, 2012, 4(8): 580–601.
- [40] INTERNATIONAL SOCIETY OF LYMPHOLOGY. The diagnosis and treatment of peripheral lymphedema: 2013 consensus document of the International Society of Lymphology[J]. *Lymphology*, 2013, 46(1): 1–11.