National Institute for Health and Care Excellence

Addendum to managing complications (chapter 6) of clinical guideline 81, advanced breast cancer

Clinical guideline 81.1

Methods, evidence and recommendations

May 2014

Developed by the Centre for Clinical Practice at the National Institute for Health and Care Excellence

NICE clinical guideline 81.1
Addendum to managing complications (chapter 6) of clinical guideline 81, advanced breast cancer

Ordering information
You can download the following documents from www.nice.org.uk/guidance/CG81

- The NICE guideline – all the recommendations.
- The NICE pathway – a set of online diagrams that brings together all NICE guidance and support tools.
- Information for the public – a summary for patients and carers.
- The addendum (this document) – all the new recommendations, details of how they were developed, and reviews of the evidence they were based on.
- The full guideline – all the original recommendations, details of how they were developed, and reviews of the evidence they were based on.

NICE clinical guidelines are recommendations about the treatment and care of people with specific diseases and conditions in the NHS in England and Wales.

This guidance represents the view of NICE, which was arrived at after careful consideration of the evidence available. Healthcare professionals are expected to take it fully into account when exercising their clinical judgement. However, the guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer, and informed by the summary of product characteristics of any drugs.

Implementation of this guidance is the responsibility of local commissioners and/or providers. Commissioners and providers are reminded that it is their responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties.

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Contents

Clinical Guideline Updates

The NICE Clinical Guidelines Update Team update discrete parts of published clinical guidelines as requested by NICE's Guidance Executive.

Suitable topics for update are identified through the new surveillance programme (see surveillance programme interim guide).

The surveillance programme when reviewing the Advanced Breast Cancer guideline identified new evidence in relation to the role of exercise in people who have, or are at risk of, breast cancer related lymphoedema. The full surveillance review decision is available on the NICE website.

These guidelines are updated using a standing committee of healthcare professionals and lay members from a range of disciplines and localities. For the duration of the update the core members of the committee are joined by up to five additional members who are have specific expertise in the topic being updated, hereafter referred to as 'topic specific members'.

In this document where 'the committee' is referred to, this means the entire committee, both the core standing members and topic specific members.

Where 'standing committee members' is referred to, this means the core standing members of the committee only.

Where 'topic specific members' is referred to this means the recruited group of members with topic specific expertise.

All of the standing members and the topic specific members are fully voting members of the committee.

Details of the committee membership and the NICE team can be found in appendix A. The committee members' declarations of interest can be found in appendix B.

1 Summary Section

Recommendations

- Discuss with people who have or who are at risk of breast-cancer related lymphoedema that there is no indication that exercise prevents, causes or worsens lymphoedema.
- Discuss with people who have or who are at risk of breast cancer related lymphoedema that exercise may improve their quality of life

Research recommendation

Assessment of the role of exercise:

- What is the role of arm and shoulder specific exercises compared with and/or used as an adjunct to established lymphoedema treatments (such as compression garments and complex decongestive therapy)?

  (These well-designed randomised controlled trials should consider differing arm and shoulder specific aerobic and/or resistive exercises that focus on strength and flexibility to improve local lymph flow, for example, swimming, weight lifting, tai chi and yoga. The studies should have a follow-up period that is sufficient to capture long term outcomes including changes to current lymphoedema or any new onset lymphoedema in other part of the limb. Outcomes for this research should include quality of life measures.

Update information

This update guidance is an addendum to Advanced breast cancer (NICE clinical guideline 81; published February 2009). This update relates to people with breast cancer related lymphoedema, the management of which is in the NICE guideline on advanced breast cancer. However this update also includes people at risk of developing breast-cancer related lymphoedema, the management of which is in Early and locally advanced breast cancer (NICE clinical guideline 80). This update guidance relates to both the NICE guideline on early and locally advanced breast cancer and the NICE guideline on advanced breast cancer.

New recommendations relating to exercise and lymphoedema have been added for people with lymphoedema or people at risk of developing lymphoedema.

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Patient-centred care

This guideline offers best practice advice relating to exercise for patients who are at risk of or who have developed breast cancer related lymphoedema.

Patients and healthcare professionals have rights and responsibilities as set out in the NHS Constitution for England – all NICE guidance is written to reflect these. Treatment and care should take into account individual needs and preferences. Patients should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If someone does not have the capacity to make decisions, healthcare professionals should follow the Department of Health's advice on consent, the

code of practice that accompanies the Mental Capacity Act and the supplementary code of practice on deprivation of liberty safeguards. In Wales, healthcare professionals should follow advice on consent from the Welsh Government.

NICE has produced guidance on the components of good patient experience in adult NHS services. All healthcare professionals should follow the recommendations in Patient experience in adult NHS services (NICE clinical guideline 138).

Methods

Please see the interim process and methods guide for updates pilot programme 2013 and the guidelines manual 2012, both of which have been followed in the development of this update.

2 Evidence Review and Recommendations

Introduction

The NICE surveillance programme undertakes regular reviews of published guidelines. Surveillance of the NICE guideline on advanced breast cancer concluded that there was potentially new evidence considering the use of exercise in those with or at risk of breast cancer-related lymphoedema and that this warranted an update.

The NICE guideline on early and locally advanced breast cancer included the management of lymphoedema within the 'Complications of local treatment and menopausal symptoms' section. This evidence review will be located as an addendum to the NICE guideline on advanced breast cancer, but is also relevant to the population covered in the NICE guideline on early and locally advanced breast cancer.

2.1 Review Question

2.1.1 Review Question

In adults with breast cancer post-treatment (excepting ongoing hormone treatment), what is the role of exercise in relation to the safety of the exercise undertaken?

2.1.2 Evidence Review

This review aimed to assess exercise in those at risk of or with breast-cancer related lymphoedema. It considered whether exercise increases the risk of lymphoedema developing or exacerbates existing lymphoedema. Though this review aimed to investigate the potential harm from exercise, it also included data on any potential benefits of exercise if available. It did not distinguish this group either by stage of cancer at diagnosis or by the treatments (surgery/chemotherapy or radiotherapy) that had been undertaken.

The search of the published literature for this question was designed to identify randomised controlled trials (RCTs), systematic reviews, non-randomised controlled trials and observational studies. Initially, the only exclusion on evidence type was applied to narrative reviews and case studies. If the evidence available within clinical trials was considered sufficient then observational studies would not be included in this review. As this question had not been specifically included in the original guidelines, there was no date restriction applied to this search. In recognition of the difficulties in defining differing exercise programmes, there was no initial restriction applied to the exercise being considered in the potentially included studies (i.e. any exercise with and without movement (such as carrying weights compared with swinging weights)).

Studies that considered postoperative physiotherapy regimens were excluded (these are included in the NICE guideline on early and locally advanced breast cancer and this section was not considered by NICE surveillance to require an evidence update).

The searches returned 2278 hits. Of these, 14 studies were selected for inclusion. These were all RCTs and considered to represent a sufficient body of evidence. Observational studies were not included. For the review protocol, see appendix C.

There are no agreed diagnostic tests and assessment methods for lymphoedema. It was not possible for the committee to agree criteria that could be used to consider whether the definitions used in the studies as markers of lymphoedema were appropriate. Therefore where study participants were reported as having lymphoedema this was taken to mean that

they had met the criteria used in that particular study. This, alongside the variety of exercise interventions in the included studies, meant that combining study outcomes within a meta-analysis was not appropriate.

Of the included studies there were 7 studies where all participants had lymphoedema at study recruitment; 4 studies where no participants were considered to have lymphoedema at recruitment and 3 studies with a mix of those with and without lymphoedema.

The table below summarises the methods of determining lymphoedema, whether or not participants had lymphoedema at baseline and the exercise intervention used, in the included studies.

Reference	Sample	Lymphoedema criteria or methods of diagnosis	Intervention
Cormie, 2013 (n=62)	All participants with lymphoedema	≥5% inter-limb discrepancy in volume or circumference at the point of greatest visible difference	High load resistance exercise group, low load resistance exercise group compared with usual care group
Hayes, 2009 (n=32)	All participants with lymphoedema	Volume difference of ≥200mL, impedance ratio >3SD above normative data	Aerobic and resistance exercise group compared with control group
Hayes, 2011 (n=295)	All participants with lymphoedema	≥10% interlimb discrepancy in volume or circumference at the point of greatest difference/obstruction of the anatomical architecture/pitting oedema; prior clinical diagnosis of lymphoedema	Weight-lifting group compared with control group (offered intervention after a 12mth delay)
Johansson, 2013 (n=29)	All participants with lymphoedema	Volume difference ≥5%	Water-based exercise programme group compared with control group
Kim, 2010 (n=40)	All participants with lymphoedema	>2cm circumference difference between affected and unaffected arm; diagnosed by lymphoscintigraphy	Active resistive exercise with CDT group compared with CDT alone
McKenzie and Kalda, 2003 (n=14)	All participants with lymphoedema	>2cm, <8cm on ≥1 measurement point	Resistance and strength training group compared with control group (later given the option of the exercise programme)
Schmitz, 2009 (n=141)	All participants with lymphoedema	Difference in the volume or circumference between the affected and unaffected of ≥10%	Weight-lifting treatment group compared with wait-list control group
Anderson, 2012 (n=104)	No participants initially with lymphoedema	Not reported	Aerobic and resistance exercise, lymphoedema prevention, patient and diet education compared with usual care group
Kilbreath, 2012 (n=160)	No participants initially with lymphoedema	Interlimb difference of ≥10% or interlimb difference of ≥2cm in at two or more measures	Resistive training and stretching exercises group compared with control group
Sagen, 2009 (n=204)	No participants initially with lymphoedema	10% increase in volume difference	No activity restriction group compared with activity restriction group
Schmitz, 2010 (n=154)	No participants initially with lymphoedema	Difference in the volume or circumference between the affected and unaffected of ≥10%	Weight-lifting treatment group compared with wait-list control group
Ahmed, 2006 (n=45)	Mixed	Self-report clinical diagnosis, self-report of symptoms of lymphoedema, by circumference measure difference >2cm	Weight training group compared with non-intervention group
Hayes, 2013 (n=194)	Mixed	L-Dex (lymphoedema index) ≥10	Aerobic and strength exercise groups compared with usual care group
Speck, 2010 (n=141)	Mixed	Difference in the volume or circumference between the affected and unaffected of ≥10%	Weight-lifting treatment group compared with wait-list control group

2.1.3 Health Economic Evidence

A search of relevant health economic databases did not identify any papers that met the inclusion criteria for this question. This topic was not prioritised for economic modelling.

2.1.4 Evidence Statements

One study that included restricting activity (including aerobic or other exercise and avoiding carrying items weighing more than 3kg), where no participants had lymphoedema at recruitment, found no evidence of a difference at two years in the development of lymphoedema between those who restricted activity and those who did not restrict activity (and also undertook resistance exercise). The quality of evidence was moderate.

Studies where all participants had lymphoedema/had a mix of participants with and without lymphoedema found no evidence that resistance exercise, weight-lifting exercise or water-based exercise caused exacerbations of lymphoedema. The quality of evidence ranged from moderate to very low.

Studies where no participants, at recruitment, were considered to have lymphoedema found no evidence that resistance exercise or weight lifting exercise caused lymphoedema. The quality of evidence ranged from moderate to low.

2.1.5 Evidence to Recommendations

Relative value of different outcomes	The committee discussed the safety aspects of exercise and considered in the context of the question of safety whether there was evidence that exercise either caused or exacerbated lymphoedema. Many of the included studies had outcomes relating to the development of or possible exacerbation of lymphoedema through measures such as arm volume or arm circumference measures. The committee discussed that while these are evidently pertinent outcomes, the quality of life outcomes were also of substantial importance for patients either with or at risk of lymphoedema. As there are no current recommendations in the NICE guidelines on early and locally advanced and advanced breast cancer relating to exercise in those with lymphoedema, the standing committee members sought information from its topic specialist members about the conventional and current advice given in practice. The topic specific members explained that there has been a historical concern that lymphoedema could be precipitated or exacerbated by undertaking strenuous activities. This concern applied both to exercise and also to activities of daily living. Anecdotally links had apparently been made between strenuous activities and lymphoedema. Therefore, the conventional advice has been to restrict strenuous exercise. The topic specific members were not aware of an evidence base that had been used to develop this advice. The publication of newer studies was causing this advice to be questioned. Alongside considering the outcomes used in the included studies, the committee noted that with many of the included studies the follow-up period had not extended beyond the period of the intervention. Therefore, longer term benefits or harms of the interventions studied would not have been captured in the data reported. This is particularly

	important for conditions like lymphoedema which can develop slowly and over an unpredictable time frame. The committee further noted that within the included studies, all the exercise programmes were of a graduated and progressive nature in terms of intensity and frequency. They discussed and agreed that this progressive and graduated approach could be appropriate to be used by people with or at risk of lymphoedema. The committee noted that this approach would also be used by anyone instigating a new exercise regimen. Based on current evidence, the committee felt it will not be appropriate to recommend a specific type of exercise (e.g. progressive and graduated exercise) until further research has confirmed its benefits and harms. The exercise programmes investigated used progressive and graduated approaches but there was substantial variety in the exercise programmes investigated.
Trade-off between benefits and harms	The committee noted that much of the evidence presented is not about avoiding exertion but about doing exercise. Among the included studies, only one did restrict activities of living. However within this particular study the intervention group did not restrict activities alone but also undertook exercise, therefore the outcomes of this study could not be viewed as having restricted daily activities alone. The committee discussed the possible harms of undertaking exercise, notably with regard to the potential for exercise related injury. They also discussed that the anecdotal advice to restrict activity with the potentially affected arm, could have resulted in those receiving this advice not exercising and therefore not getting the overall benefits of exercise. They noted that while adverse effects had not generally been well reported in the studies, where they had been reported they were not higher with participants who undertook exercise. Overall the committee agreed that the evidence does not show that exercise is harmful however, it does not show that there are specific benefits to exercise either. The committee concluded that with the evidence available they could not make recommendations that included lymphoedema related beneficial outcomes of exercise. The committee discussed that where quality of life had been used as an outcome, there was limited evidence of improvement with the exercise interventions. The committee did note that the quality of life measures used in the included studies were generic and not specifically designed in relation to lymphoedema. Nonetheless the committee considered that this evidence did show improvement in quality of life and provided evidence in this clinically important area. Therefore the committee agreed a recommendation relating to quality of life. As previously, when discussing the overall evidence base relating to the types of exercise involved, the committee did not consider it appropriate to specify the types of exercise programmes. The committee considered that they had no evidence that supported the conventional advice on restricting activities/exercise to prevent or reduce exacerbations of lymphoedema. The committee, while accepting the limitations to the evidence, agreed that they had sufficient evidence to make recommendations. As there are no specific recommendations relating to this area in the current NICE

	guidelines on early and locally advanced breast cancer and advanced breast cancer, no recommendations would need standing down. The committee discussed the ambiguity of terms surrounding the descriptions of exercise, such as strenuous or non-strenuous and that these could be liable to individual interpretation unless clearly defined. They concluded that with the recommendations, it would be most appropriate to refer to exercise without qualifying the term further as the exercise interventions used within the included studies were too varied. The committee noted that with the evidence available they could make recommendations that there was no evidence that exercise prevents, causes or worsens lymphoedema. The committee discussed how the previous advice given to patients about exercise could affect their activities of daily living. Hence, the committee wanted to highlight and further discuss one particular included study that restricted activity in line with the previous advice given (Sagen, 2009). The committee agreed that outcomes from this particular study warrant a separate evidence statement. In the absence of evidence, recommendations could not be made relating to activities of daily living. Nonetheless the committee considered that the recommendation regarding exercise would implicitly include advice relating to activities of daily living.
Quality of evidence	The committee discussed that outcomes such as changes in arm volume (or other measures of lymphoedema), quality of life measures, pain and cellulitis were important in this review. The committee also noted that making clear comparisons between studies was difficult. There are no accepted criteria used to diagnose lymphoedema and the criteria and measures used between studies varied. Furthermore, the exercise interventions varied in type of exercise (aerobic, resistance, water-based) and in the intensity, frequency and duration of the intervention. Consequently the committee agreed that, with the nature of the evidence identified, any pooling of the study outcomes across studies would be inappropriate.
Other considerations	The committee discussed the unpredictable nature of lymphoedema development both in terms of whether it develops and the time frame that this can involve. (The standing committee members received advice from the topic specific members that while there may be some linkage with the stage of breast cancer and the number of nodes removed, this is not a clear, direct link). The committee therefore noted the need for future research studies being designed with appropriate follow-up periods and considered it to be important that this was reflected in research recommendations.

2.1.6 Recommendations

- Discuss with people who have or who are at risk of breast-cancer related lymphoedema that there is no indication that exercise prevents, causes or worsens lymphoedema.

- Discuss with people who have or who are at risk of breast cancer related lymphoedema that exercise may improve their quality of life

2.1.7 Research Recommendation

- Assessment of the role of exercise: What is the role of exercise compared with and/or used as an adjunct to established breast cancer related lymphoedema treatments (such as compression garments and complex decongestive therapy)?

  These well-designed randomised controlled trials should consider differing aerobic and/or resistive exercise; have a follow-up period (possibly >2 years) that is sufficient to capture long term outcomes including later onset lymphoedema. Outcomes for this research should include quality of life measures.

  Why is this important?

  Historically people with or who are at risk of breast cancer related lymphoedema were advised to be cautious with the affected/potentially affected arm, to avoid strenuous exercise, carrying heavy weights or strenuous activities of daily living. The review undertaken in this update addendum to the NICE guideline on advanced breast cancer has reviewed evidence relating to exercise and people who have or who are at risk of developing breast cancer related lymphoedema. From this review it is clear that there is a lack of evidence, notably in regard to studies that incorporate sufficient follow-up time and/or patient focused outcomes such as quality of life. This evidence review also showed considerable variety in the types of exercise programmes used; therefore clear definition of the type of exercise in any future study is important.

3 References

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4 Glossary & Abbreviations

Please refer to the NICE glossary.

Appendices

Appendix A: Committee members and NICE teams

Standing Committee Members

Damien Longson, Chair
Consultant Liaison Psychiatrist, Manchester Mental Health and Social Care Trust

Susan Bewley, Vice Chair
Honorary Professor of Complex Obstetrics, Women's Academic Health Centre, St Thomas' Hospital

Catherine Briggs
GP Principal, Bracondale Medical Centre, Stockport

John Cape
Director of Psychological Therapies, University College London

Alun Davies
Professor of Vascular Surgery and Honorary Consultant Surgeon, Charing Cross & St Mary's Hospital & Imperial College NHS Trust

Alison Eastwood
Senior Research Fellow, Centre for Reviews and Dissemination, University of York

Sarah Fishburn
Lay Member

Amanda Gibbon
Lay Member

Jim Gray
Consultant Medical Microbiologist, The Birmingham Children's Hospital NHS Foundation Trust

Nuala Lucas
Consultant Anaesthetist, Northwick Park Hospital, Middlesex

Kath Nuttall
Director, Lancashire & South Cumbria Cancer Network (- April 2013)

Tilly Pillay
Consultant Neonatologist, Staffordshire, Shropshire and Black Country Newborn Network, Royal Wolverhampton Hospitals Trust

Nick Screaton
Radiologist, Papworth Hospital NHS Foundation Trust

Lindsay Smith
Principal in General Medical Practice, Somerset PCT

Sophie Wilne
Paediatric Oncologist, Nottingham Children's Hospital

Topic Specific Committee Members

Jane Board
Lymphoedema Clinical Nurse Specialist, Lymphoedema Specialist Services Ltd

Kate Gowans
Lymphoedema Practitioner, South Tees NHS Trust

Vaughan Keeley
Consultant in Lymphoedema / Palliative Medicine, Derby Hospitals NHS Foundation Trust

Netta Wooles
Lay member

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Katie Perryman-Ford – Guideline Commissioning Manager

Jennifer Watson-Henry – Guideline Coordinator

Louisa Wall - Implementation Lead

Laura Gibson - Communications Lead

Anne-Louise Clayton – Editor

Laura Norburn - Public Involvement Advisor

James Hall – Editor

Appendix B: Declaration of interests

Standing Member	Interest Declared	Date Declared	Type of Interest	Decision
Damien Longson	Chair, Internal Clinical Guidelines, NICE Family member employee of NICE Director of Research & Innovation, Manchester Mental Health & Social Care NHS Trust	29/05/13 (on appointment)	Personal family non-specific Personal non-specific pecuniary	Declare and participate
Susan Bewley	Self-employed academic & obstetric expert. 100 hour per annum teaching contract with Kings College London. In the last 12 months has received income or fees for: • Research projects as a principal or co-investigator or giving expert advice (presently these include projects on major postpartum haemorrhage, the organisation of maternity care, gestation time for abortion) • Academic supervision (PhD on implementation of external cephalic version, chair of 35/39 TSC on the timing of induction) • Teaching (BSc law and ethics tutor at KCL, occasional fees for lectures on obstetrics) • Medico-legal reports (approx 2/year) and Medical Defence Union cases committee and council • External reviews for NHS organisations related to obstetric expertise (serious incident & maternal mortality investigations, RCOG review) • Chairing NICE GDG • Expert advice to NHS Quest (development of a maternity 'safety thermometer')	30/05/13 (on appointment)	Personal non-specific pecuniary	Declare and participate

	• Royalties from edited books • Advice to Marie Stopes International about obstetric standards Expenses paid to attend conferences to lecture on obstetric topics. In the last year this included speaking to a Human Rights conference at the Hague, the Royal Society of Edinburgh, and the International Society of Psychosomatic Obstetrics and Gynaecology, and attending the British Maternal Fetal Medicine Society conference. Received community grant to attend the British HIV Association conference. Joint intellectual property rights in a new neonatal resuscitation trolley. These were negotiated to be handed over to Liverpool University and Inditherm. In return, the inventors negotiated that a fee generated on the sale of each trolley will be given to charity. Expressed views in publications about obstetric matters, largely based on evidence. A trustee & committee member of Healthwatch (a charity devoted to evidence and "for treatments that work") and a trustee of Sophia (a charity devoted to women with HIV and the UK arm of the Global Coalition for Women and AIDS).		Personal non-specific non-pecuniary	
Catherine Briggs	GP Partner in Stockport. Husband is a consultant anaesthetist at the University Hospital of South Manchester. Member of the Royal College of Surgeons, the Royal College of General Practitioners, the Faculty of Sexual and Reproductive Health and the BMA.	08/07/13	Personal non-specific pecuniary Personal family non-specific	Declare and participate
John	Trustee of the Anna Freud Centre, a child and family mental	10/07/13	Personal non-specific	Declare and

Cape	health charity which applies for and receives grants from DoH and NIHR. Member of British Psychological Society & British Association for Behaviour & Cognitive Psychotherapies who seek to influence policy towards psychology & psychological therapies.		non-pecuniary	participate
Alun Davies	Research grant funding: Commercial:- Vascular Insights; Acergy Ltd; Firstkind; URGO laboritoire; Sapheon Inc (terminated 2013). All administered by Imperial College London as Sponsor and Prof Davies as CI. Non commercial:- NIHR, BHF, Royal College of Surgeons, Circulation foundation, European Venous Forum. Attendance at numerous national & international meetings as an invited guest to lecture where the organising groups receive funding from numerous sources including device and pharmaceutical manufacturers. Organising groups pay expenses and occasionally honoraria - the exact source of funding is often not known. Has received travel expenses to attend the Veith Meeting NY 2013 November to give lectures by Vascutek.	04/11/13	Personal non-specific pecuniary Personal non-specific non-pecuniary	Declare and participate
Alison Eastwood	Member of an independent academic team at Centre for Review & Dissemination, University of York commissioned by NICE through NIHR to undertake technology assessment reviews.	10/07/13	Non-personal non-specific pecuniary	Declare and participate
Sarah Fishburn	Organises workshops for physiotherapists treating pelvic girdle pain. Paid for this work. Receives payment and expenses from the Nursing and Midwifery Council as a lay panellist of the Fitness to Practise Investigating Committee. Lay reviewed with the Local Supervising Authority auditing supervision of midwives - receives payment and expenses for this work.	11/11/13	Personal non-specific pecuniary	Declare and participate

	Lay reviewer for the NIHR; has reviewed a number of research proposals being considered for funding. Paid for carrying out these reviews. Chair of the Pelvic Partnership, a support group for women with pregnancy-related pelvic girdle pain. This is a voluntary position. Trained as a chartered physiotherapist and qualified in 1988 but have not been in clinical practice since 1997. Remains a non-practicing member of the Chartered Society of Physiotherapy. Recently appointed by Mott MacDonald to carry out reviews as a lay reviewer on behalf to the Nursing and Midwifery Council of Local Supervising Authorities and Universities providing courses for nurses and midwives. This is paid work.			
Amanda Gibbon	Personal shareholdings in Glaxosmithkline, Astrazeneca, Merck & Co. Will give instruction to broker to manage shares. Children have shareholdings in Glaxosmithkline. Stepping down as trustee of children's shares.	01/11/13	Personal non-specific pecuniary	Declare and participate
Jim Gray	None	10/07/13		No action
Nuala Lucas	Member Obstetric Anaesthetists' Association Executive Committee Member NICE – Intra-partum Care GDG Member, Editorial Board, International Journal of Obstetric Anesthesia	08/01/14	Personal non-specific non-pecuniary	Declare and participate
Kath Nuttall	None	02/07/13		No action
Tilly Pillay	None	11/07/13		No action
Nick Screaton	None	10/07/13		No action
Lindsay Smith	None	09/10/13		No action

Sophie Wilne	Recipient of NHS Innovation Challenge Award for clinical awareness campaign to reduce delays in diagnosis of brain tumours in children & young adults. Award will be used to develop the campaign. Co-investigator for RFPB grant to undertake systematic reviews in childhood brain tumours. Co-investigator for grant awards from charity to evaluate impact of brain tumour awareness campaign. Speaker at conferences to talk about TB – invited by Novatis – travel expenses only. Presented at educational meetings sponsored by drug companies.	08/06/13		No action
Topic Specific Members				
Jane Board	None	08/01/14		No action
Kate Gowans	None	05/11/13		No action
Vaughan Keeley	Chief Investigator for a research project which is industry funded (Tactile Industries, USA) looking at an intermittent pneumatic compression device. This is a portfolio adopted study looking at determining the optimum dose ie duration of treatment session for an intermittent pneumatic compression device in leg lymphoedema. Principal Investigator for an observational study of different compression bandaging types. This is funded by a grant from 3M. This is used in both leg and arm lymphoedema. Neither products are specifically the subject of the ABC review.	16/12/13	Personal non-specific pecuniary	Declare and participate

	Principal Investigator and Co-investigator of an NHIHR programme grant looking at the early detection and prevention of breast cancer related lymphoedema using bioimpedance and a randomised control trial using compression garments to see if these will prevent the development of lymphoedema (study acronyms are PLACE and BEA). NHIHR Co-investigator of a study developing tools for measuring the prevalence of chronic oedema in health care settings around the world. This is funded by 3M and looks at all types of chronic oedema not just breast cancer related. Chief Investigator for a research study funded by the Multiple Sclerosis Society looking at chronic oedema in people with MS Medical advisor to the Lymphoedema Support Network (the national patient group in the UK). Member of the British Lymphology Society and Chair the Consensus Group on the management of cellulitis in lymphoedema. Member of the International Society of Lymphology and the European Society of Lymphology and the Director of the International Lymphoedema Framework which is a charity looking at raising awareness about the management of lymphoedema globally.			
Netta Wooles	None	04/11/13		No action

Appendix C: Review protocol

	Details	Additional comments
Review question	In adults with breast cancer post-treatment, what is the role of exercise in relation to; - Safety of the exercise undertaken	Not including exercise as incorporated within current CDT/CPT practice. Not including exercise as part of supervised physiotherapy treatment (CDT is decongestive lymphatic therapy used as a treatment for lymphoedema. It includes manual lymphatic drainage, multilayer lymphoedema bandaging, remedial exercises and skin care. Can also be known as CPT (complex physical therapy).
Objectives	To consider the safety of exercise following treatment To consider the safety of exercise in those with breast cancer related lymphoedema	Historically the advice has been to avoid strenuous exercise as this may increase the risk of swelling and/or pain, it is now questioned as to whether this may now actually be beneficial though there are risk/benefit questions
Type of review	Intervention	
Language	English	
Study design	RCTs, controlled trials, systematic reviews If there is insufficient evidence found, observational studies will be considered	Insufficient evidence is considered to be an evidence base that does not allow the RU committee to make recommendations or research recommendations
Status	Published papers (full text only)	
Population	Adults with breast cancer following treatment Specified subgroup; those with breast cancer related lymphoedema	The initial protocols included ; - who have completed their primary cancer treatment and have no known local regional disease - and local regional recurrent disease The RU will not make this distinction and will include adults with breast cancer following treatment
Intervention	Differing exercise programmes, • including exercise with and without movement (such as carrying weights compared with swinging weights) Exercise as an adjunct to other lymphoedema treatment	Will detail the exercise programmes/descriptions used within the included studies as it is anticipated that it will be difficult to define phrases such as ‘strenuous exercise’. Some definition may be available for resistive exercise; this will become clearer following the review of the evidence. This may allow the RU committee to make recommendations or research recommendations in relation to these specific exercise programmes/descriptions (The potential exercise programmes for inclusion were those that

		could reasonably be expected to be completed at gyms or similar areas or at home, any that required equipment that would not be readily available were excluded)
Comparator	Differing exercise regimens (not including exercise as part of CDT)	Not including post-surgical physiotherapy treatment
Outcomes	<u>Outcomes:</u> Important outcomes: - changes in limb volume - pain - changes in function (mobility/range of movement) - incidence of cellulitis - quality of life (including; psychosocial tools, changes in body image, changes in depression/anxiety) Additional outcomes: - prevention of further oedema - changes in activities of living and/or time off work - changes in skin condition - changes in related infections	
Other criteria for inclusion / exclusion of studies	<u>Include</u> • Adults with breast cancer, post-treatment • Adults with breast cancer related lymphoedema <u>Exclude</u> • Lymphoedema attributed to causes other than breast cancer • Narrative reviews, case studies	
Search strategies	RCTs, systematic reviews, non-randomised controlled trials, observational studies	
Review strategies	• The NICE methodology checklists will be used as a guide to appraise the quality of individual studies • Data on all included studies will be extracted into evidence tables • Where statistically possible, a meta-analytical approach will be used to give an overall summary effect • All key outcomes from evidence will be presented in GRADE profiles or modified profiles and further summarized in evidence statements	

Appendix D: Search strategy

Database: Medline and Medline in Process

Strategy used:

Database: Ovid MEDLINE(R) <1946 to October Week 5 2013>

Search Strategy:

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1 exp Breast Neoplasms/ (227337)

2 exp "Neoplasms, Ductal, Lobular, and Medullary"/ (28719)

3 Carcinoma, Intraductal, Noninfiltrating/ (7760)

4 Carcinoma, Lobular/ (4037)

5 Carcinoma, Medullary/ (2928)

6 or/1-5 (235962)

7 exp Breast/ (32333)

8 breast$.tw. (295423)

9 7 or 8 (303571)

10 (breast adj milk).tw. (8743)

11 (breast adj tender$).tw. (473)

12 10 or 11 (9214)

13 9 not 12 (294357)

14 exp Neoplasms/ (2606354)

15 13 and 14 (224931)

16 (breast$ adj5 (neoplasm$ or cancer$ or tumo?r$ or carcinoma$ or adenocarcinoma$ or sarcoma$ or leiomyosarcoma$ or dcis or duct$ or infiltrat$ or intraduct$ or lobul$ or medullary or tubular)).tw. (219564)

17 (mammar$ adj5 (neoplasm$ or cancer$ or tumo?r$ or carcinoma$ or adenocarcinoma$ or sarcoma$ or leiomyosarcoma$ or dcis or duct$ or infiltrat$ or intraduct$ or lobul$ or medullary or tubular)).tw. (28562)

18 Paget's Disease, Mammary/ (600)

19 (paget$ and (breast$ or mammary or nipple$)).tw. (934)

20 or/15-19 (261594)

21 6 or 20 (303071)

22 exp Mastectomy/ (23230)

23 (mastectom$ or post?mastectom$ or post-mastectom$).tw. (14973)

24 (segmentectom$ or post?segmentectom$ or post-segmentectom$).tw. (2024)

25 (lumpectom$ or post?lumpectom$ or post-lumpectom$).tw. (2051)

26 (quadrectom$ or post?quadrectom$ or post-quadrectom$).tw. (2)

27 ((breast$ or mammary) adj4 surg$).tw. (13124)

28 (breast$ adj4 (radiation or radiotherap$)).tw. (5222)

29 or/22-28 (40410)

30 21 or 29 (310155)

31 exp exercise/ (115148)

32 exercis*.tw. (194023)

33 (walk* or swim* or jog* or cycling or bicycl* or gym*).tw. (145190)

34 ((strength* or resist*) adj4 train*).tw. (8477)

35 (weight adj4 (lift* or machine* or bear* or train*)).tw. (13230)

36 (push up* or pushup* or push-up*).tw. (453)

37 ((physical* or keep* or cardio* or aerobic or fitness) adj4 (fit* or activit* or train*)).tw. (108887)

38 (aerobic adj4 condition*).tw. (7673)

39 exp Exercise movement techniques/ (5311)

40 kines*.tw. (9292)

41 (yoga or pilates or tai chi or tai-chi or taichi or tai ji or tai-ji or taiji or qi gong or qigong or qi-gong or chi kung or ch i-kung or chikung or ch-i-kung).tw. (2648)

42 (dance* or dancing).tw. (3625)

43 trampolin*.tw. (209)

44 exp Sports/ (113784)

45 exp Exercise Therapy/ (30296)

46 or/31-45 (502333)

47 30 and 46 (4189)

48 animals/ not humans/ (3966240)

49 47 not 48 (3868)

50 limit 49 to english language (3590)

51 Meta-Analysis.pt. (51544)

52 Meta-Analysis as Topic/ (14144)

53 Review.pt. (1918263)
54 exp Review Literature as Topic/ (7699)
55 (metaanaly$ or metanaly$ or (meta adj2 analy$)).tw. (59306)
56 (review$ or overview$).ti. (264816)
57 (systematic$ adj4 (review$ or overview$)).tw. (53245)
58 ((quantitative$ or qualitative$) adj4 (review$ or overview$)).tw. (3798)
59 ((studies or trial$) adj1 (review$ or overview$)).tw. (7848)
60 (integrat$ adj2 (research or review$ or literature)).tw. (3674)
61 (pool$ adj1 (analy$ or data)).tw. (9731)
62 (handsearch$ or (hand adj2 search$)).tw. (6632)
63 (manual$ adj2 search$).tw. (3040)
64 or/51-63 (2069681)
65 animals/ not humans/ (3966240)
66 64 not 65 (1934209)
67 Randomized Controlled Trial.pt. (389483)
68 Controlled Clinical Trial.pt. (89863)
69 Clinical Trial.pt. (504489)
70 exp Clinical Trials as Topic/ (296142)
71 Placebos/ (33767)
72 Random Allocation/ (81721)
73 Double-Blind Method/ (131757)
74 Single-Blind Method/ (19575)
75 Cross-Over Studies/ (36107)
76 ((random$ or control$ or clinical$) adj2 (trial$ or stud$)).tw. (661072)
77 (random$ adj2 allocat$).tw. (20590)
78 placebo$.tw. (161538)
79 ((singl$ or doubl$ or trebl$ or tripl$) adj (blind$ or mask$)).tw. (129451)
80 (crossover$ or (cross adj over$)).tw. (59090)
81 or/67-80 (1353803)
82 animals/ not humans/ (3966240)
83 81 not 82 (1267199)
84 Epidemiologic Studies/ (6259)

85 exp Case-Control Studies/ (664644)

86 exp Cohort Studies/ (1367868)

87 Cross-Sectional Studies/ (180249)

88 Comparative Study.pt. (1723279)

89 case control$.tw. (76722)

90 case series.tw. (32506)

91 (cohort adj (study or studies)).tw. (81851)

92 cohort analy$.tw. (3501)

93 (follow up adj (study or studies)).tw. (36509)

94 (observational adj (study or studies)).tw. (40803)

95 longitudinal.tw. (133557)

96 prospective.tw. (338400)

97 retrospective.tw. (253389)

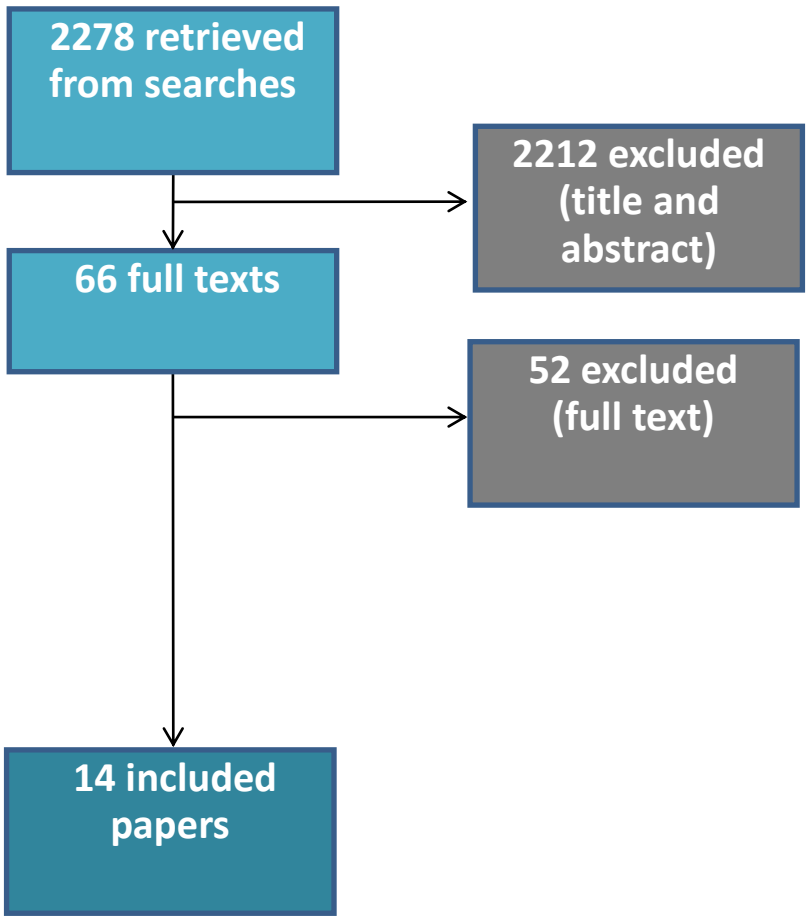
98 cross sectional.tw. (157398)

99 or/84-98 (3339889)

100 66 or 83 or 99 (5656347)

50 and 100 (2304)

Appendix E: Review flow chart



Appendix F:Excluded studies

Reference	Reason
Ainsworth BE;Sternfeld B;Slattery ML;Daguise V;Zahm SH;. Physical activity and breast cancer: evaluation of physical activity assessment methods. [Review] [43 refs]. Cancer (1998 Aug 1) 83;3:Suppl pSuppl-20	Outcomes not relevant
Ambroza C;Geigle PR;. Aquatic exercise as a management tool for breast cancer-related lymphedema. Topics in Geriatric Rehabilitation (2010) 26;2 p120-127	Review
Bicego D;Brown K;Ruddick M;Storey D;Wong C;Harris SR;. Exercise for women with or at risk for breast cancer-related lymphedema. [Review] [29 refs]. Physical Therapy (2006 Oct) 86;10 p1398-1405	Systematic review (the reference lists for the systematic reviews were checked for possible additional studies)
Bracha J;Katz-Leurer M;. The immediate effect of upper arm exercise compared with lower or combined upper and lower arm exercise on arm volume reduction in women with breast cancer related lymphedema: A randomized preliminary study. Rehabilitation Oncology (2012) 30;3 p3-8	Comparison of upper and lower arm exercise, crossover, no wash-out period
Campbell KL;Neil SE;Winters-Stone KM;. Review of exercise studies in breast cancer survivors: attention to principles of exercise training. [Review]. British Journal of Sports Medicine (2012 Oct) 46;13 p909-916	Systematic review
Cavanaugh KM;. Effects of early exercise on the development of lymphedema in patients with breast cancer treated with axillary lymph node dissection. Journal of oncology practice/American Society of Clinical Oncology (2011 Mar) 7;2 p89-93	Systematic review
Cave J;Jones A;. Physiotherapy improves shoulder function after treatment in women with early breast cancer. Cancer Treatment Reviews (2006 Aug) 32;5 p398-401	Commentary
Cemal Y;Pusic A;Mehrara BJ;. Preventative measures for lymphedema: Separating fact from fiction. Journal of the American College of Surgeons (2011) 213;4 p543-551	Review
Chan DN;Lui LY;So WK;. Effectiveness of exercise programmes on shoulder mobility and lymphoedema after axillary lymph node dissection for breast cancer: systematic review. [Review] [33 refs]. Journal of Advanced Nursing (2010 Sep) 66;9 p1902-1914	Systematic review
Cheema B;Gaul CA;Lane K;Fiatarone Singh MA;. Progressive resistance training in breast cancer: a systematic review of clinical trials. [Review] [52 refs]. Breast Cancer Research & Treatment (2008 May) 109;1 p9-26	Systematic review
Cheema B;GaulCA. Full-body exercise training improves fitness and quality of life in survivors of breast cancer. Journal of Strength and Conditioning (2006) 20:14-21	Case series

Cheifetz O;Haley L;Breast CA;. Management of secondary lymphedema related to breast cancer. [Review]. Canadian Family Physician (2010 Dec) 56;12 p1277-1284	Systematic review
Chung C;Lee S;Hwang S;Park E;. Systematic review of exercise effects on health outcomes in women with breast cancer. Asian Nursing Research (2013) 7;3 p149-159	Systematic review
Courneya KS;Blanchard CM;Laing DM;. Exercise adherence in breast cancer survivors training for a dragon boat race competition: a preliminary investigation. Psycho-Oncology (2001 Sep) 10;5 p444-452	Systematic review and guidelines
Courneya KS;Mackey JR;McKenzie DC;. Exercise for breast cancer survivors: Research evidence and clinical guidelines. Physician and Sportsmedicine (2002) 30;8 p33-42	No outcomes outlined in the protocol reported
Culos-Reed SN;Carlson LE;Daroux LM;Hately-Aldous S;. A pilot study of yoga for breast cancer survivors: physical and psychological benefits. Psycho-Oncology (2006 Oct) 15;10 p891-897	No outcomes outlined in the protocol reported
Daley AJ;Crank H;Mutrie N;Saxton JM;Coleman R;. Determinants of adherence to exercise in women treated for breast cancer. European Journal of Oncology Nursing (2007 Dec) 11;5 p392-399	Study design
Daley AJ;Mutrie N;Crank H;Coleman R;Saxton J;. Exercise therapy in women who have had breast cancer: design of the Sheffield women's exercise and well-being project. Health Education Research (2004 Dec) 19;6 p686-697	Trial recruitment
Daley AJ;Crank H;Mutrie N;Saxton JM;Coleman R;. Patient recruitment into a randomised controlled trial of supervised exercise therapy in sedentary women treated for breast cancer. Contemporary Clinical Trials (2007 Sep) 28;5 p603-613	Review
de Godoy JM;Godoy MF;. Evaluation of a new approach to the treatment of lymphedema resulting from breast cancer therapy. European Journal of Internal Medicine (2013 Jan) 24;1 p59-62	Myolymphokinetic exercise using a facilitated apparatus as a treatment for lymphoedema
Devoogdt N;Van KM;Geraerts I;Coremans T;Christiaens MR;. Different physical treatment modalities for lymphoedema developing after axillary lymph node dissection for breast cancer: a review. [Review] [21 refs]. European Journal of Obstetrics, Gynecology, & Reproductive Biology (2010 Mar) 149;1 p3-9	Review
Douglass J;Immink M;Piller N;Ullah S;. Yoga for women with breast cancer-related lymphoedema: A preliminary 6-month study. Journal of Lymphoedema (2012) 7;2 p30-38	Yoga programmes was in line with the conventional advice where arm movement and weights lifted were restricted
Fitzgerald B;. Review: regular exercise improves quality of life and physical fitness in women with breast cancer. Evidence-	Review

Based Nursing (2007 Jan) 10;1 p12-	
Fong DY;Ho JW;Hui BP;Lee AM;Macfarlane DJ;Leung SS;Cerin E;Chan WY;Leung IP;Lam SH;Taylor AJ;Cheng KK;. Physical activity for cancer survivors: meta-analysis of randomised controlled trials. BMJ (2012) 344; pe70-	No outcomes outlined in the protocol reported
Harder H;Parlour L;Jenkins V;. Randomised controlled trials of yoga interventions for women with breast cancer: a systematic literature review. [Review]. Supportive Care in Cancer (2012 Dec) 20;12 p3055-3064	No outcomes outlined in the protocol reported
Hu C;Zhou L;. Exercise interventions for upper-limb dysfunction caused by breast cancer treatment. [Review]. Clinical Journal of Oncology Nursing (2011 Oct) 15;5 p569-570	Brief review
Jeffs E; Wiseman T; Randomised controlled trial to determine the benefit of daily home-based exercise in addition to self-care in the management of breast cancer-related lymphoedema: a feasibility study. Support Cancer Care (2013) 21:1013-1023	Both groups exercised (intervention group aimed to stimulate MLD)
Johansson K;Ohlsson K;Ingvar C;Albertsson M;Ekdahl C;. Factors associated with the development of arm lymphedema following breast cancer treatment: a match pair case-control study. Lymphology (2002 Jun) 35;2 p59-71	Factors associated with the development of lymphoedema
Johnston RV;Anderson JN;Walker BL;. Is physiotherapy an effective treatment for lymphoedema secondary to cancer treatment?. Medical Journal of Australia (2003) 178;5 p236-237	Brief review
Jonsson C;Johansson K;. Pole walking for patients with breast cancer-related arm lymphedema. Physiotherapy Theory & Practice (2009 Apr) 25;3 p165-173	Pole walking on only one occasion
Kilbreath SL;Refshauge KM;Beith JM;Ward LC;Simpson JM;Hansen RD;. Progressive resistance training and stretching following surgery for breast cancer: study protocol for a randomised controlled trial. BMC Cancer (2006) 6; p273-	Study protocol
Kilgour RD;Jones DH;Keyserlingk JR;. Effectiveness of a self-administered, home-based exercise rehabilitation program for women following a modified radical mastectomy and axillary node dissection: a preliminary study. Breast Cancer Research & Treatment (2008 May) 109;2 p285-295	Rehab, post-surgery
Kwan ML;Cohn JC;Armer JM;Stewart BR;Cormier JN;. Exercise in patients with lymphedema: a systematic review of the contemporary literature. [Review]. Journal of Cancer Survivorship (2011 Dec) 5;4 p320-336	Systematic review
Lane K;Worsley D;McKenzie D;. Exercise and the lymphatic system: implications for breast-cancer survivors. [Review] [55 refs]. Sports Medicine (2005) 35;6 p461-471	Review
Lane KN;Dolan LB;Worsley D;McKenzie DC;. Upper extremity lymphatic function at rest and during exercise in breast cancer survivors with and without lymphedema compared with healthy controls. Journal of Applied Physiology (2007 Sep) 103;3 p917-925	Physiology of exercise

Lane K;Jespersen D;McKensie DC. The effect of a whole body exercise programme and dragon boat training on arm volume and arm circumference in women treated for breast cancer. European Journal of Cancer Care (2005) 14:353-8	Case series
Lee TS;Kilbreath SL;Sullivan G;Refshauge KM;Beith JM;Harris LM;. Factors that affect intention to avoid strenuous arm activity after breast cancer surgery. Oncology Nursing Forum (2009 Jul) 36;4 p454-462	Patient views on avoiding exercise
Loudon A;Barnett T;Piller N;Immink MA;Visentin D;Williams AD;. The effect of yoga on women with secondary arm lymphoedema from breast cancer treatment. BMC Complementary & Alternative Medicine (2012) 12; p66-	Study protocol
Moseley AL; Piller NB; Carati CJ; The effect of gentle arm exercises and deep breathing on secondary arm lymphoedema. Lymphology (2005) 38;136-145	Study unclear, poor reporting
McNeely ML;Campbell K;Ospina M;Rowe BH;Dabbs K;Klassen TP;Mackey J;Courneya K;. Exercise interventions for upper-limb dysfunction due to breast cancer treatment. [Review] [70 refs]. Cochrane Database of Systematic Reviews (2010) ;6 pCD005211-	Interventions post-surgery
Ohira T;Schmitz KH;Ahmed RL;Yee D;. Effects of weight training on quality of life in recent breast cancer survivors: the Weight Training for Breast Cancer Survivors (WTBS) study. Cancer (2006 May 1) 106;9 p2076-2083	No outcomes outlined in the protocol reported
Oremus M;Dayes I;Walker K;Raina P;. Systematic review: conservative treatments for secondary lymphedema. [Review]. BMC Cancer (2012) 12; p6-	Systematic review
Peters C;Schulz T;Niemeier B;Lotzerich H;Michna H;. Moderate exercise training in the rehabilitation of breast cancer patients. Journal of Cancer Research & Clinical Oncology (2001) 127;Suppl 1 pS82-	Abstract
Petrek JA;Senie RT;Peters M;Rosen PP;. Lymphedema in a cohort of breast carcinoma survivors 20 years after diagnosis. Cancer (2001 Sep 15) 92;6 p1368-1377	Incidence
Ridner SH;Fu MR;Wanchai A;Stewart BR;Armer JM;Cormier JN;. Self-management of lymphedema: a systematic review of the literature from 2004 to 2011. [Review]. Nursing Research (2012 Jul) 61;4 p291-299	Systematic review
Schmitz KH;. Balancing lymphedema risk: exercise versus deconditioning for breast cancer survivors. [Review] [35 refs]. Exercise & Sport Sciences Reviews (2010 Jan) 38;1 p17-24	Review
Schmitz KH;Speck RM;. Risks and benefits of physical activity among breast cancer survivors who have completed treatment. [Review] [107 refs]. Women's health (2010 Mar) 6;2 p221-238	Systematic review
Segal R;Evans WK;Gayton J;Woodard S;Wells G;Reid R;. Structured exercise improves physical functioning in women with	Abstract

breast cancer (BC): results of a randomized controlled trial. Breast Cancer Research & Treatment (2000) 64;1 p128-	
Sprod LK;Drum SN;Bentz AT;Carter SD;Schneider CM;. The effects of walking poles on shoulder function in breast cancer survivors. Integrative Cancer Therapies (2005 Dec) 4;4 p287-293	Groups had similar exercise programmes
Tidhar D;Katz-Leurer M;. Aqua lymphatic therapy in women who suffer from breast cancer treatment-related lymphedema: A randomized controlled study. Supportive Care in Cancer (2010) 18;3 p383-392	Lymphatic drainage
Van PM;Schmid A;Shinew KJ;Hsieh PC;. Influence of Hatha yoga on physical activity constraints, physical fitness, and body image of breast cancer survivors: a pilot study. International Journal of Yoga Therapy (2011) ;21 p49-60	No outcomes outlined in the protocol reported
Wagner JL;Hunt KK;. Effect of active resistive exercise on breast cancer-related lymphedema: A randomized controlled trial. Breast Diseases (2011) 22;3 p255-256	Unable to obtain paper (probable translation of Kim paper)
(systematic reviews were excluded where they did not meet the review outcomes; these reference lists in these reviews were considered for any possible relevant trials)	

Appendix G: Included studies evidence tables

Bibliographic reference	**Ahmed et al (2006) Randomized controlled trial of weight training and lymphedema in breast cancer survivors. Journal of Clinical Oncology** **(study design, additional details – Schmitz et al (2005) Safety and efficacy of weight training in recent breast cancer survivors to alter body composition, insulin, and insulin-like growth factor axis proteins. Cancer Epidemiol Biomarkers Prev)**
Study type & aim	Study design: post-hoc analysis from an RCT, single blinded (used a block randomization procedure that balanced participants by age and baseline body fat percentage; randomisation procedure prevented investigators from influencing treatment allocation, measurement staff remained blinded until the end of the study) Aim: to consider the hypothesis that progressive weight training would not increase the incidence of or exacerbate symptoms of lymphoedema in survivors of recent breast cancer
Number and characteristics of patients	From the Weight Training for Breast Cancer Survivors Study (WTBS), this study had lymphoedema measures as a secondary aim of the trial Women considered as survivors of breast cancer recruited from those living in the greater Minneapolis-Saint Paul area (October 2001 to June 2002), n=85 recruited, of these 78 completed baseline and 6-mth measures Recruited through flyers to oncologists, visits to breast cancer support groups, word of mouth, direct mailings to women treated through two health care systems *Inclusion criteria:* • Have completed all treatment for breast cancer (except hormone therapy), 4-36mths before baseline • This study included n=45 women who had axillary node dissection beyond sentinel node biopsy as part of their treatment • Nonsmokers • Sedentary to moderately physically active (< x3 sessions/wk of no more than moderate intensity activity), no weight training history • Body weight stable within 10% over the last year *Inclusion criteria:* • Any medical condition that would prohibit participation in a weight training programme • BMI >40kg/m^2 • SBP >160mmHg, DBP >99mmHg • Currently on a weight loss plan or planning to start one during the period of the study • Planning to move from the area, or away for >3wks during the study • Pregnant or lactating Baseline characteristics distributed similarly between groups; age, self-report clinical diagnosis of lymphoedema at baseline, self-report symptoms of lymphoedema at baseline, lymphoedema by circumference measure difference >2cm at baseline, time (mths) since first breast cancer diagnosis, breast cancer stage, time (mths) since last breast cancer treatment session, %treatment (radiation, chemotherapy, axillary dissection), no. of lymph nodes removed, adjuvant treatment, postmenopausal at baseline, leisure activity score, sport physical activity score, body fat (kg, %), lean mass (kg), total body mass (kg), height, BMI, metacarpophalangeal joint difference (cm), 10cm distal to lateral epicondyle difference (cm), 10cm proximal to lateral epicondyle difference (cm). Statistically (not clinically) significant differences between groups in ipsilateral minus contralateral measures of ulnar styloid process difference (intervention group 0.02cm mean difference (SD 0.9), control group 0.1cm mean difference (SD 0.7), p=0.02

Intervention	Intervention group (n=23): 3mths of weight training, met x2/wk with an American College of Sports Medicine certified fitness professional. Met in groups of 4 to ensure adequate instruction in safe and effective warn-up, weight training, cool down, and stretching. From 3 to 6mths participants exercised in pairs, on their own, with continued access to the fitness trainers. Participants instructed to refrain from purposeful changes in diet and exercise habits outside the intervention. Nine common exercises – using variable resistance machines and free weights, targeting muscles of the arms, back, chest, buttocks and legs. Upper body – started with no weight or half-pound weight, if no lymphoedema-related symptoms by the next session the weight was increased by the smallest available increment for each exercise Lower body – lifted the most weight they could lift in each exercise, x8-10 for each set Increased for x3 sets for each exercise over the first 2-3wks of exercise Sessions lasted approx. 60mins
Comparator	Nonintervention group (n=22): (this group was a delayed treatment group they received weight training for mths 7-12 after the completion of this 6mth section of the study; the intervention group went to a maintenance programme) All participants (both groups) instructed to allow normal seasonal variability in diet over the year of the study, not to make any purposeful changes in diet that might result in gain or loss of body weight/fat. Were also asked not to make changes in other elements of their exercise programme (e.g. walking, bicycling, swimming
Length of follow up	Weight training over a period of 6mths
Location	USA
Outcomes measures and effect sizes	Lymphoedema measured; - Arm-circumference measurements on both arms at the level of the metacarpophalangeal joints (MCP), distal to the ulnar styloid process (US), 10cm distal to the midpoint of the lateral epicondyle (DLE), and 10cm proximal to the midpoint of the lateral epicondyle (PLE). Participants lay prone, arms at their side, elbows straight, cloth measuring tape so that there was no slack and no indentation. Those using compression sleeves removed them 1hr before measurements. Mean of 2 measures used. Outcome measure – calculated difference in each circumference measure between ipsilateral and contralateral arms - Self-report of lymphoedema diagnosis, symptoms and treatment over last 3mths, via validated survey. Participant considered to have lymphoedema symptoms if she reported any lymphoedema symptoms in the survey Additional measures; body composition measures, injury assessment, medication use, demographic, dietary intake methods. Baecke Questionnaire assessed participant physical activity outside of the intervention. Upper and lower body strength assessed by one-repetition maximum tests **Results:** Adherence, all but n=1 in the intervention group attended ≥80% of the exercise sessions (Loss to follow-up; initially 42 in the intervention group, loss 45%; 43 in the control group, loss 49%)

Circumference measurements:

Group mean changes for the 4 circumference measurements were <2cm over 6mths

MCP:

		Ipsilateral Mean (SE)	Contralateral Mean (SE)	Ipsilateral minus contralateral Mean (SE)
Baseline	Intervention	19.25 (0.21)	19.27 (0.20)	-0.01 (0.12)
	Control	19.30 (0.21)	19.40 (0.20)	-0.10 (0.11)
6mths	Intervention	19.41 (0.21)	19.35 (0.20)	0.06 (0.12)
	Control	19.32 (0.21)	19.39 (0.20)	-0.07 (0.11)
Change 0-6mths	Intervention	0.16 (0.09), p=0.26	0.09 (0.08), p=0.37	0.07 (0.07), p=0.70
	Control	0.02 (0.09)	-0.01 (0.08)	0.03 (0.06)

US:

		Ipsilateral Mean (SE)	Contralateral Mean (SE)	Ipsilateral minus contralateral Mean (SE)
Baseline	Intervention	16.24 (0.23)	16.26 (0.21)	-0.02 (0.13)
	Control	16.25 (0.23)	16.12 (0.21)	0.13 (0.13)
6mths	Intervention	16.37 (0.23)	16.39 (0.21)	-0.02 (0.13)
	Control	16.40 (0.23)	16.24 (0.21)	0.17 (0.13)
Change 0-6mths	Intervention	0.13 (0.11), p=0.89	0.13 (0.10), p=0.91	0.00 (0.08), p=0.77
	Control	0.15 (0.11)	0.12 (0.10)	0.03 (0.09)

DLE:

		Ipsilateral Mean (SE)	Contralateral Mean (SE)	Ipsilateral minus contralateral

				Mean (SE)
Baseline	Intervention	24.57 (0.57)	24.36 (0.51)	0.20 (0.21)
	Control	24.26 (0.57)	23.88 (0.52)	0.38 (0.20)
6mths	Intervention	24.80 (0.57)	24.44 (0.56)	0.36 (0.21)
	Control	24.28 (0.56)	24.28 (0.57)	0.32 (0.19)
Change 0-6mths	Intervention	0.24 (0.25), p=0.53	0.08 (0.19), p=0.98	0.16 (0.17), p=0.37
	Control	0.01 (0.23)	0.08 (0.18)	-0.06 (0.16)

PLE:

		Ipsilateral Mean (SE)	Contralateral Mean (SE)	Ipsilateral minus contralateral Mean (SE)
Baseline	Intervention	31.18 (0.84)	30.84 (0.79)	0.34 (0.22)
	Control	30.79 (0.84)	29.23 (0.77)	0.55 (0.23)
6mths	Intervention	31.73 (0.84)	31.24 (0.79)	0.50 (0.23)
	Control	30.89 (0.83)	30.61 (0.78)	0.29 (0.22)
Change 0-6mths	Intervention	0.55 (0.36), p=0.39	0.40 (0.34), p=0.95	0.15 (0.18), p=0.18
	Control	0.11 (0.36)	0.37 (0.33)	-0.26 (0.17)

Self-reported incidence of lymphoedema:

At 6mths, n=2/16 (intervention), n=1/16 (control) self-reported the onset of lymphoedema since baseline (n=7, intervention and n=6, control had self-reported diagnosis of lymphoedema at baseline)

Symptoms of lymphoedema:

From baseline to 6mths, n=0 (intervention), n=3 (control) reported an increase in lymphoedema symptoms

(n=10, intervention and n=7, control had self-reported symptoms of lymphoedema at baseline)

Injuries and illnesses: (from Schmitz et al 2005), baseline to 6mths:

Injuries considered not related to study participation;

	- Immediate treatment; shin splints (n=1), wrist injury (n=1), other (muscle strain from mowing the lawn, n=1) - Delayed treatment; back injury (n=1), ankle injury (n=2), wrist injury (n=3), other (joint pain, n=1) Injuries moderately, quite a bit or entirely related to study participation; - Immediate treatment; back injury (n=4), none reported being unable to exercise as a result of a study-related injury - Delayed treatment; other (shoulder tendonitis, n=1) (Authors considered that the results of all analyses were essentially unchanged when analyses were repeated including all 78 women who completed baseline and 6mth measures)
Authors' conclusion	The results of this study support the hypothesis that a 6-month intervention of resistance exercise did not increase the risk for or exacerbate the symptoms of lymphoedema
Source of funding	Susan G. Komen Foundation Grant, National Institutes of Health Grant, University of Minnesota Thomas Shevlin pre-doctoral fellowship
Comments	Power calculations developed to determine the smallest detectable ipsilateral arm circumference and 6mth change in ipsilateral minus contralateral arm circumference differences at all 4 circumference measurement sites. Assumed a sample size of 23/group, (80% power, 2-sided t-test, type 1 error at 0.05) indicated a difference from 0.36 to 1.43cm (ipsilateral arm circumference) and 0.28 to 0.71 (comparison of ipsilateral minus contralateral arm circumference differences), over 6mths. Assuming 2.0cm to be clinically relevant, sample size was adequate.

Bibliographic reference	**Anderson et al (2012) A randomized trial of exercise on well-being and function following breast cancer surgery: the RESTORE trial. J Cancer Surviv**
Study type & aim	Study design: RCT, single-blind (randomisation via randomisation database, randomisation status known only to the interventionist) Aim: to determine the effect of a moderate, tailored exercise programme on health-related quality of life, physical function, and arm volume
Number and characteristics of patients	N=104 Participants were recruited by study staff during their first postoperative visit or by oncologist during their medical oncology visit *Inclusion criteria:* • Stage I-III breast cancer with axillary or sentinel lymph node dissection • No previous history of breast cancer • ≥18yrs • Living within 30miles of study site • Able to participate in a moderate exercise programme *Exclusion criteria:* • Safety of physical exercise uncertain or contraindicated (homebound, dependent on a walker or wheelchair, dementia, PAD, unstable angina, cardiac conduction disturbances, any chronic disease that significantly reduces survival during the study period) • Diagnosed with lymphoedema Baseline; age, (range 32 to 82yrs) ; BMI ≥25kg/m^2 in 71% with 28% obese (>30 kg/m^2), lumpectomy only (46%), mastectomy (50%), sentinel node dissection only (18%), axillary node dissection only (76%), 0 positive nudes (63%), 1-3 positive nodes (24%), 4-9 positive nodes (13%) No differences between baseline characteristics or disease characteristics and cancer treatment between the treatment groups
Intervention	Tailored exercise, lymphoedema prevention, diet education, counselling 4-12wks post-surgery N=52 Lymphoedema Prevention Module (LPM), by trained occupational or physical therapist; • Following initial LPM, 1mth follow-up to assess range of motion, strength, weight resistance

Bibliographic reference	**Anderson et al (2012) A randomized trial of exercise on well-being and function following breast cancer surgery: the RESTORE trial. J Cancer Surviv**
	• Given compression sleeve with instructions to wear during exercise, heavy arm use, air travel • Instructions on exercises to promote lymph flow • Repeat visits at 3mths and 9mths, specialist contacted by telephone 4-6wks after surgery Tailored exercise component; • X2 exercise sessions/wk • Customised to meet baseline levels of strength and function • Each session – 5min warm-up, 30min moderate to somewhat hard walking on the rating of perceived exertion scale, 20min of upper and lower body strength training using both hand weights and plate-adjusted resistance machines, 10min of stretching • Participants maintained exercise logs for both centre-based and home-based exercise • After baseline strength assessments, initial weights assigned to each patient • Resistance exercises started with 50% of established one repetition max for the 1-2wks and weights increased wkly by approx. 1-2.5lbs on upper body exercises and 1-5lbs on lower body exercises • Free weights (dumbbells) provided increments of 1lb (weights up to 10lbs) and 2.5lbs (weights above 10lbs) • Once able to complete 12 repetitions of a weight for 2 consecutive exercise sessions, were instructed to progress to the next appropriate weight • Throughout, instructed to report any symptoms or problems they might encounter during exercise and to rest as needed • An individual certified by the American College of Sports Medicine as an exercise specialist led exercise sessions • First 3mths (intensive phase) asked to attend 2 exercise sessions/wk • Mths 4 to 6, given the option to transition to home-based exercise, with exercise sessions tapered to 1/wk at the exercise centre • Mths 7 to 12, not required to attend supervised exercise sessions, if they chose to could continue x2/wk at the exercise centre
Comparator	Usual care (patient education) 4-12wks post-surgery N=52 • Given written information about lymphoedema awareness and prevention exercises • Received a newsletter every quarter that included general tips about nutrition and physical activity
Length of follow up	3mthly (3,6,9,12,18mths), final visit 18mths post-surgery (15mth assessment by telephone)
Location	USA
Outcomes measures and effect sizes	Primary outcomes; physical function (assessed with 6min walk), health related quality of life (Functional Assessment of Cancer Therapy – Breast Cancer, FACT-B) Secondary outcome; arm volume – assessed by water displacement at each 3mth visit (reliability of water displacement using trained operators and skin marks has been reported to be very high) N=82 (79%) completed the 18mth assessment, there was no differences in outcome measures between completers vs. noncompleters (P>0.10) (those not completing more proportionately African-American, 26% vs. 7%, p=0.023; obese, 48% vs. 22%, p=0.032) Reasons for noncompletion for n=21/22; overwhelmed/lack of time (38%), lost to follow-up (19%), lack of interest (0%), family issues (10%), death (10%), other reasons (10%) **Results** **Six-min walk** Total metres walked higher with intervention group (593.2m (SE, 13.0)) compared with the usual care group (558.9m (SE, 11.8)), p=0.0098 **Mean FACT-B total scores not different at 18mths** Treatment group (115.8 (SD, 1.6)) compared with usual care group (114.4 (SD, 2.5)), p=0.57 No significant effect modifiers or interactions with age or BMI were found

Bibliographic reference	**Anderson et al (2012) A randomized trial of exercise on well-being and function following breast cancer surgery: the RESTORE trial. J Cancer Surviv**
	Arm volume Based on mean change at 18mths compared to baseline; adjusted mean change in the intervention group (33.5mL) compared with control group (60.4mL), p=0.54 **Adverse events** N=39 reported, n=7 classified as serious, n=2 considered study related (pectoral muscle pain, stress fracture) **Adherence** Adherence goals were exceeded and considered to support the feasibility of an exercise programme during treatment for breast cancer 71.2% completed all prescribed exercise sessions, range 0-97% 61% attended more than 75% of prescribed sessions 13% attended <50% of sessions
Authors' conclusion	The RESTORE trial demonstrated that a multicomponent protocol of tailored exercise and lymphoedema prevention instituted within 4-12wks of surgery can improve physical function without increasing risk of lymphoedema
Source of funding	Grant funding from US Army-DAMD17-01-1-0447, Department of Defence
Comments	Distributions over time were examined in graphical and univariate analyses Models were adjusted for baseline measurements, baseline affected arm volume, number of nodes removed during surgery, age at diagnosis, number of self-reported symptoms, baseline SF-12 mental and physical component scores, visit timing and treatment group

Bibliographic reference	**Cormie et al (2013) Is it safe and efficacious for women with lymphoedema secondary to breast cancer to life heavy weights during exercise: a randomised controlled trial. J Cancer Surviv**
Study type & aim	Study design: RCT, three-arm (Stratification for age and bioimpedance spectroscopy (BIS) impedance ratio. Randomised in an allocation ratio of 1:1:1 using a random assignment computer programme. The exercise physiologists involved in assigning participants to groups were blinded to the allocation concealment) Aim: to compare the effects of high load and low load resistance exercise on the extent of swelling, severity of symptoms, physical function and quality of life in women with breast cancer related lymphoedema
Number and characteristics of patients	N=62 Participants were referred by oncologists and physiotherapists or who responded to advertisements via local newspaper and radio in Perth, Western Australia, Canberra, ACT; June to December 2010 *Inclusion criteria:* • Breast cancer ≥1yr • Clinical diagnosis of breast cancer related lymphoedema; defined as having at least a 5% inter-limb discrepancy in volume or circumference at the point of greatest visible difference • Medical clearance from GP *Exclusion criteria:* • Unstable lymphoedema; defined as receiving intensive therapy within the previous 3mths (CDT or antibiotics for infection) a musculoskeletal cardiovascular and/or neurological disorder that could inhibit them from exercising Baseline; no significant differences between groups at baseline for age, weight, BMI, percentage body fat, number of co-morbidities, number of medications, time since cancer diagnosis, cancer stage, surgery, number of lymph nodes removed, radiotherapy, chemotherapy, hormone therapy, lymphoedema grade, BIS, arm volume difference, arm circumference

Bibliographic reference	**Cormie et al (2013) Is it safe and efficacious for women with lymphoedema secondary to breast cancer to life heavy weights during exercise: a randomised controlled trial. J Cancer Surviv**
Intervention and comparator	Three arms; • High load resistance exercise (n=22) • Low load resistance exercise (n=21) • Usual care control (n=19) Participants choose whether or not they wore a compression garment during the exercise sessions High load and low load resistance exercise, 3mths; • x2, 60min sessions/wk • in an exercise clinic setting supervised by accredited exercise physiologists • groups of 8-10 participants • 6 exercise that targeted the major upper body muscle groups including the chest, back, shoulders, upper arms and forearms (chest press, seated row/let pulldown, shoulder press/lateral raise, bicep curl, tricep extension and wrist curl) • Additionally 2 exercises targeting major muscle groups of thee lower body (leg press/leg extension, squat/lunge) Differences between the high and low load groups was the load and number of repetitions completed; • High load – load of exercises from 75-85% of 1 repetition maximum (RM) using 10-6 RM for 1-4 sets/exercise • Low load – load of exercises from 55-65% of 1 repetition maximum (RM) using 20-15 RM for 1-4 sets/exercise • To ensure progression, resistance was increased in 5-10% increments for the next set and/or training session Participants rated current levels of pain, heaviness and tightness prior to every session and asked about changes in arm swelling or interferences with daily activities. rated difficulty of session on a scale All participants were instructed to maintain their usual lymphoedema self-care management regimen, physical activity levels and diet throughout the intervention period
Length of follow up	Baseline, post-intervention (3mths)
Location	Australia
Outcomes measures and effect sizes	Extent of swelling assessed using; BIS, dual energy x-ray absorptiometry (DXA), arm circumference measurements (constant tension tape to assess regional circumferences of the affected and non-affected arms; measures started just distal to the metacarpal-phalangeal joints and were taken at 4cm intervals up the arm until the base of the axilla) Symptom severity; disability of the arm, shoulder and hand questionnaire (DASH), brief pain inventory questionnaire (BPI); arm morbidity sub-scale of the Functional Assessment of Chronic Illness Therapy breast cancer questionnaire for patients with lymphodedema (FACT-B+4); the arm symptoms sub-scale of the European Organisation for Research and Treatment of Cancer breast cancer module (QLQ-BR23) Physical function; maximal grip strength, maximal strength of the major muscle groups using the 1RM method in the chest press, seated row, leg press; muscle endurance; range of motion QoL; assessed using Medical Outcomes Study short-form (SF-36) N=3 high load group withdrew (n=2, time constraints, N=1 unrelated medical condition) N=2 control group, lost to follow-up **Results** Exercise attendance; High load of 24 sessions, average 23.4±1.1 Low load of 24 sessions, average 22.9±2.4 N=10/40 chose to wear their compression garment (26.3%, 5/19 high load; 23.8%, 5/21 low load)

Bibliographic reference	Cormie et al (2013) Is it safe and efficacious for women with lymphoedema secondary to breast cancer to life heavy weights during exercise: a randomised controlled trial. J Cancer Surviv

Extent of swelling;
No differences between groups;
Change from baseline to post-exercise (adjusted for baseline value)

	High load group (Mean±SE, 95% CI)	Low load group (Mean±SE, 95% CI)	Control group (Mean±SE, 95% CI)	P value
Extent of swelling				
BIS	-0.2±1.2 (-2.5 to 2.1)	-1.6±1.2 (-3.9 to 0.8)	-0.9±1.2 (-3.4 to 1.5)	0.711
Affected arm volume (mL)	-53.5±53.9 (-161.4 to 54.5)	98.5±55.0 (-11.6 to 208.7)	1.6±58.2 (-114.8 to 118.1)	0.146
Interlimb arm volume difference (%)	-3.0±1.3 (-5.7 to -0.4)	-2.0±1.3 (-4.7 to 0.7)	1.2±1.4 (-4.0 to 1.6)	0.647
Affected arm circumference (cm, sum of)	-0.9±1.3 (-3.5 to 1.7)	0.3±1.3 (-2.4 to 2.9)	-1.7±1.4 (-4.5 to 1.0)	0.582
Interlimb arm circumference difference (%)	-1.4±1.0 (-3.5 to 0.6)	-0.9±1.0 (-3.0 to 1.2)	0.0±1.1 (-2.2 to 2.1)	0.648

Symptom severity;
No differences between groups;
Change from baseline to post-exercise (adjusted for baseline value)

	High load group (Mean±SE, 95% CI)	Low load group (Mean±SE, 95% CI)	Control group Mean±SE, (95% CI)	P value
Symptom severity				
DASH (score)	-3.4±1.8 (-7.0 to 0.1)	-5.4±1.8 (-8.9 to -1.9)	0.6±1.9 (-3.3 to 4.4)	0.114
BPI-severity (score)	-0.3±0.3 (-0.8 to 0.2)	-0.3±0.3 (-8.5 to 0.2)	0.0±0.3 (-0.6 to 0.6)	0.271
BPI-interference (score)	-0.6±0.3 (-1.2 to 0.0)	-0.5±0.3 (-1.2 to 0.1)	0.1±0.4 (-0.7 to 0.8)	0.209
FACT-B+4 arm function (score)	1.1±0.6 (0.2 to 2.4)	1.9±0.6 (0.6 to 3.1)	0.6±0.7 (-0.8 to 1.9)	0.333
QLQ-BR23 arm symptoms (score)	-6.6±3.7 (-13.9 to 0.8)	-12.6±3.6 (-19.8 to -5.5)	-0.2±4.0 (-8.1 to 7.8)	0.242

Physical function;
Change from baseline to post-exercise (adjusted for baseline value)

	High load group (Mean±SE, 95% CI)	Low load group (Mean±SE, 95% CI)	Control group (Mean±SE, 95% CI)	P value
Muscle strength				
Grip strength-affected arm (kg)	1.7±0.8 (0.2 to 3.2)	1.9±0.8 (0.4 to 3.4)	0.4±0.8 (2.1 to 1.2)	0.077
Chest press 1RM (kg)	5.6±0.8 (4.0 to 7.2)*	5.8±0.8 (4.1 to 7.4)*	1.0±0.9 (-0.7 to 2.7)	0.000
Seated row 1RM (kg)	6.4±1.1 (4.2 to 8.6)*	8.0±1.1 (5.7 to 10.2)*	0.8±1.2 (-1.6 to 3.2)	0.000
Leg press 1RM (kg)	38.4±5.5 (27.4 to 49.3)	36.7±5.6 (25.4 to 47.9)	6.7±5.9 (-5.2 to 18.6)	0.000
Muscle endurance				
Chest press RM test	52.7±13.8 (25.0 to 80.4)*	80.2±14.1 (52.0 to 108.5)*	0.0±14.9 (29.8 to 29.7)	0.001

Bibliographic reference	**Cormie et al (2013) Is it safe and efficacious for women with lymphoedema secondary to breast cancer to life heavy weights during exercise: a randomised controlled trial. J Cancer Surviv**

Seated row RM test	82.5±24.2 (34.0 to 131.0)	144.9±24.7 (95.3 to 194.4)*	7.7±25.9 (-44.2 to 59.6)	0.001
Leg press RM test	708.1±158.5 (390.9 to 1025.4)	772.1±162.0 (447.9 to 1096.4)	269.3±172.1 (-75.2 to 613.7)	0.083
Range of motion (affected arm)				
Wrist flexion (º)	3.2±1.3 (0.6 to 5.7)	2.7±1.3 (0.1 to 5.3)	-2.2±1.48 (-4.9 to 0.6)	0.011
Wrist extension (º)	1.9±1.3 (-7.8 to 1.7)	5.0±1.4 (2.2 to 7.7)	1.5±1.4 (-1.4 to 4.3)	0.163
Elbow flexion (º)	1.5±0.8 (-0.2 to 3.1)	1.0±0.9 (-0.7 to 2.7)	2.1±0.9 (0.3 to 3.8)	0.711
Elbow extension (º)	0.3±0.7 (-1.1 to 1.7)	1.5±0.7 (0.1 to 2.9)	0.1±0.8 (-1.4 to 1.7)	0.328
Shoulder flexion (º)	5.5±1.8 (1.9 to 9.1)	11.6±1.8 (7.9 to 15.2)*	3.8±1.9 (-0.1 to 7.7)	0.011
Shoulder extension (º)	1.1±1.9 (2.7 to 5.0)	3.5±1.9 (0.3 to 7.3)	1.3±2.0 (2.7 to 5.2)	0.630
Shoulder abduction (º)	-1.1±2.4 (5.8 to 3.7)	5.0±2.4 (0.1 to 9.8)	2.5±2.6 (-2.6 to 7.6)	0.210

*significantly different to the control group (p≤0.05)

QoL;
Change from baseline to post-exercise (adjusted for baseline value)

	High load group (Mean±SE, 95% CI)	**Low load group (Mean±SE, 95% CI)**	**Control group (Mean±SE, 95% CI)**	**P value**
Physical functioning#	3.1±1.2 (0.7 to 5.5)	3.9±1.2 (1.6 to 5.5)*	-0.5±1.3 (-3.1 to 2.0)	0.040
Role physical#	4.6±1.5 (1.5 to 7.6)	5.3±1.5 (2.3 to 8.3)	1.7±1.6 (-1.5 to 4.9)	0.433
Bodily pain#	2.4±1.5 (-0.5 to 5.4)	4.4±1.4 (1.6 to 7.2)	2.0±1.5 (-1.1 to 5.0)	0.418
General health#	4.4±1.5 (1.4 to 7.4)	2.9±1.5 (-0.1 to 5.8)	2.8±1.6 (-0.4 to 6.0)	0.971
Vitality#	1.6±1.8 (-1.9 to 5.2)	5.3±1.7 (1.9 to 8.7)	1.0±1.8 (-2.7 to 4.6)	0.611
Social functioning#	2.0±1.8 (-1.7 to 5.6)	5.1±1.7 (1.7 to 8.6)	2.5±1.9 (-1.2 to 6.3)	0.766
Role emotional#	1.4±1.8 (-2.2 to 5.1)	7.6±1.8 (4.0 to 11.2)	2.7±1.9 (-1.2 to 6.5)	0.199
Mental health#	2.9±1.7 (-0.4 to 6.3)	6.6±1.6 (3.5 to 9.8)	1.7±1.7 (-1.7 to 5.1)	0.195
Physical health composite (raw score)	3.5±1.3 (0.9 to 6.1)	2.9±1.2 (0.4 to 5.4)	0.7±1.3 (-2.0 to 3.4)	0.255
Mental health composite (raw score)	1.7±1.8 (-2.0 to 5.3)	6.9±1.7 (3.4 to 10.4)	2.7±1.9 (-1.0 to 6.5)	0.381

#NBS, norm-based score

Authors' conclusion	Women with breast cancer related lymphoedema can safely perform moderate- to high-intensity upper body resistance exercise with both high and low loads without fear of exacerbating their lymphoedema
Source of funding	Trial funded by the Edith Cowan University Early Career Research Scheme and the University of Canberra's Deputy Vice-Chancellor of Research Fellowship Scheme
Comments	Aimed to detect as changes as small as 2%, SD of 5% for an effect size of 0.4. With an alpha level of 0.05 and a final sample of 62, achieved 80% power to detect such a change ITT approach used for all analyses, including missing data by imputing change across time to be zero Participants randomised to the control group were offered the exercise programme after the completion of the intervention period

<table>
<tr><td>Bibliographic reference</td><td>Hayes et al (2009) Exercise and secondary lymphedema: safety, potential benefits, and research issues. Medicine & Science in Sports & Exercise</td></tr>
<tr><td>Study type & aim</td><td>Study design: RCT, single-blind
(randomisation via a computer generated table of random numbers, with stratification according to severity of lymphoedema. Assessments completed by the same assessor who was blinded to participant group allocation)
Aim: to investigate the immediate and longer term effect of participating in a supervised, mixed-type exercise programme on lymphoedema status among women with lymphoedema after breast cancer</td></tr>
<tr><td>Number and characteristics of patients</td><td>N=32
Participants were recruited via study information packs distributed via lymphoedema-treating specialists, the Lymphoedema Association of Queensland, and study authors' database (had an initial 54% response rate)
Inclusion criteria:
• <76yrs, completed treatment for unilateral breast cancer at least 6mths previously
• Had unilateral, upper-limb lymphoedema diagnosed by a health professional
• Prepared to travel to the exercise clinic for 12wks
Exclusion criteria:
• None applied
Comparable patient and treatment characteristics at baseline; mean age approx. 60yrs. At pre-intervention breast cancer diagnosis >5yrs for 70% of all participants, years since lymphoedema diagnosis; <1yr (intervention n=1 (7%), control n=2 (13%)); 1-5yrs (intervention n=9 (64%), control n=6 (38%)); >5yrs (intervention n=4 (29%), control n=8 (50%)). Lymphoedema treatment characteristics of the groups were similar</td></tr>
<tr><td>Intervention</td><td>12wk, mixed-type exercise programme, aerobic and resistance exercise – conducted by an exercise physiologist and physiotherapist
<table>
<tr><td>Weeks</td><td>Type</td></tr>
<tr><td>Wks 1-2</td><td>Aerobic only (floor-based exercise to music and walking)</td></tr>
<tr><td>Wks 3-4</td><td>Aerobic (floor-based aerobic exercise to music, water-based aerobic exercise and walking) and water based resistance exercise</td></tr>
<tr><td>Wks 5-8</td><td>Aerobic (mix of all types) and water-based and free-weight resistance exercises</td></tr>
<tr><td>Wks 9-12</td><td>Aerobic (mix of all types) and machine-weight resistance exercise</td></tr>
</table>
<table>
<tr><td>Weeks</td><td>Intensity</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>Wks 1-4</td><td>Aerobic: low to moderate (RPE: 3-5)
Resistance: low (approx. 20 repetitions per exercise)</td><td>20-30 min per session</td><td>x3/wk;
2 supervised</td></tr>
<tr><td>Wks 5-8</td><td>Aerobic: moderate (RPE: 4-6)
Resistance: moderate (last successfully completed repetition reached at approx. 15 repetitions per exercise)</td><td>30-45 min per session</td><td>X4/wk;
2 supervised</td></tr>
<tr><td>Wks 9-12</td><td>Aerobic: moderate to high (RPE: 4-7)
Resistance: moderate to high (last successfully completed repetition reached at approx. 10 repetitions per exercise)</td><td>45+ min per session</td><td>At least x4/wk;
1 supervised</td></tr>
</table>
The decision to wear compression garments during exercise sessions or not was left up to each participant</td></tr>
<tr><td>Comparator</td><td>Control group</td></tr>
<tr><td>Length of follow up</td><td>Pre-intervention, immediately post-intervention, 12wk follow-up time</td></tr>
<tr><td>Location</td><td>Australia</td></tr>
<tr><td>Outcomes measures and effect sizes</td><td>Lymphoedema assessed using; specifically bioimpedance spectroscopy (BIS), perometry (involved inserting the upper limb into a horizontally oriented frame that emits two parallel arrays of infrared light beams at right angles to each other. By assuming an elliptical cross-section, the volume of both limbs and the volume difference between the limbs were calculated.
Lymphoedema considered to be present when the impedance ratio was more than 3 SD above normative data, taking into account the significant effect of limb dominance
Lymphoedema deemed present when the volume of the treated side was at least 200mL more than the untreated side

Results
(the data of n=1 participant in the intervention group with worsening lymphoedema and subsequent recurrence was removed from the analysis)</td></tr>
</table>

<table>
<tr><td>Bibliographic reference</td><td>Hayes et al (2009) Exercise and secondary lymphedema: safety, potential benefits, and research issues. Medicine & Science in Sports & Exercise</td></tr>
<tr><td></td><td>
Lymphoedema
No differences in lymphoedema status at baseline or changes between testing phases observed between the intervention and control groups
<table>
<tr><th>Measures of lymphoedema</th><th>Number</th><th>Change pre to post-intervention (mean (SD))</th><th>Change pre-intervention to 3mth follow-up (mean (SD))</th><th>P value</th></tr>
<tr><td>BIS (ratio)</td><td colspan="4"></td></tr>
<tr><td>Intervention group</td><td>15</td><td>-0.01 (0.06)</td><td>0.02 (0.07)</td><td>0.88</td></tr>
<tr><td>Control group</td><td>16</td><td>-0.00 (0.09)</td><td>0.01 (0.09)</td><td>0.75</td></tr>
<tr><td>Perometry (mL)</td><td colspan="4"></td></tr>
<tr><td>Intervention group</td><td>15</td><td>13 (81)</td><td>2 (71)</td><td>0.53</td></tr>
<tr><td>Control group</td><td>16</td><td>43 (97)</td><td>19 (73)</td><td>0.35</td></tr>
</table>
BIS
Measurable evidence of lymphoedema;
- Pre-treatment, 9/16 (56%) intervention group, at 3mth follow-up 2/16 (13%) had showed clinical improvement with no longer measurable lymphoedema; 1/16, 6% had increased swelling throughout the study period – had attended 50% of the supervised sessions, all low to moderate intensity, following the study this participant continued to have worsening lymphoedema that did not respond to treatment, subsequently diagnosed with recurrent disease)
- Pre-treatment, 6/16 (36%) control group, (a further 1/16 had measurable evidence of lymphoedema at post-treatment, this had returned to normal at 3mths), 1/16 had clinical decline over the 3mths, the remaining 5/16 had relatively stable ratios over time
- Overall at follow-up 2/9 in the intervention group and 0/6 in the control group no longer met the criteria for lymphoedema
Perometry
Measurable evidence of lymphoedema;
- Pre-treatment, 9/15 (60%) intervention group, at 3mths follow-up 8/14 (57%)
- Pre-treatment, 9/16 (67%) intervention group, at 3mths follow-up 10/15 (67%)
- Fluctuations of >10% between treated and untreated side found in both groups, overall group declines of 6% (intervention) and 5% (control)
Adherence
88% of those in the intervention group attended ≥70% of scheduled supervised exercise sessions
Qualitative data
Comments on self-reported questionnaire;
- Illustrated that lymphoedema impacts on all facets of an individual's life
- Positive comments regarding exercise, also suggestion that heavy or repetitive use aggravates the arm; also fear that exercise may adversely affect their lymphoedema
</td></tr>
<tr><td>Authors' conclusion</td><td>The results indicate that, at minimum, exercise does not exacerbate secondary lymphoedmea. Women with secondary lymphoedema should be encouraged to be physically active, optimising their physical and psychosocial recovery</td></tr>
<tr><td>Source of funding</td><td>Lead author funded by fellowship from the National Breast Cancer Foundation</td></tr>
<tr><td>Comments</td><td>For power calculations a 10% change in perometry volumes and a 0.2 change in BIS ratio were considered clinically relevant. Approx. 10 per group were required to detect this level of change or difference between groups, with 80% power and 5% significance</td></tr>
</table>

<table>
<tr><td>Bibliographic reference</td><td>Hayes et al (2011) Does the effect of weight lifting on lymphedema following breast cancer differ by diagnostic method: results from a randomized controlled trials. Breast Cancer Res Treat
(study protocol – Schmitz et al (2009) Physical activity and lymphoedema (the PAL trial): assessing the safety of progressive strength training in breast cancer survivors. Contemp Clin Trials)</td></tr>
<tr><td>Study type & aim</td><td>Study design: RCT, single blinded
(participants assigned in equal numbers to the intervention or control group using a process called minimisation software programme, in a manner that was unpredictable and concealed from those who determined eligibility. all measurement staff remained blinded throughout the study)
Aim: PAL trial, to assess the safety of twice-weekly progressive strength training, including arm exercises, in breast cancer survivors 1 to 15yrs post diagnosis</td></tr>
<tr><td>Number and characteristics of patients</td><td>N=295
Recruited October 2005 to February 2007

Inclusion criteria:</td></tr>
</table>

Bibliographic reference	**Hayes et al (2011) Does the effect of weight lifting on lymphedema following breast cancer differ by diagnostic method: results from a randomized controlled trials. Breast Cancer Res Treat** **(study protocol – Schmitz et al (2009) Physical activity and lymphoedema (the PAL trial): assessing the safety of progressive strength training in breast cancer survivors. Contemp Clin Trials)**
	• Unilateral, nonmetastatic breast cancer • BMI ≤50kg/m^2 • ≥1 excised lymph node, no recurrence of breast cancer, no clinical signs and symptoms of breast cancer • Stable lymphoedema • Lymphoedema criteria - ≥10% interlimb discrepancy in volume or circumference at the point of greatest difference or swelling or obstruction of the anatomical architecture on close inspection or pitting oedema - Prior clinical diagnosis of lymphoedema and having had any prior intensive lymphoedema therapy - Self-reported a clinical diagnosis of lymphoedema that was later confirmed by study measurements of a qualified clinician *Exclusion criteria:* • Unstable lymphoedema - Needed intensive lymphoedema therapy within 3mths before entry into the study - Had a 10% change in volume or circumference of the affected arm that had lasted at least 7days within 3mths before entry into the study - Experienced a lymphoedema-related infection that required use of antibiotics within 3mths before entry into the study - Required a change in activities of daily living in response to exacerbation of lymphoedema within 3mths before entry into the study Baseline; age, mean 55 yrs (weight-lifting group) 57yrs (control group); 50% stage I breast cancer, time since diagnosis 50mths; >70% had had chemotherapy, radiotherapy, and/or hormone treatment; With lymphoedema; - N=71 weight-lifting group (median time since diagnosis 45mths) - N=70 control group (median time since diagnosis56mths) Baseline lymphoedema characteristics similar between the groups, irrespective of the diagnostic criteria used
Intervention	N=148 Supervised intervention sessions, delivered by certified fitness trainers x2/wk sessions for 12mths, supervised in small groups (2-6 participants) for 3mths, then unsupervised for the remaining 9mths (the fitness trainers remained available to the treatment group participants during the unsupervised portion of the intervention and contacted participants if more than one consecutive session was missed) • Each session, 60-90mins; 10min cardiovascular warm-up; 5-15min of exercises intended to strengthen spinal stabilisation muscles and deep abdominal muscles; 9 strength-training exercises using variable resistance machines and free weights (for muscles of the chest, back, shoulders, quadriceps, hamstrings, gluteals, biceps, triceps). • For upper body started with no weight or one pound weights; if no changes in symptoms or onset of lymphoedema-related symptoms by the next week the weight was increased by ½ to pound increments • For lower body standard progressive strength training approach • Built up to 3 sets per exercise over the first 3-4wks • Key element was safety, careful monitoring so that if enough sessions were missed for deconditioning to have occurred the trainer would provide guidance to back off on resistance and gradually increase weights on the same schedule as before • Participants asked weekly if they had any change in symptoms • Mthly arm measurements performs by trainers, these process evaluation measurements were not compared to the outcome measurements (done by blinded measurement staff) were used solely to determine whether there was any cause for evaluation of possible onset/flare-up of lymphoedema
Comparator	Offered the intervention after a12mth delay N=147

Bibliographic reference	**Hayes et al (2011) Does the effect of weight lifting on lymphedema following breast cancer differ by diagnostic method: results from a randomized controlled trials. Breast Cancer Res Treat** **(study protocol – Schmitz et al (2009) Physical activity and lymphoedema (the PAL trial): assessing the safety of progressive strength training in breast cancer survivors. Contemp Clin Trials)**
	All participants instructed to allow normal seasonal variation in diet, and not to make any purposeful changes in diet that might cause gain or loss of body weight/fat
Length of follow up	12mths at the end of the intervention
Location	USA
Outcomes measures and effect sizes	Measures of lymphoedema; • Limb volume; by water displacement • Circumferential measurements; participants supine, measurements taken distal to the metacarpal-phalangeal (MCP) joints, measurements every 4cms (baseline and 12mths), or every 8cms (3 and 6mths) • Bioelectrical spectroscopy (BIS); by passing a current through the body at multiple frequencies, can separate intra and extracellular fluid volumes in the arm; ratio between affected and unaffected arms (baseline and 12mths) • Self-reported lymphoedema symptoms; assessed on the Norman survey (previously assessed with specificity of 0.90, sensitivity from 0.86 to 0.92 for diagnosing lymphoedema)

Proportions of participants with lymphoedema varied with different diagnostic criteria;

Diagnostic criteria	**Number (%)**
Volumetric interlimb vol diff >5% (vol)	132 (46.5)
Circumference interlimb size diff >5% (circ)	62 (21.8)
Bioimpedance spectroscopy interlimb ratio >3 SD of normative values (BIS)	76 (26.8)
Norman survey – scores 1+ (Norman)	147 (51.8)
Combined diagnostic criteria:	
Vol+circ	62 (21.8)
Vol+BIS	68 (23.9)
Vol+Norman	105 (37.0)
Circ+BIS	54 (19.0)
Circ+Norman	62 (21.8)
BIS+Norman	65 (22.9)
Vol+circ+BIS	54 (19.0)
Vol+circ+Norman	62 (21.8)
Vol+BIS+Norman	62 (21.8)
Circ+BIS+Norman	54 (19.0)
Vol+circ+BIS+Norman	54 (19.00

Results:
No significant difference between the groups in the proportion of participants with a change in interlimb swelling, interlimb size, interlimb ratio, or survey score

Lymphoedema diagnostic criteria	**Weight-lifting group No. (%)**	**Control group No. (%)**	**Cumulative incidence ratio or mean differences (95% CI)**	**P value**
Change in interlimb vol diff:				
≥5% increase	16 (12.2)	21 (15.9)	0.8 (0.4, 1.4)	0.39
≥5% decrease	19 (14.5)	25 (18.9)	0.8 (0.4, 1.3)	0.34
Change in interlimb sum of circumference diff:				

Bibliographic reference	**Hayes et al (2011) Does the effect of weight lifting on lymphedema following breast cancer differ by diagnostic method: results from a randomized controlled trials. Breast Cancer Res Treat** **(study protocol – Schmitz et al (2009) Physical activity and lymphoedema (the PAL trial): assessing the safety of progressive strength training in breast cancer survivors. Contemp Clin Trials)**

≥5% increase	0 (0)	3 (2.3)	-	-
≥5% decrease	3 (2.3)	1 (0.75)	3.1 (0.32, 28.91)	0.37
Change in interlimb ratio:				
≥5% increase	4 (3.7)	5 (4.7)	0.8 (0.2, 2.9)	0.75
≥5% decrease	3 (2.8)	7 (6.5)	0.4 (0.1, 1.6)	0.21
Change in Norman score:				
≥5% increase	4 (3.1)	7 (5.3)	0.6 (0.2, 1.9)	0.54
≥5% decrease	66 (50.4)	59 (44.7)	1.1 (0.9, 1.5)	0.36

Authors' conclusion	The variation of in proportions of those in the trial considered to have lymphoedema at baseline highlights the potential impact of the diagnostic criteria regarding prevalence. Progressive weight lifting was shown to be safe for women following breast cancer, even for those at risk or with lymphoedema, irrespective of the diagnostic criteria used
Source of funding	Grants from national Cancer Institute (ROI-CA106851), Geisinger Research Fund (ACR 500), National Centre for Research Resources (UL1RR024134)
Comments	Randomisation stratified by lymphoedema status (diagnosed, undiagnosed), time since diagnosis, age, BMI, radiation therapy history, number of lymph nodes removed, inter-limb differences Among those with lymphoedema at baseline, sample size of 60 provided 80% power to test equivalence, lack of equivalence was defined as a ≥20% in the expected background rate of 10% lymphoedema flare ups over 12mths, sided test, significance 0.05 Among those with lymphoedema at baseline, sample size of 60 provided 80% power to test equivalence, lack of equivalence was defined as a ≥20% in the expected background rate of 6% lymphoedema onset over 12mths, sided test, significance 0.05. both sample sizes were put at 72/group to account for possible drop-outs

Bibliographic reference	**Hayes et al (2013) Exercise for health: a randomized, controlled trial evaluating the impact of a pragmatic, translational exercise intervention on the quality of life, function and treatment-related side effects following breast cancer. Breast Cancer Res Treat**
Study type & aim	Study design: RCT, single blinded (randomised via computer generated, unblocked sequence of random numbers. Questionnaire and physical tests implemented by Exercise Physiologists blinded to group allocation) Aim: to compare the effectiveness of face-to-face (FtF) and telephone (Tel) delivered exercise on quality of life, patient-reported and clinically measured function and treatment-related side-effects
Number and characteristics of patients	N=194 Recruited October 2006 to June 2008 from four Brisbane hospitals *Inclusion criteria:* • Aged 20-69yrs, within 30km radius of Brisbane central business district *Exclusion criteria:* • Pregnant or lactating • Planning breast reconstructive surgery • With poor English Baseline; age, median age 52yrs (range 29-70yrs), personal and diagnostic factors, including BMI, lymph node status, stage of disease, adjuvant therapy similar across the groups
Intervention	Exercise intervention; • Face-to-face (FtF), n=67 • Telephone (Tel), n=67

<table>
<tr><td>Bibliographic reference</td><td>Hayes et al (2013) Exercise for health: a randomized, controlled trial evaluating the impact of a pragmatic, translational exercise intervention on the quality of life, function and treatment-related side effects following breast cancer. Breast Cancer Res Treat</td></tr>
<tr><td></td><td>8mth exercise intervention (started 6wks post-surgery) – 180+min/wk, aerobic and strength-based exercises;
• x4+/wk, all included upper and lower body range of motion exercises as part of warm-up and cool-down
• 16 scheduled visits (in person or via phone), starting wkly tapering to mthly

<table>
<tr><th>8-month intervention</th><th>Type/intensity/duration</th><th>Frequency of sessions with physiologist and responsibility of setting exercise prescription</th></tr>
<tr><td>Wks 1-4 (mth 1)</td><td>Aerobic/low-moderate/20-30min</td><td>x1/wk , exercise physiologist</td></tr>
<tr><td>Wks 5-8 (mth 2)</td><td>Aerobic with strength introduced/moderate/30-40min</td><td>x1/wk , exercise physiologist</td></tr>
<tr><td>Wks 9-16 (mths 3 and 4)</td><td>Aerobic and strength/moderate-high/45+min</td><td>x1/fortnight , shared, exercise physiologist and participant</td></tr>
<tr><td>Wks 17+ (mths 5-8)</td><td>Aerobic and strength/moderate-high/45+min</td><td>x1/mth , participant</td></tr>
<tr><td>Progression and overload</td><td colspan="2">Manner and rate was individually tailored with exercise history, exercise confidence, adherence for previous period, presence and severity of treatment-related side effects</td></tr>
</table>
</td></tr>
<tr><td>Comparator</td><td>Usual care – given no advice outside of that provided through usual care; this varied depending on treating clinician and/or hospital
N=60</td></tr>
<tr><td>Length of follow up</td><td>Pre, 6mths and post-intervention (12mths, post-surgery)</td></tr>
<tr><td>Location</td><td>Australia</td></tr>
<tr><td>Outcomes measures and effect sizes</td><td>Primary; QoL (FACT-B +4 questionnaire)
Secondary; patient-reported function and treatment-related symptoms (included lymphoedema status measured via bioimpedance spectrophy – BIS, ratio of treated to untreated side calculated and converted into a lymphoedema index; L-Dex)

Classified as having lymphoedema – L-Dex ≥10

Results
Quality of life;
QoL improved in all groups across the time of the study from pre to post-intervention
Change in QoL 6mths-pre scores (95% CI);
• FtF; +2.9 (-1.2 to 7.2)
• Tel; +8.4 (4.8 to 11.9), clinically meaningful over time, p≤0.05 compared to usual care group
• Usual care; -0.1 (-4.0 to 3.7)
Change in QoL 12mths-pre scores (95% CI);
• FtF; +9.5 (5.3 to 3.8)
• Tel; +13.5 (10.0 to 17.0), clinically meaningful over time, p≤0.05 compared to usual care group
• Usual care; +6.5 (1.8 to 11.1)

Lymphoedema;
There was no difference between L-Dex measured at baseline, mid and post intervention for all groups. There were no significant or clinically relevant differences between groups for the proportion of participants with lymphoedema
<table>
<tr><th></th><th>Baseline No. (%)</th><th>Mid-intervention (6mths), No. (%)</th><th>Post-intervention (12mths), No. (%)</th></tr>
<tr><td colspan="4">Self-report of a clinical diagnosis</td></tr>
<tr><td>FtF</td><td>2 (3.2%)</td><td>4 (6.9)</td><td>5 (8.9)</td></tr>
</table>
</td></tr>
</table>

Bibliographic reference	**Hayes et al (2013) Exercise for health: a randomized, controlled trial evaluating the impact of a pragmatic, translational exercise intervention on the quality of life, function and treatment-related side effects following breast cancer. Breast Cancer Res Treat**
	<table><tr><td>Tel</td><td>1 (1.5%)</td><td>6 (10.3)</td><td>2 (3.3)</td></tr><tr><td>Usual care</td><td>2 (3.6%)</td><td>5 (10.2)</td><td>4 (8.2)</td></tr><tr><td colspan="4">Objectively measured by BIS</td></tr><tr><td>FtF</td><td>1 (1.5%)</td><td>4 (6.5)</td><td>8 (13.1)</td></tr><tr><td>Tel</td><td>1 (1.5%)</td><td>4 (6.6)</td><td>8 (12.9)</td></tr><tr><td>Usual care</td><td>0 (0.0%)</td><td>6 (10.7)</td><td>9 (16.4)</td></tr></table> Aerobic fitness, fatigue, self reported outcomes, anxiety, depression and BMI changes also reported, not included in this ET
Authors' conclusion	Findings from this study highlight that a translational exercise intervention implemented within 6wks post-breast cancer surgery is safe and effective at preventing fatigue and declines in fitness and optimising QoL
Source of funding	National Breast Cancer Foundation
Comments	ITT analysis Sample size calculations indicated a minimum of 40/group was required to detect a clinically important difference of 8 units in overall QoL, with 90% power and 5% type I error risk

Bibliographic reference	**Johansson et al (2013) Water-based exercise for patients with chronic arm lymphedema. Am J Phys Med Rehabil**
Study type & aim	Study design: RCT (in random block of 4 in envelopes with computer-generated sequences, no details on blinding) Aim: to evaluate the feasibility and effect of a water-based exercise programme (WBE) on lymphedema status and shoulder range of motion among women with BCRL.
Number and characteristics of patients	Women with BCRL who had expressed interest in the trial were invited. *Inclusion criteria:* • History of unilateral breast cancer but were disease free, had arm lymphedema (volume difference ≥5%), pre-existing more than 6 months but had not received active treatment for the past 3 months, except the use of compression garments. *Exclusion criteria:* • Pre-existing medical conditions considered contraindicated to participating in an exercise intervention or who were uncomfortable exercising in the water. **Baseline characteristics (n=29) (in median with IQR):** Age: Group 1 = 64 (56-74); Group 2 = 62 (58-71) Months since cancer diagnosis: Group 1 = 110 (92-144); Group 2 = 119 (101-159) Lymphedema duration (mths): Group 1 = 52.5 (32.8-90.5); Group 2 = 58.0 (26.0-101.7) Lymphedema relative volume (LRV): Group 1 = 23.5 (10.3-51.3); Group 2 = 21.1 (10.1-39.3) Bioimpedance spectroscopy (BIS) ratio: Group 1 = 1.15 (1.08-1.54); Group 2 = 1.20 (1.08-1.24) Note: baseline no statistical significant differences.
Intervention	Group 1 (n=15): WBE WBE: 30mins session per week for 8 weeks (swimming and/or performing shoulder exercises in the water continuously for 30mins). All women were given instruction on 6 exercises all of which required women to keep their shoulders under the water.
Comparator	Group 2 (n=14): Control Control: instructed to continue exercises, if any, in the same way as they had done before to the study.
Length of follow up	8 weeks endpoint.
Location	Sweden
Outcomes measures and effect sizes	4 lost to follow-up (1 from Group 1, 3 from Group 2); reasons not reported, no ITT. **Measurement of lymphedema and shoulder ROM (in median with IQR):** <table><tr><th></th><th colspan="2">Pre-treatment</th><th colspan="2">Post-treatment</th></tr><tr><th></th><th>G1 (n=14)</th><th>G2 (n=11)</th><th>G1 (n=14)</th><th>G2 (n=11)</th></tr><tr><td>LRV,%</td><td>21.3 (9.5-44.3)</td><td>21.6 (17.9-42.8)</td><td>21.4 (8.6-40.1)</td><td>21.0 (14.8-31.7)</td></tr></table>

Bibliographic reference	**Johansson et al (2013) Water-based exercise for patients with chronic arm lymphedema. Am J Phys Med Rehabil**

BIS, ratio	1.13 (1.08-1.5)	1.22 (1.12-1.25)	1.13 (1.07-1.42)	1.22 (1.17-1.31)
TDC value				
Upper arm	28.0 (24.8-33.0)	26.1 (23.0-29.9)	28.0 (25.7-31.4)	27.4 (25.1-29.5)
Forearm	26.5 (23.4-32.9)	23.3 (22.0-29.4)	26.8 (22.2-32.3)	26.8 (23.6-33.4)

TDC = tissue dielectric constant.
Note: No statistical significant between group (p>0.05)

Changes in degrees (from baseline) of shoulder ROM:

	G1 (n=14)	G2 (n=11)	p-value
Adduction, degrees	0.5 (-3 to 3.3)	0 (-1 to 1)	0.32
Flexion, degrees	6 (1 to 10)	0 (0 to 1)	0.001
External rotation, degrees	6 (0 to 15.5)	3 (0 to 3)	0.07

(in median with IQR)

Authors' conclusion	The study showed that water-based exercise is feasible for breast cancer survivors with arm lymphedema and that shoulder range of motion can be improved years after cancer treatment has been completed.
Source of funding	Funds from Swedish Cancer Society, the National Breast Cancer Foundation, YMCA.
Comments	Very small sample size, issues on blinding, effect estimate reported in median.

Bibliographic reference	**Kilbreath et al (2012) Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. Breast Cancer Res Treat** **(study protocol – Kilbreath et al (2006) Progressive resistance training and stretching following surgery for breast cancer: study protocol for a randomised controlled trial. BMC Cancer. BMC Cancer)**
Study type & aim	Study design: RCT, single-blind (an investigator with no direct contact with subjects generated the randomisation list; randomisation list used to prepare numbered opaque envelopes; randomisation stratified by axillary node dissection and sentinel node biopsy. Measurements by a research assistant blinded to group allocation. Treatment group coded to enable blinded analysis) Aim: to investigate whether women can commence resistance training within a few weeks of their surgery
Number and characteristics of patients	N=160; axillary node dissection (AND) n=96, sentinel node biopsy (SNB) n=64 Recruited from three metropolitan hospitals in Sydney *Inclusion criteria:* • Had undergone surgery for stage I-III breast cancer that included a sentinel node biopsy or axillary node dissection • Able to communicate in English and attend for treatments and follow-up • All had received post-op care and may have been seen by a breast nurse, physiotherapist and/or occupational therapist *Exclusion criteria:* • History of lymphoedema, bilateral breast cancer, metastatic breast cancer • Pre-existing arm impairments that would interfere with testing or exercises for the arm At baseline, two groups similar in age, BMI and medical management of breast cancer Age, exercise group (53.5yrs, SD 12.1), control (51.6yrs, SD 11.0) Dominant limb affected; exercise, 49/81; control 51/79 Self-report symptoms, arm; exercise 22 (11-33); control 22 (11-33) Self-report symptoms, breast; exercise 25 (8-33); control 25 (8-33)
Intervention	Participants in both groups received the post-operative care in the hospital; • Given written information about exercises

<table>
<tr><td>Bibliographic reference</td><td>Kilbreath et al (2012) Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. Breast Cancer Res Treat
(study protocol – Kilbreath et al (2006) Progressive resistance training and stretching following surgery for breast cancer: study protocol for a randomised controlled trial. BMC Cancer. BMC Cancer)</td></tr>
<tr><td></td><td>• Brief, active-assisted, active overhead movements in the frontal and sagittal planes
• Were provided with literature on prevention of lymphoedema, including instructions not to lift heavy objects, and undertake prolonged activities such as scrubbing, as well as avoiding insect bites, injections, and blood pressure on the affected arm

Intervention started 4-6wks post-op
• Wkly supervised exercise session of resistance and passive stretching for shoulder muscles
• Instructed in a home programme of resistance training and stretching
• Resistance training, targeted should muscles; supervised session used free weights, for home programme provided with Thera-band. Instructed to perform x2 sets of 8-15 repetitions for each exercise
• The resistance at which women commenced training was low, median, affected side, 1-1.5kg. By the end of training 3kg for shoulder abductionand flexion and 4kg for horizontal flexion and extension
• Three stretches; shoulder flexion, two arm abduction stretches; to be performed supine , each stretch 5-15mins</td></tr>
<tr><td>Comparator</td><td>Control group
• No exercise or advice
• Seen fortnightly to assess for presence of lymphoedema</td></tr>
<tr><td>Length of follow up</td><td>At end of 8wk intervention period, 6mths</td></tr>
<tr><td>Location</td><td>Australia</td></tr>
<tr><td>Outcomes measures and effect sizes</td><td>Self-reported arm and breast symptoms and QoL from the European Organisation for Research and Treatment of Cancer, Breast; EORTC Br23 and core modules
Primary outcome; self-reported arm symptoms from EORTC Br23; arm pain, swelling, difficulty elevating arm, 4-point scale
Secondary outcome; breast symptoms from Br23 questions; physical measures of shoulder range, strength and presence of lymphoedema

Physical measures; ROM, strength, arm circumference (10cm intervals from the ulnar styloid to 40cm proximally on both arms – used to derive arm volume), bioimpedance analysis

Two cut-off criteria – interlimb difference of ≥10% or interlimb difference of ≥2cm in at two or more measures

Results
Adherence;
• Median number of sessions 7/8 sessions
• Adherence to supervised training 78%
• Minimum requirement for the home programme 40 sessions of stretching, 24 sessions of resistance training over 8wks, mean compliance 90%

Change in symptoms (from EORTC BR23);
Change at 8wks post exercise and at 6mths follow-up, compared with baseline:
<table>
<tr><td></td><td colspan="2">Post-exercise</td><td colspan="2">Follow-up</td></tr>
<tr><td></td><td>Mean (SD)</td><td>Between group diff (95% CI)</td><td>Mean (SD)</td><td>Between group diff (95% CI)</td></tr>
<tr><td>BR23 arm symptoms</td><td>Exercise; 13 (17)
Control; 10 (14)</td><td>4 (-1 to 9), p=0.15</td><td>Exercise; 12 (20)
Control; 8 (16)</td><td>4 (-2 to 10), p=0.24</td></tr>
<tr><td>BR 23 breast symptoms</td><td>Exercise; 8 (15)
Control; 7 (18)</td><td>2 (-4 to 7), p=0.59</td><td>Exercise; 10 (17)
Control; 6 (20)</td><td>4 (-3 to 10), p=0.24</td></tr>
</table></td></tr>
</table>

Bibliographic reference

Kilbreath et al (2012) Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. Breast Cancer Res Treat
(study protocol – Kilbreath et al (2006) Progressive resistance training and stretching following surgery for breast cancer: study protocol for a randomised controlled trial. BMC Cancer. BMC Cancer)

Change in shoulder range and motion;
Change at 8wks post exercise and at 6mths follow-up, compared with baseline:

	Post-exercise		**Follow-up**	
Range of motion (º)	**Mean (SD)**	**Between group diff (95% CI)**	**Mean (SD)**	**Between group diff (95% CI)**
Forward flexion	Exercise; 19.5 (16.4) Control; 13.1 (13.1)	**6.3 (1.5 to 11.1), p=0.01**	Exercise; 16.5 (17.7) Control; 14.6 (20.3)	1.9 (-4.5 to 8.2), p=0.56
Abduction	Exercise; 19.2 (15.9) Control; 14.0 (16.4)	5.2 (0.0 to 10.4), p=0.05	Exercise; 20.1 (16.7) Control; 10.1 (21.6)	**10.0 (3.6 to 16.5), p=0.003**
External rotation	Exercise; 27.1 (14.1) Control; 25.0 (12.8)	-2.0 (-6.4 to 2.3), p=0.36		-1.2 (-6.2 to 3.8), p=0.63
Horizontal extension	Exercise; 9.2 (14.6) Control; 6.8 (14.4)	2.4 (-2.2 to 7.1), p=0.30	Exercise; 7.5 (15.9) Control; 1.7 (15.4)	**5.8 (0.5 to 11.0), p=0.03**
Strength (N)	**Mean (SD)**	**Between group diff (95% CI)**	**Mean (SD)**	**Between group diff (95% CI)**
Abduction	Exercise; 25.9 (32.3) Control; 15.7 (28.6)	**10.2 (0.4 to 20.0), p=0.04**	Exercise; 23.4 (38.4) Control; 20.4 (31.5)	3.0 (-8.8 to14.7), p=0.62
Forward flexion	Exercise; 21.5 (26.0) Control; 14.3 (24.7)	7.3 (-1.0 to 15.5), p=0.08	Exercise; 18.1 (30.1) Control; 14.3 (27.7)	3.8 (-6.0 to 13.5), p=0.44
Horizontal extension	Exercise; 17.9 (26.1) Control; 13.7 (26.2)	4.2 (-4.2 to 12.6), p=0.33	Exercise; 17.3 (25.8) Control; 14.3 (28.1)	3.0 (-6.0 to 12.0), p=0.52
Horizontal flexion	Exercise; 17.4 (35.4) Control; 14.6 (29.2)	2.8 (-7.7 to 13.3), p=0.60	Exercise; 14.4 (30.6) Control; 18.2 (26.0)	-3.8 (-13.3 to 5.7), p=0.43

Lymphoedema;
Number with lymphoedema at 8wks post exercise and at 6mths follow-up, compared with baseline:

	Post-exercise		**Follow-up**	
	No (%)	**Chi-square**	**No (%)**	**Chi-square**
Exceeds BIS ratio	Exercise; 5 (7) Control; 11 (15)	2.7, p=0.10	Exercise; 6 (8) Control; 9 (13)	0.88, p=0.35
Interlimb circ diff*	Exercise; 6 (8) Control; 5 (5)	0.07, p=0.79	Exercise; 5 (7) Control; 4 (6)	0.08, p=0.78
Interlimb arm vol[#]	Exercise; 8 (11) Control; 8 (10)	0.00, p=0.96	Exercise; 6 (8) Control; 9 (13)	0.46, p=0.50

* ≥2 measures >2cm
[#] ≥10% diff

Authors' conclusion

An 8wk supervised, weekly, exercise programme that targeted range and strength of muscles about the shoulder did not reduce the self-reported impairments more than written instructions and a reminder to use their arm at 6mths post-surgery

Source of

Supported by the NSW Cancer Council, author research fellowship funded by the National Breast Cancer Foundation

Bibliographic reference	**Kilbreath et al (2012) Upper limb progressive resistance training and stretching exercises following surgery for early breast cancer: a randomized controlled trial. Breast Cancer Res Treat (study protocol – Kilbreath et al (2006) Progressive resistance training and stretching following surgery for breast cancer: study protocol for a randomised controlled trial. BMC Cancer. BMC Cancer)**
funding	
Comments	Determined that 69 participants/group were required to give 80% power to detect as significant at the two-sided 5% level a mean difference between the groups in arm symptom score of 12 points. Recruited 160 to allow for 14% mortality and loss to follow-up. Analysis was by intention-to-treat

Bibliographic reference	**Kim et al (2010) Effect of active resistive exercise on breast cancer-related lymphedema: a randomized controlled trial. Arch Phys Med Rehabil**
Study type & aim	Study design: RCT (assessor blinded, method for randomization was not reported). Aim: To investigate the differences between the effects of complex decongestive therapy (CDT) with and without active resistive exercise for the treatment of patients with breast cancer–related lymphedema.
Number and characteristics of patients	40 patients were consecutively selected by a physician from the outpatient clinic based on the following inclusion and exclusion criteria. *Inclusion criteria:* • Patients who had a greater than 2-cm circumference difference between the affected arm and the normal arm • Patients who had lymphedema diagnosed via lymphoscintigraphy (decreased uptake or no uptake by the lymph nodes, dermal backflow, poor to no visualization of the collateral and main lymphatics, and decreased or no clearance of radioisotope from the injection site). *Exclusion criteria:* • Patients who were older than 70 years • Patients who had cancer recurrence within 6 months from the time of entering this study • Patients who had lymphedema in both arms • Patients who had vascular disease • Patients who had any neurologic signs, such as decreased motor power, sensory changes, or decreased deep tendon reflexes • Patients who could not communicate. **Patient characteristics (table reproduced from Kim et al. 2010):**

	Active resistance exercise group (n=20)	Nonactive resistance exercise group (n=20)	*P*
Age (y)	50.50±10.58 (27–71)	50.90±9.15 (39–76)	.85
BMI (kg/m^2)	25.09±2.99 (20.3–31.6)	24.93±2.67 (20.08–31.04)	.90
Onset to treatment (mo)	4.35±12.91 (1–57)	5.24±12.61 (0.5–68)	.62
Lymphedema site (%)			
Right	45	60	.26
Left	55	40	
Lymph node invasion (%)			
Yes	75	90	.20
No	25	10	
Infection (%)			
Yes	5	10	.50
No	95	90	

Data: mean with SD.

Intervention	Group 1: CDT with active resistive exercise (n=20) CDT: manual lymphatic drainage, compression therapy, and remedial exercise (assisted by physical therapist for the first 2 weeks, then continued self-administered CDPT for another 6 weeks. Active resistive exercise: using dumbbells for 15 minutes while wearing a compression stocking or a multilayer bandage. The prescribed exercises included seated row, bench press, latissimus dorsi pull-down, 1-arm bent-over row, triceps extension, and biceps curl (2 sets of 10 repetitions of each exercise: 2 weeks supervised, followed by 6 weeks unsupervised.
Comparator	Group 2: CDT only (n=20)

Bibliographic reference	**Kim et al (2010) Effect of active resistive exercise on breast cancer-related lymphedema: a randomized controlled trial. Arch Phys Med Rehabil**
	Components of CDT: same as Group 1.
Length of follow up	Treatment period: 8 weeks. Outcomes were measured at baseline, then at 8-weeks as endpoint.
Location	Outpatient clinic of the Department of Rehabilitation Medicine of Kosin University Gospel Hospital, Korea, from January 2009 to December 2009.
Outcomes measures and effect sizes	• Distal/proximal/total arm volume (cm^3). • QoL: Korean version of SF-36 version 2. **Volume Changes Between Pretreatment and Posttreatment** (reproduced from Kim et al. 2010)

Outcome	Pretreatment	95% CI	Posttreatment	95% CI
Active resistance exercise group (n=20)				
Distal arm volume (cm^3)	2925.21±358.47	2768.08–3082.32	2226.98±279.95	2104.28–2349.72
Proximal arm volume (cm^3)	4987.90±412.19*	4807.25–5168.55	4012.76±331.42*†	3867.56–4158.04
Total arm volume (cm^3)	7913.11±394.32	7740.28–8085.92	6239.74±293.17	6111.2–6368.20
Nonactive resistance exercise group (n=20)				
Distal arm volume (cm^3)	2825.84±271.88	2706.63–2944.97	2257.33±241.17	2151.59–2363.01
Proximal arm volume (cm^3)	4744.30±729.43*	4424.63–5063.97	4036.67±604.94*†	3771.49–4301.71
Total arm volume (cm^3)	7570.14±429.63	7381.82–7758.38	6294.17±574.91	6042.24–6546.16

NOTE. Values are mean ± SD or as otherwise indicated.
Abbreviation: CI, confidence interval.
*$P<.05$ according to repeated-measures analysis of variance between pretreatment and posttreatment within each group.
†$P<.05$ according to repeated-measures analysis of variance between active resistance exercise group and nonactive resistance exercise group.

Changes in SF-36 Between Pretreatment and Posttreatment (reproduced from Kim et al. 2010)

Outcomes	Pretreatment	Posttreatment
Active resistance exercise group (n=20)		
Physical functioning	68.25±17.42 (40.0–100)*	85.12±13.89 (60–110)*
Role physical	59.38±26.66 (12.50–100)*	83.75±18.74 (50–100)*†
Body pain	53.50±22.77 (0–80)*	57.12±24.12 (0–80)*
General health	58.50±11.82 (40–90)*	66.75±13.40 (35–100)*†
Vitality	64.06±10.71 (43.75–87.5)	67.81±11.19 (37.5–87.5)
Social functioning	54.38±9.31 (50–87.5)	55.56±9.80 (50–87.5)
Emotional health	68.33±24.12 (25–100)	82.92±26.14 (33.33–125)
Mental health	66.25±15.12 (35–100)*	75.25±14.73 (25–85)*
Nonactive resistance exercise group (n=20)		
Physical functioning	68.50±11.01 (55–85)*	76.00±12.73 (55–100)*
Role physical	57.81±31.47 (12.5–100)*	68.75±30.75 (18.75–118.75)*†
Body pain	53.50±21.03 (10–80)*	56.00±21.52 (10–80)*
General health	55.75±11.84 (35–75)	60.24±12.73 (40–90)†
Vitality	59.69±11.19 (43.75–75)	64.19±12.90 (43.75–93.75)
Social functioning	50.00±9.93 (25–62.5)	51.88±10.16 (25–75)
Emotional health	64.83±28.11 (16.67–100)	75.00±28.66 (16.67–116.67)
Mental health	64.25±16.85 (40–95)*	69.50±17.63 (40–110)*

NOTE. Values are mean ± SD (range).
*$P<.05$ according to repeated-measures analysis of variance between pretreatment and posttreatment within each group.
†$P<.05$ according to repeated-measures analysis of variance between active resistance exercise group and nonactive resistance exercise group.

	After 8 weeks of treatment, the ARE group showed a significantly reduced volume in the proximal arm, compared with that of the non-ARE group. However, there was no significant difference in volume reduction of the distal and total arms between the groups. Comparing the 2 groups, ARE group showed significant improvements only in 'role physical' and 'general health', as compared with non-ARE group, but no significant difference between groups in other SF-36 domains.
Authors' conclusion	The study demonstrated that ARE reduced the volume of BCRL and helped to improve QOL. Therefore, cancer care professionals should recommend ARE with CDPT, along with BCRL treatment, for improvement in BCRL severity and QOL. A future large-scale study to further analyze the effects of ARE on BCRL is recommended.
Source of	Not reported.

Bibliographic reference	**Kim et al (2010) Effect of active resistive exercise on breast cancer-related lymphedema: a randomized controlled trial. Arch Phys Med Rehabil**
funding	
Comments	Small sample size, method for randomization was not reported, poor reporting quality on effects estimates.
Intervention	Group 1 (n=21): advanced PCT for truncal/chest/arm (a total dose of 30 x one hour per day treatments during the study).
Comparator	Group 2 (n=21): PCT for arm only (a total dose of 30 x 36 min per day treatments while on study).
Length of follow up	Treatment period and endpoint = 30 days of home self-care using Flexi-touch System
Location	USA, actually setting not reported.
Outcomes measures and effect sizes	The Lymphedema symptom intensity and distress survey- Arm (LSIDS-A) was used to evaluate physical, psychological, or situational symptoms. The 15-item Functional assessment screening questionnaire (FASQ; Activity Level/Function) was used to assess function. To obtain the arm circumferential measurements, a non-stretch, retractable, Gulick II Tape that applies four ounces of tension when used. **Table: Summaries of changes in symptoms and symptom burden from baseline to end of study (reproduced from Ridner et al. 2012)**

	Study group	
	Arm only ($N = 21$) Median [25th, 75th IQR] (Min, Max)	Truncal/chest/arm ($N = 21$) Median [25th, 75th IQR] (Min, Max)
Number of symptoms ($P = .145$)*		
Baseline	12.0 [7.5, 16.0] (1, 20)	15.0 [9.5, 20.0] (3, 27)
End of study	6.0 [4.0, 11.5] (0, 21)	10.0 [6.0, 17.5] (3, 28)
Effect size	−0.72**	−0.43**
Overall symptom burden ($P = .051$)*		
Baseline	2.6 [1.4, 7.2] (0.2, 20.7)	9.7 [1.4, 22.8] (0.2, 47.4)
End of study	1.1 [0.5, 2.0] (0, 19.5)	4.0 [0.8, 9.2] (0.1, 26.3)
Effect size	−0.89**	−0.44**

The effect sizes are Cohen's d statistics for the change from baseline to end-of-study using transformed values to meet assumption
*Tests of differences in the changes between groups
**Statistically significant changes within groups

Table: Summaries of changes in impedance and arm volume from baseline to end of study (reproduced from Ridner et al. 2012)

Bibliographic reference	**Kim et al (2010) Effect of active resistive exercise on breast cancer-related lymphedema: a randomized controlled trial. Arch Phys Med Rehabil**

Location	Study group	
	Arm only ($N = 21$)	Truncal/chest/arm ($N = 21$)
	Median [IQR]	Median [IQR]
Impedance ($P = .481$)*		
Baseline	1.31 [1.21, 1.48]	1.25 [1.09, 1.77]
End of study	1.26 [1.12, 1.41]	1.20 [1.05, 1.62]
Effect size	−0.31**	−0.15**
Affected arm volume ($P = .609$)*		
Baseline (ml)	2346.55 [1952.38, 2661.56]	2526.83 [2198.08, 3346.96]
End of study (ml)	2376.53 [1934.68, 2622.99]	2539.93 [2168.28, 3295.97]
% Change from Baseline	−0.38 [−2.56, +1.34]	−2.66 [−4.20, −0.55]
Effect size	−0.04	−0.07
Unaffected Arm Volume ($P = .471$)*		
Baseline (ml)	2104.12 [1738.20, 2305.31]	2159.26 [1811.79, 2635.06]
End of study (ml)	2114.57 [1722.92, 2289.93]	2114.33 [1810.88, 2639.21]
% Change from Baseline	−0.81 [−1.69, +1.69]	−0.56 [−1.90, +0.71]
Effect size	+0.02	−0.04

The effect sizes are Cohen's d statistics for the change from baseline to end-of-study using transformed values to meet assumption
*Tests of differences in the changes between groups
**Statistically significant changes within groups

Summary:

- After controlling for baseline values, there were no statistically significant differences in the number of symptoms between the groups (p=0.145) nor the self-reported overall symptom burden scores (p=0.051).
- All participants were high functioning upon enrolment into the study (Mean = 21.1, SD = 5.8) and this level of functioning was maintained throughout study participation (Mean = 20.6, SD = 6.2), (p=0.897), also, no differential pattern of change between the groups in function (p=0.408).
- After controlling for baseline values, there were no statistically significant differences in impedance and arm volume between the groups.

Authors' conclusion	The study indicated that both configurations are effective, but that there may be no added benefit to advanced pneumatic treatment of the truncal lymphatics prior to arm massage when the trunk is not also affected. Further research is indicated in a larger sample.
Source of funding	This study was funded by a grant from Tactile Systems Technology, Inc.
Comments	Small sample size (not sufficient for non-inferiority trial), unclear blinding, unclear allocation concealment, poor reporting quality on effects estimates [Median (with IQR) was used due to the data was severely skewed].

Bibliographic reference	**McKenzie and Kalda (2003) Effect of upper extremity exercise on secondary lymphoedema in breast cancer patients: a pilot study. Journal of Clinical Oncology**
Study type & aim	Study design: RCT (no details on randomisation) Aim: to examine the effect of a progressive upper-body exercise programme on lymphoedema secondary to breast cancer treatment
Number and characteristics of patients	N=14 *Inclusion criteria:* • Breast cancer stage I/II, treatment completed >6mths • Lymphoedema, unilateral, >2cm <8cm on ≥1 measurement point

Bibliographic reference	**McKenzie and Kalda (2003) Effect of upper extremity exercise on secondary lymphoedema in breast cancer patients: a pilot study. Journal of Clinical Oncology**
	Exclusion criteria: • Breast cancer stage III • Bilateral lymphoedema • Requiring medication that might affect upper extremity swelling At baseline, no significant difference between the two groups in age (56.6±9.0yrs), weight, height, BMI, average difference in circumference (2.8±1.2), percentage circumference difference (111.5±5.0), percentage of water displacement volume difference of affected to other arm (12.62±13.6)
Intervention	N=7 8wks, supervised, x3sessions/wk • Stretching exercises for each major body part • Resistance training; beginning with light weights, and progressing as tolerated • Strength exercises; seated row, bench press, lat dorsi pull down, one-arm bent rowing, tricep extension, bicep curl – x2 sets, 10 repetitions first wk, x3/wk after • After 2wks added upper body exercise using arm ergometer under supervision
Comparator	N=7 No specific exercise instruction (after the study given the option of being taught the exercise programme)
Length of follow up	Assessed every 2wks, for 8mths
Location	Canada
Outcomes measures and effect sizes	Arm circumference; • Every 3cm from styloid process of the ulna to 45cm proximally, as well as the metacarpals and midhand • Volume calculated from this Upper extremity volume; via water displacement QoL; SF-36 **Results** **Volume changes;** No significant differences in the percentage change of measured arm volume (numbers not reported) **QoL;** Non-significant increases in physical functioning, general health and vitality in the exercise group Non-significant increase in mental health in both groups Comparison of volume measurement techniques reported, not included in this ET
Authors' conclusion	Participation in an upper-body exercise program caused no changes in arm circumference or arm volume in those with lymphoedema after breast cancer, and they may have experienced an increase in quality of life
Source of funding	Not reported
Comments	

Bibliographic reference	**Sagen et al (2009) Physical activity for the affected limb and arm lymphedema after breast cancer surgery. A prospective, randomized controlled trial with two years follow-up. Acta Oncologica**
Study type & aim	Study design: RCT, single-blind (randomisation in blocks of 10 using a computer-generated programme. All data managed in an anonymised format, outcomes assessor blinded and not involved in the interventions

Bibliographic reference	Sagen et al (2009) Physical activity for the affected limb and arm lymphedema after breast cancer surgery. A prospective, randomized controlled trial with two years follow-up. Acta Oncologica
	performed at the outpatient clinic) Aim: to investigate the development of arm lymphoedema, pain, and a sensation of heaviness in the affected limb after two different programmes that involve different physical activity levels of the upper limbs
Number and characteristics of patients	N=204; Recruited from two hospitals in Norway, 1999 to 2003 *Inclusion criteria:* • Early-stage breast cancer, stage I and II *Exclusion criteria:* • >75yrs • Difficulty understanding Norwegian • Metastasized breast cancer • Other types of cancer, injury, or poor functioning of the upper limb which prevented participating in the rehabilitation programmes at the outpatient clinics At baseline, two groups were balanced for age, BMI, affected arm volume, control arm volume, surgery, cancer treatment, histology and working status
Intervention	No activity restrictions; • No restrictions on physical activity that used the affected limb for 6mths • Supervised programme of moderate resistance exercise training; x2-3/wk • Resistance exercises; 45min; 15 reps each exercise; used low resistance weights (0.5kg) during the first two wks increased individually for each patient
Comparator	Activity restrictions • Told to restrict the activity of the affected limb for 6mths • Told to avoid heavy or strenuous physical activities, included aerobic or other types of exercise classes that include physical activity or work, and to avoid carrying or lifting groceries or other items weighing more than 3kg • Participated in the usual care physical therapy programme carried out wkly at outpatients – comprised 6 different standardised passive manual techniques emphasising flexibility and light massage of the affected shoulder, arm, and scar (total intervention time 45min) – x1/wk for 6mths
Length of follow up	Assessed at 3mths, 6mths and 2yrs after surgery
Location	Norway
Outcomes measures and effect sizes	Voldiff (mL); difference between volume of the affected arm and the control arm using simplified water displacement Lymphoedema; • Identification of risk factors for the development of lymphoedema, cut-off set at Voldiff >200mL • Incidence of lymphoedema, a 10% increase in Voldiff between the affected arm and the control arm (35 participants had a Voldiff >200mL, allowed the inclusion of four independent factors (10%) in the analysis) VAS scales; to record pain and sensation of heaviness in the affected limb Adherence; via questionnaire developed to record upper limb physical activity (categorised into physical activity at work, at home, or during leisure time **Results** (N=207 randomised, 3 excluded (n=2 had not had axillary node dissection, n-1 baseline data accidently removed)) N=204 N=52 lost to follow-up at 2yrs **Arm volume;** Arm volume of the affected and control arms, Voldiff and lymphoedma – NS difference between the no activity restriction and activity restriction groups

<table>
<tr><td>Bibliographic reference</td><td>Sagen et al (2009) Physical activity for the affected limb and arm lymphedema after breast cancer surgery. A prospective, randomized controlled trial with two years follow-up. Acta Oncologica</td></tr>
<tr><td></td><td>N=35 with Voldiff >200mL at 2yrs

<table>
<tr><th colspan="4">Voldiff in mL</th></tr>
<tr><td></td><td>No activity restriction , mean (SD)</td><td>Activity restriction, mean (SD)</td><td>No restriction – restriction , mean difference in mL</td></tr>
<tr><td>3mths</td><td>20 (120)</td><td>49 (125)</td><td>-8</td></tr>
<tr><td>6mths</td><td>32 (129)</td><td>64 (158)</td><td>-15</td></tr>
<tr><td>2yrs</td><td>52 (153)</td><td>82 (165)</td><td>-16</td></tr>
</table>

Pain and sensation of heaviness;
Significantly higher (p<0.05) in the no activity restriction group than the activity restriction group at 3mths and 6mths after surgery. No difference at 2yr follow-up
<table>
<tr><th>VAS</th><th>No activity restriction (%)</th><th>Activity restriction, (%)</th></tr>
<tr><td>3mths:
- no pain 0mm
- pain 1-20mm
- pain >21mmm</td><td>
19 (22)
35 (40)
33 (38)</td><td>
47 (55)
16 (19)
22 (26)</td></tr>
<tr><td>6mths:
- no pain 0mm
- pain 1-20mm
- pain >21mmm</td><td>
41 (40)
36 (25)
27 (25)</td><td>
64 (64)
23 (23)
13 (13)</td></tr>
<tr><td>2yrs:
- no pain 0mm - pain 1-20mm
- pain >21mmm</td><td>
62 (61)
26 (24)
16 (15)</td><td>
64 (64)
20 (17)
16 (17)</td></tr>
</table>

Risk factors for development of lymphoedema (the n=35 with lymphoedema at follow-up allowed for the inclusion of four independent factors in the follow-up);
BMI at baseline (>25kg/m^2); OR 3.42 (95% CI; 1.45, 8.06), p=0.005
Voldiff pre-operatively (>0mL); OR 1.43 (95% CI; 0.59, 3.49), p=0.427
Sensation of heaviness at 3mths (VAS >0mm); OR 1.54 (95% CI; 0.46, 5.24), p=0.486
Pain at 3mths (VAS >0mm); OR 0.78 (95% CI; 0.23, 2.67), p=0.781

Adherence to the intervention programmes;
Analysis of physical activity of the upper limbs based on home activity and leisure time activity (nearly 80% not working at 6mths, activities at work not included)
• Home physical activity score significantly higher at 3mths and 6mths in the no activity restriction group than the activity group (p<0.001) - the no activity restriction group had been told not to limit their level of physical activity
• Physical activity scores did not differ between the groups preoperatively or at 2yrs</td></tr>
<tr><td>Authors' conclusion</td><td>Patients that undergo breast cancer surgery with axillary lymph node dissection should be encouraged to maintain physical activity in their daily lives without restrictions and without fear of developing arm lymphoedema</td></tr>
<tr><td>Source of funding</td><td>Health and Rehabilitation, the Norwegian Cancer Society, and The Norwegian Women's Public Health Association</td></tr>
<tr><td>Comments</td><td>Data analysis ITT
Power analysis based on the mean Voldiff of 79mL (SD 124), 65 patients required in each group to detect a minimal clinically relevant Voldiff of 50mL between the groups at two-tailed significance level <0.05, 0.90 power</td></tr>
</table>

Bibliographic reference	**Sagen et al (2009) Physical activity for the affected limb and arm lymphedema after breast cancer surgery. A prospective, randomized controlled trial with two years follow-up. Acta Oncologica**
	Due to the heavy post-surgical burden of radio/chemotherapy adherence to rehabilitation programmes was set at 70% and was defined as the number of visits to the outpatients clinics and the number of patients who completed the 2wk physical activity questionnaire

Bibliographic reference	**Schmitz et al (2009) Weight lifting in women with breast-cancer-related lymphedema. N Engl J Med**
Study type & aim	Study design: RCT (randomised through computerized process called minimization; assessor was blinded). Aim: Weight lifting has generally been proscribed for women with breast-cancer–related lymphedema. The aim was to performed a 1-year randomized, controlled trial involving breast-cancer survivors with lymphedema to assess the effects of controlled weight lifting.
Number and characteristics of patients	N=141 (recruited from October 2005 through March 2007) *Inclusion criteria:* • history of unilateral nonmetastatic breast cancer 1 to 15 years before study entry • BMI≤ 50kg/m2 • not actively trying to lose weight • no current evidence of cancer • no medical conditions that would limit exercise • no history of weight lifting during the previous year • ≥1 lymph node removed • a clinical diagnosis of stable breast-cancer–related lymphedema. Lymphedema was defined as a difference in the volume or circumference between the affected and unaffected limb of 10% or more. Stable lymphedema was defined as the absence in the past 3 months of therapist-delivered treatment, more than one arm infection requiring antibiotics, change in ability to perform activities of daily living, and verified changes in arm swelling of more than 10%. **Baseline characteristics:** All participants had a clinical diagnosis of lymphedema; 12 had lymphedema classified as grade 0 at baseline but were included because, once diagnosed, lymphedema is considered to be manageable but not curable. NS differences in baseline between the groups for measures of strength, anthropometric data, diet and physical exercise

Bibliographic reference	Schmitz et al (2009) Weight lifting in women with breast-cancer-related lymphedema. N Engl J Med

Characteristic	Weight Lifting (N=71)	Control (N=70)	P Value
Age — yr	56±9	58±10	0.56
Education — no. (%)			0.80
High school or less	13 (18)	16 (23)	
Some college	26 (37)	24 (34)	
College degree or more	32 (45)	30 (43)	
Self-reported race — no. (%)			0.87
White	40 (56)	42 (60)	
Black	28 (39)	26 (37)	
Other	3 (4)	2 (3)	
Occupation — no. (%)			0.15
Professional	29 (41)	23 (33)	
Clerical or service	10 (14)	11 (16)	
Homemaker, student, or unemployed	8 (11)	4 (6)	
Other or unknown	9 (13)	4 (6)	
Retired	15 (21)	28 (40)	
Months since cancer diagnosis	79±45	88±45	0.23
Cancer stage — no. (%)			0.19
1	33 (46)	24 (34)	
2	1 (1)	0	
3	22 (31)	22 (31)	
Data not available	15 (21)	24 (34)	
No. of nodes removed	15±8	16±8	0.59
Chemotherapy — %	83	80	0.67
Radiation — %	83	76	0.30
Current receipt of drugs — %			
Tamoxifen	20	4	0.008
Aromatase inhibitor	0	1	0.50
Difference in volume between the affected and unaffected limbs — %	15.0±14.7	17.3±16.6	0.49
Common Toxicity Criteria lymphedema grade — no. (%)†			0.25
0	5 (7)	7 (10)	
1	18 (25)	12 (17)	
2	32 (45)	26 (37)	
3	16 (23)	25 (36)	

Table reproduced from Schmiz et al. (2009).

Intervention

Group 1 (n=71): 1-year weight-lifting treatment group

- first 13 weeks, instructed x2/wk (groups 2-6 patcipants) at a community fitness centre, led by certified fitness professionals, 90-min sessions
- stretching, 10 min of cardiovascular warm-up, 'core' exercises to strengthen abdominal and back muscles, and weight-lifting exercises – upper body; seated row, chest press, latereral or front raises, bicep curls, tricep pushdowns – lower body; leg press, back extension, leg extension, leg curl
- 13 wks to 1ys, continued x2/wk unsupervised exercise .

Bibliographic reference	**Schmitz et al (2009) Weight lifting in women with breast-cancer-related lymphedema. N Engl J Med**
	During lymphedema exacerbations, women continued all exercises except the upper body exercises, which were resumed only after approval of their lymphedema therapist. At baseline and 6 months, participants in both groups were given a custom-fitted compression garment (Jobst, BSN Medical). Participants in the weight-lifting group were required to wear these garments during weight lifting. Participants in both groups were required to attend a 1-hour educational lecture that reviewed the National Lymphedema Network guidelines for risk reduction, treatment, and exercise. Final analysis: n=65, 6 lost to follow up, reasons not reported.
Comparator	Group 2 (n=70): wait-list control Control group participants were asked not to change their level of exercise during study participation. At baseline and 6 months, participants in both groups were given a custom-fitted compression garment (Jobst, BSN Medical). Participants in both groups were required to attend a 1-hour educational lecture that reviewed the National Lymphedema Network guidelines for risk reduction, treatment, and exercise. Final analysis: n=65, 5 lost to follow up, reasons not reported.
Length of follow up	12 months follow-up
Location	US study
Outcomes measures and effect sizes	An exacerbation was defined as if there was an increase in the volume of the affected limb of 5% or more, accompanied by an increase of 5% or more in the difference in the volume or circumference between the affected and unaffected limbs and by indications of sustained tissue changes. Table reproduced from Schmiz et al. (2009).

Variable	Weight Lifting		Control		Cumulative Incidence Ratio or Mean Difference (95% CI)†	P Value‡
	no. of patients with data	*value*	*no. of patients with data*	*value*		
Change in interlimb volume difference						
≥5% increase — no. (%)	70	8 (11)	69	8 (12)	1.00 (0.88 to 1.13)	1.00
≥5% decrease — no. (%)	70	13 (19)	69	15 (22)	0.96 (0.81 to 1.14)	0.68
Mean interlimb volume discrepancy between baseline and 12 mo (percentage points)	70	−0.69±5.87	69	−0.98±7.31	−0.29 (−1.94 to 2.51)	0.80
Exacerbation — no. (%)	65	9 (14)	65	19 (29)	0.47 (0.23 to 0.97)	0.04
Change in no. of symptoms reported between baseline and 12 mo§	70	−1.81±2.16	69	−1.17±1.94	−0.63 (−1.32 to 0.06)	0.07
Change in severity of symptoms between baseline and 12 mo§	70	−0.51±0.80	69	−0.22±0.71	−0.29 (−0.54 to −0.03)	0.03

* Plus–minus values are means ±SD.
† The mean difference is given for the weight-lifting group as compared with the control group for the difference in interlimb volume discrepancies (the interarm difference over time) and changes in number and severity of symptoms. The cumulative incidence ratio is given for the weight-lifting group as compared with the control group for differences in percentages.
‡ P values were calculated with the use of Fisher's exact test for between-group comparisons of percentages and the Wilcoxon rank-sum test for between-group comparisons of the difference in interlimb volume discrepancies and changes in number and severity of symptoms.
§ Data were reported by patients regarding 14 symptoms: rings too tight, watch too tight, bracelets too tight, clothing too tight, puffiness, knuckles not visible, veins not visible, skin feels leathery, arm feels tired, pain, pitting, swelling after exercise, difficulty writing, or other. The change in severity of symptoms is the mean of the changes in severity for all 14 symptoms, with the possible severity score for each ranging from 0 (no symptom) to 4 (very severe).

Adherence;
- Median rates of exercise-session attendance; 96% (first quarter), 88% (second quarter), 81% (third quarter), 75% (final quarter)

Bibliographic reference	**Schmitz et al (2009) Weight lifting in women with breast-cancer-related lymphedema. N Engl J Med**
Authors' conclusion	The results of this study reduce concerns that weight lifting will worsen arm and hand swelling associated with lymphedema in breast-cancer survivors. These findings support the potential benefits of a slowly progressive weight-lifting program in women with breast-cancer–related lymphedema, in conjunction with appropriate use of compression garments and close monitoring for arm and hand swelling.
Source of funding	Supported by grants from the National Cancer Institute and the National Center for Research Resources, BSN Medical provided custom-fitted compression garments, and the fitness centers where the weight-lifting sessions took place (YMCA of Philadelphia and Vicinity, Sisters in Shape, and the Family YMCA of Burlington County, NJ) provided discounted membership fees for study participants.
Comments	

Bibliographic reference	**Schmitz et al (2010) Weight lifting for women at risk for breast-cancer-related lymphedema. A randomised trial. JAMA**
Study type & aim	Study design: RCT (randomised through computerized process called minimization that balanced confounders at baseline (age, no of lymph nodes removed, obesity, history of radiation treatment); assessor was blinded)). Aim: To evaluate lymphoedema onset after 1-yr weight lifting exercise compared with control among those at risk of breast cancer-related lymphoedema
Number and characteristics of patients	N=154 (recruited from October 2005 through March 2007) *Inclusion criteria:* • history of unilateral nonmetastatic breast cancer 1 to 15 years before study entry • BMI≤ 50kg/m2 • not actively trying to lose weight • no current evidence of cancer • no medical conditions that would limit exercise • no history of weight lifting during the previous year • ≥1 lymph node removed • At risk of breast-cancer–related lymphedema. Lymphedema was defined as a difference in the volume or circumference between the affected and unaffected limb of ≥10% No differences in baseline between the groups for age (range 36 to75yrs), education, race/ethnicity, occupation, mths since cancer diagnosis, cancer stage, no.of nodes removed, treatment, arm volume difference
Intervention	Intervention group (n=77): 1-year weight-lifting treatment group - first 13 weeks, instructed x2/wk (groups 2-6 participants) at a community fitness centre, led by certified fitness professionals, 90-min sessions - stretching, 10 min of cardiovascular warm-up, 'core' exercises to strengthen abdominal and back muscles, and weight-lifting exercises – upper body; seated row, chest press, lateral or front raises, bicep curls, tricep pushdowns; with free weights or resistance machines – lower body; leg press, back extension, leg extension, leg curl; with resistance machines - 13 wks to 1ys, continued x2/wk unsupervised exercise Trainers asked about changes in symptoms wkly, mthly assessment of circumference and water volume measures. Any changes treated promptly Participants in both groups were required to attend a 1-hour educational lecture that reviewed the National Lymphedema Network guidelines for risk reduction, treatment, and exercise.
Comparator	Control group 2 (n=77): wait-list control Control group participants were asked not to change their level of exercise during study participation. Participants in both groups were required to attend a 1-hour educational lecture that reviewed the National Lymphedema Network guidelines for risk reduction, treatment, and exercise.
Length of follow up	12 months follow-up
Location	USA
Outcomes	Primary outcome; lymphoedema, defined as a ≥5% in arm swelling (by interlimb water volume difference)

Bibliographic reference

Schmitz et al (2010) Weight lifting for women at risk for breast-cancer-related lymphedema. A randomised trial. JAMA

measures and effect sizes

Fitness used a standardised clinical evaluation based on the Common Toxicity Criteria vs – including interlimb differences, changes in tone or texture, symptoms
Strength measurements

Intervention group, 6 lost to follow-up, 5 recurrent disease
Control group, 7 lost to follow-up, 2 recurrent disease

Results:
Lymphoedema at 12mths

	Intervention	Control		
	No./total no. (%)	No./total no. (%)	Cumulative incidence ration (95%CI)	P value
All participants				
≥5% increase in arm swelling*	8/72 (11%)	13/75 (17%)	0.64 (0.28 to 1.45)	0.003
Clinician-defined onset	1/66 (1.5%)	3/68 (4.4%)	0.34 (0.04 to 3.22)	0.12
Participants with ≥5 lymph nodes removed				
≥5% increase in arm swelling*	3/45 (7%)	11/49 (22%)	0.30 (0.09 to 1.00)	0.001
Clinician-defined onset	1/42 (2.4%)	3/46 (6.5%)	0.37 (0.04 to 3.38)	0.13

*arm swelling (affected arm volume-unaffected arm volume/unaffected arm volume)

	Intervention		Control				
	Total no.	Mean (SD)	Total no.	Mean (SD)	Mean (SD) difference	P value	
All participants							
Change in no. of symptoms reported	72	-0.51 (1.57)	75	-0.42 (2.26)	-0.10 (0.32)	0.77	
Change in symptom severity	72	0.27 (0.97)	75	-0.28 (0.86)	0.003 (0.15)	0.99	
Participants with ≥5 lymph nodes removed							
Change in no. of symptoms reported	45	-0.63 (1.86)	49	-0.83 (1.52)	0.21 (0.35)	0.55	
Change in symptom severity	45	-0.30 (1.06)	49	-0.41 (0.88)	0.12 (0.20)	0.56	

Strength, anthropometry, and diet and physical activity at 12mths

	Intervention	Control	P value	Intervention	Control	P value
	No. (mean (SD))	No. (mean (SD))		No. (mean (SD))	No. (mean (SD))	
Strength						
Bench press, lb	77 (41 (13))	75 (41 (13))	0.93	59 (54(12))	63 (43 (11))	<0.001
Leg press, lb	77 (170 (48))	76 (181 (54))	0.23	61 (213(50))	63 (192 (53))	0.02
Anthropometry						
Weight, kg	77 (73.87 (15.21))	77 (76.76 (17.16))	0.27	66 (72.36 (14.88))	68 (75.46 (17.07))	0.27
BMI	77 (27.52 (5.09))	77 (28.55 (6.17))	0.26	66 (26.94 (4.99))	68 (28.03 (5.95))	0.25
Body fat, %	77 (37.71	77 (39.26	0.11	65 (37.34	68 (39.59	0.03

Bibliographic reference	**Schmitz et al (2010) Weight lifting for women at risk for breast-cancer-related lymphedema. A randomised trial. JAMA**

	(5.60))	(6.38))		(5.35))	(6.45))	
Fat mass, kg	77 (28.11 (9.10))	77 (30.56 (10.69))	0.13	65 (27.18 (8.48))	68 (30.3 (10.57))	0.06
Lean mass, kg	77 (46.84 (7.05))	77 (47.30 (7.50))	0.70	65 (46.25 (7.42))	68 (46.3 (7.58))	0.97
Diet and physical activity						
Dietary intake	1637 (1139)	1691 (1446)	0.79	1492 (798.8)	1535 (844.2)	0.77
Self-reported physical activity*	2670.4 (2.34)	2079.7 (3.06)	0.14	3041.2 (2.29)	2440.6 (3.10)	0.46

*metabolic equivalent, min/wk

Authors' conclusion	Our results combined with previously published results for women with breast cancer-related lymphoedema suggest that the many health benefits of weight lifting should now become available to all breast cancer survivors
Source of funding	Supported by grants from the National Cancer Institute and the National Center for Research Resources, BSN Medical provided custom-fitted compression garments, and the fitness centres where the weight-lifting sessions took place (YMCA of Philadelphia and Vicinity, Sisters in Shape, and the Family YMCA of Burlington County, NJ) provided discounted membership fees for study participants.
Comments	ITT The study was designed with 80% power to show equivalent lymphoedema onset between the weight lifting intervention and control groups, allowing a 20% loss to follow-up

Bibliographic reference	**Speck et al (2010) Changes in body image and relationship scale following a one-year strength training trial for breast cancer survivors with or at risk of lymphedema. Breast Cancer Res Treat**
Study type & aim	Study design: RCT (randomised through computerized process called minimization; allocator was blinded). Aim: to evaluate the impact of a twice-weekly strength training intervention on perceptions of body image in 234 breast cancer survivors (112 with lymphedema) who participated in the Physical Activity and Lymphedema (PAL) trial (for trial details see evidence tables for Schmitz 2009 and 2010)
Outcomes measures and effect sizes	This paper reported on both branches of the PAL study; from the n=295 randomised (n=141 with lymphoedema and n=154 at risk of lymphoedema) N=234 in this analysis (n=112/141 from lymphoedema branch and n=122/154 at risk of lymphoedema Body image was measured by the Body Image and Relationships Scale (BIRS) General QoL was measured by SF-36 Upper and lower body strength was measured by One-Repetition-Maximum = 1-RM.

	Treatment (n)	12-mth mean (SD)	% Δ mean (SD)	Control (n);	12-mth mean (SD)	% Δ mean (SD)	p-value*
BIRS – all participants							
Total	113	70.2 (17.8)	12.0 (16.7)	121	74.7 (18.2)	2.0 (15.4)	<0.0001
Strength and health	113	27.8 (8.9)	14.9 (22.8)	121	30.5 (8.9)	2.7 (19.4)	<0.0001
Social barriers	111	14.8 (5.5)	5.4 (34.2)	119	14.9(6.1)	-1.8 (35.5)	0.31
Appearance and sexuality	104	27.5 (6.1)	7.3 (16.6)	111	28.4 (6.2)	-0.7 (18.1)	0.004
SF-36							
Mental composite	112	53.2 (9.6)	3.3 (18.6)	120	53.8 (8.7)	0.4 (15.5)	0.30
Physical	112	50.7 (8.2)	6.1 (17.9)	120	49.1 (9.3)	3.4 (19.5)	0.12

Bibliographic reference	Speck et al (2010) Changes in body image and relationship scale following a one-year strength training trial for breast cancer survivors with or at risk of lymphedema. Breast Cancer Res Treat

composite					
Strength 1-RM					
Bench press	113	52.9 (15.3)	33.2 (40.8)	119 40.9 (11.8)	7.6 (43.7)	<0.0001
Leg press	113	223.4 (59.6)	33.2 (33.9)	119 175.1 (53.5)	7.9 (26.6)	<0.0001

	Treatment (n)	12-mth mean (SD)	% Δ mean (SD)	Control (n);	12-mth mean (SD)	% Δ mean (SD)	p-value*
BIRS – lymphoedema participants							
Total	54	70.0 (19.5)	12.0 (18.2)	58	78.0 (18.3)	-0.4 (14.3)	<0.0001
Strength and health	54	27.7 (9.3)	15.7 (24.7)	58	32.8 (8.8)	-0.2 (16.9)	<0.0001
Social barriers	52	14.7 (5.8)	6.5 (34.8)	57	15.8 (6.5)	-4.5 (37.1)	0.17
Appearance and sexuality	47	27.8 (7.0)	7.6 (18.9)	54	28.8 (6.2)	-1.4 (19.7)	0.04
SF-36							
Mental composite	54	54.3 (9.6)	3.3 (11.9)	58	53.3 (9.0)	-2.5 (12.9)	0.02
Physical composite	54	48.7 (8.9)	5.5 (18.8)	58	47.1 (10.4)	2.5 (21.7)	0.50
Strength 1-RM							
Bench press	54	52.2 (18.0)	30.5 (35.6)	58	38.9 (12.3)	5.0 (23.6)	<0.0001
Leg press	54	235.9 (68.1)	32.5 (33.6)	58	162.4 (54.3)	7.6 (22.7)	<0.0001

	Treatment (n)	12-mth mean (SD)	% Δ mean (SD)	Control (n);	12-mth mean (SD)	% Δ mean (SD)	p-value*
BIRS – at risk of lymphoedema participants							
Total	59	70.4 (16.3)	12.0 (15.5)	63	71.5 (17.7)	4.1 (16.2)	0.03
Strength and health	59	27.9 (8.7)	15.3 (21.2)	63	28.2 (8.5)	6.2 (21.2)	0.08
Social barriers	59	14.9 (5.2)	4.4 (33.8)	62	14.1 (5.8)	0.7 (34.0)	0.98
Appearance and sexuality	57	27.3 (5.3)	7.2 (14.6)	57	28.1 (6.2)	-0.2 (6.2)	0.04
SF-36							
Mental composite	58	52.2 (9.5)	3.3 (23.2)	62	54.2 (8.5)	3.1 (17.2)	0.92
Physical composite	58	52.4 (7.0)	6.6 (17.1)	62	51.0 (7.8)	4.1 (17.3)	0.10
Strength 1-RM							
Bench press	59	53.5 (12.5)	35.7 (45.0)	61	43.0 (11.0)	10.2 (56.1)	0.006
Leg press	59	211.9- (48.3)	33.8 (34.2)	61	187.3 (50.2)	8.2 (29.9)	<0.0001

Bibliographic reference	**Speck et al (2010) Changes in body image and relationship scale following a one-year strength training trial for breast cancer survivors with or at risk of lymphedema. Breast Cancer Res Treat**
	+% change indicates improvement, -% change indicates decline *Comparison between groups in difference in percent change is adjusted for baseline value of outcome
Authors' conclusion	Twice-weekly strength training positively impacted self-perceptions of appearance, health, physical strength, sexuality, relationships, and social functioning.
Source of funding	Not reported.
Comments	

Appendix H: GRADE tables

Lymphoedema and exercise - GRADE profiles

Weight-training compared with non-intervention

Quality assessment							No of patients		Effect (change 0-6mths, ipsilateral – contralateral)	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: circumference measurements (metacarpophalangeal), 6mths										
Ahmed, 2006	RCT	Serious[a]	N/A	No serious	Serious[b]	None	23	22	I: mean 0.07cm (SE 0.07), p=0.70) C: mean 0.03cm (SE 0.06)	LOW
Outcome: circumference measurements (ulnar styloid process), 6mths										
Ahmed, 2006	RCT	Serious[a]	N/A	No serious	Serious[b]	None	23	22	I: mean 0.00cm (SE 0.08), p=0.77) C: mean 0.03cm (SE 0.09)	LOW
Outcome: circumference measurements (distal to the midpoint of the lateral epicondyle), 6mths										
Ahmed, 2006	RCT	Serious[a]	N/A	No serious	Serious[b]	None	23	22	I: mean 0.16cm (SE 0.17), p=0.37) C: mean -0.06cm (SE 0.16)	LOW
Outcome: circumference measurements (proximal to the midpoint of the lateral epicondyle), 6mths										
Ahmed, 2006	RCT	Serious[a]	N/A	No serious	Serious[b]	None	23	22	I: mean 0.15cm (SE 0.18), p=0.18) C: mean -0.26cm (SE 0.17)	LOW

Intervention: 3mths of weight training group
Comparator: non-intervention group
N/A: Non-applicable as only single study
[a] Downgraded 1-level: large loss to follow-up low
[b] Downgraded 1-level: very small sample size (n<100)

Exercise, patient diet education, counselling compared with usual care (patient education)

Quality assessment							No of patients		Effect ()	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		

Outcome: FACT-B (QoL) scores, 18mths										
Anderson, 2012	RCT	Very serious[a]	N/A	No serious	No serious	None	52	52	I: 115.8 (SD 11.8) C: 114.4 (SD 2.5) P=0.57	LOW
Outcome: Arm volume, compared to baseline, 18mths										
Anderson, 2012	RCT	Very serious[a]	N/A	No serious	No serious	None	52	52	I: mean change 33.5mL C: mean change 60.4mL P=0.54	LOW

Intervention: exercise, diet education, counselling
Comparator: usual care
N/A: Non-applicable as only single study.
[a] Downgraded 2-levels: multifactorial, unclear levels of exercise in the comparator group, unclear criteria used for lymphoedema

High load resistance exercise, low load resistance exercise group compared with usual care

Quality assessment							No of patients		Effect ()	Quality
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Intervention (I)**	**Comparator (C)**		
Outcome: extent of swelling (arm volume difference), 3mths										
Cormie, 2013	RCT	No serious	N/A	No serious	Serious[a]	None	High load (HL), 22 Low load (LL), 21	19	I, HL: -3.0±1.3 (-5.7, -0.4) I, LL: -2.0±1.3 (-4.7,0.7) C: 1.2±1.4 (-4.0, 1.6) p=0.647	MODERATE
Outcome: symptom severity (FACT-B+4), 3mths										
Cormie, 2013	RCT	No serious	N/A	No serious	Serious[a]	None	High load (HL), 22 Low load (LL), 21	19	I, HL: 1.1±0.6 (0.2, 2.4) I, LL: 1.9±0.6 (0.6,3.1) C: 0.6±0.7 (-0.8, 1.9) p=0.333	MODERATE
Outcome: physical function (grip strength, affected arm), 3mths										
Cormie, 2013	RCT	No serious	N/A	No serious	Serious[a]	None	High load (HL), 22 Low load (LL), 21	19	I, HL: 1.7±0.8 (0.2, 3.2) I, LL: 1.9±0.8 (0.4,3.4) C: 0.4±0.8 (2.1, 1.2) p=0.077	MODERATE
Outcome: quality of life (physical functioning), 3mths										
Cormie, 2013	RCT	No serious	N/A	No serious	Serious[a]	None	High load (HL), 22 Low load (LL), 21	19	I, HL: 3.1±1.2 (0.7, 5.5) I, LL: 3.9±1.2 (1.6,5.5) C: -0.5±1.3 (-3.1, 2.0) p=0.040	MODERATE

Intervention: high load resistance exercise or low load resistance exercise (3arms)
Comparator: usual care

N/A: Non-applicable as only single study
[a] Downgraded 1-level: very small sample size (n<100)

Aerobic and resistance exercise compared with control

Quality assessment							No of patients		Effect ()	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: lymphoedema (BIS ratio), 12wks										
Hayes, 2009	RCT	Serious[a]	N/A	No serious	Serious[b]	None	15	16	I: mean 0.02 (SD 0.07), p=0.88 C: mean0.01 (SD 0.09), p=0.75	LOW
Outcome: lymphoedema (perometry, mL), 12wks										
Hayes, 2009	RCT	Serious[a]	N/A	No serious	Serious[b]	None	15	16	I: mean 2 (SD 71), p=0.53 C: mean 19 (SD 73), p=0.35	LOW

Intervention: aerobic and resistance exercise
Comparator: control
N/A: Non-applicable as only single study
[a] Downgraded 1-level: unclear levels of exercise in the comparator group
[b] Downgraded 1-level: very small sample size (n<100)

Weight-lifting compared with control

Quality assessment							No of patients		Effect ()	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: change in interlimb volume difference, 12mths										
Hayes, 2011	RCT	Serious[a]	N/A	No serious	No serious	None	148	147	≥5% increase I: 16 (12.2%) C: 21 (15.9%), p=0.39 ≥5% decrease I: 19 (14.5%) C: 25 (18.9%), p=0.34	MODERATE
Outcome: change in interlimb circumference difference, 12mths										
Hayes, 2011	RCT	Serious[a]	N/A	No serious	No serious	None	148	147	≥5% increase I: 0 C: 3 (2.3%) ≥5% decrease I: 3 (2.3%) C: 1 (0.75%), p=0.37	MODERATE

Intervention: weight lifting exercise
Comparator: control
N/A: Non-applicable as only single study
[a] Downgraded 1-level: unclear levels of exercise in the comparator group

Aerobic and strength exercise compared with usual care

Quality assessment							No of patients		Effect ()	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: change in quality of life, 10mths										
Hayes, 2013	RCT	Serious[a]	N/A	No serious	No serious	None	Face-to-face, 67 Telephone, 67	60	FtF: 9.5 (5.3 to 13.8) Tel: 13.5 (10.0 to 17.0) C: 6.5 (1.8 to 11.1) p≤0.05 (Tel compared with C)	MODERATE
Outcome: lymphoedema, self-report, 10mths										
Hayes, 2013	RCT	Serious[a]	N/A	No serious	No serious	None	Face-to-face, 67 Telephone, 67	60	FtF: n=5 (8.9%) Tel: n=2 (3.3%) C: n=4 (8.2%) NS diff between groups	MODERATE
Outcome: lymphoedema, by BIS, 10mths										
Hayes, 2013	RCT	Serious[a]	N/A	No serious	No serious	None	Face-to-face, 67 Telephone, 67	60	FtF: n=8 (13.1%) Tel: n=8 (12.9%) C: n=9 (16.4%) NS diff between groups	MODERATE

Intervention: weight lifting exercise
Comparator: control
N/A: Non-applicable as only single study
[a] Downgraded 1-level: unclear levels of exercise/no details given of the usual care group advice (varied depending on treating hospital)

Water-based exercise compared with control (continue normal exercise, if any)

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: Median lymphedema relative volume (LRV%) at 8-week endpoint (at 8-week)										
Johansson, 2013	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	14	11	I: Median = 21.4% (IQR:8.6-40.1) C: Median = 21.0%	VERY LOW

									(IQR:14.8-31.7) p>0.05	
Outcome: Median changes in degrees (from baseline) of shoulder ROM (Abduction) at 8-week endpoint (at 8-week)										
Johansson, 2013	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	14	11	I: Median = 0.5 (IQR: -3 to 3.3) C: Median = 0 (IQR: -1 to 1) P=0.32	VERY LOW
Outcome: Median changes in degrees (from baseline) of shoulder ROM (Flexion) at 8-week endpoint (at 8-week)										
Johansson, 2013	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	14	11	I: Median = 6 (IQR: 1 to 10) C: Median = 0 (IQR: 0 to 1) P=0.001	VERY LOW
Outcome: Median changes in degrees (from baseline) of shoulder ROM (External rotation) at 8-week endpoint (at 8-week)										
Johansson, 2013	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	14	11	I: Median = 6 (IQR: 0 to 15.5) C: Median = 3 (IQR: 0 to 3) P=0.07	VERY LOW

Intervention: Water-based exercise (WBE)
Comparator: Control (continue normal exercise, if any)
N/A: Non-applicable as only single study.
[a] Downgraded 2-levels: unclear blinding, unclear exercise in the control group
[b] Downgraded 1-level: very small sample size (n<100)

Resistance training compared with control

Quality assessment							No of patients		Effect	Quality
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Intervention (I)**	**Comparator (C)**		
Outcome: lymphoedema (at 6mths)										
Kilbreath, 2012	RCT	Serious[a]	N/A	No serious	No serious	None	81	79	BIS; I: n=6 (8%) C: n=9 (13%) Interlimb circ diff, ≥2 measures >2cm; I: n=5 (7%) C: n=4 (6%) Interlimb arm vol ≥10%; I: n=6 (8%) C: n=9 (13%)	MODERATE
Outcome: range of motion (at 6mths)										
Kilbreath, 2012	RCT	Serious[a]	N/A	No serious	No serious	None	81	79	Forward flexion; I: mean 16.5 (SD 17.7) C: 14.6 (20.3)	MODERATE

									Abduction; I: mean 20.1 (SD 16.7) C: 10.1 (21.6), p=0.003 Horizontal extension; I: mean 7.5 (SD 15.9) C: 1.7 (15.4), p=0.03	
Outcome: strength (at 6mths)										
Kilbreath, 2012	RCT	Serious[a]	N/A	No serious	No serious	None	81	79	Forward flexion; I: mean 18.1 (SD 30.1) C: 14.3 (27.7) Abduction; I: mean 23.4 (SD 38.4) C: 20.4 (31.4) Horizontal extension; I: mean 17.3 (SD 25.8) C: 14.3 (28.1) Horizontal flexion; I: mean 14.4 (SD 30.6) C: 18.2 (26.0)	MODERATE
Outcome: change in arm symptoms, EORTC (at 6mths)										
Kilbreath, 2012	RCT	Serious[a]	N/A	No serious	No serious	None	81	79	I: mean 12 (SD 20) C: 8 (16)	MODERATE
Outcome: change in breast symptoms, EORTC (at 6mths)										
Kilbreath, 2012	RCT	Serious[a]	N/A	No serious	No serious	None	81	79	I: mean 10 (SD 17) C: 6 (20)	MODERATE

Intervention: Resistance training and stretching

Comparator: Control

N/A: Non-applicable as only single study.

[a] Downgraded 1-level: unclear exercise in the control group

Complex decongestive therapy with active resistive exercise compared with complex decongestive therapy

Quality assessment							No of patients		Effect	Quality
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Intervention (I)**	**Comparator (C)**		
Outcome: Mean total arm volume (cm^3) at 8-week endpoint (at 8-week)										
Kim, 2010	RCT	Serious[a]	N/A	No serious	Serious[b]	None	20	20	I: 6239.74 cm^3 (95%CI: 6111.2 to 6368.2) C: 6294.17 cm^3	LOW

									(95%CI: 6042.2 to 6546.2)	
Outcome: Mean distal arm volume (cm^3) at 8-week endpoint (at 8-week)										
Kim, 2010	RCT	Serious[a]	N/A	No serious	Serious[b]	None	20	20	I: 2226.98 cm^3 (95%CI: 2104.3 to 2349.7) C: 2257.33 cm^3 (95%CI: 2151.6 to 2363.0)	LOW
Outcome: Mean proximal arm volume (cm^3) at 8-week endpoint (at 8-week)										
Kim, 2010	RCT	Serious[a]	N/A	No serious	Serious[b]	None	20	20	I: 4012.76 cm^3 (95%CI: 3867.6 to 4158.0) C: 4036.67 cm^3 (95%CI: 3771.5 to 4301.7) p<0.05	LOW
Outcome: Mean SF-36 score at 8-week endpoint (at 8-week)										
Kim, 2010	RCT	Serious[a]	N/A	No serious	Serious[b]	None	20	20	Physical functioning; I: 85.12 (60–110) C: 76.00 (55–100) Role physical; I: 83.75 (50–100) C: 68.75 (18.75–118.75) Body pain; I: 57.12 (0–80) C: 56.00 (10–80) General health; I: 66.75 (35–100) C: 60.24 (40–90) P<0.05 Vitality; I: 67.81 (37.5–87.5) C: 64.19 (43.75–93.75) Social functioning; I: 55.56 (50–87.5) C: 51.88 (25–75) Emotional health; I: 82.92 (33.33–125) C: 75.00 (16.67–116.67) Mental health; I: 75.25 (25–85) C: 69.50 (40–110)	LOW

Intervention: Complex decongestive therapy and active resistive exercise

Comparator: Complex decongestive therapy

N/A: Non-applicable as only single study.

[a] Downgraded 1-level: method for randomization was not reported, unclear allocation concealment, only assessor blinded

[b] Downgraded 1-level: very small sample size (n<100)

Upper extremity exercise compared with control group

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: arm volume, at 8wks										
McKenzie and Kalda, 2003	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	7	7	Results reported as significant or non-significant, no supporting figures reported	VERY LOW
Outcome: QoL, at 8wks										
McKenzie and Kalda, 2003	RCT	Very serious[a]	N/A	No serious	Serious[b]	None	7	7	Results reported as significant or non-significant, no supporting figures reported	VERY LOW

Intervention: Upper extremity exercise
Comparator: Control
N/A: Non-applicable as only single study.
[a] Downgraded 2-levels: no details reported on randomisation or allocation concealment, exercise in control group unknown, arm volume measurement techniques not reported
[b] Downgraded 1-level: very small sample size (n<100)

No physical activity restrictions compared with activity restrictions

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: arm volume difference in mL, 2yrs										
Sagen, 2009	RCT	Serious[a]	N/A	No serious	No serious	None	104	100	I: mean 52 (SD 153) C: 82 (165)	MODERATE
Outcome: pain and sensation of heaviness, 2yrs										
Sagen, 2009	RCT	Serious[a]	N/A	No serious	No serious	None	104	100	VAS score (0-100mm); No pain (0mm) I: n=62 (61%) C: n=64 (64%) Pain (1-20mm) I: n=26 (24%) C: n=20 (17%)	MODERATE

									Pain (>20mm) I: n=16 (15%) C: n=16 (17%)	

Intervention: No activity restrictions
Comparator: Activity restrictions
N/A: Non-applicable as only single study
[a] Downgraded 1-level: high loss to follow-up

Weight-lifting programme compared with control

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: change in interlimb vol ≥5% decrease, 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	70	69	I: 8 (11%) C: 8 (12%) Mean difference: 1.00 (95%CI:0.88 to 1.13)	LOW
Outcome: change in interlimb vol ≥5% increase, 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	70	69	I: 13 (19%) C: 15 (22%) Mean difference: -0.29 (95%CI: -1.94 to 2.51)	LOW
Outcome: No. of exacerbation (increase in the volume of the affected limb of 5% or more) , 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	65	65	I: 9 (14%); C: 19 (29%) Cumulative incidence ratio: 0.47 (95%CI: 0.23 to 0.97), p=0.04	LOW
Outcome: change in number of symptoms , 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	70	69	I: -1.81±2.16 C: -1.17±1.94 Cumulative incidence ratio: -0.63 (95%CI:-1.32 to 0.06)	LOW
Outcome: change in severity of symptoms , 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	70	69	I: -0.51±0.80 C: -0.22±0.71 Cumulative incidence ratio: -0.29 (95%CI:-0.54 to -0.03)	LOW

Intervention: Weight-lifting programme and compression garments
Comparator: Control (not to change their normal exercise level during study period) and compression garments

N/A: Non-applicable as only single study.
[a] Downgraded 1-level: unclear allocation concealment, exercise in control group unclear

Weight-lifting programme compared with control

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: change in interlimb vol ≥5% increase, 12mths										
Schmitz, 2010	RCT	Very serious[a]	N/A	No serious	No serious	None	72	75	I: 8 (11%) C: 13 (17%) Cumulative incidence ratio: 0.61 (0.28 to 1.45), p=0.0003	LOW
Outcome: change in interlimb vol ≥5% increase, ≥5 nodes removed 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	45	49	I: 3 (7%) C: 11 (22%) Cumulative incidence ratio: 0.30 (0.09 to 1.00), p=0.001	LOW
Outcome: change in number of symptoms , 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	72	75	I: -0.51±1.57 C: -0.42±2.26 Mean difference: -0.10 (SD 0.32)	LOW
Outcome: change in severity of symptoms , 12mths										
Schmitz, 2009	RCT	Very serious[a]	N/A	No serious	No serious	None	72	75	I: 0.27±0.97 C: -0.28±0.86 Mean difference: 0.003 (SD 0.15)	LOW

Intervention: Weight-lifting programme and compression garments
Comparator: Control (not to change their normal exercise level during study period) and compression garments
N/A: Non-applicable as only single study.
[a] Downgraded 1-level: unclear allocation concealment, exercise in control group unclear

Weight-lifting programme compared with control

Quality assessment							No of patients		Effect	Quality
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention (I)	Comparator (C)		
Outcome: SF-36: mental composite , 12-mths										
Speck, 2010	RCT	Very serious[a]	N/A	No serious	No serious	None	54	58	I: +3.3% (SD:11.9) C: -2.5% (SD:12.9) P=0.02	LOW
Outcome: SF-36: physical composite, 12mths										
Speck, 2010	RCT	Very serious[a]	N/A	No serious	No serious	None	54	58	I: +5.5% (SD:18.8) C: +2.5% (SD:21.7) P=0.50	LOW

Intervention: Weight-lifting programme

Comparator: Upper extremity exercise programme and compression garments

N/A: Non-applicable as only single study.

[a] Downgraded 2-level: unclear blinding, control exercise unclear as asked only not to change their level of exercise

Appendix I: Research Recommendation

1. What is the role of arm and shoulder specific exercises compared with and/or used as an adjunct to established lymphoedema treatments (such as compression garments and complex decongestive therapy?

Why this is important?

Historically people with or who are at risk of breast cancer related lymphoedema were advised to be cautious with the affected/potentially affected arm, to avoid strenuous exercise, carrying heavy weights or strenuous activities of daily living. The review undertaken in this update addendum to the NICE guideline on advanced breast cancer has reviewed evidence relating to exercise in people who have or who are at risk of developing breast cancer related lymphoedema. From this review it is evident that there is a lack of evidence, notably in regard to evidence that incorporates sufficient follow-up time and patient focused outcomes such as quality of life. This evidence review also showed considerable variety in the types of exercise programmes used; therefore clear definition of the type of exercise in any future study is important.

PICO question	Population: People with breast cancer related lymphoedema considered to require treatment Intervention: Arm and shoulder specific aerobic and/or resistive exercises (that focused on strength and flexibility to improve local lymph flow) either alone or as an adjunct to existing treatment Comparison: Existing breast cancer related lymphoedema treatments (such as compression garments, or complex decongestive treatment (CDT)) Primary outcomes: Quality of life measures, lymphoedema related outcomes (limb volume/circumference, inter-limb differences, pain, changes in function)
Importance to patients or the population	The provision of clearer advice to patients regarding exercise (including types of exercise) and breast cancer related lymphoedema would assist patients with making exercise choices
Study design	RCT
Other comments	Examples for arm and shoulder specific aerobic and/or resistive exercises: swimming, weight lifting, tai chi and yoga.