Exercise and Secondary Lymphedema: Safety, Potential Benefits, and Research Issues

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ABSTRACT

HAYES, S. C., H. REUL-HIRCHE, and J. TURNER. Exercise and Secondary Lymphedema: Safety, Potential Benefits, and Research Issues. Med. Sci. Sports Exerc., Vol. 41, No. 3, pp. 483–489, 2009. Purpose: Participating in regular physical activity is encouraged after treatment for breast cancer, with exception of those who have subsequently developed lymphedema. The purpose of this project was to investigate, in a randomized controlled trial, the effect of participating in a supervised, mixed-type exercise program on lymphedema status among women with lymphedema after breast cancer. Methods: Women younger than 76 yr, who completed breast cancer treatment at least 6 months prior and had subsequently developed unilateral, upper-limb lymphedema, were randomly allocated to an intervention (n = 16) or control (n = 16) group. The intervention group (IG) participated in 20 supervised, group, aerobic and resistance exercise sessions over 12 wk, whereas the control group (CG) was instructed to continue habitual activities. Lymphedema status was assessed by bioimpedance spectroscopy (impedance ratio between limbs) and perometry (volume difference between limbs), and independent t-tests (two-tailed \( P < 0.05 \)) were used to determine statistical significance of observed changes. Results: Mean ratio and volume measures at baseline were similar for the IG (1.13 ± 0.15 and 337 ± 307 mL, respectively) and the CG (1.13 ± 0.19 and 377 ± 416 mL, respectively), and no changes were observed over time for either group. Although no group change was observed between preintervention and 3-month follow-up for the IG (ratio and volume change = 0.02 ± 0.07 and 2 ± 71 mL, respectively), two women in this group no longer had evidence of lymphedema by study end. Average attendance was more than 70% of supervised sessions, there were no withdrawals, and several qualitative comments from participants support the program acceptability. Conclusions: The results from this pilot study indicate that, at minimum, exercise does not exacerbate secondary lymphedema. Women with secondary lymphedema should be encouraged to be physically active, optimizing their physical and psychosocial recovery. Key Words: PHYSICAL ACTIVITY, BREAST CANCER, RECOVERY, TREATMENT-RELATED SIDE EFFECTS, ARM SWELLING

By 18 months postsurgery, at least 30% of Australian breast cancer survivors have had lymphedema (16), a debilitating, distressing condition (31) that impairs the performance of ordinary tasks (5,22), sets woman apart socially, and is a constant reminder of the cancer (26). There is significant evidence demonstrating that participating in exercise during and after treatment for breast cancer is associated with improvements in psychosocial and physical outcomes (8,9,12,15,28) and emerging evidence linking active lifestyles with improved survival (1,17,18). Women with lymphedema have traditionally been excluded from participating in exercise for fear of exacerbating the condition. However, recent findings suggest that sedentary lifestyles may increase risk of developing lymphedema (16). Further, participating in regular exercise plays an important role in maintaining a healthy and stable body weight, and being overweight or obese is considered risk factors for developing lymphedema (10,25).

Although there is a paucity of research regarding the role of exercise for women with lymphedema, preliminary work demonstrates that participation in an exercise program does not precipitate lymphedema nor does it exacerbate the condition (2,13,20,21). Unfortunately, these studies are limited by the type of sample (include no or only some women with lymphedema), size of the sample (\( n = 14-45 \)), methods of lymphedema assessment (indirect methods
used), duration of the exercise program, and/or lack of long-term follow-up. The purpose of this project was to investigate, in a randomized controlled trial (RCT) using a direct objective method of lymphedema assessment, the immediate- and longer-term effect of participating in a supervised, mixed-type exercise program on lymphedema status among women with lymphedema after breast cancer. The study also sought to determine the acceptability of the program from the participant’s perspective.

METHODS

Subject group. Women younger than 76 yr, who had completed treatment for unilateral breast cancer at least 6 months prior, subsequently had unilateral, upper-limb lymphedema diagnosed by a health professional, and were prepared to travel to the exercise clinic for 12 wk (if randomly allocated to the intervention group [IG]) were eligible. There were no other exclusion criteria applied. After ethical approval, study information packs (n = 316) were distributed via lymphedema-treating specialists (221), the Lymphedema Association of Queensland (80) and our own database (31). Of those that responded (34% response rate), 27 women declined to participate and did not provide any patient or treatment information, 7 women were ineligible, and 32 women were eligible and provided informed written consent to participate. The remaining 106 women provided patient and treatment information but were unable to participate due to the intervention requirements.

Study design. This study was a single-blind, RCT of a specific exercise program. All measures were assessed preintervention (time 1; T1), immediately postintervention (time 2; T2), and at 12-wk follow-up (time 3; T3) and were conducted by the same assessor who was blinded to participant group allocation. Participants were randomly allocated (using a computer generated table of random numbers) to the intervention group (IG) or the control group (CG) after T1. Stratifying according to severity of lymphedema was necessary because 38% of the sample (n = 12) lacked objective evidence of the condition (CG, n = 6; IG, n = 6), as defined by our diagnostic criteria, at T1.

Intervention. The intervention involved a 12-wk, mixed-type exercise program, including aerobic and resistance exercise (Table 1), conducted by an exercise physiologist and physiotherapist. Although intensity was most often “moderate,” intensity progressed throughout the program. Participants used the Borg's revised rating of perceived exertion scale (4) to monitor aerobic-based exercise intensity while the maximum number of repetitions successfully completed with a given resistance assessed resistance-based intensity. Exercise progression occurred throughout the 12-wk intervention period, and the program was designed to maximize exposure to various types of exercise in an attempt to develop “independent and capable exercisers” by study end. The prescriptive nature of the program progressed to levels that met national physical activity guidelines (3), and on completion of the 12-wk intervention, participants were instructed to continue with their established exercise regime but were not monitored. The decision to wear compression garments during exercise sessions or not was left up to each participant.

Measures. Lymphedema was assessed via standard objective measures, specifically bioimpedance spectroscopy (BIS; SEAC SFB3; Impedimed, Brisbane, Australia) and perometry (Manual Perometer Type 350 S; Petro-System Messgerate GmbH, Wuppertal, Germany). Using BIS, the impedance of the extracellular fluid for each limb at a range of frequencies was assessed using the manufacturer’s software, and the ratio of these values comparing the treated and untreated sides was calculated. Lymphedema was considered to be present when the impedance ratio was more than three SD above normative data, taking into account the significant effect of limb dominance (7). Perometry involved inserting the upper limb into a horizontally oriented frame that emitted 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. Lymphedema was deemed present when the volume of the treated side was at least 200 mL more than the untreated side. For the purpose of power calculations, a 10% change in perometry volumes and a 0.2 change in BIS ratio were considered clinically relevant. Approximately 10 women per group were required to detect this level of change or difference between groups, with power and significance set at 80% and 5%, respectively.

| TABLE 1. Parameters of the exercise intervention |
|-----------------|-----------------|
| Type            |                 |
| Weeks 1–2       | Aerobic only (floor-based aerobic exercise to music and walking) |
| Weeks 3–4       | Aerobic (floor-based aerobic exercise to music, water-based aerobic exercise and walking) and water-based resistance exercises |
| Weeks 5–8       | Aerobic (mix of all types) and water-based elastic-resistance exercises |
| Weeks 9–12      | Aerobic (mix of all types) and machine-weight resistance exercise |
| Intensity       |                 |
| Weeks 1–4       | Aerobic: low to moderate (RPE: 3–5) |
| Weeks 5–8       | Resistance: low (9–28 repetitions per exercise) |
| Weeks 9–12      | Aerobic: moderate to high (RPE: 4–7) |
| Duration        |                 |
| Weeks 1–4       | 20–30 min per session |
| Weeks 5–8       | 30–45 min per session |
| Weeks 9–12      | 45+ min per session |
| Frequency       |                 |
| Weeks 1–4       | 3 times per week (2 supervised) |
| Weeks 5–8       | 4 times per week (2 supervised) |
| Weeks 9–12      | At least 4 times per week (1 supervised) |

All sessions included upper and lower body stretches as part of the warm-up and cool-down periods.

* Supervised sessions were group based, with a maximum of 10 women in any session. RPE, rating of perceived exertion scale.
We also recorded the number of supervised sessions attended per participant as well as the reasons given for periods of absence. Qualitative comments regarding the program and the lymphedema status provided by the women during exercise sessions were recorded. Together, exercise adherence rates and qualitative comments were used to provide insight into the acceptability of the program. For both IG and CG, data were collected via self-report on patient and treatment characteristics (Table 2). At T2 and T3, additional information on changes made to undergarments, compression garments, and/or lymphedema treatment was collected. Women also responded to prompts, such as “you may wish to tell us what having lymphedema feels like, what do you think caused your lymphedema, whether certain activities aggravate or improve your lymphedema” in the questionnaire.

**Statistical analysis.** Lymphedema values as assessed by BIS (ratios) and perometry (volumes in milliliters) were approximately normal for the study group at each testing phase, as were change scores between T1 and T2 and T1 and T3. Therefore, means and SD have been used with independent t-tests (two-tailed \( P < 0.05 \)) to determine statistical significance of observed changes. Qualitative comments were examined to determine the presence of common themes or points of difference across respondents and phases.

**RESULTS**

**Group characteristics.** The patient and the treatment characteristics of the study sample \( (n = 32) \) were similar to those who were unable to participate \( (n \approx 106) \), although the participants were more likely to have been diagnosed with breast cancer more than 5 yr previously (Table 2). The IG and the CG also reported comparable patient and treatment characteristics at baseline, with mean age approximately 60 yr, about half reporting low levels of education and more than two thirds being in a significant relationship, with children. At T1, breast cancer was diagnosed more than 5 yr ago for 70% of IG and CG, whereas about half of the CG but only one third of the IG experienced lymphedema for more than 5 yr. Lymphedema treatment characteristics of the groups were similar, and comparable behaviors (specifically, adherence to “common” lymphedema prevention guidelines) at baseline were also observed (data not shown).

**Lymphedema.** There were no significant differences in lymphedema status at baseline or changes between testing phases observed between the IG and the CG. Mean impedance ratios at T1 were 1.13 ± 0.15 for the IG and 1.13 ± 0.19 for the CG, whereas mean changes in impedance ratios between T1 and T2 were \(-0.01 \pm 0.06\) and \(-0.00 \pm 0.09\) and between T1 and T3 were \(0.02 \pm 0.07\) and \(0.07 \pm 0.09\) for the IG and the CG, respectively (Table 3). With perometry, baseline volume differences for the IG and the CG were 337 ± 307 and 377 ± 416 mL, respectively. Mean volume changes between testing phases were insignificant.

**CLINICAL SCIENCES**

**TABLE 2. Personal, demographic, and clinical characteristics of nonparticipants and participants.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Nonparticipants</th>
<th>All Participants</th>
<th>Control</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr), n (mean ± SD)</td>
<td>106 (60 ± 18)</td>
<td>32 (59 ± 9)</td>
<td>16 (50 ± 11)</td>
<td>16 (59 ± 7)</td>
</tr>
<tr>
<td>Children in care, n (%)</td>
<td>19 (18)</td>
<td>5 (16)</td>
<td>2 (13)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Children (unknown)</td>
<td>28 (25)</td>
<td>10 (31)</td>
<td>5 (31)</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Children aged &gt;14 yr</td>
<td>51 (49)</td>
<td>14 (44)</td>
<td>8 (50)</td>
<td>6 (38)</td>
</tr>
<tr>
<td>Children aged &lt;14 yr</td>
<td>8 (8)</td>
<td>3 (9)</td>
<td>1 (6)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>Education, n (%)</td>
<td>Low</td>
<td>57 (54)</td>
<td>16 (50)</td>
<td>7 (44)</td>
</tr>
<tr>
<td>Moderate</td>
<td>33 (31)</td>
<td>9 (23)</td>
<td>5 (31)</td>
<td>4 (25)</td>
</tr>
<tr>
<td>High</td>
<td>16 (15)</td>
<td>7 (22)</td>
<td>4 (25)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>Marital status, n (%)</td>
<td>Married</td>
<td>71 (67)</td>
<td>23 (72)</td>
<td>12 (75)</td>
</tr>
<tr>
<td>Divorced</td>
<td>35 (33)</td>
<td>9 (29)</td>
<td>4 (25)</td>
<td>5 (31)</td>
</tr>
<tr>
<td>Treated side, n (%)</td>
<td>Dominant</td>
<td>33 (30)</td>
<td>19 (59)</td>
<td>8 (50)</td>
</tr>
<tr>
<td>Nondominant</td>
<td>53 (50)</td>
<td>13 (41)</td>
<td>8 (50)</td>
<td>11 (69)</td>
</tr>
<tr>
<td>Years since breast cancer treatment, n (%)</td>
<td>6 months to 5 yr</td>
<td>57 (54)</td>
<td>10 (31)</td>
<td>5 (31)</td>
</tr>
<tr>
<td>&gt;5 yr</td>
<td>45 (46)</td>
<td>22 (69)</td>
<td>11 (69)</td>
<td>11 (69)</td>
</tr>
<tr>
<td>Adjuvant treatment (yes), n (%)</td>
<td>Chemotherapy</td>
<td>41 (39)</td>
<td>17 (53)</td>
<td>7 (44)</td>
</tr>
<tr>
<td>Radiotherapy</td>
<td>75 (71)</td>
<td>21 (66)</td>
<td>11 (69)</td>
<td>10 (63)</td>
</tr>
<tr>
<td>Hormone therapy</td>
<td>51 (48)</td>
<td>14 (44)</td>
<td>8 (50)</td>
<td>6 (38)</td>
</tr>
<tr>
<td>Extent of lymph node removal, n (%)</td>
<td>All nodes removed</td>
<td>30 (28)</td>
<td>10 (31)</td>
<td>6 (38)</td>
</tr>
<tr>
<td>≥1 node removed</td>
<td>76 (72)</td>
<td>22 (69)</td>
<td>10 (63)</td>
<td>12 (75)</td>
</tr>
<tr>
<td>Years since lymphedema diagnosis, n (%)</td>
<td>&lt;1 yr</td>
<td>18 (17)</td>
<td>3 (9)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>1–5 yr</td>
<td>47 (44)</td>
<td>15 (47)</td>
<td>6 (38)</td>
<td>9 (64)</td>
</tr>
<tr>
<td>&gt;5 yr</td>
<td>23 (22)</td>
<td>6 (18)</td>
<td>8 (50)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Current lymphedema treatment, n (%)</td>
<td>Physiotherapy</td>
<td>13 (12)</td>
<td>4 (13)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>Massage</td>
<td>44 (42)</td>
<td>13 (41)</td>
<td>5 (31)</td>
<td>8 (50)</td>
</tr>
<tr>
<td>Compression</td>
<td>27 (26)</td>
<td>9 (28)</td>
<td>4 (25)</td>
<td>5 (31)</td>
</tr>
<tr>
<td>Exercise</td>
<td>8 (8)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>9 (60)</td>
</tr>
<tr>
<td>Lymphatic drainage</td>
<td>6 (6)</td>
<td>1 (3)</td>
<td>0 (0)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Laser</td>
<td>6 (6)</td>
<td>3 (9)</td>
<td>3 (19)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (4)</td>
<td>1 (4)</td>
<td>1 (6)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

P values not shown but all were greater than 0.10.

1. Children in care: reflects the number of children currently being cared for within the family.
2. Education categories: low education defined as no formal education through to grade 10 high school; moderate education defined as completing school (grade 12) or a trade/apprenticeship; high education defined as any formal education beyond completing grade 12 high school.

An additional table is required to explain the changes observed in lymphedema between pre-intervention and 3-month follow-up.

**TABLE 3. Changes observed in lymphedema between pre- and postintervention and percent intervention and 3-month follow-up.**

<table>
<thead>
<tr>
<th>Measures of Lymphedema</th>
<th>N</th>
<th>Mean (SD)</th>
<th>Change between T1 and T2</th>
<th>Change between T1 and T3</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS (ratio)</td>
<td></td>
<td></td>
<td>-0.00 (0.09)</td>
<td>0.01 (0.09)</td>
<td>0.75</td>
</tr>
<tr>
<td>CG</td>
<td>16</td>
<td></td>
<td>-0.01 (0.08)</td>
<td>0.02 (0.07)</td>
<td>0.88</td>
</tr>
<tr>
<td>IG</td>
<td>15</td>
<td></td>
<td>-0.01 (0.08)</td>
<td>0.02 (0.07)</td>
<td>0.88</td>
</tr>
<tr>
<td>Perometry (volume, mL)</td>
<td></td>
<td></td>
<td>43 (97)</td>
<td>19 (73)</td>
<td>0.35</td>
</tr>
<tr>
<td>CG</td>
<td>16</td>
<td></td>
<td>13 (81)</td>
<td>2 (71)</td>
<td>0.53</td>
</tr>
<tr>
<td>IG</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( ^* \) T1, preintervention.
\( ^* \) T2, postintervention.
\( ^* \) T3, 3-month follow-up.
and ranged from 2 mL (IG: T1–T3) to 43 mL (CG: T1–T2) (Table 3).

**Bioimpedance spectroscopy.** Evaluation of individual lymphedema status by BIS at each of the three testing phases demonstrated that 9 (56%) of 16 IG participants had measurable evidence of the condition at T1. Two (13%) of these women showed clinical improvements, so that by T3, they no longer had measurable lymphedema (ratio declined by 0.10 and 0.15). One IG participant experienced a significant increase in swelling throughout the study period (ratios/volumes; T1: 1.16/689 mL; T2: 1.47/923 mL; T3: 2.25/1870 mL). This participant attended 50% of the group-supervised sessions (sessions 1–8, 10, and 20), all at low to moderate intensity involving whole-body, aerobic-based exercise. A prolonged or repeated upper respiratory tract infection was the reason for missed sessions, and her lymphedema became worse midway through her illness period. Since completion of the study, this participant continued to experience worsening lymphedema that did not respond to treatment and was later diagnosed with recurrent disease (approximately 6 months after study end). Due to these circumstances, her data were removed. Importantly, no adverse changes to lymphedema status were found in those who participated more completely and at higher intensities in the intervention. In regard to the CG, six women (38%) had measurable evidence of the condition at T1 and T3. An additional woman had measurable evidence of lymphedema at T2; however, her ratio declined again to within “normal” by T3. One (6%) of the 16 women in the CG showed a clinical decline in her ratio over time but continued to have measurable evidence of the condition by T3. The remainder of the CG had relatively stable ratios over time.

**Perometry.** With perometry, 9 (60%) out of 15 and 8 (57%) out of 14 IG women had measurable evidence of lymphedema at T1 and T3, respectively, whereas 9 (56%) out of 16 and 10 (67%) out of 15 CG women had evidence of lymphedema at T1 and T3, respectively. Fluctuations of more than 10% volume difference between the treated and untreated sides were observed for individuals in both groups, irrespective of lymphedema status according to perometry criteria, and resulted in overall group declines of 6% in the IG and 5% in the CG.

**Study adherence.** The majority of women (88%) allocated to the IG participated in 70% or more of scheduled supervised exercise sessions. The intervention was scheduled over winter, and missed sessions were mostly related to respiratory illnesses (n = 10). Other reasons included having a skin lesion removed (n = 1), having gynecological surgery (n = 1), and work commitments (n = 2). As already noted, one participant missed 50% of supervised sessions. All participants (n = 32) participated in T1 and T2, whereas data were unavailable for two participants (one in the IG and one in the CG) at T3. To ensure that the missing data did not contribute to results found, data analysis was repeated excluding these two participants, and no differences in results were observed (data not shown).

**Qualitative data.** Comments recorded on the self-reported questionnaire revealed one overarching concern: lymphedema impacts all facets of an individual’s life. Illustrative quotes are provided in Table 4. The sense of grief and frustration expressed by many women was exacerbated by uncertainty about the likely outcome of lymphedema treatment, conflicting advice from health professionals, and the perceived need to maintain vigilance about activities that might exacerbate the problem, despite lack of clear evidence to guide them. In addition, more in-depth interactions with those in the IG provided us with

<table>
<thead>
<tr>
<th>Themes</th>
<th>Illustrative Quotes</th>
</tr>
</thead>
</table>
| **Pervasive impact of lymphedema** | "It (lymphedema) affects some capacity of every day-to-day activity."
| | "Feel like my whole body is affected by this lymphedema."
| | "I don’t like the way my arm seems to affect all extremities especially my left arm and my back."
| | "It just seems all the energy is gone at times and you really have to force yourself to do things."
| | "I have tried many things to help myself and try to control the swelling, the pain I am experiencing but nothing seems to help, or if it does, it’s only briefly. I only want relief from this swelling... At present I cannot come to terms with what has happened to my arm, because there are many things and reasons I hate about it."
| | "...only talk to persons who may have had it (lymphedema)—as it is difficult trying to explain."
| | "The need to wear a constrictive sleeve always prompts questions from people which I find difficult to answer."
| | "Compression garment hard to hide so tend not to wear same."
| | "It (exercise) makes me feel like I am able to use it more."
| | "Sweating seems to be a good exercise! Lifting grandchildren also a good exercise (not so good on the back)!
| | "I felt the lymphedema was more under control while I was participating in the supervised exercise sessions (I also felt fitter at the latter part of the 12 weeks)."
| | "I never knew I was able to do so much."
| | "However, when asked what "aggravates your lymphedema" heavy or repetitive use and heavy lifting featured in responses (two in the IG, two in the CG)."

| **Isolation/social impact** | "Without having you to guide me, there is no way I would have ever done the things I've done as part of this program."
| | "You gave me the confidence to know what I want and my arm can do."
| | "I would not have tried the things I've done but for the study. I now feel capable of joining an aqua class."
| | "You've shown me what I can do rather then tell me what I shouldn't do."

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exercise breast cancer (1,17,18). Therefore, although exercise cur-

These are important findings because it is known that resistance-based exercise alone (2) set at moderate intensi­

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DISCUSSION

The use of the treated arm after breast cancer treatment and the potential to influence risk of developing lymphedema are topics with limited evidence driving clinical recommendations. Although it seems sensible to be cautious regarding use of the treated side, it is pertinent to acknowledge that the “muscle pump” is considered the primary mechanism for moving lymph throughout the body (32), and participating in physical activity activates the muscle pump mechanism. This single-blind, RCT sought to evaluate the effect of participating in a 12-wk supervised-exercise program on lymphedema status among women previously diagnosed with clinical lymphedema after breast cancer.

No group changes were observed in lymphedema status over the study period, although two (22%) of nine IG women with clinical evidence (by BIS) at baseline no longer had evidence of the condition at T3. These results support the notion that participation in exercise is safe for those with upper-limb lymphedema, and that at minimum, exercise does not exacerbate swelling. The specific intervention involved both aerobic- and resistance-based exercise that targeted large as well as small muscle groups, including those of the upper-limb, and was undertaken predominantly at moderate to high intensities. No adverse changes on lymphedema status have been reported by others who have also examined the effect of mixed-type exercise programs (aerobic and resistance based) (21,33) or resistance-based exercise alone (2) set at moderate intensities. These are important findings because it is known that sedentary lifestyles are associated with being overweight and that both of these characteristics are independent risk factors for developing breast cancer (6,11,30), lymphedema after breast cancer (10,14,16,25), and reduced survival after breast cancer (1,17,18). Therefore, although exercise cur-
objective status. It seems plausible that the increase in physical activity levels was contributing to changes in lymph movement and/or load and in turn changes in arm symptoms. It was clear that had these women not been under supervision and assessment, these changes in arm symptoms would have led to withdrawal from their planned exercise. Other qualitative comments provided by the IG participants further highlighted the importance of the intervention being supervised. Of note, average attendance by the IG was more than 70% of supervised sessions and there were no withdrawals. Therefore, under the “right” conditions, it seems participation in exercise is acceptable to women with lymphedema.

Anecdotally, current practice encourages use of garments while exercising. As this recommendation lacks an evidence base, we encouraged each IG participant to make this decision herself. Three women (22%) chose to wear a garment while exercising. Similar to findings from others (19), no relationship between garment use and change in lymphedema status was identified. Although these results are preliminary and require replication, factors such as impairment of heat transfer mechanisms, reduced range of motion, and discomfort associated with wearing garments should be considered by clinicians and patients when making decisions about garment use during exercise.

The intervention was designed by a team experienced in both research and clinical practice and reflecting the disciplines of exercise physiology, physiotherapy, and psychiatry. The primary outcome, lymphedema, was assessed using two objective measures, and data collection allowed making decisions about garment use during exercise.

The authors acknowledge Professor Beth Newman for her contributions to the study and manuscript, Sheree Harrison and Elizabeth Winkler for statistical analysis, the National Breast Cancer Foundation for funding Dr. Hayes’ fellowship, and the women who made this research possible. The results of the current study do not constitute endorsement by ACSM.

REFERENCES

20. Lane K, Jeypersen D, McKenzie DC: The effect of a whole body...


