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Bone Mineral Density, Balance Performance, Balance Self-Efficacy, and Falls in Breast Cancer Survivors With and Without Qigong Training: An Observational Study

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Abstract

Purpose: A deterioration in bone strength and balance performance after breast cancer treatment can result in injurious falls. Therefore, interventions need to be developed to improve the bone strength and balance ability of breast cancer survivors. This cross-sectional exploratory study aimed to compare the bone mineral density (BMD), balance performance, balance self-efficacy, and number of falls between breast cancer survivors who practiced qigong, breast cancer survivors who did not practice qigong, and healthy individuals. **Methods:** The study included 40 breast cancer survivors with more than 3 months of qigong experience, 17 breast cancer survivors with no qigong experience, and 36 healthy controls. All the participants underwent dual-energy X-ray absorptiometry scans to measure their lumbar spine, total hip, femoral neck, and total radius BMDs. The participants also underwent a timed one-leg stand test to measure their single-leg standing balance. The participants' balance self-efficacy was assessed using the activities-specific balance confidence scale, and the number of falls experienced by each participant was assessed in a face-to-face interview. **Results:** The lumbar spine, total hip, femoral neck, and total radius BMDs were similar between the 3 groups ($P > .05$). The breast cancer-qigong group outperformed the breast cancer-control group by 27.3% when they performed the one-leg stand test on a foam surface ($P = .025$), and they also had a higher balance self-efficacy score ($P = .006$). Nevertheless, the numbers of falls were comparable between the 3 groups ($P > .05$). **Conclusion:** Qigong may be a suitable exercise for improving the balance performance and balance self-efficacy of breast cancer survivors.

Keywords

mind-body exercise, breast carcinoma, postural control, falls, skeletal health

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Introduction

Breast cancer is the most commonly diagnosed cancer in women of all ages.[1] Despite the increased survival rates associated with breast cancer,[1] conventional cancer treatments, such as adjuvant chemotherapy, often result in many side effects including accelerated bone loss, osteoporosis,[2] and neurologic toxicity-induced sensorimotor dysfunctions.[3] The deterioration in bone strength coupled with the poor sensorimotor and balance performance in some breast cancer survivors can result in falls, skeletal fractures,[4,5] an increased fear of falling,[6] and activity restrictions.[7] These can, in turn, adversely affect their quality of life.[8]

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Interventions should be developed to ameliorate the skeletal and neurological side effects associated with breast cancer treatments.

Previous studies have indicated that resistance training may prevent the loss of bone mineral density (BMD)[9] and improve the functional balance performance[10] of breast cancer survivors. However, resistance training may not be a popular exercise among survivors of breast cancer and it seems to be contraindicated in the clinical lore, especially for those who have lymphedema.[11] Hence, alternative exercise interventions should be developed for this population to prevent bone loss, improve balance performance and balance self-efficacy, and reduce the number of falls.

Qigong is a mind-body exercise that involves weight-bearing and originated in traditional Chinese medicine. It is a globally popular self-help technique for managing the side effects of conventional cancer treatments and improving the biopsychosocial health of cancer survivors.[12,13] Qigong has been shown to be effective at attenuating declines in BMD[14] and improving both balance performance[15] and balance confidence[16] in healthy middle-aged and older adults. In addition, our previous research suggested that qigong can improve the one-leg stand (OLS) balance performance of cancer survivors[17] without increasing the incidence of upper limb lymphedema.[18] Therefore, we hypothesized that qigong might be a suitable alternative exercise intervention to reduce bone loss and improve balance performance and confidence in breast cancer survivors and, as a result, prevent falls. However, no previous studies have examined the effects of qigong in survivors of breast cancer. This pilot study aimed to compare the BMD, balance performance, balance self-efficacy, and falls between breast cancer survivors who practiced qigong, breast cancer survivors who did not practice qigong, and healthy controls.

Methods

Study Design

The study was a cross-sectional exploratory study.

Sample Size Calculation

A sample size calculation was performed using G*Power software version 3.1.0 (Franz Faul, University of Kiel, Germany), based on a statistical power of 0.8 and a 2-tailed α level of .05. According to studies on exercise training for breast cancer survivors by our research team[17] and Waltman et al,[9] the effect sizes range from 0.5 to 1.1 for BMD outcomes and 0.1 to 0.4 for balance outcomes. Therefore, an effect size of 1.0 was used in the sample size calculation. As a result, the estimated minimum number of participants required to detect a significant between-group difference in BMD and balance outcomes was 17 per group.

Participants

Between October 2015 and March 2016, a convenience sample of breast cancer survivors was recruited from a medical clinic, the Nature Health Qigong Association, and the local community using posters and social media advertising. All the volunteers were screened in accordance with the inclusion and exclusion criteria by a medical doctor, a nurse, or a physiotherapist. The inclusion criteria were as follows: (1) had a history of breast cancer, (2) had completed conventional cancer treatments at a hospital and was medically stable, (3) was between 35 and 85 years of age and had an expected survival time of more than a year, (4) was a Hong Kong Chinese woman, (5) could ambulate independently without using an assistive device, (6) had normal cognitive and sensorimotor functions, and (7) for those in the breast cancer-qigong group, had regularly practiced 18-form tai chi qigong[19] for a minimum of 3 months (attended a 2-hour face-to-face training session per week at the Nature Health Qigong Association) or, for those in the breast cancer-control group, did not have any tai chi or qigong experience. The exclusion criteria were as follows: (1) receiving active cancer treatments (which could include traditional Chinese medicine), (2) had additional types of cancer besides breast cancer, (3) had a chronic medical condition such as poorly controlled diabetes mellitus or symptomatic orthostatic hypotension, (4) had a significant neurological, musculoskeletal, or cardiopulmonary disorder that may affect test performance, (5) had a metal implant, or (6) smoked.

Participants were recruited for the healthy control group from the local community using posters and social media advertising during the same recruitment period. They were required to fulfill the same inclusion and exclusion criteria described above except that they did not have a history of cancer and they had not received cancer treatment. In addition, they were required to have no experience of tai chi, qigong, or martial arts.

All eligible participants gave informed written consent to participate in the study. The study was approved by the Human Research Ethics Committee of the University of Hong Kong, and it was conducted according to the Declaration of Helsinki regarding experiments involving humans.

Outcome Measurements

All the measurements were performed by a physiotherapist and 2 research assistants. The assessments took place in the dual-energy X-ray absorptiometry (DXA) laboratory and the physical activity laboratory at the University of Hong Kong. Before the physical measurements were taken, the participants were asked to provide their demographic information and medical history. In addition, their physical activity levels (in metabolic equivalent [MET] hours per week) were calculated based on their self-reported exercise intensity level (light, moderate, or hard), duration (hours/ session), and frequency (sessions/week) combined with the MET value of the activity according to the Compendium of Physical Activities.[20] Sunlight exposure was estimated according to the time per week spent on outdoor activities. After these data were recorded, each participant underwent the following physical assessments in a random order.

BMD: DXA

Each participant underwent 3 scans (a whole-body scan, a hip scan, and a forearm scan; regarding the latter 2 scans, the breast cancer survivors had scans of their affected sides and the healthy controls had scans of their dominant sides) on the same day using a DXA scanner (Horizon A, Hologic Inc, Bedford, MA). All the scans were performed by the same licensed research assistant following standardized procedures (as described in the Hologic user manual).[21] The lumbar spine, total hip, femoral neck, and total radius BMDs (in g/cm^2) were determined using the DXA scanner's region of interest program and these variables were used in the analysis. Regarding the precision of the DXA scanner in vivo, the coefficient of variation for the femoral neck BMD and the spine BMD were reported to be 1.5% and 1.2%, respectively.[22]

Balance Performance: OLS Time

The timed OLS test was performed to assess each participant's single-leg stand balance performance. The participants were instructed to stand barefoot on their dominant leg (defined as the leg they used to kick a ball) both on a firm surface and on foam (Stability Trainer, Hygenic Corporation, Akron, OH). They were advised to focus on a spot on a nearby wall in front of them and rest their arms by their sides. A stopwatch was used to record the OLS time (in seconds). The test started when the nondominant foot left the ground and ended when the same foot touched the ground or the participant hopped on their weight-bearing leg. Each test lasted for a maximum of 60 seconds, and 2 trials were performed. The mean OLS time of the 2 trials was calculated and used in the analysis. A longer OLS time indicates a greater balance ability.[17]

Balance Self-Efficacy: Activities-Specific Balance Confidence (ABC) Scale

Balance self-efficacy (or fear of falling) was assessed using the Chinese version of the ABC scale, which has been validated. It has been shown that this instrument has high internal consistency (Cronbach's α = .97), a good interrater reliability (intraclass correlation coefficient [ICC] = 0.85), and an excellent test-retest reliability (ICC = 0.99) for older adults.[23] Each participant was invited to rate their self-perceived balance confidence from 0 (which represented no confidence at all) to 100 (which represented full confidence) associated with 16 daily activities. The mean score of the 16 items was calculated for each participant, with a minimum score of 0 to a maximum score of 100. A higher ABC score indicates a lower fear of falling.[23]

Fall History: Self-Reported Falls

The participants' fall histories were obtained from self-reports of the number of falls and the associated injuries, if any, in the previous 12 months. A fall was defined as unintentionally coming to rest on the ground (regardless of whether it resulted in injury). It has been reported that recall accuracy among the elderly regarding the number of falls in the preceding year is satisfactory (sensitivity = 89% and specificity = 95%).[24]

Statistical Analysis

SPSS version 20.0 (IBM, Armonk, NY) was used to analyze the data. First, the normality of the data was checked using the Shapiro-Wilk test and histograms. Second, one-way analyses of variance (ANOVAs) were used to compare the continuous demographic variables between the 3 groups, and χ^2 tests were used to compare the categorical demographic variables. The demographic variables that were significantly different between the groups were treated as covariates in the subsequent analyses of the outcome variables. Third, one-way analyses of covariance (ANCOVAs) were used to compare the outcome variables between the 3 groups. Where appropriate, post hoc comparisons with Bonferroni adjustments were performed to avoid an inflation of the type I error. Finally, Cohen's d was calculated to provide an indication of the size of the between-group differences in the outcome variables. By convention, Cohen's d values of 0.2, 0.5, and 0.8 represent small, medium, and large effect sizes, respectively.[25] An overall 2-tailed significance level of .05 was used for all the statistical tests.

Results

The volunteers who were screened in accordance with the exclusion criteria comprised 63 women with a history of breast cancer and 38 healthy women. Six breast cancer survivors were excluded as a result of having a metal implant (n = 1) or a history of nasopharyngeal cancer (n = 1), ovarian cancer (n = 1), lung cancer (n = 1), or colorectal cancer (n = 2). Two healthy participants were excluded because they had previously practiced tai chi. As a result, data from 57 breast cancer survivors and 36 healthy individuals were included in the study. Table 1 presents the basic

Table 1. Characteristics of Participants[a].

	Breast Cancer-Qigong Group (n = 40)	Breast Cancer-Control Group (n = 17)	Healthy-Control Group (n = 36)	*P*
Age, years	52.8 ± 6.7	54.0 ± 7.0	56.9 ± 8.3	.056
Weight, kg	54.7 ± 10.0	53.8 ± 7.1	59.8 ± 15.1	.112
Height, cm	160.7 ± 16.8	157.1 ± 5.0	157.1 ± 6.2	.356
Body mass index, kg/m^2	21.5 ± 4.2	21.8 ± 2.6	24.0 ± 4.7	.025*
Breast cancer-affected/surgical side, n				.857
Left	19	7	NA	
Right	18	9	NA	
Bilateral	3	1	NA	
Time since diagnosis, years	2.9 ± 2.9	3.9 ± 4.6	NA	.315
Type of surgery, n				.907
Mastectomy	26	10	NA	
Lumpectomy/partial mastectomy	4	2	NA	
Unknown	10	5	NA	
Adjunct treatment, n				.982
Chemotherapy	15	8	NA	
Radiotherapy	7	2	NA	
Tamoxifen	30	13	NA	
Calcium/vitamin D supplements	17	6	NA	
Bisphosphonates	1	1	NA	
Estrogen replacement	20	10	NA	
Thyroid supplements	2	1	NA	
Lymphedema-affected arm, n				.064
Present	9	8	NA	
Absent	31	9	NA	
Menopausal status, n				.191
Premenopausal	14	5	6	
Postmenopausal	26	12	30	
Tai chi qigong experience, years	2.1 ± 3.2	NA	NA	
Physical activity level, MET hours per week	8.6 ± 13.1	4.6 ± 10.7	5.6 ± 13.4	.451
Time spent on outdoor activities (sunlight exposure), hours per week	2.8 ± 3.1	1.3 ± 2.4	2.0 ± 2.3	.165
Marital status, n				.386
Single	6	1	2	
Married	30	15	31	
Divorced	2	1	2	
Widow	2	0	1	

Abbreviations: MET, metabolic equivalent; NA, not applicable.
[a]All values are means ± standard deviations unless otherwise noted.
*$P < .05$.

characteristics of the participants. There were no significant between-group differences for any of the demographic variables except for body mass index (BMI). Therefore, only BMI was treated as a covariate in the subsequent ANCOVA.

The ANCOVA results revealed that the lumbar spine, total hip, femoral neck, and total radius BMDs were similar between the 3 groups ($P > .05$). The OLS time on a firm surface was also comparable between the 3 groups ($P = .596$). However, those in the breast cancer-qigong group outperformed those in the breast cancer-control group by 27.3% in terms of their OLS times when they performed the test on a foam surface (effect size = 0.65, $P = .025$). In this test, those in the breast cancer-qigong group actually performed similarly to those in the healthy-control group ($P = .848$). Moreover, the qigong-trained breast cancer survivors had a higher balance self-efficacy score (10.7%) than the nontrained breast cancer survivors (effect size = 0.80, $P = .006$). The balance self-efficacy of the qigong-trained breast cancer survivors was no different from that of the healthy individuals ($P = .543$). Nevertheless, the numbers of self-reported falls in each of the 3 groups were similar ($P > .05$; Tables 2 and 3).

Table 2. Comparison of Outcome Measures Between Groups[a].

	Breast Cancer-Qigong Group (n = 40)	Breast Cancer-Control Group (n = 17)	Healthy-Control Group (n = 36)	P
Bone mineral density, g/cm^2				
Lumbar spine	0.89 ± 0.11	0.92 ± 0.13	0.90 ± 0.14	.644
Total hip	0.87 ± 0.12	0.90 ± 0.09	0.89 ± 0.15	.590
Femoral neck	0.67 ± 0.09	0.69 ± 0.09	0.68 ± 0.12	.422
Total radius	0.49 ± 0.06	0.49 ± 0.06	0.47 ± 0.08	.058
OLS time, seconds				
On a firm surface	18.41 ± 5.23	17.27 ± 5.15	18.45 ± 4.15	.596
On foam	15.72 ± 4.89	12.35 ± 5.39	15.94 ± 4.94	.021**
Balance self-efficacy				
ABC score	89.98 ± 10.06	81.31 ± 11.53	88.42 ± 12.23	.031*
Fall history				
Number of participants reporting falls, n (%)	4 (10.0%)	1 (5.9%)	1 (2.8%)	.439
Mean number of falls per participant in the previous year	0.20 ± 0.61	0.12 ± 0.49	0.06 ± 0.33	.635

Abbreviations: ABC, Activities-Specific Balance Confidence scale; OLS, one-leg stand.
[a]All values are means ± standard deviations unless otherwise noted.
*P < .05. **P < .025 (Bonferroni adjusted).

Table 3. Pairwise Comparisons of Outcome Measures.

	Breast Cancer-Qigong Group Versus Breast Cancer-Control Group		Breast Cancer-Qigong Group Versus Healthy-Control Group		Breast Cancer-Control Group Versus Healthy-Control Group	
	P	Effect Size (d)	P	Effect Size (d)	P	Effect Size (d)
Bone mineral density, g/cm^2						
Lumbar spine	.423	0.25	.820	0.08	.622	0.15
Total hip	.428	0.28	.601	0.15	.780	0.08
Femoral neck	.539	0.22	.977	0.09	.644	0.09
Total radius	.670	0.00	.149	0.28	.465	0.28
OLS time, seconds						
On a firm surface	.453	0.22	.968	0.01	.386	0.25
On foam	.025	0.65	.848	0.04	.020	0.69
Balance self-efficacy						
ABC score	.006*	0.80	.543	0.14	.050	0.60
Fall history						
Mean number of falls per participant in the previous year	.623	0.14	.198	0.29	.588	0.14

Abbreviations: ABC, Activities-Specific Balance Confidence scale; OLS, one-leg stand.
*P < .017 (Bonferroni adjusted).

Discussion

To the best of our knowledge, this was the first study to explore the relationship between the practice of qigong and regional BMD in breast cancer survivors. In contrast to our hypothesis, the results showed that breast cancer survivors who practiced qigong and those who did not had similar lumbar spine, total hip, femoral neck, and total radius BMDs. The lack of any differences in the BMD outcomes between the 2 breast cancer groups may be largely attributable to the short duration of the qigong practice that some of the participants undertook (as the study included participants with a minimum of 3 months of practice). Indeed, a previous study demonstrated that 2 months of qigong practice failed to improve the bone strength (measured using ultrasound) of middle-aged women.[26] However, a longer duration (>3 months) of qigong practice can maintain the overall BMD and reduce the levels of interleukin-6 (a marker of bone resorption) in the same population.[14]

Regarding the healthy controls, we found that their BMD at different body sites was similar to that of the breast cancer survivors who practiced qigong and also to that of breast cancer survivors who did not practice qigong. This may be due to the fact that a significant proportion of the breast cancer survivors were taking medications (eg, tamoxifen) that prevent bone loss,[27] so their BMD was comparable to that of age-matched healthy individuals. A clinical trial with a longer duration of qigong practice (>3 months) and a more homogenous group of participants (ie, only those not taking medications that significantly affect bone metabolism) is necessary to confirm the effects of qigong on BMD in breast cancer survivors.

Our results showed that the OLS balance performance on a firm surface was similar between the 3 groups. However, when standing in a sensory-challenging environment (ie, on foam), the OLS balance performance of the breast cancer survivors who practiced qigong was significantly better than that of those who did not practice qigong. In addition, the OLS time of the qigong-trained breast cancer survivors was comparable to that of the healthy controls. This result is consistent with our previous finding that qigong-trained cancer survivors had a longer OLS time in a sensory-challenging environment than nontrained cancer survivors.[17] The possible mechanisms underlying the better OLS balance performance of the qigong-trained individuals are the following: (1) they can better use their vestibular input for standing balance control[15] and (2) repeated practice of qigong may induce neuroplastic changes in the brain that lead to an improvement in balance performance.[28] Nevertheless, given the cross-sectional design of this study, a prospective randomized controlled trial is needed to confirm the beneficial effect of qigong on the balance performance of breast cancer survivors.

The qigong-trained breast cancer survivors had a higher balance self-efficacy (which was as high as that of the healthy controls) compared to their nontrained counterparts. The qigong-trained participants had a mean ABC score of 90.0, which is higher than the norm in Chinese adults (71.6).[23] The qigong-trained breast cancer survivors may have had a better balance self-efficacy as a result of their better OLS balance performance in sensory-challenging environments; most of them had not experienced a fall in the previous 12 months.[7] Additionally, practicing 18-form tai chi qigong might have strengthened their leg muscles, which is associated with greater balance confidence.[7] However, due to the cross-sectional study design and the convenience sampling method, we cannot be certain whether qigong improves balance confidence or whether cancer survivors with better balance confidence are more likely to practice qigong (ie, whether there was a self-selection bias).[25] Therefore, a randomized controlled trial is needed to confirm the results.

Despite the encouraging findings regarding balance performance and balance self-efficacy, the incidence of falls in the previous 12 months and the number of falls per person in the previous 12 months did not differ between the 3 groups. This finding contrasts with the findings of previous studies that showed that tai chi and qigong can reduce falls in older adults.[29,30] However, the discrepancy between the findings was not entirely surprising because the mobility level of our participants was relatively high (they could ambulate independently without using an assistive device) and they were much younger (mean age = 52.8 years) than the participants in the study by Li et al[29] (mean age = 77.5 years). Therefore, falls may not have been a large problem for the breast cancer survivors in our study and so qigong may not have been able to reduce their (already very low) incidence of falls.

Overall, the results of this study suggest that qigong may be useful for enhancing OLS balance performance in sensory-challenging environments and balance self-efficacy. However, qigong may not be able to reduce the number of falls nor improve the BMD of breast cancer survivors. Given the aforementioned limitations in the study design and the sampling method, a randomized controlled trial is needed to confirm the results. Future studies should also take confounding factors, including the stage of breast cancer at diagnosis, the family history of osteoporosis, dietary habits, and the exact duration since menopause (for postmenopausal participants), into account when analyzing BMD outcomes.[2] Moreover, further exploration is warranted into the relationship between qigong and biopsychosocial health (and its resultant effects on health-related quality of life) in survivors of breast cancer.

Conclusions

The qigong-trained breast cancer survivors had better balance performance (according to the OLS test) in a sensory-challenging environment than their nontrained counterparts, and their balance performance was comparable to that of healthy individuals. In addition, the qigong-trained breast cancer survivors had higher balance self-efficacy than those who did not practice qigong. However, there were no differences in the BMD and the number of falls between the breast cancer survivors who practiced qigong, those who did not, and the healthy controls. Therefore, qigong may be a suitable exercise for improving the balance performance and balance self-efficacy of breast cancer survivors. A randomized controlled trial is warranted to confirm these results.

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