**Title:** A progressive resistance weight training program does not have a significant effect on the development or progression of breast cancer-related lymphedema in women

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**Date:** December 13, 2010  
**Review date:** December 13, 2012

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### CLINICAL SCENARIO

**Client Population:** Women who have been diagnosed with breast cancer-related upper extremity lymphedema

**Treatment Context:** Progressive resistance weight training interventions in the studies reviewed occurred in an outpatient clinic and community centers (YMCA and local university recreation center).

**Problem/Condition:** The lymphatic system is essential for maintaining homeostasis of the cardiovascular system. The purpose of the lymphatic system is to return excess fluid (a combination of proteins, white blood cells, and water) in the tissues and return it back to the bloodstream. Lymphatic vessels collect fluid from tissues and drain the fluid into the right and left subclavian veins. The lymphatic system also plays an important role in the body's immune response; lymph nodes filter the lymph fluid before it returns to circulation (Koeppen & Stanton, 2008).

When lymph nodes are surgically removed or damaged from radiation therapy, the lymphatic system loses a channel that removes excess fluid in the extremity. This occurs because lymph vessels are wrapped around lymph nodes and unfortunately, both the vessel and node must be removed (American Cancer Society, 2010). Lymphedema is a build up of fluid and proteins in the tissue. Breast cancer-related lymphedema is defined as a chronic swelling in the arm as a result of breast cancer treatment; approximately 27-49 percent of women will develop breast cancer-related lymphedema after breast cancer (Lane, Worsley, & McKenzie, 2005).

**Why Problem is treated by Occupational Therapists:** Lane, Worsley, & McKenzie (2005) report breast cancer-related lymphedema may cause decreased range of motion, pain, decreased functional ability, and an increased risk of infection in the affected arm. Psychosocial issues are also problematic; anxiety, depression, and a reduced quality of life may interfere with daily occupations. Generally speaking, breast cancer-related lymphedema may interfere with a woman's participation in meaningful occupations (Lane, Worsley, & McKenzie, 2005). Lymphedema falls in the domain of occupational therapy practice; it is a client factor (body structure and function), and occupational therapists use preparatory methods in treatment to prepare the individual for occupation participation (AOTA, 2008). ICF terminology categorizes lymphedema as a body structure and function impairment level variable.

**Intervention:** Progressive resistance weight training utilizes dumbbells and resistance machines to increase muscular strength and endurance. This protocol starts with little or no resistance, and gradually increases the amount of resistance as tolerated by the individual. There is no cap placed on the amount of weight lifted. The American College of Sports Medicine (ACSM) (2007) recommends participating in a weight training program twice a week to gain physiological benefits. For the general population, the ACSM recommends performing 8 to 10 weight lifting exercises that target major muscle groups for 8 to 12 repetitions per set. Only one set of each exercise is recommended for new lifters (ACSM, 2007). The American Cancer Society (ACS) partnered with the ACSM and created a special certification that qualifies personal trainers to work with individuals diagnosed with cancer and cancer survivors (ACS, 2010). It is recommended to contact an ACSM certified cancer exercise trainer for guidance and read position papers released by the National Lymphedema Network (NLN) prior to treating a woman with breast cancer-related lymphedema (Schmitz et al. 2009). Previously, resistance training was contraindicated for women with breast cancer-related lymphedema because of the belief that lymphedema was the result of a single obstruction to the lymphatic system; the belief was that exercise would increase fluid retention in the arm. The cause of breast cancer-related lymphedema is now believed to be multidimensional and exercise is no longer contraindicated for these women (Lane, Worsley, & McKenzie, 2005).

**OT Theoretical Basis:** The biomechanical frame of reference (FOR) supports occupational therapy interventions utilizing weight lifting protocols. The purpose of the biomechanical FOR is to analyse movement necessary to participate in occupations; it addresses client factors that interfere with participation in occupations. The biomechanical FOR assesses and restores problems related to range of motion, muscular strength, and endurance. Intervention techniques may include exercising and splinting (Pendleton & Schultz-Krohn, 2006).

**Science behind Intervention:** Exercise will help remove fluid from the tissues in the swollen extremity, reducing lymphedema. During exercise, the lymphatic system’s purpose is to return fluid and plasma proteins that have leaked into the tissues back to the cardiovascular system. Exercise increases cardiac output and capillary filtration rates which contribute to an increase in the body’s interstitial pressure. An increased interstitial pressure helps fluids and proteins that have leaked into tissue enter the lymphatic capillaries to be returned to the cardiovascular system (Lane, Worsley, & McKenzie, 2005). Lane, Worsley, and McKenzie (2005) report lymphatic clearance rates increase during exercise in individuals with an intact lymphatic system. Exercise also increases the amount and intensity of skeletal muscle contractions. This acts as a pumping method that returns lymphedema to the cardiovascular system (Bicego, et al., 2006).
<table>
<thead>
<tr>
<th>FOCUSED CLINICAL QUESTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient/Client Group:</strong> Women with breast cancer-related lymphedema</td>
</tr>
<tr>
<td><strong>Intervention (or Assessment):</strong> Progressive resistive weight training</td>
</tr>
<tr>
<td><strong>Comparison Intervention:</strong> Traditional lymphedema therapy or no treatment</td>
</tr>
<tr>
<td><strong>Outcome(s):</strong> Reduction in lymphedema (arm volume)</td>
</tr>
</tbody>
</table>

Is progressive resistance weight training effective in reducing arm volume in women with breast cancer-related lymphedema or does it increase lymphedema in comparison to traditional therapy or no treatment?

**Limitation of this CAT:** This critically appraised paper has been reviewed by occupational therapy graduate students and the course instructor.

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**SUMMARY**
The purpose of this critically appraised topic was to determine if progressive resistive weight training is effective in reducing arm volume in women with breast cancer-related lymphedema or does it increase lymphedema in comparison to traditional therapy or no treatment. Four databases were searched and 16 articles were located: 5 systematic reviews, 8 randomized control trials (RCTs), 1 non-randomized control group, 1 single subject design, and 1 qualitative case study. Three RCTs were selected for critique based upon their recent publication dates, large sample sizes, similar intervention designs, and primary dependent variable, lymphedema. The reviewed articles all had a rigorous study designs as identified by the PEDro scale: 7/10, 7/10, and 6/10. The three RCTs reviewed are all in agreement; a progressive resistance weight training program does not increase, decrease, or cause lymphedema.

**CLINICAL BOTTOM LINE**
There is strong evidence to support progressive resistance weight training for women with breast cancer-related lymphedema does not increase, decrease, or cause lymphedema.
**SEARCH STRATEGY:**

<table>
<thead>
<tr>
<th>Databases Searched</th>
<th>Search Terms</th>
<th>Limits used</th>
<th>Inclusion and Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINAHL Plus with Full Text (EBSCOhost)</td>
<td>Lymphedema and Exercise and upper extremity</td>
<td>And</td>
<td>Inclusion:</td>
</tr>
<tr>
<td>Cochrane Collection Plus (EBSCOhost)</td>
<td>Lymphedema and Exercise and Arm</td>
<td></td>
<td>- Lymphedema</td>
</tr>
<tr>
<td>OT Search (AOTA)</td>
<td>Lymphedema and Physical activity and Arm</td>
<td></td>
<td>- Exercise</td>
</tr>
<tr>
<td>Health Professions Databases Via EBSCOHOST</td>
<td>Lymphedema and Physical activity and Upper extremity</td>
<td></td>
<td>- Breast Cancer</td>
</tr>
<tr>
<td></td>
<td>Lymphedema and exercise</td>
<td></td>
<td>- Upper Extremity</td>
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<tr>
<td></td>
<td>Hayes and Lymphedema</td>
<td></td>
<td>- Arm</td>
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<td></td>
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<td></td>
<td>- Holistic Exercise</td>
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<td>- Full Text</td>
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<td></td>
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<td>- Articles available through Inner Library Loan</td>
</tr>
</tbody>
</table>
RESULTS OF SEARCH

Table 2: Summary of Study Designs of Articles Retrieved

<table>
<thead>
<tr>
<th>Level</th>
<th>Study Design/Methodology of Articles Retrieved</th>
<th>Number Located</th>
<th>Source</th>
<th>Citation (Name, Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>Systematic Review</td>
<td>5</td>
<td>The Cochrane Collaboration lymphoedema reviewPhysiotherapy Canada</td>
<td>(Mcneely, 2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical Therapy</td>
<td>(Harris, 2004)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sports Medicine</td>
<td>(Bicego, 2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exercise and Sport Sciences Reviews</td>
<td>(Lane, 2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Schmitz, 2010)</td>
</tr>
<tr>
<td>Level 1</td>
<td>Randomized Control Trials</td>
<td>8</td>
<td>Medicine &amp; Science in Sports &amp; Exercise</td>
<td>(Hayes, 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Journal of Clinical Oncology</td>
<td>(McKenzie, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>American Journal of Occupational Therapy</td>
<td>(McClure, 2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Contemporary Clinical Trials</td>
<td>(Schmitz, 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>New England Journal of Medicine</td>
<td>(Schmitz, 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turkish Journal of Physical Medicine and Rehabilitation</td>
<td>(Irdesel, 2007)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Journal of Clinical Oncology</td>
<td>(Ahmed, 2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acta Oncologica</td>
<td>(Sagen, 2009)</td>
</tr>
<tr>
<td>Level 2</td>
<td>Non-Randomized Control Group (two group)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>Non-Randomized Control Group (one group)</td>
<td>1</td>
<td>Physiotherapy Theory and Practice</td>
<td>(Jonsson, 2009)</td>
</tr>
<tr>
<td>Level 4</td>
<td>Single-Subject/Repeated Measures Designs</td>
<td>1</td>
<td>Rehabilitation Oncology</td>
<td>(Sander, 2006)</td>
</tr>
<tr>
<td>Level 5</td>
<td>Qualitative, Case Study</td>
<td>1</td>
<td>Journal of Lymphoedema</td>
<td>(Bracha, 2010)</td>
</tr>
</tbody>
</table>
### STUDIES INCLUDED

#### Table 3: Summary of Included Studies

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Intervention Investigated</td>
<td>104 subjects at start of the study</td>
<td>71 subjects at the start of the study with a mean age of 56 years</td>
<td>42 subjects at the start of the study with mean age of 52 years</td>
</tr>
<tr>
<td>Early-stage breast cancer</td>
<td>Subjects had a history of breast cancer in the past 15 years and currently had a diagnosis of lymphedema</td>
<td>Subjects were breast cancer survivors and half of the subjects had an axillary node dissection</td>
<td></td>
</tr>
<tr>
<td>Had mastectomy or breast-conserving surgery with axillary node dissection</td>
<td>Progressive resistance weight training program for 90 minutes/session, 2 days/week, for 1 year at the YMCA</td>
<td>Progressive resistance weight training program for 60 minutes/session, 2 days/week, for 6 months</td>
<td></td>
</tr>
<tr>
<td>Allocated into groups 2 days after surgery</td>
<td>Program consisted of stretching, cardiovascular warm-up, weight lifting exercises and abdominal and back exercises.</td>
<td>Program consisted of a warm-up, weight training, cool-down, and stretching exercises</td>
<td></td>
</tr>
<tr>
<td>No activity restrictions for 6 months (NAR group)</td>
<td>Participants were required to wear compression garments during exercise</td>
<td>Participants instructed to follow guidelines from lymphedema specialist regarding use of compression garments.</td>
<td></td>
</tr>
<tr>
<td>Moderate intensity progressive resistance weight training program for 45 minutes/session, 2-3 days/week for 6 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight training protocol was not outlined in the study</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unclear if compression garments were worn</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Comparison Intervention

- **100 subjects at start of study**
- Early-stage breast cancer
- Had mastectomy or breast-conserving surgery with axillary node dissection
- Allocated into groups 2 days after surgery
- Subjects were asked not to lift more than 3 kgs, participate in exercise or aerobic classes and avoiding laborious lifting for 6 months (AR group)
- Passive manual techniques and/or traditional massage for 45 minutes, 1 day/week for 6 months

- **70 subjects at the start of the study with a mean age of 58 years**
- Subjects had a history of breast cancer and currently had a diagnosis of lymphedema
- Instructed not to change current activity level
- Subjects were wait listed
- Subjects were provided a custom fit compression garment

- **43 subjects at the start of the study with a mean age of 51 years**
- Subjects were breast cancer survivors and half of the subjects had an axillary node dissection
- No intervention was provided for subjects in this group

### Outcome Variables and Measures

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Outcome Measures</th>
<th>Dependent Variables</th>
<th>Outcome Measures</th>
<th>Dependent Variables</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of arm lymphedema</td>
<td>Voldiff: water displacement instrument</td>
<td>Lymphedema (Arm Volume)</td>
<td>Water displacement instrument</td>
<td>Lymphedema (Arm Volume)</td>
<td>-Arm circumference measurements (12 body landmarks) -Self report of symptoms</td>
</tr>
<tr>
<td>Pain in the affected arm</td>
<td>Visual Analogue Scale</td>
<td>Strength</td>
<td>1 Repetition Maximum Tests (Bench Press and Leg Press)</td>
<td>Strength</td>
<td>1 Repetition Maximum Tests (Bench Press and Leg Press)</td>
</tr>
<tr>
<td>Sensation of arm heaviness in the affected arm</td>
<td>Visual Analogue Scale</td>
<td>Strength</td>
<td>1 Repetition Maximum Tests (Bench Press and Leg Press)</td>
<td>Strength</td>
<td>1 Repetition Maximum Tests (Bench Press and Leg Press)</td>
</tr>
</tbody>
</table>

### Findings

- Lymphedema, pain, and sensation of arm heaviness in the subjects in the AR and NAR were compared in this RCT.
- Both the NAR and AR group had a significant increase in arm lymphedema
- The effects of weight training vs. no intervention on subjects with breast cancer-related lymphedema were compared.
- Lymphedema: No significant difference (increase or decrease) in swelling of the affected arms of subjects in either group
- The effects of a weight training intervention and no intervention on lymphedema and strength were compared in this RCT.
- P-values (range) for the development of lymphedema in the affected arm
SYNTHESIS:

This investigation addressed the following question: Is progressive resistance weight training effective in reducing arm volume in women with breast cancer-related lymphedema or does it increase lymphedema in comparison to traditional therapy or no treatment?

**Overall Conclusions**

Three RCTs trials were included in this paper. All three studies examined the effects of a progressive resistance exercise program on arm lymphedema related to breast cancer. The progressive resistance weight training protocol for two of the studies met twice a week for six months (Ahmed et al., 2006; Sagen et al., 2009). Subjects in the other RCT participated in a progressive resistance weight training program twice a week for one year (Schmitz et al., 2009). Two of the study’s exercise protocols included a warm-up, stretching, and an exercise component (Ahmed et al., 2006; Schmitz et al., 2009). Sagen et al. (2009) did not disclose the weight lifting protocol used in the study. The mean age of the female participants in the intervention and control groups for all of the RCTs ranged between 51 years old to 58 years old. The primary dependent variable for all three studies was lymphedema. Schmitz et al. (2009) and Sagen et al. (2009) used a water displacement method as the primary outcome measure. Ahmed et al. (2006) measured lymphedema through circumference measurements. All three studies utilized traditional lymphedema therapy techniques administered by an experienced lymphedema professional to help control the lymphedema development or exacerbations (an increase greater than five percent in the affected arm) if they occurred during the time of the study.
The three RCT studies included in this paper were all in agreement; there was no statistically significant difference found in the development of lymphedema in the affected upper extremity after participating in a progressive resistance weight training program. A statistically significant increase in strength was reported by two RCTs (Ahmed et al., 2006; Schmitz et al., 2009). However, two of the RCT studies found subjects in the control groups had higher incidences of lymphedema exacerbations, an increase in arm volume of two centimetres or an increase of greater than five percent difference between arms, than subjects in the exercise intervention groups (Ahmed et al., 2006; Schmitz et al., 2009). As a secondary measure, one study examined possible risk factors associated with the development of lymphedema in their subjects. Sagen et al. (2009) identified that individuals with a BMI $\geq 25$ were three times more likely to develop lymphedema.

**Boundaries**

Subjects in all three RCTs were adult women at risk for or diagnosed with breast cancer-related upper extremity lymphedema around the age of 55. The cause of dysfunction of the lymphatic system may also alter the effect of a weight training program on lymphedema. The interventions took place in varying contexts: an outpatient clinic, local YMCA, and a university recreational center. This intervention can be applied in varying treatment contexts as this was represented in the studies reviewed. This is a practical intervention for women with breast cancer-related lymphedema; different progressive resistance protocols in different contexts over different lengths of time did not increase lymphedema.

It is important to note only one RCT reported the required use of compression bandages during exercise (Schmitz et al., 2009). Ahmed et al. (2009) stated a lymphedema specialist provided individual recommendations for the use of compression bandages during the progressive resistance weight training program. It is unclear if Sagen et al. (2009) utilized compression bandages during the weight training protocol. All three RCT had different policies for the use of compression bandages; recommendations for the use of compression bandages during progressive resistance weight training programs cannot be made.

**Implications for practice**

The three RCT studies reviewed suggest that a progressive resistance weight training protocol does not increase, decrease, or cause lymphedema, but it improves strength in the affected arm. So, other treatment methods that focus on the reduction of lymphedema should be reviewed. Women with breast cancer-related lymphedema may be encouraged to engage in progressive resistance weight training programs to possibly gain the physiological benefits associated with weight training as outlined by the ACSM: improve ADL performance, decreased risk of osteoporosis, low back pain, hypertension, and diabetes. The ACSM also reported resistance training increases muscular strength, endurance, bone density, and improves body composition (ACSM, 2006, p.154). However, it is important to note that the other associated benefits of resistance training were not outcome measurements examined by the three RCT included in this CAT.

The resistance training protocol was different for all three of the RCTs. The RCTs by Schmitz et al. (2009) and Ahmed et al. (2009) used ACSM trainers and similar ACSM guidelines. General guidelines recommended by the ACSM (2006) suggest a progressive resistance training protocol should begin at a moderate intensity (12/20 on an RPE scale) or lower. The ACSM also recommends eight to ten exercises targeting major muscle groups. Each exercise should be performed 8-12 times, for one set, at least twice a week on non-consecutive days (ACSM, 2006, p. 158). Sagen et al. (2009) reported the duration and intensity of the resistance training protocol: 45 minutes/session, 2-3 times/week, at a moderate intensity. However, the authors did not reveal which exercises were prescribed or the number of repetitions and sets the women completed each session.
If lymphedema or a lymphedema flare-up arises during participation in a resistance training program, traditional lymphedema treatment should be provided to minimize and control lymphedema. An exacerbation is defined as an increase in limb volume of at least five percent or a five percent volume or circumference difference between the affected limb and unaffected limb (Schmitz et al., 2009). All three RCTs utilized traditional lymphedema techniques facilitated by certified lymphedema professional or by the participant to control and stabilize lymphedema if it occurred during the studies.

Future research should be completed on the physiological effects of progressive resistance weight training on women with breast cancer-related lymphedema. Further research is warranted to determine if wearing compression garments is necessary to prevent lymphedema exacerbations during exercise.
References

Reviewed Articles


Related Articles


**Sources Referenced in CAT**


Appendix

Experimental Study Critique

Title:

Permalink:

Purpose of the Study:
The primary purpose of this study was to conduct a RCT that compared the effects of two different physical activity protocols on the upper extremity in individuals after breast cancer surgery. The authors wanted to examine the effects of different protocols on the development of lymphedema, pain, and the sensation of heaviness in the affected upper extremity. The secondary purpose of this study was to identify risk factors that may contribute to the development of arm lymphedema two years after breast cancer surgery.

Author's hypotheses:
1. “There would be no differences in arm volume or ALE between 1) patients who participated in a physical activity program with no activity restrictions, which included moderate resistance exercise training, and 2) patients who participated in a program involving physical activity restrictions of the affected limb and usual physical therapy treatment” (Sagen, Karesen, & Risberg, 2009, p. 1103).
2. “There would be no differences in pain or a sensation of heaviness in the affected limb between the two groups” (Sagen, Karesen, & Risberg, 2009, p. 1103).

Study Design:
- Randomized Control Trial
  o Level 1 (according to the AOTA levels of evidence)
- Two groups:
  o No activity restriction + moderate resistance exercise program (NAR group)
  o Activity restriction (AR group)
- The study had four data collection periods:
  o Pre-test (baseline)
  o 3 month testing
  o 6 month testing
  o 2 year follow-up

Setting:
- The interventions, for both the NAR and AR group, took place at an outpatient clinic in Norway.

Participants:
- During the course of the study, women were lost to follow-up:
  o At baseline measurements: 204 women were included in the study
    ▪ 104 subjects were randomly allocated to the NAR group
    ▪ 100 subjects randomly allocated to the AR group
During the three month follow-up 23 women were lost:
- NAR group total: 91 women
  - NAR group total loss: 13 women
- AR group total: 90 women
  - AR group total loss: 10 women

During the 6 month follow-up an additional women was lost in the NAR group and the AR group gained 7 women that were previously lost during the three month follow-up:
- NAR group total: 90 women
  - NAR group total loss: 14 women
- AR group total: 97
  - AR group total loss: 3 women

During the two year follow-up a total of 52 women were lost:
- NAR group total: 68 women
  - NAR group total loss: 36 women
- AR group total: 84 women
  - AR group total loss: 16 women

Participants were lost to follow-up for several reasons:
- 14 women died
- 3 women moved
- 13 were not found at the address or phone number provided to researchers
- 7 women refused to participate in the follow-up measurements
- 4 women were too ill
- 2 women had surgery on their control side (axillary node dissection)
- 9 women were lost for follow-up due to other reasons

- Diagnosed with early-stage breast cancer
  - Underwent mastectomy/breast-conserving surgery (with complete axillary node dissection)

- Recruited from Ullevall or Akershus Hospitals in Norway between 1999 and 2003
  - This was a convenience sample.
  - Subject recruitment methods were not provided.

- All subjects were randomized into an intervention group two days after their surgery.
- Inclusion criteria:
  - Early stage breast cancer and received a mastectomy or breast-conserving surgery with axillary node dissection (Level I and II).
  - Receiving treatment at Ullevaal and Akershus Hospitals in Norway between the years 1999 and 2003

- Exclusion criteria:
  - Over the age of 75
  - Not fluent in Norwegian
  - Existence of metastasized breast cancer (or other types of cancer)
  - Poor upper extremity function (or an injury to the upper extremity)

- The participants were not blinded to the treatment groups.
- Demographic variables were compared between the two groups prior to the study and found to be balanced; no statistically significant differences existed.
  - NAR Group Demographic Variables:
    - Mean age: 54 years old
    - Mean starting arm volume difference: -12 mm
    - Common type of surgery: 55% of subjects underwent a breast conserving surgery
  - AR Group Demographic Variables:
- Mean age: 55 years old
- Mean starting arm volume difference: 20 mm
- Common type of surgery: 51% of subjects underwent a breast ablation surgery

**Intervention Investigated**
- Subjects were randomly assigned to a group two days after surgery
- The interventions took place at an outpatient clinic in Norway between 1999 and 2003 and facilitated by physical therapist(s)
  - Did not state how many physical therapists were involved in the study
- The article did not state how the therapist(s) providing the interventions were trained
- The outcome assessor:
  - Blinded to the subject's group assignment
  - Blinded to the intervention methods
  - Subjects were told not to inform the assessor about their therapy programs
- Several other blinding methods were taken:
  - Patient information was anonymous in the computer
  - Administrative information and subject contact information were located in separate databases
- The interventionists were not blinded
  - The article stated the physical therapist(s) at the outpatient clinic were included and collaborated with the authors of the study in regards to the intervention program

**No Activity Restriction Group (NAR group)**
- The subjects in this group received a sealed envelope containing a detailed description of the NAR protocol:
  - No upper extremity limitations for six months.
  - Prescribed Exercise: supervised moderate progressive resistance exercise program to enhance muscular strength and endurance
    - 45 minutes/session, 2-3 times/week, for 6 months
      - Total treatment time: 36-54 hours
    - Starting weight (1st 2 weeks): .5 kg
    - Amount of weight lifted is individually progressed after two weeks
    - 15 repetitions per set
    - Weight lifting exercises: not documented
    - Start date of weight lifting: not documented
  - If subjects in this group developed lymphedema, they were referred to a physical therapist that specialized in lymphedema treatment.

**Activity Restrictions Group (AR group)**
- Information was provided to these subjects in a sealed envelope upon group assignment containing a detailed description of the AR protocol:
  - Activity restrictions for six months
    - Avoid strenuous physical activities:
      - Aerobic exercise classes that used the upper extremity
      - Heavy lifting
      - Carrying items larger than 3 kg
    - Traditional physical therapy lymphedema program
      - 45 minutes/session, 1 session/week, for six months
        - Total treatment time: 18 hours
    - Treatment:
      - Lead by a physical therapist
6 standardized passive manual techniques focused on:
- flexibility
- Light massage on the affected arm and scar

If the subject in this group developed lymphedema, they were referred to a physical therapist that specialized in lymphedema treatment.

Dependent Variables:
- Development of arm lymphedema (primary variable)
- Pain in the affected arm
- Arm heaviness in the affected arm
  - IFC Level (for all dependent variables):
    - Body structures and functions impairment level variables (IFC Level)
  - OT Framework Terminology (for all dependent variables):
    - Client factors:
      - Body function
        - Sensory functions and pain
        - Neuromusculoskeletal and movement-related functions
        - Cardiovascular and immunological system function
      - Body structures
        - Cardiovascular and immunological systems
        - Structures related to movement

Outcome Measures:
- The outcome measure for the primary dependent variable, development of arm lymphedema, was the Voldiff
  - The voldiff is a simplified water displacement method (volometer). The Voldiff is used to identified the difference in arm volume between the affected and non-affected arms
    - An increase of 10% in arm volume was used to determine the occurrence of arm lymphedema
    - A high difference between the affected and control arm (measured by the Voldiff) indicates lymphedema (dysfunction)
    - The Voldiff collects interval data
- The outcome measure used to identify pain and feelings of heaviness in the arm was a visual analogue scale (VAS).
  - The VAS score included three different categories: no pain, pain between 1-20, and pain greater than 21
    - However, it is unclear what the authors used as a descriptor at each end of the continuum
    - The VAS is a horizontal line that is 100mm long
    - Subjects ranked their pain along the continuum with a check mark: zero is no pain and 100 is pain
    - The lowest score on the VAS is a 0, indicating no dysfunction (no pain/sensation of heaviness), and the highest score on the VAS is 100mm, which indicates dysfunction (pain/sensation of heaviness)
    - The VAS collects ordinal data
- Additional outcome measurements used for secondary analyses: Risk Factors
  - Weight and height
    - Used to calculate the subject’s body mass index (BMI)
      - BMI=kg/(m²).
A heavy subject that is overweight or obese will have a higher BMI (indicating dysfunction). A high BMI is indicative of future health problems.

BMI collects interval data

Main Findings

Hypothesis 1: “There would be no differences in arm volume or ALE between 1) patients who participated in a physical activity program with no activity restrictions, which included moderate resistance exercise training, and 2) patients who participated in a program involving physical activity restrictions of the affected limb and usual physical therapy treatment” (Sagen, Karesen, & Risberg, 2009, p. 1103).
- Subjects in both groups had an increase in arm volume significantly over the two year period.
  - The arm volume did not change significantly between the NAR and AR group at any time during the data collection (3 months, 6 months, 2 years)
  - The NAR group had an increase in arm volume by 8% over two years
  - The AR group had an increase in arm volume by 6% over two years

Table 1. Mean and standard deviation scores between Voldiff water displacement measurements (ml) between the affected and the control arm.

<table>
<thead>
<tr>
<th>Test Time Points</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>95% Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAR Baseline</td>
<td>-12</td>
<td>121</td>
<td>-35-11</td>
</tr>
<tr>
<td>NAR 3 months</td>
<td>20</td>
<td>120</td>
<td>-3-43</td>
</tr>
<tr>
<td>NAR 6 months</td>
<td>32</td>
<td>129</td>
<td>7-57</td>
</tr>
<tr>
<td>NAR 2 years</td>
<td>52</td>
<td>153</td>
<td>23-81</td>
</tr>
<tr>
<td>AR Baseline</td>
<td>20</td>
<td>132</td>
<td>-6-46</td>
</tr>
<tr>
<td>AR 3 months</td>
<td>49</td>
<td>125</td>
<td>25-74</td>
</tr>
<tr>
<td>AR 6 months</td>
<td>64</td>
<td>158</td>
<td>33-95</td>
</tr>
<tr>
<td>AR 2 years</td>
<td>82</td>
<td>165</td>
<td>50-114</td>
</tr>
</tbody>
</table>

Hypothesis 2: “There would be no differences in pain or a sensation of heaviness in the affected limb between the two groups” (Sagen, Karesen, & Risberg, 2009, p. 1103).
- During the three and six month data collection, the NAR group reported significantly more pain and significantly more feelings of heaviness in the affected arm after physical activity.
- The NAR and AR group did not differ significantly at the two-year follow-up in regards to pain and sensation of heaviness in the affected arm.
- No data on the sensation of heaviness in the affected limb was reported.

Secondary Analyses

Arm lymphedema risk factors:
A baseline BMI greater than 25 kg/m² increased the risk of developing arm lymphedema two years after surgery.

The odds ratio indicated a 3.42 greater chance of developing arm lymphedema. (p<0.005).

**Program Adherence**
- Individual report of the frequency/amount of physical activity: house work & leisure activity
  - The NAR group had significantly higher physical activities scores during the 3 and 6 month follow-ups
  - There was no significant difference between the NAR and AR group at the 2 year follow-up
- The subjects in the NAR group had an adherence rate of 83% to the rehabilitation intervention:
- The subjects in the AR group had an adherence rate of 89% to the rehabilitation intervention

**Occurrence of adverse events**
- Two subjects were diagnosed with frozen shoulder (adhesive capsulitis).
- One subject was diagnosed with supraspinatus tendinopathy.

**Original Authors’ Conclusion**

**Hypothesis 1:** "There would be no differences in arm volume or ALE between 1) patients who participated in a physical activity program with no activity restrictions, which included moderate resistance exercise training, and 2) patients who participated in a program involving physical activity restrictions of the affected limb and usual physical therapy treatment."

- Individuals that have undergone breast cancer-related surgery do not need to restrict upper extremity physical activity to prevent the development of breast cancer-related arm lymphedema.
- A moderate intensity weight lifting program does not increase the risk of developing breast cancer-related arm lymphedema.
- The results found in this study are similar to the results of previous trials
  - Johansson et al.
  - Round et al.
  - Courneya et al.

**Hypothesis 2:** "There would be no differences in pain or a sensation of heaviness in the affected limb between the two groups"

- The NAR group reported higher pain and sensation of heaviness during the six month intervention due to the increased use of their affected extremity. However, this should not detour individuals from using the upper extremity in physical activity after breast cancer surgery because the increased pain and sensation of heaviness are only temporary.

**Validity**
- Pedro Score: 7/10
- Items that rated “Yes”
  - Participants were randomly assigned to a group
  - Allocation was concealed
  - Demographic variables and amount of lymphedema similar at baseline
  - Outcome assessors were blinded
  - Data was analyzed by “intention to treat”
  - One key outcome measure reports between-group statistical comparisons
  - Point measures and measures of variability are provided
Items that rated “No”

- The blinding of participants
- The blinding of therapists
- At least 85% of subjects participated in post-intervention testing

**Interpretation of Results**

- There were no statistically significant differences in the development of lymphedema between the NAR and AR groups
  - The intervention was effective; lymphedema in the NAR group did not differ from the AR group. The NAR group was not associated with an increased risk of developing lymphedema
- Moderate progressive resistance exercises and physical activity does not increase lymphedema.
  - This indicates that it is important for clinicians to educate women on the benefits of physical activity such as reduced surgical complications and improved body composition.
- Arm lymphedema increased significantly over time for both groups
- There was a statistically significant difference between the rating of pain and sensation of heaviness between the groups.
  - NAR group had higher ratings during the 3 and 6 month follow-up.
- P-values were not given, but the authors stated no significant difference was found between groups, except for the sensation of pain felt by the subjects during the 3 and 6 month follow-up. Effect sizes were not calculated.
- Special outcomes of interest:
  - There were no statistically or clinically significant findings.
  - BMI > 25 increases the risk of developing arm lymphedema.
    - This indicates that it is important for clinicians to educate women about the risk of being overweight and the increased risk of lymphedema development.
- Study limitations:
  - Many women were lost to the 2 year follow-up
  - Subjects in the NAR group received over double the treatment time as compared to the AR group
  - Muscular strength and endurance changes were not measured

**Summary/Conclusion**

- A moderate resistive training protocol and no activity restrictions does not increase the chance of developing lymphedema more than activity restrictions and traditional lymphedema treatment in women that had breast cancer surgery. This study indicates these women should be encouraged to participate in a weight lifting protocol and use their affected upper extremity in daily routines to possibly achieve the following physiological benefits:
  - Decreased surgical complications
  - Improvement of body composition
  - Increased muscular strength and endurance
- BMI > 25 increases the risk of developing lymphedema; clinician should educate women on this risk factor.