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Effect of hatha yoga intervention on cardiovascular system in women after breast cancer surgery

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Tetiana Odynets[1], Yuriy Briskin[2], Borys Dolinsky[3], Iryna Osipova[4], Tetiana Pasichna[5], Anzhelika Yefremova[6]

[1] Department of Physical Rehabilitation, Khortytsia National Academy, Zaporizhzhya, Ukraine
[2] Department of Theory of Sport and Physical Culture, Lviv State University of Physical Culture, Lviv, Ukraine
[3] Department of Gymnastics and Martial Arts, South Ukrainian National Pedagogical University named after K.D. Ushynsky, Odessa, Ukraine
[4] Department of Theory and Methods of Physical Culture and Sports Disciplines, South Ukrainian National Pedagogical University named after K.D. Ushynsky, Odessa, Ukraine
[5] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
[6] Department of Physical Education and Sport, Ukrainian State University of Railway Transport, Kharkiv, Ukraine

Abstract

Introduction. The aim of this study was to investigate and compare the effects of 2 different exercise regimens on cardiovascular fitness in women with breast cancer.

Methods. A total of 110 women consented to take part in the study but only 102 met the inclusion criteria and were involved (8 patients did not meet the research criteria and were excluded); 95 women completed the interventions and were included in the final analysis. The patients' mean age was 57.53 ± 1.92 years for group A and 58.00 ± 1.27 years for group B. The participants were randomly assigned to 2 groups. Group A (n = 48) received hatha yoga intervention and group B (n = 47) received Pilates intervention for 3 months. Impedance cardiography was used to measure pre- and post-intervention functional capacity of the cardiovascular system.

Results. Post-intervention impact was observed for both intervention approaches, but better improvement was noted in the group of hatha yoga than that of Pilates. The actual values of stroke volume and left ventricular power were significantly higher in group A compared with group B by 6.05 ml/beat ($p < 0.05$) and 0.19 W ($p < 0.05$), respectively; the relative values were correspondingly better by 6.22% ($p < 0.05$) and 10.71% ($p < 0.05$).

Conclusions. Hatha yoga and Pilates interventions are both effective in improving cardiovascular function, but hatha yoga turns out more beneficial.

Key words: breast cancer, hatha yoga, cardiovascular system, Pilates, physical intervention

Introduction

Cardiovascular disease is the most common cause of mortality in patients who have survived cancer [1, 2]. Most studies have shown a high frequency of cardiovascular side effects after breast cancer treatment [3, 4]. This circumstance leads to a variety of interventions designed to improve the quality of life of patients with breast cancer [5–10].

Women commonly experience cardiotoxicity, and issues related to maximal oxygen uptake, cardiovascular endurance, and respiratory function [11–13]. Using radiation therapy in the chest [14, 15] reduces the adaptive capacity of the cardiovascular system, which is confirmed by a significant increase in tachycardia and a decrease in heart rate variability [16]. Also, a small effect on the left ventricle diastolic function is observed.

Post-treatment trophic disorders occur as a result of radiation, surgery, toxic tissue damage, vascular compression (lymph, blood), and nerve compression. In this way, low cardiovascular endurance and adaptive capacity, as well as functional disorders are common problems of these patients and might be important targets for yoga intervention [4, 17–20].

The results of previous research underline the significant role of different interventions in improving functional capacity of the cardiovascular system in breast cancer patients. These interventions include aerobic exercises [10, 21–23], water exercises [24], yoga exercises [25], and combined aerobic and resistance exercise programs [11, 26]. Nevertheless, previous studies have principally focused on the efficacy of yoga therapy in reducing fatigue, depression, and cancer-related lymphoedema in women suffering from breast cancer [27–29].

Thus, the rehabilitation of women with this diagnosis has a very high priority, since the evolution of functionally sparing operations does not exclude the need for individualized intervention. In addition, chemotherapy applied along with radiation therapy increases the number of treatment-induced problems that patients experience over a long period [1, 3], which necessitates the development of differentiated physical rehabilitation aimed at preventing post-treatment complications and improving the functional state of the cardiovascular system.

The assumed hypothesis here was that hatha yoga intervention might have a positive effect on cardiorespiratory fitness in women after breast cancer surgery. The study was conducted to investigate and compare the effects of 2 different exercise regimens on cardiovascular fitness in women with breast cancer.

Correspondence address: Tetiana Odynets, Department of Physical Rehabilitation, Khortytsia National Academy, 59 Naukove Mistechko Str., 69017, Zaporizhzhya, Ukraine, e-mail: tatyana01121985@gmail.com

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Subjects and methods

A total of 110 women consented to take part in the study but only 102 met the inclusion criteria and were involved (8 patients did not meet the research criteria and were excluded). Overall, 95 women completed the interventions and were included in the final analysis (Figure 1).

Comprehensive demographic and clinical characteristics of the participants are shown in Table 1. The women were randomized by using sequentially numbered, opaque sealed envelopes. The randomization was performed by an independent person via random numbers generated in Microsoft Excel. An independent person who was separate from the assessment and recruitment of the patients opened the envelopes. The participants' mean age was 57.53 ± 1.92 years for group A (hatha yoga) and 58.00 ± 1.27 years for group B (Pilates). There were no significant differences in the baseline cardiovascular parameters between the groups ($p > 0.05$). The inclusion criteria were as follows: Ukrainian individuals aged between 55 and 60 years, I–II stages of the tumour; the average time after breast cancer surgery (Madden mastectomy) ranged between 3 and 4 weeks. The exclusion criteria involved cognitive deficiency or psychiatric disease, bilateral mastectomy, heart failure, stage III tumour, refusal to participate. Impedance cardiography was used to measure pre- and post-intervention cardiovascular function. The independent researcher who administered the impedance cardiography was blinded to the group assignment of the participants. Overall, 95 women completed the intervention and were included in the final analysis.

The participants of group A and group B performed relevant programs 3 times per week for 3 months. The hatha yoga and Pilates intervention sessions lasted 60 minutes. Exercise intensity was individualized for the patients and varied from 50% to 60% of heart rate reserve. Both interventions took place at the Zaporizhzhya Regional Cancer Centre and

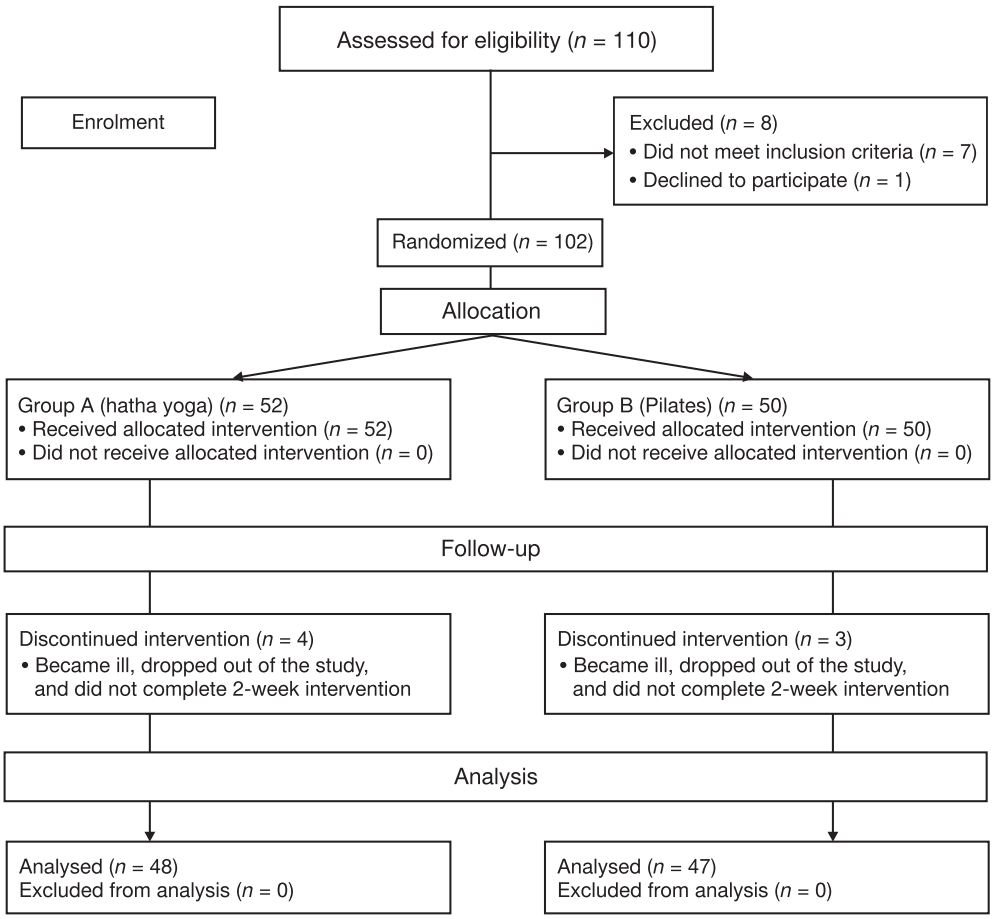

Figure 1. CONSORT flow diagram of the study

Table 1. Demographic and clinical characteristics of the participants

Characteristics		Groups		*p*
		A (*n* = 48)	B (*n* = 47)	
Age, years (*M* ± *SD*)		57.53 ± 1.92	58.00 ± 1.27	> 0.05
Race	White, n (%)	46 (96)	45 (96)	> 0.05
	Black, n (%)	2 (4)	2 (4)	> 0.05
Body mass index, kg/m^2 (*M* ± *SD*)		24.23 ± 0.38	24.25 ± 0.43	> 0.05
Time since surgery treatment completion, weeks (M ± SD)		3.23 ± 1.17	3.25 ± 1.19	> 0.05
Cancer stage	1, *n* (%)	8 (17)	9 (19)	> 0.05

were performed by the same *certified yoga* and Pilates therapist.

Hatha yoga application was conducted 3 times a week for 12 weeks. Each session consisted of several continuous poses (static, dynamic, stato-dynamic, relaxing, and respiratory) that were based on the participants' individual baseline functional capacity of the cardiovascular system. The yoga intervention consisted of breathing exercises (10 min), asanas in standing, sitting, lying positions (40 min), and relaxation exercises in lying position (10 min). The patients adhered to the following recommendations throughout their hatha yoga sessions:

1. Each hatha yoga session began with the dynamic performance of joint gymnastics exercises that increased the range of motion in the joints and prepared them for static loading.

2. Complex application of asanas and breathing exercises occurred in one session, as well as their combinations from various starting points for the full involvement of all muscle groups in the work.

3. The implementation of dynamic and static respiratory actions was well harmonized, which allowed to achieve full coordination of movements and capabilities for a long time to maintain physical activity in an optimal pulse mode.

4. At the beginning of the asanas learning, breath holding and closing of the eyes were avoided; after mastering the good technique, the women were recommended to close their eyes to provide a better concentration of attention on movements and gradually increase the time of posture holding.

5. In the final part of the session, the women achieved muscular and mental relaxation by focusing on their feelings in one of the asanas (Shavasana, Makarasana, or Balasana).

6. It is advisable to combine the performance of several asanas without rest breaks into stato-dynamic complexes to maintain a predetermined heart rate; passive rest breaks were performed between Shavasana or Makarasana if necessary.

7. To overcome the obstructive type of respiratory dysfunction, static pranayama was used to change the phases of the respiratory cycle (time of inhalation and exhalation); with alternate change of the type of breathing (elements of full breathing); with forced exhalations due to abdominal and diaphragm muscles (Kapalabhati, Bhastrika breathing); with delayed breathing after prolonged exhalation (Rechaka, Shunyaka, rhythmic breathing); with increasing strength and endurance of expiratory respiratory muscles (Uddiyana Bandha, Uddiyana Bandha Kriya, etc.).

8. To regulate the activity of the autonomic nervous system, the women focused on the duration of the respiratory cycle phases, respiratory retardation, and stimulation of breathing of air through the corresponding nostrils: to increase the activity of the parasympathetic department to make prolonged non-forced exhalation, delay after exhalation and asymmetric breathing; to increase the activity of the sympathetic department – on forced inhalation and exhalation through the right nostril, delay after inhalation.

9. Inverted asanas were carefully used for women who had high blood pressure. Values of the blood pressure ranged from 120/80 to 150/90 in the breast cancer patients, but we did not use inverted asanas for women with blood pressure exceeding 140/90.

Group B participants performed a Pilates program that included Pilates matwork exercises (50%), Power Pilates (20%), Pilates ball (20%), and Pilates stretch (10%). The main purpose of Pilates matwork exercises was to teach the women safe and rational techniques of performing basic exercises, breathing properly, and focusing on the movements performed. Exercise intensity was related to the functional capacity of the cardiovascular system in the women after breast cancer surgery.

Using impedance cardiography, the following parameters were evaluated: stroke volume (ml/beat), cardiac output (l/min), stroke index (ml/beat/m^2), systemic vascular resistance (dyn · s/cm^5), left ventricular work (gm-m/beat), left ventricular power (W).

The obtained data were analysed with the Statistical Package for the Social Sciences (SPSS) computer program. The Shapiro-Wilk test was preliminarily completed to spot the normal distribution of data. Dependent t-test was used to compare pre- and post-treatment cardiovascular changes for each group. Independent t-tests served to compare post-intervention cardiovascular parameters between group A and group B.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethical committee of Khortytsia National Academy.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

It was identified that hatha yoga and Pilates positively influenced cardiovascular functions in patients with breast cancer. As presented in Table 2, the dependent and independent t-test analysis revealed that in both groups there was a significant increase in the functional state of the cardiovascular system.

Post-intervention impact was observed for both intervention approaches, but better improvement was noted in the group of hatha yoga than that of Pilates ($p < 0.05$).

After the 3-month hatha yoga intervention, a significant increase was observed in group A: in actual stroke volume by 6.05 ml/beat ($p < 0.01$), in stroke index by 3.84 ml/beat/m^2 ($p < 0.01$), in left ventricular work by 0.41 gm-m/beat ($p < 0.05$), and in left ventricular power by 0.27 W ($p < 0.05$). The predicted values of stroke volume and left ventricular power improved significantly in patients of group A by 8.88% ($p < 0.05$) and 11.22% ($p < 0.05$), respectively. It is also worth noting a decrease in the total peripheral vascular resistance in both groups: by 246.20 dyn · s/cm^5 ($p < 0.05$) in group A and by 26.10 dyn · s/cm^5 ($p > 0.05$) in group B.

Applying the Pilates intervention in group B resulted only in a significant improvement of stroke volume by 3.92 ml/beat ($p < 0.05$) and stroke index by 2.54 ml/beat/m^2 ($p < 0.05$).

A comparison of post-intervention score averages of the cardiovascular function between the groups showed advantages of hatha yoga compared with Pilates for some indicators (Table 2). The actual values of stroke volume and left ventricular power were significantly higher in group A compared with group B participants: by 6.05 ml/beat ($p < 0.05$) and by 0.19 W ($p < 0.05$), respectively; the relative values were correspondingly better by 6.22% ($p < 0.05$) and 10.71% ($p < 0.05$).

Table 2. The evolution of cardiovascular function (mean ± error of mean) measured by impedance cardiography in the studied groups

Indicator		Group A (n = 48)			Group B (n = 47)		
		Beginning	3-month intervention	p	Beginning	3-month intervention	p
Stroke volume, ml/beat	Actual	45.88 ± 1.51	55.74 ± 1.72*	< 0.01	45.77 ± 1.58	49.69 ± 1.86	< 0.05
	% of predicted	73.07 ± 2.14	81.95 ± 1.95*	< 0.05	72.30 ± 1.61	75.73 ± 1.72	> 0.05
Stroke index, ml/beat/m^2		26.39 ± 0.99	30.23 ± 1.11	< 0.01	26.11 ± 0.62	28.65 ± 1.01	< 0.05
Cardiac output, l/min		3.34 ± 0.10	3.51 ± 0.10	> 0.05	3.36 ± 0.08	3.50 ± 0.12	> 0.05
Systemic vascular resistance, dyn · s/cm^5	Actual	2151.27 ± 63.73	1905.07 ± 60.13*	< 0.05	2107.06 ± 57.47	2080.96 ± 51.78	> 0.05
	% of predicted	134.47 ± 4.21	117.72 ± 3.44*	< 0.01	131.16 ± 3.22	127.49 ± 3.31	> 0.05
Left ventricular work, gm-m/beat	Actual	4.02 ± 0.11	4.43 ± 0.11	< 0.05	4.12 ± 0.11	4.21 ± 0.15	> 0.05
	% of predicted	74.25 ± 2.10	79.27 ± 1.31	< 0.05	75.06 ± 1.87	76.43 ± 2.79	> 0.05
Left ventricular power, W	Actual	2.07 ± 0.08	2.34 ± 0.06*	< 0.05	2.14 ± 0.09	2.15 ± 0.06	> 0.05
	% of predicted	78.22 ± 2.60	89.97 ± 2.97*	< 0.01	78.13 ± 2.77	79.26 ± 2.94	> 0.05

* $p < 0.05$ for comparing the data between group A and group B

Discussion

The present study was conducted to evaluate the impact of hatha yoga intervention on the cardiovascular system in patients after breast cancer surgery. Most previous yoga programs for patients with breast cancer have been performed to reduce cancer treatment-related symptoms such as fatigue, heart rate variability, lymphoedema, depression, anxiety, and poor quality of life [17–19, 30]. Some previous studies have identified that yoga considerably impacts on cardiorespiratory fitness and strength in healthy adults [31–33], but hatha yoga effect on functional capacity of the cardiovascular system in breast cancer Ukrainian patients has not been reported. Recent evidence suggests that combined aerobic and resistance exercises [11, 34–36], combined exercise plus diet program [37], and a water program [24, 38] contribute to an improvement in cardiorespiratory fitness in breast cancer survivors.

Previous studies of water therapy conducted by Odynets et al. [24, 38] involved an intervention of 3 times a week for 3 months and resulted in more significant improvements in cardiac output, stroke index, systemic vascular resistance, left ventricular work, and respiratory function compared with a Pilates program in women after breast cancer therapy. However, the average time after surgery was about 5 months: significantly longer than the time presented in the current study. A combined exercise plus diet program described by Okumatsu et al. [37] was effective to improve relative and absolute maximal oxygen uptake in breast cancer patients, but the inclusion criteria involved a period of at least 1 year after surgery. This circumstance makes it difficult to provide comparisons with our results.

The current results demonstrated significant positive effects of the hatha yoga intervention on increasing stroke volume, stroke index, left ventricular work, and left ventricular power. Moreover, the 3-month yoga classes led to a significant decrease in peripheral vascular resistance, which is an important predictor of high blood pressure. These findings might be particularly important for women with low capacity to participate in traditional aerobic or resistance programs. The results of this research agree with those of other studies which suggest that yoga exercises are a safe and effective intervention for patients with breast cancer.

The current study has several notable strengths, which include a complex application of asanas and breathing exercises in accordance with the type of respiratory and autonomic dysfunction. To regulate the activity of the autonomic nervous system, emphasis was placed on the duration of the respiratory cycle phases, respiratory retardation, and stimulation of breathing through the corresponding nostrils. To increase the activity of the parasympathetic department, we focused on prolonged non-forced exhalation through the left nostril and delay after exhalation; to increase the activity of the sympathetic one – on forced inhalation and exhalation through the right nostril, delay after inhalation. Different asanas were performed in standing, sitting, and lying positions.

It is planned that next research will be aimed at determining the effectiveness of a hatha yoga intervention on improving quality of life in women after Madden mastectomy.

Limitations

The limitations of this study comprise a homogeneous population and a limited number of participants.

Conclusions

In the face of these results, we consider that the hatha yoga intervention was more effective, with a favourable impact on functional capacity of the cardiovascular system in women after breast cancer surgery. The actual values of stroke volume and left ventricular power were significantly higher in group A compared with group B by 6.05 ml/beat ($p < 0.05$) and 0.19 W ($p < 0.05$), respectively; the relative values were correspondingly better by 6.22% ($p < 0.05$) and 10.71% ($p < 0.05$).

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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