



Original



## Comparative effectiveness of Yoga and Pilates intervention on respiratory function of patients with breast cancer

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### ABSTRACT

**Objective:** Most modern breast cancer treatments are shown to be effective in terms of survival but lead to side effects such as dysfunction of the upper limb, lymphedema, pain syndrome, plexitis, cardiotoxicity, fatigue, and pulmonary complications. Applied radiotherapy enhances the number of side effects that patients with breast cancer experience over a long period. The aim of this study was to compare effectiveness of Hatha Yoga and Pilates interventions on respiratory function in patients with breast cancer.

**Methods:** 95 women completed the interventions and were included in the final analysis. The participants, staged I-II, were randomly assigned to 2 groups. Group A (n = 48, 57.53 ± 1.92 years) received Hatha Yoga intervention and group B (n = 47, 58.00 ± 1.27 years) received Pilates intervention. Both programs were conducted for 12 weeks, with three 60-min sessions per week. Spirometry was used to measure pre- and post-intervention functional capacity of the respiratory system.

**Results:** Significant differences (p<0.05) were found in Vital Capacity, Forced Vital Capacity, Peak Expiratory Flow, Maximum Expiratory Flow25, Expiratory Reserve Volume and Maximal Voluntary Ventilation in Hatha Yoga group compared with Pilates group. There was no significant difference between both groups in Force Expiratory Volume and Maximum Expiratory Flow50 (p>0,05)

**Conclusions:** Hatha Yoga and Pilates interventions are both effective in respiratory function, but Hatha Yoga turns out more beneficial.

**Keywords:** Breast cancer; Respiratory system; Yoga; Pilates

## Efectividad de la intervención de Yoga vs Pilates en la función respiratoria de pacientes con cáncer de mama

### RESUMEN

**Objetivo:** La mayoría de los tratamientos modernos contra el cáncer de mama han demostrado ser efectivos en términos de supervivencia, pero provocan efectos secundarios como disfunción del miembro superior, linfedema, síndrome de dolor, plexitis, cardiotoxicidad, fatiga y complicaciones pulmonares. La radioterapia aplicada aumenta la cantidad de efectos secundarios que experimentan los pacientes con cáncer de mama durante un período prolongado. El objetivo de este estudio fue comparar la efectividad de las intervenciones de Hatha Yoga y Pilates sobre la función respiratoria en pacientes con cáncer de mama.

**Métodos:** 95 mujeres completaron las intervenciones y fueron incluidas en el análisis final. Los participantes, estadios I-II, fueron asignados aleatoriamente a 2 grupos. El grupo A (n = 48, 57.53 ± 1.92 años) recibió intervención de Hatha Yoga y el grupo B (n = 47, 58.00 ± 1.27 años) recibió intervención de Pilates. Ambos programas se realizaron durante 12 semanas, con tres sesiones de 60 min por semana. La espirometría se utilizó para medir la capacidad funcional del sistema respiratorio antes y después de la intervención.

**Resultados:** Se encontraron diferencias significativas (p<0.05) en Capacidad Vital, Capacidad Vital Forzada, Flujo Espiratorio Pico, Flujo Espiratorio Máximo25, Volumen de Reserva Espiratorio y Ventilación Voluntaria Máxima en el grupo de Hatha Yoga comparado con el grupo de Pilates. No hubo diferencia significativa entre ambos grupos en Volumen Espiratorio Forzado y Flujo Espiratorio Máximo50 (p>0.05).

**Conclusiones:** Las intervenciones de Hatha Yoga y Pilates son efectivas en la función respiratoria, pero Hatha Yoga resulta más beneficiosa.

**Palabras clave:** Cáncer de mama; Sistema respiratorio; Yoga; Pilates

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## Eficácia comparativa da intervenção de Yoga e Pilates na função respiratória de pacientes com câncer de mama

### RESUMO

**Objetivo:** A maioria dos tratamentos modernos de câncer de mama se mostram eficazes em termos de sobrevida, mas levam a efeitos colaterais como disfunção do membro superior, linfedema, síndrome da dor, plexite, cardiotoxicidade, fadiga e complicações pulmonares. A radioterapia aplicada aumenta o número de efeitos colaterais que as pacientes com câncer de mama experimentam por um longo período. O objetivo deste estudo foi comparar a eficácia das intervenções Hatha Yoga e Pilates na função respiratória em pacientes com câncer de mama.

**Métodos:** 95 mulheres completaram as intervenções e foram incluídas na análise final. Os participantes, estágio I-II, foram distribuídos aleatoriamente em 2 grupos. O grupo A (n = 48, 57.53 ± 1.92 anos) recebeu intervenção de Hatha Yoga e o grupo B (n = 47, 58.00 ± 1.27 anos) recebeu intervenção de Pilates. Ambos os programas foram realizados durante 12 semanas, com três sessões de 60 minutos por semana. A espirometria foi utilizada para medir a capacidade funcional pré e pós-intervenção do sistema respiratório.

**Resultados:** Foram encontradas diferenças significativas (p<0.05) na Capacidade Vital, Capacidade Vital Forçada, Pico de Fluxo Expiratório, Fluxo Expiratório Máximo25, Volume Expiratório de Reserva e Ventilação Voluntária Máxima no grupo Hatha Yoga comparado ao grupo Pilates. Não houve diferença significativa entre os dois grupos no Volume Expiratório de Força e Fluxo Expiratório Máximo50 (p>0.05).

**Conclusões:** As intervenções de Hatha Yoga e Pilates são eficazes na função respiratória, mas Hatha Yoga se mostra mais benéfica.

**Palavras-chave:** Câncer de mama; Sistema respiratório; Yoga; Pilates

### Introduction

Modern data underline the rise in the number of women with breast cancer.<sup>1</sup> Most modern oncological treatment methods are shown to be effective in terms of survival but lead to side effects such as dysfunction of the upper limb, lymphedema, pain syndrome, plexitis, cardiotoxicity, fatigue, and pulmonary complications, fatigue, and pulmonary complications induced by adjuvant cancer therapies.<sup>2-4</sup> Furthermore, applied radiotherapy enhances the number of side effects that patients experience over a long period,<sup>5</sup> which necessitates the development of differentiated physical rehabilitation aimed at preventing post-treatment complications and improving the functional state of the cardiovascular system.

Numerous studies have shown that thoracic radiotherapy in patients with breast cancer might lead to significant impairment in functional capacity of respiratory system (chest mobility restriction, muscle weakness, dyspnea, impaired lung diffusion) and exercise performance,<sup>6-8</sup> which is imperative to consider when developing a rehabilitation program.

Previous studies have emphasized the significant role of different interventions in improving functional capacity in breast cancer patients. These interventions include aerobic exercises,<sup>2</sup> Pilates exercises,<sup>10</sup> yoga exercises,<sup>11-15</sup> and combined aerobic and resistance exercise programs.<sup>16,17</sup> 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.<sup>18-21</sup>

To date, there are publications that show the positive role of Pilates in improving the respiratory function in patients with multiple sclerosis<sup>22</sup> and cardiorespiratory parameters in healthy sedentary women with low respiratory capacities.<sup>23</sup> Contemporary publications also show that regular Yoga practice increases the vital capacity, timed vital capacity, maximum voluntary ventilation, breath holding time and maximal inspiratory and expiratory pressures in yoga practitioners<sup>24</sup> and lung cancer patients.<sup>25</sup> The aim of this study was to compare effectiveness of Hatha Yoga and Pilates interventions separately on respiratory function in patients with breast cancer.

### Methods

#### Participants

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). 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. Overall, 95 women completed the interventions and were included in the final analysis (Figure 1).

Subject characteristics and breast cancer stage 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).

**Table 1.** Demographic and clinical characteristics of the participants

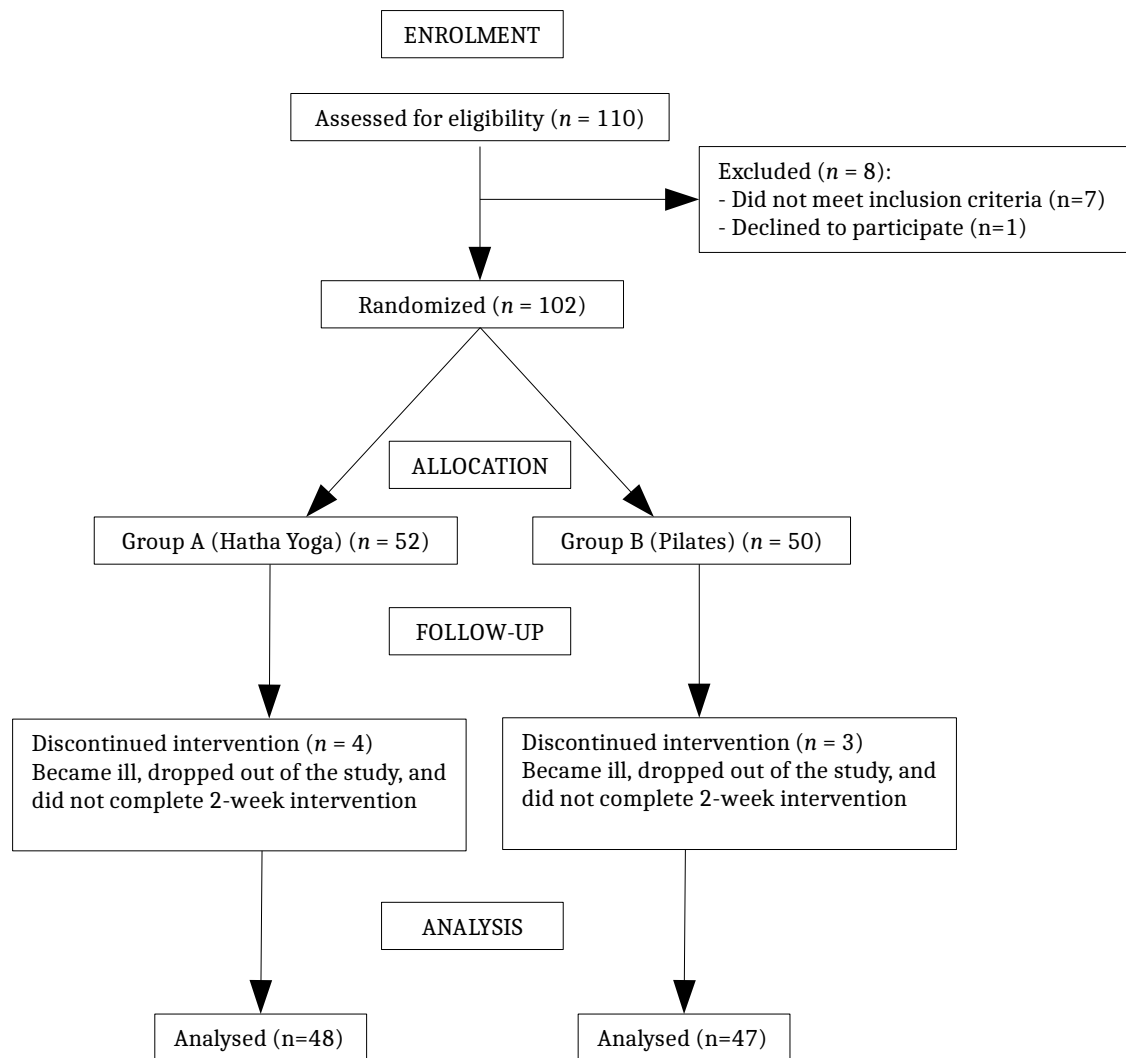
Characteristics	Groups		P
	A (n = 48)	B (n = 47)	
Age, years (M ± SD)	57.53±1.92	58.00±1.27	> 0.05
Race	White, n (%)	46 (96)	45 (96)
	Black, n (%)	2 (4)	2 (4)
Body mass index, kg/m <sup>2</sup> (M ± SD)	24.23±0.38	24.25±0.38	> 0.05
Weeks since surgery treatment completion (M± SD)	3.23 ± 1.17	3.25 ± 1.19	> 0.05
Cancer stage	1, n (%)	8 (17)	9 (19)
	2, n (%)	40 (83)	38 (81)

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

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#### Procedure

The independent researcher who administered the spirometry was blinded to the group assignment of the participants. Spirometry was used to measure pre- and post-intervention



**Figure 1.** CONSORT flow diagram of the study

respiratory function. Spirometry was performed with the help of SMP-21/01 RD Spirometer SMP-21/01 RD (Monitor Ltd. Co., Rostov-on-Don, Russia). The following variables were assessed:

- Vital Capacity (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.

- 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.

- 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.

- 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.

- Maximum Expiratory Flow at 25% of FVC (MEF25): the maximum expiratory flow, when 25% of the FVC has been exhaled.

- Maximal Expiratory Flow at 50% FVC (MEF50): the maximum expiratory flow, when 50% of the FVC has been exhaled.

- Maximum Volume of Ventilation (MVV): the maximum volume of air a subject can breathe over a specified period.

- Inspiratory Reserve Volume (IRV): the maximal volume of air inhaled from end-inspiration.

- Expiratory Reserve Volume (ERV): the maximal volume of air exhaled from end-expiration, expressed.

Heart rate control mode during hatha yoga and Pilates sessions were monitored using a tracker Polar.

#### Interventions

The participants of group A and group B performed both programs for 12 weeks, with three 60-min sessions per week. Exercise intensity was individualized for the patients and varied from 50% to 60%. Heart rate control mode during hatha yoga and Pilates sessions. Both interventions took place at the Zaporizhzhya Regional Cancer Centre and were performed by the same certified yoga and Pilates therapist. Each session of yoga intervention consisted of several continuous poses (static, dynamic, statodynamic, 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

**Table 2.** Dynamics of respiratory function in the studied groups

Indicator	Group A (n = 48)		Group B (n = 47)		
		Beginning	3-month intervention	Beginning	3-month intervention
Vital capacity, l	Actual	2.58±0.04	2.83±0.07**	2.51±0.08	2.60±0.07
	% of predicted	79.72±1.98	85.92±2.09*	78.00±2.73	79.82±2.20
Forced vital capacity, l	Actual	2.50±0.02	2.65±0.04**	2.47±0.04	2.48±0.03
	% of predicted	79.12±1.41	83.36±1.51*	79.68±1.70	79.96±1.68
Forced expiratory volume in 1 second, l	Actual	1.97±0.07	2.36±0.06***	1.96±0.05	2.23±0.04***
	% of predicted	79.90±3.28	89.16±2.74**	79.35±2.07	89.91±2.24**
Peak expiratory flow, l/sec	Actual	3.86±0.13	4.66±0.16**	3.74±0.17	3.75±0.15
	% of predicted	63.88±2.13	72.84±2.70*	61.96±2.96	62.16±2.64
Maximum expiratory flow 25, l/sec	Actual	3.52±0.14	3.99±0.13*	3.48±0.16	3.57±0.14
	% of predicted	65.72±2.46	76.68±2.50**	65.04±3.16	66.84±2.82
Maximum expiratory flow 50, l/sec	Actual	3.42±0.12	3.75±0.15	3.39±0.14	3.40±0.15
	% of predicted	90.00±3.24	98.76±3.62	89.72±3.93	89.82±4.23
Inspiratory reserve volume, l		1.11±0.03	1.19±0.07	0.99±0.06	1.11±0.07
Expiratory reserve volume, l		0.70±0.03	0.96±0.08**	0.88±0.12	0.70±0.08
Maximal voluntary ventilation, l/min		58.86±1.52	67.77±2.40*	64.61±3.15	61.04±2.18

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001 for the data in groups A and B after intervention; VC – Vital capacity, FVC – Forced vital capacity, FEV1 – Forced expiratory volume in 1 second, PEF – Peak expiratory flow, MEF25 – Maximum expiratory flow 25, l/sec, MEF50 – Maximum expiratory flow 50, IRV – Inspiratory reserve volume, ERV – Expiratory reserve volume, MVV – Maximal voluntary ventilation.

**Table 3.** A comparison of post-intervention score averages of the spirometry indicators between the groups

Indicator	Group A (n = 48)		Group B (n = 47)		p
		3-month intervention	3-month intervention		
Vital capacity, l	Actual	2.83±0.07	2.60±0.07	<0.05	
	% of predicted	85.92±2.09	79.82±2.20	<0.05	
Forced vital capacity, l	Actual	2.65±0.04	2.48±0.03	<0.05	
	% of predicted	83.36±1.51	79.96±1.68	<0.05	
Forced expiratory volume in 1 second, l	Actual	2.36±0.06	2.23±0.04	>0.05	
	% of predicted	89.16±2.74	89.91±2.24	>0.05	
Peak expiratory flow, l/sec	Actual	4.66±0.16	3.75±0.15	<0.05	
	% of predicted	72.84±2.70	62.16±2.64	<0.05	
Maximum expiratory flow 25, l/sec	Actual	3.99±0.13	3.57±0.14	<0.05	
	% of predicted	76.68±2.50	66.84±2.82	<0.05	
Maximum expiratory flow 50, l/sec	Actual	3.75±0.15	3.40±0.15	>0.05	
	% of predicted	98.76±3.62	89.82±4.23	>0.05	
Inspiratory reserve volume, l		1.19±0.07	1.11±0.07		
Expiratory reserve volume, l		0.96±0.08	0.70±0.08	<0.05	
Maximal voluntary ventilation, l/min		67.77±2.40	61.04±2.18	<0.05	

VC – Vital capacity, FVC – Forced vital capacity, FEV1 – Forced expiratory volume in 1 second, PEF – Peak expiratory flow, MEF25 – Maximum expiratory flow 25, l/sec, MEF50 – Maximum expiratory flow 50, IRV – Inspiratory reserve volume, ERV – Expiratory reserve volume, MVV – Maximal voluntary ventilation.

positions (40 min), and relaxation exercises in lying position (10 min).

To improve the functional state of the respiratory system, 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.).

Group B participants performed a Pilates program that included Pilates matwork exercises (30 min), Power Pilates (10 min), Pilates ball (10 min), and Pilates stretch (10 min). 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.

*Statistical Analysis*

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 respiratory changes for each group. Independent t-tests served to compare post-intervention respiratory parameters between group A and group B.

**Results**

All indicators of respiratory function were equivalent in the study groups at the beginning of the rehabilitation. Thus, the

groups were homogeneous at the start of the study. Dynamics of respiratory function in the studied groups is presented in [Table 2](#).

As presented in [Table 2](#), the dependent and independent t-test analysis revealed that in group A there was a significant increase in the functional state of the respiratory system.

Post-intervention impact (p < 0.05) in patients of group B was noted only by the forced expiratory volume in 1 second that significantly increased by 0.27 l. Applying the 3-month hatha yoga intervention, a significant increase was observed in group A: in vital capacity by 0.25 l (p < 0.01), in forced vital capacity by 0.15 l (p < 0.01), in forced expiratory volume in 1 second by 0.39 l (p < 0.001), in peak expiratory flow by 0.80 l/sec (p < 0.01), in maximum expiratory flow 25 by 0.47 l/sec (p < 0.05), in expiratory reserve volume by 0.26 l (p < 0.01) and in maximal voluntary ventilation by 8.91 l (p < 0.05). The predicted values of vital capacity improved significantly in patients of group A by 6.20% (p < 0.05), forced vital capacity by 4.24% (p < 0.01), forced expiratory volume in 1 second by 9.26% (p < 0.01), peak expiratory flow by 8.96 % (p < 0.05), maximum expiratory flow 25 by 10.96 % (p < 0.01) respectively. A comparison of post-intervention score averages of the spirometry indicators between the groups is presented in [Table 3](#).

The actual values of vital capacity, forced vital capacity, peak expiratory flow, maximum expiratory flow 25, expiratory reserve volume and maximal voluntary ventilation were significantly higher in group A compared with group B participants: by 0.23 l (p < 0.05), by 0.17 l (p < 0.05), 0.91 l/sec (p < 0.05), 0.42 l/sec (p < 0.05), 0.26 l (p < 0.05) and 6.73 l/min respectively. The predicted values of vital capacity was significantly higher in group A compared with group B patients by 6.10% (p < 0.05), forced vital capacity by 3.4% (p < 0.01), peak expiratory flow by 10.68% (p < 0.05), maximum expiratory flow 25 by 9.84 % (p < 0.01) respectively. No differences were found in FEV and MEF50 between groups after intervention.

## Discussion

The study was conducted to assess the impact of Hatha Yoga intervention on the functional state of the respiratory system in patients after breast cancer surgery. It was found a positive effect of Hatha Yoga on respiratory function in patients with breast cancer. Most antecedent yoga intervention for patients with breast cancer have been organized to reduce cancer treatment-related symptoms such as fatigue,<sup>21</sup> functional state of the upper limb,<sup>11,26</sup> peripheral muscle strength,<sup>27</sup> lymphedema,<sup>28</sup> depression, anxiety,<sup>18</sup> and health-related quality of life.<sup>29</sup> Some previous studies have identified that yoga considerably impacts on cardiorespiratory fitness and strength in healthy adults,<sup>14,24</sup> but Hatha Yoga effect on functional capacity of the respiratory system in breast cancer Ukrainian patients has not been reported.

The current results demonstrated significant positive effects of the Hatha Yoga intervention on increasing vital capacity, in forced vital capacity, forced expiratory volume in 1 second, peak expiratory flow, maximum expiratory flow<sup>25</sup>, expiratory reserve volume and in maximal voluntary ventilation. 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. Despite the positive results, our study has some limitations. 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.

As conclusion, in the face of these results, we consider that the Hatha Yoga intervention was more effective than Pilates, with a favourable impact on functional capacity of the respiratory system in women after breast cancer surgery. Yoga exercises are a safe and effective intervention for patients with breast cancer.

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