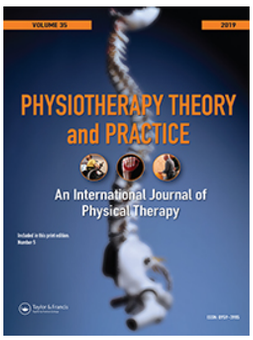

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RESEARCH REPORT

Effect of individualized physical rehabilitation programs on respiratory function in women with post-mastectomy syndrome

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ABSTRACT

Purpose: The purpose of this study was to determine the effectiveness of an individualized physical rehabilitation programs aimed at improving respiratory function in women with post-mastectomy syndrome. ***Methods***: In a randomized controlled trial 50 women with post-mastectomy syndrome were enrolled in the experimental group (EG, $n = 25$) or the comparison group (CG, $n = 25$). The program for the EG included: aqua aerobics (i.e. aqua jogging, aqua building, and aqua stretching); conditional swimming; and recreational aerobics. The program for the CG included: conditional swimming and Pilates exercises. Both intervention groups attended individualized physical rehabilitation programs three times per week for 48 weeks. The primary outcome measure was spirometry of the patients measured before, 6 and 12 months after the intervention. ***Results***: This study demonstrated that most of the respiratory function parameters increased significantly in both groups over the year of exercise training. After the year of training the individualized physical rehabilitation program for the EG was significantly better ($p < 0.01$) as compared with the CG, except for inspiratory reserve volume and maximal voluntary ventilation, which were not statistically different. ***Conclusions***: The results of the study suggest that individual programs of physical rehabilitation could be considered effective for the improvement of respiratory function of the patients with post-mastectomy syndrome. The results obtained could serve as a basis for more widespread clinical program development.

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Post-mastectomy syndrome; spirometry; cardiopulmonary rehabilitation

Introduction

Breast cancer is a common pathology of females not only in Ukraine but throughout the world (Canário et al., 2016; Fedorenko et al., 2016; Yu and Jones, 2016). Overall, 134,477 breast cancer cases were registered in oncology medical institutions of Ukraine in 2015. Modern methods of breast cancer treatment include: radiotherapy; chemotherapy; hormone therapy; and immunotherapy. Nevertheless surgery still remains the primary intervention (Kwan et al., 2012; Orçin et al., 2015; Verbelen, Gebruers, and Tjalma, 2015). Despite increasing survival rates, the disease and subsequent treatment continue to burden survivors with adverse sequelae, such as: lymphedema; limited shoulder motion; shoulder pain; muscle weakness; decreased functional capacity of the upper extremity; fatigue; depression; and cardiovascular and pulmonary complications (Briskin and Odinets, 2015; Mehnert et al., 2011; Scaffidi et al., 2012; Sung, 2011; Zagar, Cardinale, and Marks, 2016). All these complications are referred to as post-mastectomy syndrome (PMS).

Previous research (Balazs and Phillip, 2015; Briskin, Odinets, and Pityn, 2016; Canário et al., 2016; Lindquist et al., 2015; Odinets and Briskin, 2016) has shown that all patients, who have undergone breast cancer radical mastectomy are in pressing need of physical rehabilitation and psychological support. The high prevalence of cardiovascular and respiratory side effects makes these important targets for interventions in breast cancer survivors (Casla et al., 2015; O'Donnell et al., 2016; Yu and Jones, 2016). Adequate physical rehabilitation contributes to a noticeable improvement in health and physical condition and also significantly improves the quality of life.

Previous studies (O'Donnell et al., 2016; Yu and Jones, 2016) reported that breast cancer survivors often experience activity-related dyspnea, impaired lung diffusion, and exercise intolerance. At the same time, it is emphasized that rehabilitation programs should be individualized for all breast cancer patients according to their preferences, and physical activity level. Only a few studies have shown the importance of individualized exercise for the improvement of cardiopulmonary parameters, fatigue reduction, and quality of life in breast cancer survivors (Anulika Aweto,

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Akinbo, and Olawale, 2015; Baumann et al., 2016; Casla et al., 2015; De Luca et al., 2016; Murtezani et al., 2014; Vardar et al., 2015).

Analysis of the available scientific publications suggests that the issues related to physical rehabilitation of patients with PMS have not been completely solved. All the above studies mention the importance of developing and introducing individualized physical rehabilitation programs and determining benefit for the respiratory system in patients with PMS. The purpose of this study was to determine the effectiveness of individualized physical rehabilitation programs aimed at the improvement of the functional state of the respiratory system in women with PMS.

Methods

Participants

The study was designed as a randomized, prospective, controlled trial. The study was conducted at the Zaporizhzhya Regional Cancer Center, Ukraine, between October 2014 and September 2016. We screened 64 women for eligibility; 8 (13%) were not eligible, and 4 (6%) were not interested in participating. The primary reasons for ineligibility were diagnosis with Stage 3 breast cancer ($n = 3$), less than 6 months or more than 12 months post treatment completion ($n = 3$), and body mass index greater than 25 kg/m^2 ($n = 2$). A CONSORT flow diagram is presented in Figure 1.

Fifty-two women with PMS were enrolled for the individualized physical rehabilitation program (EG, $n = 27$) and for the comparison individualized physical rehabilitation program (CG, $n = 25$). Written informed consent was obtained from all the participants before randomization. Patients were randomized into one of two groups (EG and CG) using sequentially numbered, opaque sealed envelopes. Medical information concerning the stage of disease, surgery, and adjuvant therapy was obtained from medical records.

The inclusion criteria were as follows: 50–60 years of age; recent history of modified radical mastectomy; normal body mass index; consent to participate in the study; treatment-related pain; lymphedema; limitation of shoulder joint motion; and decreased muscle strength of the hand on the side of the surgery. The exclusion criteria were as follows: bilateral lymphedema; metastasis; body mass index exceeding 25 kg/m^2; primary lymphedema; pulmonary edema; chronic nonspecific lung disease; congestive heart failure; or any contraindications limiting activity. All the women who were selected for the research met the eligibility criteria.

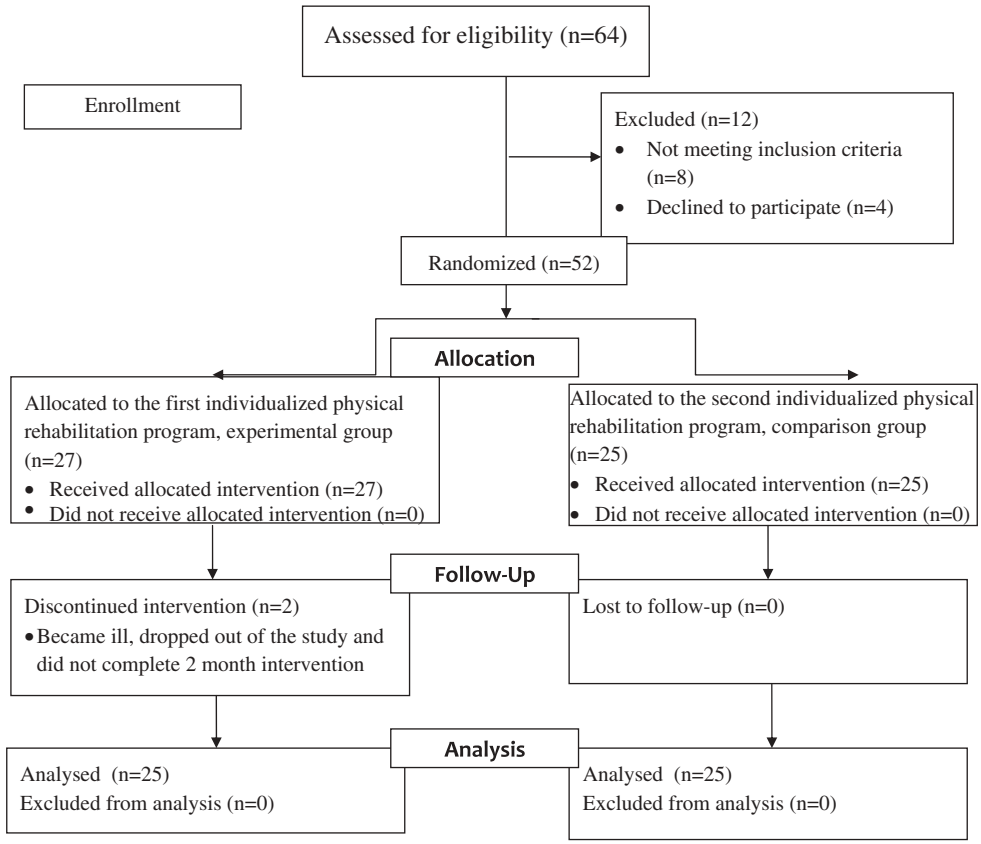

Figure 1. CONSORT flow diagram.

The research was performed at the Regional Cancer Center in Zaporizhzhya (Ukraine). The study was fulfilled in compliance with World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects. All the patients were informed about the aim of the study.

Interventions

Two individualized physical rehabilitation programs were created, one for the EG and another for the CG. The program for the EG included: aqua aerobics (i.e. aqua jogging, aqua building, aqua stretching); conditional swimming; and recreational aerobics. The program for the CG included: conditional swimming; and Pilates exercises. Both groups attended appropriate individualized physical rehabilitation programs three times per week for 48 weeks. The choice of the exercises was based on preliminary examination of the respiratory function and individual goals of the patient as well as the acceptability of the aquatic environment for exercise training of patients with PMS. According to the study hypothesis, a rational combination of land-based and aquatic exercises could lead to a significant improvement of pulmonary function in women with PMS.

These individualized physical rehabilitation programs included a reasonable choice of exercises and forms of physical activity. The exercises and forms of physical rehabilitation were selected individually for each patient in both groups. Individualization of exercises for each program was carried out based on type of ventilatory disorders (i.e. obstructive or restrictive). Application of special exercises for patients with different types of ventilation disorders was performed during certain phases of the respiratory cycle. Having identified any obstructive disorders of respiratory function, the focus was aimed at full exhalation and breath holding after the expiration phase. In the case of restrictive disorders, exercises were directed at full inspiration and increasing chest excursion. In the case of mixed type disorders, exercises were performed for both phases, with breath holding after each phase.

The experimental individualized physical rehabilitation program included: aqua aerobics (i.e. aqua jogging, aqua building, aqua stretching); conditional swimming; and recreational land aerobics. Aqua aerobics and conditional swimming were carried out in the pool with water temperature about 28–30°C. Aqua aerobics was performed at the optimum depth of the pool, that of 120–130 cm, which allowed patients to submerge in water almost all parts of the body and to load all muscle groups. The aqua aerobics consisted of aqua jogging exercises (20%), aqua building (50%), and aqua stretching (30%). Special equipment was used (e.g. noodles and aqua dumb-bells) for performing strength exercises. Exercises like underwater breathing and flotation were carried out to improve the functional state of respiratory system, as well as to ensure that it was comfortable for the participants to move around the pool. Recreational land aerobics were conducted at either low or moderate-impact as determined by the participants' health status. Exercise intensity for women ranged from 40% to 60% of heart rate reserve.

The comparison individualized physical rehabilitation program included conditional swimming and Pilates exercises practiced three times a week. The level of women's physical condition, the number of laps, power zone, the number of repetitions and exercise intensity, rest interval during planning for conditional swimming were taken into consideration. The load intensity was selected individually for each patient.

The structure of Pilates classes consisted of Pilates matwork exercises (50%), Power Pilates (20%), Pilates ball (20%), and Pilates stretch (10%). Exercise intensity for women ranged from 40% to 60% of heart rate reserve depending on the participants' health status. Each Pilates exercise session was individualized for the women with PMS but generally included a 10-min warm-up, 40 min of aerobic exercise, resistance training and stretching, and was concluded with a 10-min cool-down. Resistance and flexibility training consisted of exercises subjected to all of the major muscle groups. The training sessions were concluded with a low-intensity (<40% HRR) cool-down targeted at all major muscle groups.

Procedures

Patients were involved in their individualized programs throughout an entire calendar year. The primary outcome measure was spirometry of the patients at baseline, 6, and 12 months. Spirometry was performed with the help of SMP-21/01 RD Spirometer SMP-21/01 RD (Monitor Ltd. Co., Rostov-on-Don, Russia). Before performing spirometry, the equipment was calibrated and standard spirometry instruction was given to each patient. Examined women were tested in the seated and relaxed position wearing a nose clip with no air leaks between the mouth and the mouthpiece.

Results were recorded as both raw data (liters, liters per second) and percent predicted according to height, age, sex, and weight. Multiple maneuvers (i.e. vital capacity (VC), forced VC, and maximal voluntary ventilation (MVV)) were obtained from each patient, and the spirometry values associated with the best maneuver were inputted into the database.

The following variables were assessed: (1) VC: the largest volume measured on complete exhalation after full inspiration, expressed in liters and was performed unforced. For VC, the largest value from at least three acceptable maneuvers was recorded; (2) Forced vital capacity (FVC): the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, expressed in liters. The subject inhaled rapidly and completely from functional residual capacity while the breathing tube was inserted into the subject's mouth with lips sealed around the mouthpiece and tongue not occluding the mouthpiece; (3) Forced expiratory volume in 1 s (FEV_1): the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters. FVC and FEV_1 were measured from three forced expiratory curves that had an acceptable start of test and were free from artifact. The largest FVC and the largest FEV_1 were recorded after examining the data from all of the usable curves; (4) Peak expiratory flow (PEF): the highest flow achieved from a maximum forced expiratory maneuver started without hesitation from a position of maximal lung inflation, expressed in l/s. PEF is dependent on effort and lung volume, with subject cooperation being essential. PEF must be achieved as rapidly as possible and at as high a lung volume as possible, in order to obtain the maximum value. The subject was encouraged to blow as vigorously as possible. The neck should be in a neutral position, not flexed or extended, and the subject must not cough; (5) maximum expiratory flow at 25% of FVC (MEF_{25}): the maximum expiratory flow, when 25% of the FVC has been exhaled, expressed in l/s. Previously the subject should make a full expiratory and inspiratory loop as a single maneuver. The subject is asked to take a rapid full inspiration from room air through the mouth, then insert the mouthpiece and, without hesitation, perform an expiration with maximum force until no more air can be expelled, followed by a quick maximum inspiration. This indicator shows the patency of the large bronchi; (6) maximal expiratory flow at 50% FVC (MEF_{50}): the maximum expiratory flow, when 50% of the FVC has been exhaled, expressed in l/s. This indicator shows the patency of the medium bronchi; (7) MVV: the maximum volume of air a subject can breathe over a specified period (12 s), expressed in l/min. The subject was tested in the sitting position wearing a nose clip. After the subject makes an airtight seal around the mouthpiece, at least three resting tidal breaths should be obtained, followed by breathing as rapidly and deeply as possible; (8) Inspiratory reserve volume (IRV): the maximal volume of air inhaled from end-inspiration, expressed in liters; and (9) Expiratory reserve volume (ERV): the maximal volume of air exhaled from end-expiration, expressed in liters.

Obstructive disorders were identified only if: FEV1 < 80% predicted; and FEV1/FVC < 70%. Restrictive disorders were identified only if: FEV1 was reduced (<80% predicted normal); FVC reduced (<80% predicted normal); and FEV1/FVC ratio normal (>70%).

Statistical analysis

Data analysis was performed with the help of Statistica for Windows (version 8.00). Previously all variables were analyzed for normality by using the Shapiro-Wilk test was used. According to the Shapiro-Wilk test, if the p-value is less than the chosen alpha level ($p < 0.05$), then the null hypothesis is rejected and there is evidence that the data tested are not from a normally distributed population. Results that were not normally distributed were analyzed by the use of Mann-Whitney U-test for significant differences between the experimental and the CGs. Within-group comparisons were performed by means of the Wilcoxon signed-rank test. P values < 0.05 were considered statistically significant.

Results

Demographic and treatment-related characteristics of study participants are presented in Table 1. Two additional women dropped out of the trial from the EG, so the final number of participants was 50 (25 in each group). There were no baseline differences between the two intervention groups. The average age of the tested individuals in the experimental and CGs made up 55.44 ± 1.06 and 55.60 ± 1.14 years, respectively. Body mass index in the EG was 24.12 ± 0.42 kg/m^2, and 24.20 ± 0.44 kg/m^2 in the

Table 1. Demographic and treatment-related characteristics of study participants.

Characteristics	Experimental group (n = 25)	Comparison group (n = 25)
Age, (M±SD)	55.44 ± 1.06	55.60 ± 1.14
Race:		
White, n (%)	24 (96%)	23 (92%)
Black, n (%)	1 (4%)	2 (8%)
Married/committed relationship, n (%)	12 (48%)	13 (52%)
High school graduate, n (%)	11 (44%)	10 (40%)
College graduate, n (%)	11 (44%)	13 (52%)
Post-graduate, n (%)	3 (12%)	2 (8%)
Body mass index, kg/m^2, (M±SD)	24.12 ± 0.42	24.20 ± 0.44
Treatment:		
Radiotherapy, n (%)	21 (84%)	22 (88%)
Chemotherapy, n (%)	4 (16%)	3 (12%)
Surgery type (mastectomy by Madden), n (%)	25 (100%)	25 (100%)
Time since treatment completion, months (M±SD)	6.42 ± 2.54	6.83 ± 2.79
Cancer Stage:		
Stage 1, n (%)	10 (40%)	11 (44%)
Stage 2, n (%)	15 (60%)	14 (56%)

CG. All of the patients underwent Madden radical mastectomy followed by adjuvant radiotherapy or chemotherapy. The postsurgical period for the women in the trial was approximately 6 months.

This study demonstrated that most of the respiratory function parameters increased in both groups over the year of exercise training. Changes in the respiratory function parameters of the EG are presented in Table 2. The results presented in Table 2 show that most indicators of lung function improved significantly after 6 months of training as compared to baseline. VC improved by 270 ml ($p < 0.01$); forced expiratory volume in 1 s (FEV_1) improved by 0.16 l ($p < 0.05$); MVV improved by 11.67 l/min ($p < 0.05$); and the percent predicted value of VC, FEV_1, MEF_{25}, and MEF_{50}, improved by 8.68% ($p < 0.01$), 6.96% ($p < 0.01$), 7.72% ($p < 0.05$), and 11.36% ($p < 0.05$), respectively. All studied parameters of lung function increased significantly during the second half of the year, except for MVV.

Changes in the respiratory function parameters in the CG are presented in Table 3. The main indicators that characterized the process of expiration increased significantly after 6 months of intervention: FEV_1 improved by 0.15 l ($p < 0.01$); PEF improved by 0.64 l/s ($p < 0.001$); MEF_{25} improved by 0.60 l/s ($p < 0.001$); MEF_{50} improved by 0.57 l/s ($p < 0.001$); and the percent predicted value of these variables improved by 5.92% ($p < 0.01$), 10.88% ($p < 0.001$), 11.56% ($p < 0.001$), and 15.60% ($p < 0.001$), respectively. During the second half of the year, the actual and percent predicted value of VC increased significantly, by 0.17 l ($p < 0.01$) and 5.48% ($p < 0.01$), respectively, and those of FVC increased by 0.15 l ($p < 0.01$) and 5.24% ($p < 0.01$), respectively.

Detailed analysis of forced VC (after one year of training) showed that 80% of the EG and 52% of the CG patients had normal values. Analysis of PEF showed that it was normal for 44% of the EG and 20% of the CG patients.

Table 2. The evolution of respiratory function (M ± SD) in patients of the experimental group (EG) during the rehabilitation.

		EG (n = 25)		
Indicator, units of measurement		Beginning	Six months	One year
Vital capacity, l	Actual	2.63 ± 0.36	2.90 ± 0.45**	3.11 ± 0.43••
	% of predicted	80.92 ± 10.98	89.60 ± 15.04**	96.52 ± 3.03••
Forced vital capacity, l	Actual	2.45 ± 0.24	2.58 ± 0.41	2.97 ± 0.33•••
	% of predicted	79.36 ± 8.83	84.00 ± 15.68	97.16 ± 2.44•••
Forced expiratory volume in 1 second, l	Actual	2.26 ± 0.34	2.42 ± 0.27*	2.84 ± 0.26•••
	% of predicted	88.16 ± 13.70	95.12 ± 14.79**	112.08 ± 2.45•••
Peak expiratory flow, l/s	Actual	4.26 ± 0.56	4.67 ± 0.89	5.18 ± 0.80•••
	% of predicted	70.84 ± 10.50	78.20 ± 18.21	87.08 ± 2.99•••
Maximum expiratory $flow_{25}$, l/	Actual	3.94 ± 0.68	4.31 ± 0.81	4.71 ± 0.72••
	% of predicted	73.68 ± 12.50	81.40 ± 17.54*	89.24 ± 3.03••
Maximum expiratory $flow_{50}$, l/s	Actual	3.75 ± 0.78	4.08 ± 0.89	4.65 ± 0.64••
	% of predicted	98.76 ± 18.11	110.12 ± 23.64*	125.12 ± 4.39•••
Inspiratory reserve volume, l		1.19 ± 0.39	1.19 ± 0.33	0.98 ± 0.31••
Expiratory reserve volume, l		0.86 ± 0.44	0.91 ± 0.45	1.25 ± 0.55••
Maximal voluntary ventilation, l/min		64.77 ± 19.03	76.44 ± 20.13*	75.55 ± 11.21

Notes: *$p < 0.05$ compared with the initial data. **$p < 0.01$ compared with the initial data. •$p < 0.05$ compared with the data for 6 months. ••$p < 0.01$ compared with the data for 6 months. •••$p < 0.001$ compared with the data for 6 months.

Table 3. The evolution of respiratory function (M ± SD) in patients of the comparison group (CG) during the rehabilitation.

		CG (n = 25)		
Indicator, units of measurement		Beginning	Six months	One year
Vital capacity, l	Actual	2.49 ± 0.36	2.62 ± 0.26	2.79 ± 0.26••
	% of predicted	76.32 ± 11.78	80.40 ± 8.71	85.88 ± 11.20••
Forced vital capacity, l	Actual	2.36 ± 0.18	2.43 ± 0.17	2.58 ± 0.19••
	% of predicted	76.16 ± 8.41	78.80 ± 7.73	84.04 ± 8.57••
Forced expiratory volume in 1 s, l	Actual	2.23 ± 0.23	2.38 ± 0.19**	2.43 ± 0.19
	% of predicted	86.84 ± 11.23	92.76 ± 9.37**	95.28 ± 11.15
Peak expiratory flow, l/s	Actual	3.75 ± 0.77	4.39 ± 0.48***	4.14 ± 0.74
	% of predicted	62.16 ± 13.21	73.04 ± 8.38***	69.16 ± 12.73
Maximum expiratory $flow_{25}$, l/s	Actual	3.57 ± 0.70	4.17 ± 0.45***	3.67 ± 0.62••
	% of predicted	66.84 ± 14.11	78.40 ± 8.95***	69.28 ± 12.69••
Maximum expiratory $flow_{50}$, l/s	Actual	3.38 ± 0.78	3.95 ± 0.52***	3.85 ± 0.77
	% of predicted	89.12 ± 21.19	104.72 ± 15.37***	103.00 ± 22.22
Inspiratory reserve volume, l		1.01 ± 0.36	0.90 ± 0.32	1.01 ± 0.33
Expiratory reserve volume, l		0.70 ± 0.42	0.76 ± 0.27	0.96 ± 0.40
Maximal voluntary ventilation, l/min		61.04 ± 10.92	68.28 ± 11.79*	68.98 ± 19.28

Notes: **$p < 0.01$ compared with the initial data. ***$p < 0.001$ compared with the initial data; ••$p < 0.01$ compared with the data for 6 months. •••$p < 0.001$ compared with the data for 6 months.

Table 4. Comparison parameters of respiratory function between patients of the experimental group and comparison group during the rehabilitation.

Indicator, units of measurements		Six months		One year	
		EG (n = 25)	CG (n = 25)	EG (n = 25)	CG (n = 25)
Vital capacity, l	Actual	2.90 ± 0.45	2.62 ± 0.26**	3.11 ± 0.43	2.79 ± 0.26••
	% of predicted	89.60 ± 15.04	80.40 ± 8.71**	96.52 ± 3.03	85.88 ± 11.20••
Forced vital capacity, l	Actual	2.58 ± 0.41	2.43 ± 0.17	2.97 ± 0.33	2.58 ± 0.19••
	% of predicted	84.00 ± 15.68	78.80 ± 7.73	97.16 ± 2.44	84.04 ± 8.57••
Forced expiratory volume in 1 s, l	Actual	2.42 ± 0.27	2.38 ± 0.19	2.84 ± 0.26	2.43 ± 0.19••
	% of predicted	95.12 ± 14.79	92.76 ± 9.37	112.08 ± 2.45	95.28 ± 11.15••
Peak expiratory flow, l/s	Actual	4.67 ± 0.89	4.39 ± 0.48	5.18 ± 0.80	4.14 ± 0.74••
	% of predicted	78.20 ± 18.21	73.04 ± 8.38	87.08 ± 2.99	69.16 ± 12.73••
Maximum expiratory flow $_{25}$, l/s	Actual	4.31 ± 0.81	4.17 ± 0.45	4.71 ± 0.72	3.67 ± 0.62••
	% of predicted	81.40 ± 17.54	78.40 ± 8.95	89.24 ± 3.03	69.28 ± 12.69••
Maximum expiratory flow $_{50}$, l/s	Actual	4.08 ± 0.89	3.95 ± 0.52	4.65 ± 0.64	3.85 ± 0.77••
	% of predicted	110.12 ± 23.64	104.72 ± 15.37	125.12 ± 4.39	103.00 ± 22.22••
Inspiratory reserve volume, l		1.19 ± 0.33	0.90 ± 0.32**	0.98 ± 0.31	1.01 ± 0.33
Expiratory reserve volume, l		0.91 ± 0.45	0.76 ± 0.27	1.25 ± 0.55	0.96 ± 0.40•
Maximal voluntary ventilation, l/min		76.44 ± 20.13	68.28 ± 11.79	75.55 ± 11.21	68.98 ± 19.28

Notes: **$p < 0.01$ compared with the data of the experimental group and the comparison group in 6 months; •$p < 0.05$; ••$p < 0.01$ compared with the data of the experimental group and the comparison group in 12 months.

Comparison of the respiratory function parameters between patients of the EG and the CG during the rehabilitation is presented in Table 4. Comparison of respiratory function between the EG and the CG during the 6 months period showed significant differences for some of them. In particular, the actual values of VC and IRV were greater in the EG women by 280 and 290 ml ($p < 0.01$), respectively, as compared with the CG. The individualized physical rehabilitation program in the EG produced advantageous effect on all the respiratory function variables after one year of training as compared with the CG, with the exception of the IRV, and MVV, which were not statistically different.

Discussion

Results from this randomized controlled trial indicated that individualized physical rehabilitation programs targeted at improving the function of the respiratory system could produce a feasible therapeutic effect upon females with PMS. Improvement in respiratory function for patients with PMS is important, and aquatic exercise is a suitable option for breast cancer survivors to reduce breast cancer-related lymphedema (Ambroza and Geigle, 2010); arthralgia (Cantarero–Villanueva et al, 2013a); and fatigue (Cantarero–Villanueva et al, 2013b). Although water-based exercise is frequently encouraged, relatively little research has been conducted in this area as compared to land-based exercise and combined land and water based programs.

A considerable body of research, including clinical trials and meta-analysis, indicates that exercise may be an effective non-pharmacological method of attenuating the harmful effects of breast cancer therapies on the cardiovascular system, fatigue, and cancer-related lymphedema. Supervised, combined aerobic-resistance exercise shows positive results of reducing fatigue for breast cancer patients (Lipsett et al., 2017; Meneses-Echávez, González-Jiménez, and Ramírez-Vélez, 2015). Application of resistance exercise training produces significant gains in muscular strength for breast cancer survivors (Nelson, 2016).

Some studies have examined cardiopulmonary parameters and aerobic exercise training in breast cancer survivors (Anulika, Akinbo and Olawale, 2015; Yu and Jones, 2016). Differences in exercise training methods and outcome variables make it somewhat difficult to make direct comparisons between studies and the current study. Previous studies suggested aerobic training frequencies of 2–3 sessions per week, with different durations and intensities. The results of Baumann et al. (2016) and Cantarero-Villanueva et al. (2013a) suggest that conducting training over 8 weeks may reduce pain and waist circumference in breast cancer.

The current study applied low and moderate impact aerobic exercises according to the individual participants' health status in the pool and gym. Exercise intensity for women ranged from 40% to 60% of heart rate reserve. In accordance with the data obtained, conclusions could be drawn that the patients bronchial patency, forced VC, forced expiratory volume in 1 s, PEF, IRV, ERV, and MVV improved significantly, thus having ameliorated all the functions of the respiratory system. The results suggest that individual exercise programs of moderate intensity improve pulmonary function.

Limitations

Even though the results are very encouraging, our study is not devoid of limitations. For one thing, the sample involved in our research study was small and only included female participants from the Ukraine, thus

limiting the possibility to make generalization to other populations. In addition, the study was conducted in just one institution, therefore institutional bias might limit the generalization of the results obtained. Finally, the results obtained cannot fully explain the changes in pulmonary function, because our study lacked a control group that received no intervention. In addition, minor differences in the lifestyle and genetic factors of the women studied could have influenced the results obtained.

Conclusions

Thus, the results of the study suggest that individual programs of physical rehabilitation could be considered effective for the improvement of respiratory function of the patients with PMS. The results obtained could serve as a basis for more widespread clinical program development.

Declaration of interest

The authors declare that there is no conflict of interest.

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