Effects of Pilates Exercises on Shoulder Range of Motion, Pain, Mood, and Upper-Extremity Function in Women Living With Breast Cancer: A Pilot Study

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Abstract

Background and Purpose: The purpose of this study was to examine the effects of Pilates exercises on shoulder range of motion (ROM), pain, mood, and upper-extremity (UE) function in women who had been treated for breast cancer.

Participants: The participants were 4 women who had undergone axillary dissection and radiation therapy for stage I to IV breast cancer.

Methods: A nonconcurrent, multiple-baseline, single-subject research design was used to examine the effects of Pilates exercises on the 4 outcomes.

Results: Visual analyses of the data suggest a modest effect of the Pilates exercise program in improving shoulder abduction and external rotation ROM. Statistically significant improvement in shoulder internal and external rotation in the affected UE was shown for the one participant with pre-existing metastatic disease. The improving baselines seen for pain, mood, and UE function data made it impossible to assess the effects of Pilates exercises on those outcomes. No adverse events were experienced.

Discussion and Conclusion: Pilates exercises may be an effective and safe exercise option for women who are recovering from breast cancer treatments; however, further research is needed.

For women who have been treated for breast cancer, rehabilitation aims to restore independence and self-sufficiency while focusing on quality of life (QOL).[1] Although conventional forms of exercise or physical therapy[2-9] and dance therapy[10] for women with breast cancer have been studied, the complementary exercise known as Pilates has not been researched in cancer rehabilitation. Complementary therapies aim to improve QOL by addressing issues of the body, mind, and spirit and symptom management[11] and are used by up to 80% of women with breast cancer.[12] We examined the effects of Pilates exercises on shoulder range of motion (ROM), pain, mood, and upper-extremity (UE) function in women who previously had been treated for breast cancer.

Systematic searches of PubMed, MEDLINE, CANCERLIT, and CINAHL (1983–July 2007) revealed no studies that had examined the effects of Pilates exercises on women with breast cancer. Key words used in the searches were "breast cancer," "breast neoplasm," "Pilates," "radiation," "axillary dissection," and "rehabilitation."

Axillary dissection (AD) for breast cancer staging and application of radiation therapy to the breast or axilla can contribute to reduced shoulder mobility,[4,13–18] lasting up to 8 years after treatment.[14] Postoperative exercise programs can prevent shoulder stiffness and enhance ROM[16] without leading to lymphedema.[4,15] Shoulder pain, another side effect of AD,[13,14,17–19] can result from radiation fibrosis, surgical scarring, or intercostobrachial nerve damage[18] and can persist from months to years after surgery,[14] negatively influencing mood and QOL.[14] Anxiety, depression, anger, and poor body image are other common sequelae[19] that can continue despite improved physical function.[20] Emotional well-being (mood) is a significant predictor of QOL,[1] with emotional distress associated with surgery-related pain.[17] Exercise has been shown to decrease anxiety[5] and improve self-esteem,[7] vigor,[6] and satisfaction with life.[20]

Women with long-term survival after breast cancer tend to have poorer functional status than women who have not had breast cancer.[21] Reduced shoulder ROM after axillary surgery and radiation is related to reduced functional ability.[18]

Pilates Exercises

Originally called "Contrology," Pilates is an exercise approach developed in the early 1900s that is based on Eastern theories of body-mind-spirit interaction combined with Western theories of biomechanics, motor learning, and core stability.[22,23] "Spirit" encompasses emotional well-being,[24] and mind-body exercise incorporates an inwardly directed, nonjudgmental focus and specific attention to breathing and proprioception.[25] During a Pilates exercise session, mental effort focuses on activating specific muscles in a functional sequence at controlled speeds, emphasizing quality, precision, and control of movement. Exercise repetitions rarely exceed 10, with resistance usually in the form of body weight or springs. Proponents of Pilates exercises claim that regular practice leads to relaxation and control of the mind, enhanced body- and self-awareness, improved core stability, better coordination, more ideal posture, greater joint ROM, uniform muscle development, and decreased stress.[23,26]

The effects of Pilates exercises on dancers' posture, strength (force-generating capacity), and technique,[27–31] as well as on muscle contraction,[32] body composition, and flexibility in adults who are healthy,[33] have been studied. Pilates exercise has been recommended to prevent and rehabilitate overuse injuries in ballet dancers[34] as well as to treat groin[35] and foot and ankle[36] injuries. Despite the increasing popularity of Pilates exercises, their effects have not been studied in individuals with chronic disease.

Because its proponents claim that regular Pilates exercise leads to increased joint ROM[23,26] (which can translate into improved UE function[18]) and decreased stress,[23,26] we chose to examine the effects of Pilates exercises on shoulder ROM, pain, mood, and UE function in women who had received AD and radiation therapy for stage I to IV breast cancer[37] at least 6 months prior. We hypothesized that a Pilates exercise program would increase shoulder ROM, decrease pain, enhance mood, and improve UE function.

Method

Study Design

A nonconcurrent, multiple-baseline, single-subject research design (SSRD) was used.[38] Well suited to rehabilitation settings,[39] SSRD allows isolation of variables directly contributing to changes in performance.[40] Systematic, repeated measurement of a target behavior during both baseline and intervention phases (with each participant serving as his or her own control)[39] allows for comparisons before, during, and after an intervention within each participant.

To control for history and maturation, 4 participants were randomly assigned to baselines of 3, 5, 7, or 9 sessions of repeated measures.[38] Baselines of varying lengths established the preintervention rate of performance and served as a comparison after intervention was introduced, thus strengthening the evidence that intervention effects were not due to extraneous variables to which participants were exposed. Phase changes were made based on shoulder ROM data, the primary outcome measure. Intervention was introduced after the preselected baseline if the ROM baselines demonstrated stability.[38] When a baseline failed to exhibit stability, it was extended until stability was attained or until the intervention had to begin due to social validity concerns (ie, the unacceptability of an extended baseline to participants). To examine the effects of the independent variable on the dependent variables over time, follow-up data were collected approximately 4 weeks after completion of the intervention.

Participants and Setting

Participants were 4 volunteers who had undergone AD and completed radiation therapy for stage I to IV breast cancer at least 6 months prior and who had restricted shoulder ROM secondary to breast cancer treatments (ie, a limitation of $\geq 10°$ between the surgical and nonsurgical shoulders in flexion, abduction, internal rotation [IR], or external rotation [ER]).[14] One participant had previous experience with Pilates exercise. To recruit participants, an article was published in the provincial breast cancer newsletter, posters advertising the study were distributed to local cancer support groups and posted in the provincial cancer center and community centers around the city, e-mail messages were sent to local breast cancer dragon boat teams, and announcements were made at local breast cancer forums. Women who were undergoing chemotherapy; had a history of bilateral breast cancer; were attending regular physical therapy, chiropractic, massage therapy, or psychological counseling sessions; or had previous shoulder injuries or other health problems were excluded. Participant demographic information is presented in Tables 1 and 2. Signed informed consent was acquired from all participants.

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Table 1.

Participant Background Information

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Table 2.

Participant Treatment Information

The Pilates exercise and data collection sessions took place at Meridian Pilates Studio in Vancouver, British Columbia, Canada, typical of many community-based Pilates exercise studios in existence today. The home exercise sessions took place in the participants' homes.

Outcome Measures

Shoulder ROM.

We defined *shoulder ROM* as the range through which the participant could move the shoulder while maintaining a neutral thorax. Measurements were taken with a single plastic, 30.48-cm (12-in) universal goniometer with the participant positioned supine on a plinth-like platform, using standardized procedures[41] to measure ROM. Range of motion was measured in a supine position to decrease variability related to placement of the thorax. Active shoulder flexion, abduction, IR, and ER (with the shoulder in 90° of abduction) were measured bilaterally, using the unaffected shoulder (measured first) for comparison. Three consecutive measurements were taken in each plane, with trials averaged for the final score. Because there are no published data for what constitutes a “minimal detectable change” for ROM measurements, we used the measurement difference for interrater agreement in our study, which was 7 degrees (see “Interrater Agreement” section).

Level of pain.

Pain was assessed using the Brief Pain Inventory—Short Form (BPI),[42] a 15-item, self-administered tool developed for use in patients with cancer. The BPI provides information on pain intensity and the degree to which pain interferes with function and QOL. Front and back views of a human figure on which the participant shades the areas of pain and 7 pain interference questions (eg, “How much has your pain interfered with general activity over the past 24 hours?”) comprise the BPI. Items are rated on an 11-point scale, with lower scores indicating less pain. The test takes about 10 minutes to complete and has shown respectable test-retest item correlations over short intervals.[42]

Mood state.

Mood was assessed using the Profile of Mood States-Short Form (POMS),[43] which rates a variety of mood states using a 30-item adjective checklist rated on a 5-point Likert scale. Total mood disturbance is calculated by summing the scores of the 6 POMS factors and then subtracting that score from the vigor subscale score. A lower score indicates less mood disturbance. Test-retest reliability estimates (r_{tt}) range from .65 for the vigor subscale to .74 for the depression subscale.[43] Concurrent validity (r=.80, P<.01) was demonstrated between the Tension-Anxiety section of the POMS and the Taylor Manifest Anxiety Scale.[43]

UE functioning.

A 12-item, self-report questionnaire was used to enable each participant to assess the functional status of the affected UE. Tasks require a combination of movements through a variety of shoulder ranges, representing typical daily activities. Items are scored on a 10-point Likert scale from "no difficulty with the task" to "completely unable to do the task." The questionnaire was modified from that used by Wingate[8] and expanded from 5 to 10 points to enhance responsiveness.[16] Lower scores indicate improved UE function. Box et al[16] attempted to validate 10 of the 12 tasks by examining their associations with shoulder ROM. Significant associations ($P<.05$) were reported for 6 of the 10 tasks with a variety of different shoulder movements (ie, abduction, flexion, extension, IR, and ER).[16]

UE circumference.

Circumference measurements of both UEs at recommended anatomical landmarks[44] were collected weekly as a safety guide for potential lymphedema. If a difference of ≥2 cm had been noted at any landmark, the participant would have been referred to her oncologist and to a physical therapist for in-depth assessments. Results of a previous study of circumferential measures of both UEs in women who had been treated for breast cancer showed high inter-rater reliability (intraclass correlation coefficient=.99) and test-retest reliability (intraclass correlation coefficient=.99).[45]

Intervention and Data Collection

Pilates intervention.

The same certified Pilates exercise instructor conducted most of the sessions, based on exercises described by Stott Pilates.[46] When that instructor was unavailable, another certified instructor led the exercise programs. Sessions were 1 hour long, 3 times per week, for 12 weeks (Appendix 1). We used a generic, whole-body exercise program in this study because we believed it is most accessible (in terms of class offerings at a typical studio or gym, as well as cost per class) to the average woman and may be most commonly offered at studios and gyms in North America. Participants began with pre-Pilates exercises and individualized stretches, progressing to beginner-level exercise and, when appropriate, to intermediate-level exercises. Progression was based on assessment of the participants' "working level" (ie, the level at which the participants could be safely "in their body," making appropriate neuromuscular connections while still being challenged). Equipment was manufactured by Peak Pilates.* Participants also were given a Pilates exercise program to perform at home, 1 time per week, for 12 weeks (Appendix 2).

Data collection.

A trained rater (not blind to study phase or hypothesis) collected all baseline and intervention data at the studio where the intervention took place. Measurements were collected in the same order, at the same time of day, on the same day of the week. During both baseline and intervention phases, shoulder ROM data were collected 2 times per week, whereas pain, mood, and UE function data were collected 1 time per week. Follow-up data were collected on the same day of the week and time of day as during the baseline and intervention phases.

Interrater Agreement

A physical therapist trained the 2 study raters. A woman who had undergone AD and radiation for breast cancer was measured while the physical therapist guided the raters through standardized shoulder ROM measurement procedures.[41] The raters repeated the procedure 5 more times, without the physical therapist's guidance, with 2 women who had been treated for breast cancer and a woman who had not been treated for breast cancer.

Interrater agreement was conducted for 20% of all ROM data collection sessions, balanced across study phases. To account for lack of primary rater blinding, a trained outside rater, blind to study phase and hypothesis, served as the second rater for these sessions. Differences of ≤7 degrees were considered acceptable interrater variability.[47] Interrater agreement was 74%. To prevent observer drift, the rater and co-investigator periodically reviewed procedures for ROM measurement and questionnaire administration over the course of the study.

Treatment Integrity

To ensure that the Pilates exercise instructor was adhering to the study protocol, a Pilates exercise instructor trainer monitored one session for each participant after being provided with a sheet outlining the exercises. We required adherence to the basic choreography and Pilates exercise principles, with flexibility for images and visualizations used with each participant. In all 4 cases, the trainer confirmed that the Pilates exercise instructor was adhering to the protocol. For the intervention to be "complete," participants could miss no more than 15% of the supervised Pilates exercise sessions. The Pilates exercise instructor standardized and documented the exercises performed during each session.

Data Analysis

Graphed data were analyzed visually using standard rules of evidence for SSRD.[40] Levels, trends, and variability within and across phases were analyzed for all repeated measures on all participants, and data paths were compared across participants. *Level* represents changes in magnitude of the data, conveyed by changes in the mean level for each phase (ie, average rate of performance across 2 or more phases).[40] *Trend* is the direction of change within a phase. An accelerating trend moves in an upward direction, whereas a decelerating trend progresses downward.[40] Trends for all data paths were determined using the Microsoft Excel[†] "linear regression" option. To aid in visually analyzing trends, baseline trend lines were extended into intervention and follow-up phases. The number of data points above and below the extended trend lines, across phases, was compared to determine the intervention effect.[40] *Variability* refers to the amount of fluctuation in a data series.[40]

Statistical analysis was conducted using ITSACORR, an interrupted time-series analysis software program.[48] Using an omnibus F test to determine significance of overall change in intercept and slope between baseline and intervention phases with ≥5 data points, ITSACORR controls for autocorrelation. Analyses were performed only on ROM data sets in which all participants had baseline phases of ≥5 data points. Significance was set at $P<.05$.

Results

Throughout the results, “unaffected” refers to the untreated UE and “affected” refers to the surgical or irradiated UE. For shoulder ROM, an accelerating trend indicates increasing range, and a decelerating trend indicates decreasing range. Decelerating trends for pain, mood state, and UE functioning suggest improvement. It is important to note that trends in SSRD do not relate to statistical significance (or lack thereof) but rather to the direction of the data paths.

Shoulder ROM

Unaffected UE.

Based on changes in average level from baseline to intervention, all participants improved in shoulder flexion and ER. Participants 1 and 3 also showed improved abduction and IR, and participant 4 also showed improved abduction. No change in level was observed for participant 2 in abduction, and deterioration occurred for participants 2 and 4 in IR (Figs. 1, 2, 3, and 4). Improving trends were seen for participant 1 in flexion, abduction, and IR; for participant 2 in IR only; for participant 3 in abduction, IR, and ER; and for participant 4 in ER only. Participant 2 changed from a deteriorating to a stable trend for abduction. Improving baseline trends, followed by an improving or stable trend during intervention, were seen for participant 2 for shoulder flexion and for participant 4 for shoulder flexion and abduction.

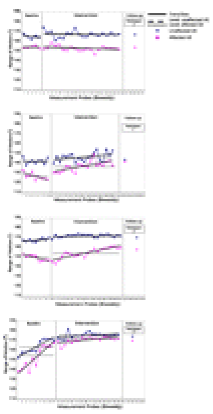

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Figure 1.

Shoulder flexion: mean level lines and trend lines for each phase. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

Figure 2.

Shoulder abduction: mean level lines and trend lines for each phase. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

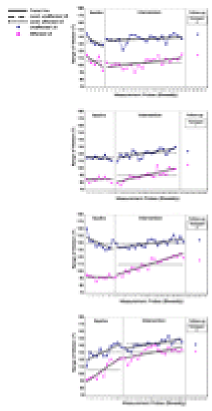

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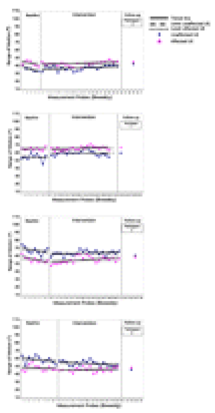
Figure 3.

Shoulder internal rotation: mean level lines and trend lines for each phase. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.



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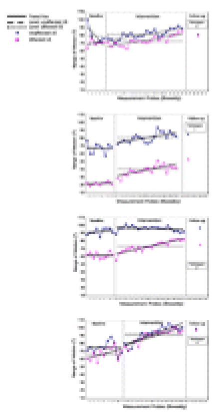

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Figure 4.

Shoulder external rotation: mean level lines and trend lines for each phase. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

For participants 1 and 3, most shoulder flexion intervention data points were above baseline trend lines (**Fig. 5**). For participant 2, almost all intervention data points were below or on the baseline trend line, whereas all intervention data points were below the baseline trend line for participant 4. For shoulder abduction, the majority of intervention data points for participants 1, 2, and 3 were above baseline trend lines (**Fig. 6**); all except one intervention data point for participant 4 was below the baseline trend line.

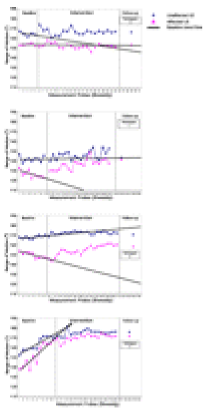

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Figure 5.

Shoulder flexion: baseline trend line extended into intervention and follow-up. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

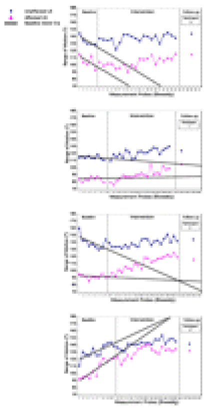

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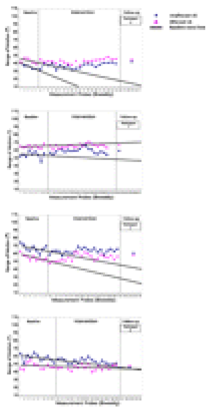
Figure 6.

Shoulder abduction: baseline trend line extended into intervention and follow-up. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

For shoulder IR, the majority of intervention data points for all participants were above baseline trend lines (**Fig. 7**). For ER, the majority of intervention data points were above the baseline trend lines for participants 1, 3, and 4 (**Fig. 8**) but the majority of intervention data points were below the baseline trend line for participant 2.

Figure 7.



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Shoulder internal rotation: baseline trend line extended into intervention and follow-up. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

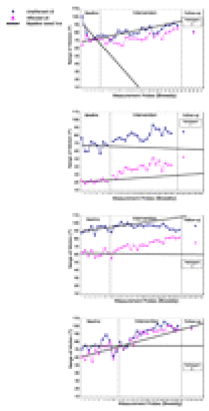

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Figure 8.

Shoulder external rotation: baseline trend line extended into intervention and follow-up. Graphs are organized from shortest to longest baseline for ease of interpretation. UE=upper extremity.

Based on visual analyses, only 2 participants showed change that exceeded the measurement difference for interrater agreement (7°), which we interpreted as the minimal detectable change: Participant 1 increased average shoulder ER by 14 degrees, and participant 4 increased average shoulder flexion by 12 degrees, shoulder abduction by 12 degrees, and shoulder ER by 18 degrees.

Affected UE.

All participants improved in average level of ER from baseline to intervention. Participants 1, 2, and 4 also improved in flexion and abduction. Average levels of shoulder flexion and abduction deteriorated slightly for participant 3 (by 1° and 2°, respectively). No participant improved in average level of IR from baseline to intervention. A change in trend, from stable or deteriorating to improving, was seen in participants 1 and 2 for all 4 planes of movement and in participant 3 for abduction and IR. An improving baseline trend (followed by an improving or stable trend during intervention) was seen for participant 4 for flexion, abduction, and ER, as well as for participant 3's ER.

For shoulder flexion, all except one intervention data point for participants 1 and 2 were above baseline trend lines (**Fig. 5**). The majority of intervention data points for participant 3 and all data points for participant 4 fell below baseline trend lines. For shoulder abduction, the majority of intervention data points for participants 1, 2, and 3 were above the baseline trend lines (**Fig. 6**), with all intervention data points for participant 4 below the baseline trend line.

For shoulder IR, the majority of intervention data points for participants 1, 2, and 3 were above the baseline trend lines (**Fig. 7**). For ER, the majority of intervention data points were above the baseline trend lines for participants 1, 2, and 4 (**Fig. 8**). For participant 3, all intervention data points were below the baseline trend line.

Based on visual analyses, participant 1 showed 2 changes that exceeded the measurement difference for interrater agreement (7°): average shoulder flexion increased by 10 degrees, and average ER increased by 18 degrees. For participant 2, average shoulder abduction and ER on the affected side increased by 18 and 12 degrees, respectively. Participant 4 showed improvement in average shoulder flexion (17°), abduction (24°), and ER (23°).

Level of Pain

During the baseline phase, all participants showed decelerating trends, indicating decreasing pain (Supplemental Figs. 1 and 2). After intervention, the average level of pain continued to decrease for participant 1, whereas data for participants 3 and 4 exhibited no trend (average pain score of 0). At the 1-month follow-up, participants 1, 3, and 4 had pain scores of 0.

For participant 2, average level of pain increased from baseline to intervention. Both baseline and intervention phases demonstrated decelerating trends (indicating a decreasing level of pain), but the slope of the intervention trend line was not as steep as that of the baseline trend line.

Mood State

Participants 1, 2, and 4 demonstrated improving mood (decelerating trends) during the baseline phase (Supplemental Fig. 3). This improvement continued into the intervention phase, but did not accelerate as quickly (Supplemental Fig. 4). For participants 2 and 4, follow-up data points suggested greater mood disturbance. For participants 1, 2, and 4, the majority of intervention data points were above the baseline trend lines, whereas all data points for participant 3 were below the baseline trend lines.

UE Functioning

During the baseline phase, participants 1, 3, and 4 reported improving UE functioning (decelerating trends) prior to introducing the Pilates exercise program (Supplemental Fig. 5). During intervention, improvement continued (decelerating trends) for participants 1 and 3. For participant 4, the level of functioning was stable during intervention, showing an average score of 12 (range=11–13).

At follow-up, UE functioning had deteriorated for participant 1 when compared with the mean of the last 3 data points in the intervention phase (Supplemental

Fig. 6). For participant 3, the follow-up data point (29 points) was 3 points above both the last data point in the intervention phase (26 points) and the mean for the intervention phase (26 points), suggesting deterioration. For participant 4, the level of functioning was the same at follow-up as that seen during intervention. For participant 2, baseline data were relatively stable, with an average UE functioning score of 24 (range=21–28). During intervention, slightly decreased function occurred, with an average score of 22 (range=19–26). Function was further decreased at follow-up (at 30 points).

For participant 1, all except one intervention data point was above the baseline trend line. For participant 2, almost as many intervention data points were above as were below the baseline trend line. For participants 3 and 4, all intervention data points were above the baseline trend line.

Statistical Analysis of Shoulder ROM

Although some of the changes noted in the foregoing sections may have been clinically relevant to individual participants, the only analyses that indicated statistically significant change were those for participant 3's affected UE shoulder IR (P=.028) and ER (P=.049) ranges.

Treatment Adherence

Adherence to the supervised exercise sessions ranged from 86% to 94%. To monitor adherence to home exercise, participants were asked at the start of each intervention week how many of the home program exercises had been completed. Adherence to home exercise sessions for participants 1 to 4 was 100%, 100%, 33%, and 92%, respectively.

Discussion

Shoulder ROM

When all participants' unaffected UE ranges were considered, 13 of 16 comparisons showed improved levels, and 8 of 16 comparisons showed improved trends. Seven of 16 comparisons showed improvement in both average level and trend from baseline to intervention: for participant 1 in shoulder flexion, abduction, and ER; for participant 3 in abduction, IR, and ER; and for participant 4 in ER.

For affected UE ranges, 10 of 16 comparisons showed improved levels from baseline to intervention, and 10 of 16 comparisons showed improved trends. Overall, 6 of 16 comparisons showed improved levels and trends (flexion, abduction, and ER for participants 1 and 2), suggesting a modest functional effect of the Pilates exercise program on improving these ranges in 2 participants.

Based on visual analyses, participant 1 showed the greatest improvement in shoulder ROM following implementation of the intervention, but only 3 of these changes exceeded the accepted measurement difference for interrater agreement. Worth noting is that participant 1 was only 6 months following radiation treatment when she joined the study. She also was the oldest participant (71 years of age); had the highest overall scores for pain, disturbed mood, and difficulty with UE functional tasks; and showed the most impaired affected shoulder ROM in flexion, abduction, and ER when compared with the other participants, despite being the only one who had not had a mastectomy.

One month after completing the intervention, participant 2 was diagnosed with metastases to the patellae and skull, suggesting that she was living with metastatic cancer while taking part in the Pilates intervention. Even with metastatic cancer, participant 2 improved in both level and trend for shoulder flexion, abduction, and ER in the affected UE.

Although participant 3 was the only one to show statistically significant change in affected shoulder ROM for IR and ER, visual analysis suggests that she may have experienced the least change of the 4 participants due to the Pilates exercise program. That is, her changes in level from baseline to intervention across all ranges were the smallest, and, in 3 planes (flexion, abduction, and IR) in the affected UE, average ROM decreased from baseline to intervention. She did show increases, however, in both level and trend for shoulder abduction, IR, and ER in the unaffected UE.

Secondary Dependent Measures

Level of pain.

Except for participant 1, high levels of pain at the study outset were not reported. Average pain level decreased by 2 to 11 points from baseline to intervention for participants 1, 3, and 4 but increased by 1 point for participant 2, due perhaps to the undiagnosed patellar metastases, as indicated by her markings on the body diagram. The fact that all participants had decreasing pain during the baseline phase makes it difficult to conclude that the Pilates exercise program was responsible for the further decrease in pain over the course of the study.

Mood state.

All participants showed decreases in mood disturbance from baseline to intervention. However, the fact that mood was improving for participants 1, 2, and 4 during the baseline phase makes it difficult to conclude that improvement during intervention was due to the Pilates exercises. At the 1-month follow-up, participant 4 showed a dramatic increase in mood disturbance, as compared with her mood level during the last part of the intervention phase.

The POMS asked participants to rate their mood “during the past week, including today” and was completed prior to the exercise sessions. Participants reported feeling very relaxed and calm after the Pilates exercise sessions, suggesting that the program may have had a transient effect on mood that the POMS was unable to detect. Participants 1 and 2 commented that they believed the POMS to be ineffective and inappropriate as an outcome measure.

UE functioning.

While participants 1, 2, and 4 improved in average level of UE functioning from baseline to intervention, participants 1 and 4 also showed trends toward improved function during the baseline phase, making it difficult to be sure that improvement during intervention was due to the exercises. Participant 3 showed an average level that deteriorated by 1 point from baseline to intervention due, perhaps, to the fact that, on the day for which she reported the most difficulty with UE functioning (the first day of intervention), she was recovering from a sinus infection and had been bedridden for several days leading up to the Pilates exercise session. When her data for day 1 of the intervention phase are ignored, her average level of performance for the baseline phase is the same as for the intervention phase.

Strengths and Limitations of the Study

This was the first study to demonstrate an experimental effect of Pilates exercises on shoulder ROM. Safety of Pilates exercises for women treated for breast cancer, when under the direction of a certified instructor, was shown as well as modest effects of Pilates exercises on multiple outcome measures. Our study demonstrated the feasibility of using an SSRD in a clinical setting and adds to the limited literature on exercise for patients with metastatic cancer (ie, participant 3 had undergone surgery and radiation for metastases to the brain 1.5 years prior to the study, and participant 2 was diagnosed with metastases in the patellae and skull 1 month after completing the intervention). Both women successfully completed the intervention and reported benefits from it. Additionally, Pilates exercise is increasingly being sought as a form of post-rehabilitation exercise for which there is little scientific support. This study adds to the limited data on Pilates exercises and patient populations.

The modest results seen in this study may be due to the Pilates exercises selected and the intervention's length. The 3-month intervention was based on the conceptual framework outlined originally by Pilates.[26] Because our participants were from a patient population, 3 participants were over age 50 years, and 2 participants had metastatic disease, the exercises outlined in Pilates' book[26] would have been inappropriate. It also is possible that the participants might have needed more than a 3-month intervention to show dramatic change in ROM. The program we used included several exercises that required movement into shoulder abduction and ER, which might explain why these were the ranges that improved most. Only one exercise required notable IR, which may explain why the IR range appeared to have been less affected by the program, based on visual analyses. Additionally, the Pilates exercise program was a generic “whole-body” program. An individualized, UE-specific program might have resulted in greater shoulder ROM gains. It also is possible that the intensity of the exercise program was too low to elicit significant changes in shoulder ROM. Lastly, the cancer metastases diagnosed in participant 2 one month after completing the intervention may explain the lack of improvement in her pain and UE functioning scores over the course of the intervention.

Testing effects may have threatened internal validity. Improving ROM, pain, mood, or function during the baseline phase made it difficult to accurately assess the intervention effects. Based on these pilot data, it appears that 3 baseline data points are not sufficient to establish “stable” shoulder ROM data. The need to extend the baseline phases for 2 participants (participants 1 and 4) was problematic, as they were anxious to begin the intervention. The lack of reliability information for the UE function measure is another limitation, making it impossible to know whether the changes in UE function were true changes or were due to measurement error.

Because the primary rater worked at the studio where the intervention took place, it was impossible to blind her to the study hypothesis or phase. To account for this, we used a blind outside rater for interrater agreement sessions. No standards exist for what constitutes acceptable interrater agreement for shoulder ROM in women treated for breast cancer. Our interrater agreement was somewhat below the usual standard of 80%, despite a standardized measurement protocol and trained raters, suggesting that shoulder ROM may be more variable in this population. A study of patients with other types of shoulder dysfunction[47] supports our findings. Hayes and colleagues[47] investigated interrater reliability for shoulder flexion, abduction, and ER in patients with rotator cuff repair, adhesive capsulitis, or scapulothoracic fusion. Interrater correlation coefficients (r_s) ranged from .64 to .69, suggesting fair to good reliability.

Although a concurrent multiple-baseline design would have been stronger, we selected a nonconcurrent design because it was not known whether the intervention would have an effect on shoulder ROM. If ROM had improved after introducing the intervention, it was expected to be gradual, meaning that participants would have had to remain in the baseline phase for long periods of time. A longer follow-up period would have allowed us to determine how long the improved ROM (where applicable) would last in the absence of a thrice-weekly, supervised Pilates exercise program.

Although this was intended to be a pilot study, the small number of participants limits the generalizability of the findings. Furthermore, the exercise dose may have differed slightly across participants, participants' energy levels differed, actual time spent exercising per session may have varied (eg, participant 3 often started late and had to leave early), and adherence to the home exercise program differed. For participants who improved in shoulder ROM, it was impossible to sort out whether the improvement was due to the overall Pilates exercise program or to specific exercises.

Clinical Implications

None of the participants experienced adverse events in the study, suggesting that community-based Pilates exercise programs may be safe for women living with breast cancer. However, the effects of Pilates exercises on improving shoulder ROM were limited and exceeded measurement error only in 3 planes (flexion, abduction, and ER) for 2 participants (participants 1 and 4) in the unaffected UE and in 3 planes (flexion, abduction, and ER) for 3 participants (participants 1, 2, and 4) in the affected UE.

Physical therapists should encourage interested clients to seek out trained Pilates exercise instructors who have knowledge of breast cancer and related cautions. Ideally, women with breast cancer could begin with individual Pilates exercise sessions to ensure safe performance of exercises and proceed to group classes. Because of its low intensity and focus on neuromuscular repatterning, Pilates exercise would be a sensible starting point from which women could gradually return to their regular activities after breast cancer treatments.

Rehabilitation is unlikely to have an impact if the intervention is not important, viable, and acceptable to consumers. Study participants stated that they would recommend the Pilates exercise program to other women living with breast cancer, suggesting that they found the program acceptable. Pilates exercise may benefit women with breast cancer in ways not examined in our study. Although the participants in this study found the intervention acceptable, it is unlikely that many women could afford to attend individualized Pilates exercise sessions 3 times a week for 3 months, as in our study.

Suggestions for Future Research

Studies with larger samples comparing Pilates exercises with more typical physical therapy exercise programs would be worthwhile, as would longer interventions with more responsive outcome measures. Randomized controlled trials comparing different exercise interventions (eg, standard physical therapy, yoga, tai chi) with Pilates exercise clearly are needed. Individualized Pilates exercise programs could be compared with the generic program provided in this study, including cost–benefit analyses of the 2 approaches. Because there are no standard definitions of “reduced shoulder mobility” or “acceptable shoulder ROM reliability” after breast cancer, research to develop such definitions would enable more accurate comparisons across studies.

Conclusion

Not every woman treated for breast cancer will develop impaired shoulder ROM, but appropriate interventions are necessary for those who do develop impaired shoulder ROM. Although more people are engaging in Pilates exercise as a form of post–rehabilitation exercise therapy, few patient-based studies have been conducted. Although further study is needed, our preliminary data suggest that Pilates exercise appears to have a modest effect on improving shoulder abduction and ER.

Appendix 1.


Appendix 1.
Pilates Studio Program[a]

Exercise	Progression/Notes

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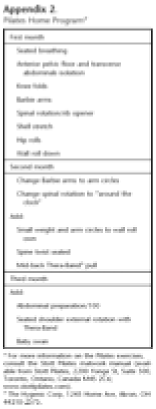
Appendix 1.

Pilates Studio Program[a]

[a] For more information on the Pilates exercises, consult the Stott Pilates Reformer and Cadillac manuals (available from Stott Pilates, 2200 Yonge St, Suite 500, Toronto, Ontario, Canada M4S 2C6; www.stottpilates.com).

[b] The Hygenic Corp, 1245 Home Ave, Akron, OH 44310–2575.

Appendix 2.



Appendix 2.
Pilates Home Program[a]

First month
Seated breathing
Anterior pelvic floor and transverse abdominals isolation
Knee folds
Barbie arms
Spinal rotation/rib opener
Shell stretch
Hip rolls
Wall roll down
Second month
Change Barbie arms to arm circles
Change spinal rotation to "around the clock"
Add:
Small weight and arm circles to wall roll down
Spine twist seated
Mid-back Thera-Band[b] pull
Third month
Add:
Abdominal preparation/100
Seated shoulder external rotation with Thera-Band
Baby swan

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Appendix 2.

Pilates Home Program[a]

[a] For more information on the Pilates exercises, consult the Stott Pilates matwork manual (available from Stott Pilates, 2200 Yonge St, Suite 500, Toronto, Ontario, Canada M4S 2C6; www.stottpilates.com).

[b] The Hygenic Corp, 1245 Home Ave, Akron, OH 44310–2575.

Footnotes

Ms Keays, Dr Harris, and Dr Lucyshyn provided concept/idea/research design and writing. Ms Keays provided data collection and facilities/equipment. Ms Keays and Dr Lucyshyn provided data analysis. Ms Keays and Dr Harris provided project management, fund procurement, and participants. Dr Harris provided institutional liaisons. Dr Harris, Dr Lucyshyn, and Dr MacIntyre provided consultation (including review of manuscript before submission).

This study was approved by the Clinical Research Ethics Board at the University of British Columbia.

The study was undertaken in partial fulfillment of the requirements of Ms Keays' degree of Master of Science in Rehabilitation Sciences.

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