The impact of land-based exercise on quality of life and subjective symptoms in lower-limb lymphoedema: a systematic review

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Key words

Exercise, Lower-limb lymphoedema, Health-related quality of life, Symptomology, Patient outcomes

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Abstract

Chronic lower-limb lymphoedema disrupts physical and mental health and requires labour-intensive therapies. This review synthesised evidence on the impact of exercise therapy on sufferer quality of life and symptom experience, concluding that exercise may improve strength, fitness, function, and decrease fatigue. It might also improve quality of life and subjective symptom scores, or at least have no negative impact. Existing studies are heterogenous in terms of size and exercise type, intensity, and frequency. Larger, more coordinated trials of longer duration are required in the future.

Lower-limb lymphoedema (LLL) is a relatively common condition characterised by an increased collection of lymphatic fluid in one or both limbs causing chronic swelling and often changes in skin and tissue (Sleigh and Manna, 2019). Individuals report chronic lymphoedema as profoundly disruptive to physical and mental health, often progressing to a reduced quality of life (QoL) and loss of function (Brown et al, 2014; Ergin et al, 2017; Greene and Meskell, 2017). Reduction in function often results from swelling and limb heaviness (Kim et al, 2015), restricted range of movement, pain, or impaired wound healing.

More specifically, patients with LLL may experience significant alterations in balance and proprioception (Doruk Analan and Kaya 2019) affecting their ability to walk or even sit. This, in turn, limits their participation in their usual occupation, eventually reducing their ability to do housework, social activities (Dunberger, Lindquist et al, 2013) and basic activities of daily living, thereby ultimately restricting independence (Ergin et al, 2017; Fukushima et al, 2017). Along the trajectory of the condition, psychological morbidity is frequently experienced with increases in fear and anxiety, depression, isolation, and reduction in self-esteem (Greenslade and House, 2006).

Without timely therapy or effective interventions, the changes to the lymphatic system can become irreversible (Kwan et al, 2011). Moreover, if lymphoedema progresses, it may leave patients twice as vulnerable to complications that require hospitalisation and additional costly treatments (Tidhar et al, 2014). Indeed, there is no cure for lymphoedema, so the hopes are pinned on treatments that improve and halt the progression of the condition. This has furthered the demand for conservative and accessible interventions that are effective.

A range of conservative therapies has been developed for managing lymphoedema. These include manual lymphatic drainage (MLD), compression therapy, exercise, taping, thermal therapy, and pneumatic compression (Tzani et al, 2018). The gold standard treatment is considered to be complete decongestive therapy (CDT) (Földi and Földi, 2011) and several studies have reported some effectiveness in reducing limb volume (Finnane et al, 2015a).

However, despite its promise, the effectiveness of CDT still ranges between 22–73% (Forner-Cordero and Munoz-Langa, 2012), with much of the variability attributed to the patient compliance, as well as the predisposing aetiology. The evidence for MLD leans towards it being beneficial as a preventative therapy or when combined with CDT (Muller et al, 2018; Tzani et al, 2018), however, research findings remain inconsistent (Finnane et al, 2015a). The associated costs of MLD, as well as limited availability of trained professionals, make it inaccessible to many (Gutknecht et al, 2017).

Furthermore, a meta-analysis of randomised control trials of MLD found it to be no more effective than standard treatment (Huang et al, 2013). Other treatments fare no better. The effectiveness of multilayer compression bandaging (CB) suffers from high non-adherence rates with more than 50% of patients non-compliant, either due to poor tolerance or motivation (Miller et al, 2011). Meanwhile, a recent systematic review has brought into question the effectiveness of intermittent pneumatic compression (IPC), concluding that it may not provide any additional benefits when used in combination with routine management (Tran and Argaez, 2017).

This leaves exercise, being one of the established pillars of CDT, as an obvious frontier for exploration, especially considering the minimal barriers to access, no-to-low cost, and its potential to empower patients. In reviewing the evidence for exercise therapy, it is important to remember

that the patient's priorities for treatment may differ to those of the therapist (Tidhar and Armer, 2018). For example, quality of life may not be directly associated with limb size (Finnane et al, 2015b; Morton et al, 2017), and yet limb volume is the outcome most studies measure. Indeed, analysis of data from interviews with long-term patients, revealed that patient concerns included hope, clarity regarding progress towards long-term phases of treatment, personal empowerment, and maintenance of the gains made in therapy (Tidhar and Armer, 2018). For these patients, improvements in the subjective experience of heaviness or tightness are considered the highest priority for treatment outcomes (Finnane et al, 2015b).

Although 'success' of the initial phases of treatment may be defined as a decrease in swelling and pain with increases in function, over the long-term patients may define 'success' as maintaining stability, halting the progression of the condition and sustaining functional independence (Tidhar and Armer, 2018).

Aims

The aim of this systematic literature review is to examine the availability and strength of evidence for the impact of land-based exercise on the health-related outcomes of patients with LLL. More specifically, the authors examine the effect of exercise on subjective symptoms, quality of life, skin and pitting oedema, as well as strength, fitness and function.

The key question of this review is, therefore, 'what are the effects of land-based exercise on patient subjective symptoms and quality of life, skin and pitting oedema, and health-related outcomes such as strength, fitness, and function?'

Methods

The review followed the standard reporting format prescribed by PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher et al, 2009).

Inclusion criteria

Studies were eligible for inclusion in the review if they met all of the criteria laid out below.

Population

Studies must describe adult populations (≥18 years of age) undergoing treatment for unilateral or bilateral chronic lower limb lymphoedema irrespective of aetiology.

Interventions

Studies were included if they focused on exercise as a single modality. Studies including exercise in conjunction with other therapeutic modalities, or as a component of CDT, were eligible providing authors reported outcomes for each element separately, making it possible to extract the results for exercise.

Outcomes of interest

Studies needed to evaluate the effects of exercise on patient-reported quality of life, mobility, function, and symptoms such as fatigue, pain, limb heaviness, and dermatological condition. The association between exercise and weight loss, or reduction in Body Mass Index (BMI), is also of interest. Outcomes should be assessed using well-established validated tools.

Settings

All clinical and geographic settings were eligible.

Study types

The review considered only primary studies with an experimental or observational methodology focused on determining the association between exercise and patient-reported outcomes. Study types included, but were not limited to, randomised controlled trials, cohort, before-and-after, case-control, cross-sectional, pilot and case studies.

Publication types

Studies published in English in a peer-reviewed journal without date restriction were eligible for consideration.

Exclusion criteria

The following exclusion criteria applied:

- Unpublished articles and those not in English
- Animal studies
- Paediatric studies
- Exercise studies of hydro- or aqua-therapy
- Articles focused on the treatment of lymphovenous disorders, lymphaticovenous anastomosis, venous leg ulcers, dematolymphangioadenitis, filariasis or elephantiasis, phlebolymphedema, non-lymphoedema causes of swelling
- Treatment studies on truncal lymphoedema or lymphoedema of the upper limb, head, neck or trunk
- Studies that refer to exercise as part of CDT but do not disentangle the effects of exercise from that of CDT as a bundled therapy.

Information sources

The search for published studies was undertaken using the following electronic databases: Medline (Ovid version, 1948), Embase (Ovid, 1974-), CINAHL (EBSCOhost) and the Cochrane Central Register of Controlled Trials. Additionally, the authors scanned the reference lists of included studies, allowing for the capture of any relevant studies not identified by the database searches.

Search strategy

The search strategy was first drafted and extensively tested in Medline before being translated for other databases using their own native syntax. Search strategies combined database-specific subject headings, where available, and an extensive range of textwords describing each of the concepts in the research question. All search strategies are available on request.

Study records

All citations retrieved by database searches were imported into an EndNote X9 Library. Duplicates were identified and removed. Both authors independently screened all remaining citations for relevance, first based on title and abstract alone, and then by reading the full text article. Differences in opinion were resolved by discussion.

Risk of bias of individual studies

Both authors critically appraised included studies using the McMaster Critical Review Form for quantitative studies (Law et al, 1998). Study strengths and weaknesses were noted but studies were not eliminated based on their quality. The classification schema titled 'Decision rules for summative evaluation of a body of evidence' was consulted to derive a conclusion on the overall strength of the evidence (Mitchell and Friese, 2011).

Data extraction

One author (KJ) extracted the data of

research interest and recorded it in an Excel spreadsheet. The following fields were captured: authors, year, country of study, study design, number and type of participants, intervention and its duration, relevant outcomes assessed and findings relevant to this review.

Data synthesis

It was determined *a priori* to conduct a narrative synthesis of each study's findings if outcomes were too heterogenous, precluding the possibility of a meta-analysis.

Results

All search strategies together retrieved a total of 3,970 citations, which was reduced to 2,538 after removing duplicates. After applying eligibility criteria to the titles, abstracts, and then full text documents, five studies remained for inclusion, as depicted in the PRISMA flow diagram (*Figure 1*).

The final five included studies comprised a case study (Mirandola et al, 2019), two one-group before-after studies (Moseley et al, 2004, Katz et al, 2010), and two randomised control trials (Do et al, 2017, Fukushima et al, 2017). A total of 107 patients were included, representing 99 females and 8 males. All studies were limited by small numbers, the smallest study involving a single patient and the largest having ≤40 participants. All participants had LLL secondary to cancer.

Programme duration varied greatly. Three interventions required participants to remain engaged with an exercise programme for a duration of 3 to 5 weeks (Moseley et al, 2004; Do et al, 2017; Fukushima et al, 2017) while two interventions required a commitment of five months (Katz et al, 2010; Mirandola et al, 2019). Exercise intensity varied between two x 15-minute aerobic workouts spread across several weeks; a maximum of 24 minutes passive exercise per day; two x 1-hour mixed exercise sessions per week; two x 90-minute resistance exercises per week; and at the high end, five x 40-minute mixed exercise sessions per week. Only one study (Moseley et al, 2004) included a follow up of patients several weeks after the final exercise session to see if the results had been maintained. The characteristics of each study are detailed in *Table 1*.

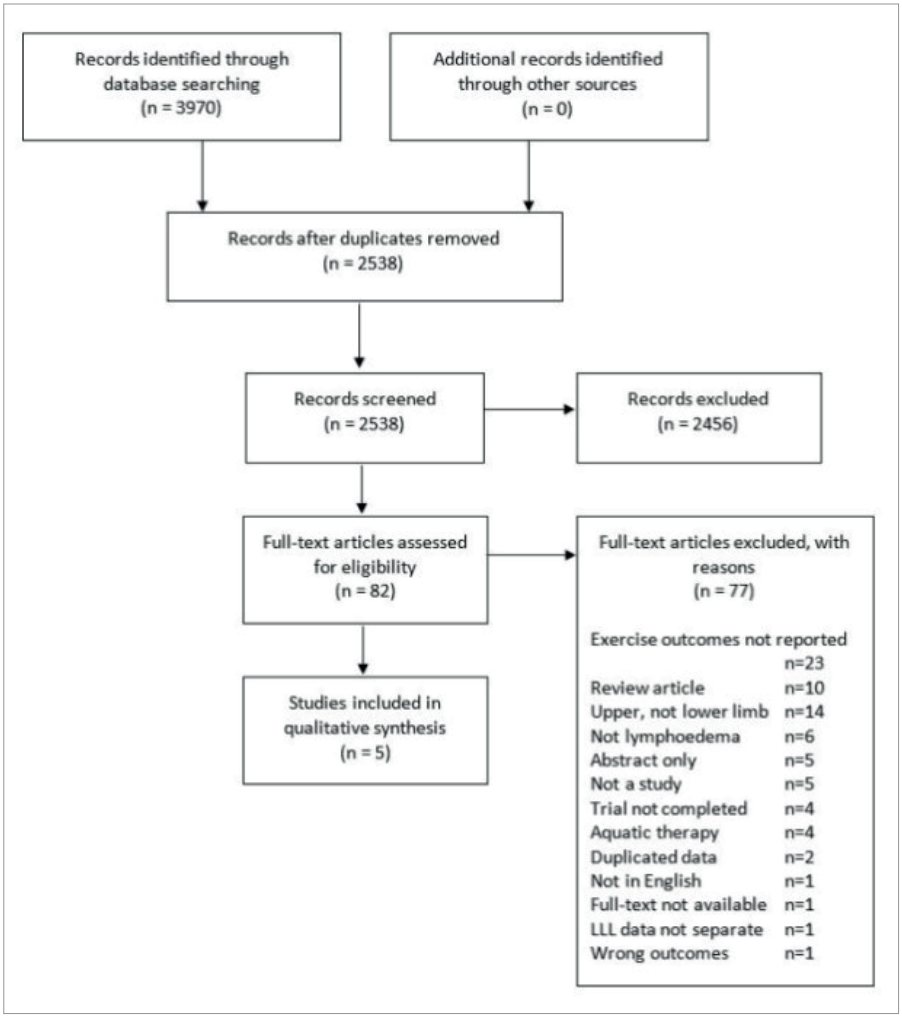

Figure 1. PRISMA flow diagram of selection decisions.

Effect of exercise on subjective symptoms and quality of life

Subjective symptoms and/or QoL were investigated in all studies. Validated QoL questionnaires included the Short Form-12 (Katz et al, 2010; Mirandola et al, 2019), the McGill QoL Questionnaire (Moseley et al, 2004), and the EORTC QLQ-C30 (Do et al, 2017). The visual analogue scale was used in two studies to assess self-reported pain and heaviness (Katz et al, 2010; Fukushima et al, 2017). The Korean version of the Gynecologic Cancer Lymphedema Questionnaire (GCLQ-K) was employed to determine fatigue and pain scores (Do et al, 2017), while a modified version of an upper-limb lymphoedema questionnaire captured self-reported symptoms of pain and mobility (Katz et al, 2010).

Statistically significant improvements in pain perception scores were made post treatment for the case study (Mirandola et al, 2019) and in both the intervention and control group for one study (Do et al, 2017). Fukushima et al (2017) also reported statistically significant improvements in pain and heaviness scores for all three interventions — high and low intensity exercise, as well as compression therapy on its own. However, no significant differences existed between the three interventions to favour one over another. The researchers of this study postulate that this improvement in pain scores could be because minimal differences were seen in overall reduction of limb volume or because the VAS tool may not have been sensitive enough to detect differences in pain scoring between the interventions.

Furthermore, Moseley et al (2004) reported a statistically significant improvement in pain scores at month two, although there was some return of symptoms at the one month follow up. In contrast, Katz et al (2010) reported no statistical improvements in pain based on the VAS scale, possibly because pain scores were low (average = 0.75/10) at the three time periods in this study.

Regarding the sensation of heaviness, statistically significant improvements were

Table 1. Characteristics of included studies.

Author, Year (country of study)	Study design	Number & types of participants	Intervention and duration	Relevant outcomes assessed	Findings relevant to this review
Mirandola et al, 2019 (Italy)	Case study	1 x 69-year-old female with both ULL post breast cancer and pronounced left LLL with fibrosis post-gynaecological cancer treatments	Intervention: Tailored fitness programme of stretching, aerobic, and strengthening exercises. Circuit training workout alternated low-intensity and higher workload exercises. Intensity: One-hour sessions performed. during 2 non-consecutive days per week. Duration: 20 weeks (8 weeks of adapted physical activity programme + 12 weeks of adapted fitness programme).	QoL evaluated by Short Form-12 (SF-12) at baseline, after 8 weeks, and after 20 weeks. Lower-limb pain intensity evaluated by numerical rating scale questionnaires at baseline, after 8 weeks and after 20 weeks	Reduction in lower-limb pain perception, improved QoL in physical and mental domains.
Fukushima et al, 2017 (Japan)	Randomised controlled crossover trial	23 women with LLL secondary to gynaecological cancer	Intervention: Bicycle ergometer use + compression therapy with short stretch bandages. Intensity: 1 x 15-minute aerobic session at high load and a 1 x 15-minute session at low load at another date. Control: Compression alone. Duration: One-week washout period between each of the three interventions.	Lower-limb pain and heaviness were assessed via visual analog scale (VAS) before and after each intervention. Skin symptoms of pitting and stiffness assessed using palpation before and after each intervention.	Significant improvements in pain and heaviness with all interventions. No significant improvement in skin stiffness but significant difference in pitting oedema seen in all three interventions. For all outcomes, no significant differences in least square mean percentage changes were observed between the three interventions. Severity of pre-intervention skin symptoms was significantly correlated with limb volume reduction after high and low load active exercise with compression therapy.
Do et al, 2017 (South Korea)	Randomised pilot study	40 females with unilateral LLL secondary to gynaecological cancer	Intervention: A complex rehabilitation programme comprising stretching, strengthening, and aerobic exercises + CDT. Intensity: Moderate, 40 mins, 5 x weekly Control: 40-minute sessions of CDT. Duration: 4 weeks.	Lymphoedema-related symptoms assessed by GCLQ-K Muscular strength was assessed using a handheld dynamometer. Lower-limb strength was assessed using the 30 second chair sit-to-stand test QoL was evaluated using EORTC QLQ-C30. All tests were applied at baseline and 4 weeks.	Intervention group had significant improvement in physical function scores, muscular strength of the knee extensor, and performance on the sit-to-stand test compared to control group. Both groups showed significant improvements in fatigue, pain, and GCLQ-K scores without exacerbating LLL.

Table 1. Characteristics of included studies (Continued).

Author, Year (country of study)	Study design	Number & types of participants	Intervention and duration	Relevant outcomes assessed	Findings relevant to this review
Katz et al, 2010 (USA)	One-group pre-test/ post-test non-controlled pilot and feasibility study	10 gynaecological or melanoma cancer survivors with LLL (7 females, 3 males)	Intervention: Weightlifting programme. Intensity: 90 mins sessions, 2 x weekly with slowly increasing resistance. Duration: 5 months.	Norman (2001) survey adapted for self-report of LLL symptoms. Visual analogue scale used to assess pain from lymphoedema Upper- and lower-body strength assessed by 1-repetition maximum tests for the bench press and leg press. Cardiorespiratory functional endurance measured by the 6-minute walk test. Dynamic balance assessed by Short Physical Performance Battery. QoL assessed by Medical Outcomes Study 36-Item. Short-Form Health Survey All assessments were made at baseline and at 2 and 5 months.	Clinically meaningful improvements in measures of functional status and strength: bench press, time to walk 50 feet, and distance walked in 6 minutes 25% improvement in balance. 120% improvement in dorsiflexion of the affected ankle. No significant changes in QoL. Average lymphoedema symptom severity significantly improved.
Moseley et al., 2004 (Australia)	One-group pre-test/ post-test	33 patients with a >1yr formal diagnosis of secondary lymphoedema (28 females, 5 males)	Intervention: Home-based mechanical device (Sun Ancon Chi Machine Aerobic Exerciser) that elevates and provides passive lower-limb exercise. Intensity: Morning and evening use. Days 1–2: 5 mins per session; days 3–7: 8 minutes per session; and days 8–21: 12 minutes per session. Duration: 3 weeks with measurements made after 3 weeks and 7 weeks.	McGill Quality of Life Questionnaire used to measure subjective leg symptoms. These included pain, heaviness, tightness, pins and needles, cramping, burning sensations and perceived leg size. Questionnaire administered at baseline and then at weekly intervals.	Statistically significant improvements in leg pain, tightness, heaviness, skin dryness and participant perceptions of their leg size(s). Patient-perceived improvements in ability to undertake physical activity and exercise, improved body image, and reduction in depression. No significant improvement in symptoms such as cramping, burning sensations and pins and needles. Some return of fluid and symptoms observed at 7 weeks but still below pre-treatment levels.

reported in all three groups from pre- to post-surveys by Fukushima et al (2017) and there remained a statistically significant improvement in heaviness, skin dryness, and tightness perception post intervention with the Sun Ancon Chi Machine (Moseley et al, 2004).

In terms of QoL, there was a statistically significant improvement in the intervention group for Do et al (2017), as well as the case study (Mirandola et al, 2019). In addition, Moseley et al (2004) highlighted that participants had a more positive body image, viewed themselves as less impaired and experienced a reduction in depression. Meanwhile, Katz et al (2010) found that average lymphoedema symptom severity scores also improved from 1.1 to 0.8 at 2 months then plateaued (P=0.20). Improvements in fatigue scores were noted by Do et al (2017) but only in the intervention group, despite their control group undertaking CDT.

Effect of exercise on skin and pitting oedema

Tonometry is a measurement of tissue resistance to pressure, providing insight as to compliance of the dermis and depth of fibrotic induration. Using this validated tool, Moseley et al (2004) found no significant differences in the tissues throughout the trial. Katz et al (2010) used a modified Norman Lymphoedema Questionnaire (Norman et al, 2001), which solicited patient reporting of skin changes; however, they did not find any instances of skin changes except for two cases of cellulitis.

Fukushima et al (2017) provide an in-depth analysis into the effect of exercise on skin and pitting oedema in LLL. They found no significant improvements with respect to skin stiffness in any of the groups (high-load AECT, P=0.16; low-load AECT, P=1.00; and CT, P=1.00). However, there was a significant improvement in pitting oedema within all three groups (high-load AECT, P=0.03; low-load AECT, P<0.05; CT, P=0.03). They also found that the pre-intervention skin-stiffness and pitting oedema severity correlated closely with limb volume decreases for both the high- and low-intensity exercise group, and not for the control group with compression only.

Thus, Fukushima et al (2017) argued that exercise (with compression) was superior to compression only when treating severe LLL with more advanced pitting oedema and skin stiffness, while exercise (with compression) was comparable to only compression in mild LLL.

Effect of exercise strength and fitness

Two studies assessed changes to strength and fitness. Katz et al (2010) reported statistically significant improvements in strength based on bench press, walking speed for 50 feet, and shortness of breath after the 6-minute walking test. Similarly, Do et al (2017) reported significant improvements in muscular strength of the knee extensor and 30-second chair stand test, in the intervention group only. There was also a decrease in fatigue in the intervention group, which Do et al (2017) highlight as clinically important given that this is an established barrier to exercise (Mizrahi et al, 2015). Although Moseley et al (2004) did not directly measure strength and fitness, participants reported self-perceived improvements in their ability to undertake physical activity and exercise.

Effect on function and mobility

In addition to improvements in strength and fitness, Katz et al (2010) reported clinically meaningful improvements in measures of function including a 25% improvement in participant balance and 120% improvement in dorsiflexion of the affected ankle. Similarly, the intervention group in Do et al (2017) showed significant improvement in physical function scores.

Association between BMI and oedema symptoms

Katz et al (2010) and Mirandola et al (2019) depict no change in BMI from baseline while Moseley et al (2004) noted that participants lost weight (median 0.5kg, P=0.015) with an average reduction in BMI of 0.15kg/m^2, which remained at the one month follow up. Moseley et al (2004) suggest that while this may be attributed to fluid loss, it may also represent a loss of body fat, which would be of clinical relevance given the difficulties LLL patients can have with inactivity and weight gain which further stresses their lymphatic system. Moseley et al (2004) also note that the fluid loss correlated with improvements in subjective symptoms of LLL, as well as QoL.

Quality of included studies

The overall study quality was sound based on the type of study conducted. All studies used reliable and valid outcome measures. Furthermore, the two randomised controlled trials, plus the Katz et al (2010) study, reported employing either trained personnel or a single qualified person to conduct the intervention and/or record the many measurements as an attempt to reduce variation in intervention conduct and assessor measurement technique. The case study demonstrated an appropriate exploratory approach to the question of structured physical activity pathways for cancer survivors.

The two RCTs were adequately powered based on sample size calculations and the randomisation process was described. However, while it was expected that neither participants nor exercise trainers/supervisors could be blinded to group allocation, the reports do not describe blinding of data collectors and those analysing the outcomes. Knowledge of the extent to which these individuals were aware of who received the treatment would assuage concerns of the possibility for bias in favour of the intervention. Furthermore, reasons for dropouts were not fully explained in Fukushima et al (2017) and neither RCT appears to have conducted an intention to treat analysis to counter the problems of noncompliance and missing outcomes due to dropouts. Details of the critical analysis are provided in *Table 2*.

Discussion

This review selected to focus on the outcomes of participant quality of life and subjective symptom reduction despite the fact that reduction in lower-limb volume is generally regarded as a sign of therapy success in LLL. This focus is supported by the finding of Finnane et al (2015b) that improvements in limb swelling, heaviness and tightness are the highest priorities for many patients. Furthermore, other long-term lymphoedema patients define treatment success as a maintenance of function and independence, as well as halting the progression of the disease (Tidhar and Armer, 2018).

Where these outcomes are concerned, even a minimal level of exercise appears to bestow benefits on people experiencing LLL with improvements in quality of life and subjective symptom scores reported in most of the included studies. That said, it is difficult to attribute the effects of exercise to these outcomes, given that many of the

Table 2. Critical appraisal of included studies using McMaster Critical Review Form for Quantitative studies (Law et al. 1998).

	Mirandola et al, 2019	Fukushima et al, 2017	Do et al, 2017	Katz et al, 2010	Moseley et al, 2004
Study purpose Stated clearly?	Yes	Yes	Yes	Yes	Yes
Literature Relevant background literature reviewed?	Yes	Yes	Yes	Yes	Yes
Design Study design	Case study	Randomised controlled crossover trial	Randomised pilot study	Before-after	Before-after
Sample					
Was sample described in detail?	Yes	Yes	Yes	Yes	No
Sample size justified?	Yes	Yes	Yes	No	No
Outcomes					
Outcome measures reliable?	Yes	Yes	Yes	Yes	Yes
Outcomes measures valid?	Yes — for case study	Yes	Yes	Yes	Yes
Intervention					
Intervention described in detail?	Yes	Yes	Yes	Yes	Yes
Contamination avoided?	NA	Yes		NA	NA
Cointervention avoided?	NA	Not addressed		NA	NA
Results					
Reported in terms of statistical significance?	No	Yes	Yes	Yes	Yes
Analysis method(s) appropriate?	Not addressed	Yes	Yes	Yes	Yes
Clinical importance reported?	No	No	Yes	Yes	No
Drop-outs reported?	NA	Yes — no reasons or ITT analysis	Yes — no ITT analysis	Yes — no reasons	No — only compliance
Conclusions and implications					
Appropriate given study methods and results	No – trend only observed in 1 patient	Yes	Yes	Yes	Yes

participants in study control groups also improved. Furthermore, the small scale of these trials, heterogeneity in programme design and duration, lack of substantial follow up, as well as some contradictions in the results, hamper definite conclusions. Further research is required with larger numbers of participants and a standardised exercise programme in terms of exercise type, intensity, frequency and duration.

Importantly, no study reported a worsening in pain, QoL, fatigue or heaviness post intervention. Overall, however, based on a summative evaluation of the total evidence, we conclude that the effectiveness of exercise on QoL, subjective symptoms of LLL, skin and pitting oedema, strength, fitness, and function has not been established.

To our knowledge, the association between exercise, resultant weight loss, and improvements in QoL and symptom experience is still not clear in the context of lymphoedema. One review by Forner-Cordero and Munoz-Langa (2012) investigated the effect of body mass index (BMI) as one of the factors affecting variability of response to DCT. They concluded that available evidence on the influence of BMI on response to treatment was controversial. Only one study in their review involved LLL patients and this found BMI to be negatively associated with a reduction in oedema, with response to treatment decreasing as BMI increased (Hinrichs et al, 2004). Given controversies surrounding weight loss and BMI in LLL, it would be premature to draw any robust conclusions on weight loss effects from the few studies in this review.

Strengths and limitations of this systematic review

This systematic review relied on a comprehensive search process and clearly defined eligibility criteria to retrieve studies of relevance. Despite this, restricting to articles in English and not contacting authors of ongoing trials for available data may have resulted in some studies being overlooked. Furthermore, the paucity of research on this topic creates an inherent limitation in this review. Together, all studies included only 107 patients and only 8 of these were male. This may have significant implications, particularly when examining subjective symptoms and QoL. We particularly note the lack of homogeneity between the studies, which makes drawing robust conclusions difficult.

Although exercise as a treatment for LLL is an under-researched field, we have deliberately avoided relying on findings from studies on breast cancer. The authors

do note, however, that even within the trials that focus on LLL, much of the foundational rationale emerges from upper-limb lymphoedema trials. An existing systematic review and meta-analysis on the role of exercise for patients with lymphoedema included studies of both lower- and upper-limb lymphoedema (Singh et al, 2016). In fact, 95% of the 21 studies included in that review were based on women with breast cancer and only 1 study was LLL (Katz et al, 2010). This LLL study was included in its own right in this review. The authors commend the authors of this comprehensive review, however, since it draws so heavily on breast cancer related lymphoedema studies, it was not possible to draw any relevant conclusions for LLL patients.

Implications for further research

Overall, our findings highlight the need for further research into the effect of different land-based exercises on subjective symptoms and QoL in people experiencing lymphoedema of the lower-limb secondary to cancer. More robust evidence than is currently available will be vital if cancer survivors are to be supported to maintain functional independence and avoid the debilitating burden of poor physical, psychosocial and financial health. The nature, duration, and intensity of any exercise regimens will be important factors in designing and testing rehabilitative programmes for people with LLL.

To date, no studies have been able to demonstrate an optimal exercise prescription for LLL with program duration ranging from 3 weeks of passive, low-intensity exercise (Moseley et al, 2004) to 20 weeks of heavy resistance training undertaken for 3 hours per week (Katz et al, 2010). This might require long-term trials that follow the effects of sustained exercise programmes or investigate the sustained effects of short-term programmes and their impact on health-related outcomes. Ideally, exercise should be evidence-based, easy to comply with, conveniently located at home at no or very low cost to the participant, and able to be performed without healthcare professional supervision.

Conclusion

Despite exercise being an established pillar of treatment in LLL for over 150 years, there remains a paucity of research on its ability to reduce subjective symptoms and improve QoL. It appears that exercise improves a variety of fitness measures and decreases fatigue, while possibly improving QoL and subjective symptom scores in some studies, and not making them worse in any of the other studies. Specifically, no study reported a worsening in pain, QoL, fatigue or heaviness post-intervention.

Nevertheless, the effectiveness of exercise on quality of life, subjective symptoms, dermatological complaints or BMI has not been established with low numbers of study participants and no consistency between approaches to exercise. Thus, the authors call for prompt further research into this promising and potentially cost-effective element of treatment in LLL.

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