ORIGINAL ARTICLE

Enhancing respiratory function through Yoga and Pilates in women aged 45-50

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Abstract

Background and Study Aim: Respiratory function in women aged 45-50 often declines due to natural physiological changes associated with aging. These changes include reduced lung elasticity, decreased diaphragm efficiency, and a general reduction in physical activity. The purpose of this study was to assess the impact of a combined yoga and Pilates program on respiratory function in women aged 45-50.

Material and Methods: The study involved 38 women with an average age of 47.7 ± 2.5 years. A pedagogical experiment was conducted over six months. The experimental group (n=19) participated in a training regimen focused on improving respiratory function through a combination of yoga and Pilates. The control group (n=19) followed a yoga-based training program. Both groups completed an equal number of sessions—72 in total. The external respiratory function of the participants was assessed using spirometry at two key points: at the beginning of the study and after six months.

Results: The comparison of respiratory function indicators between the experimental and control groups after 6 months of training revealed significant differences across most parameters. The actual value of Vital Capacity was significantly greater in the experimental group compared to the control group by 0.17 L ($p < 0.01$), forced vital capacity by 0.30 L ($p < 0.01$), forced expiratory volume by 0.19 L ($p < 0.01$), peak expiratory flow by 0.23 L/sec ($p < 0.01$), maximum expiratory flow at 25% of Forced Vital Capacity by 0.96 L/sec ($p < 0.001$), maximum expiratory flow at 50% of Forced Vital Capacity by 0.59 L/sec ($p < 0.001$), expiratory reserve volume by 0.47 L ($p < 0.001$), and maximal voluntary ventilation by 17.00 L/min ($p < 0.001$).

Conclusions: The combined Yoga and Pilates training regimen was more effective in improving external respiratory function than Yoga alone. This result highlights the benefits of an integrated approach to respiratory health for women aged 45-50. The study demonstrates the potential advantages of combining different types of exercise to counteract age-related declines in respiratory function. Such programs could play a significant role in promoting overall well-being in this age group.

Keywords: respiratory impairments, functional state, respiratory function, preventive training

Introduction

Respiratory function in women aged 45-50 often declines due to natural physiological changes associated with aging. These changes include reduced lung elasticity, decreased diaphragm efficiency, and a general reduction in physical activity. Lifestyle factors can further worsen this decline. Sedentary behavior and the onset of menopausal symptoms may contribute to respiratory issues and a decrease in overall quality of life.

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Modern research shows that aging is linked to decreased lung capacity, reduced chest wall compliance, and weaker respiratory muscles. These changes result in diminished oxygen intake and a higher risk of respiratory conditions [1, 2]. This problem is especially evident in women going through menopause. Hormonal changes during this period can intensify respiratory challenges, further impacting their health and well-being [3, 4, 5].

Yoga and Pilates have emerged as effective interventions for enhancing respiratory function. They are particularly beneficial due to their emphasis on breath control, posture, and core stability [6]. Recent research has highlighted the potential of mind-

body practices, such as yoga and Pilates, to improve respiratory function through controlled breathing, core strengthening, and flexibility exercises [7]. Yoga incorporates pranayama (breathing exercises) that directly target respiratory efficiency. In contrast, Pilates focuses on core stability and posture, which indirectly supports better respiratory mechanics. Studies have shown that regular practice of pranayama can significantly improve lung capacity, respiratory endurance, and overall breathing efficiency [8, 9]. Pilates, with its focus on controlled movements, posture alignment, and diaphragmatic breathing, can enhance respiratory mechanics by strengthening the respiratory muscles [10]. Additionally, Pilates has been shown to increase thoracic mobility and improve diaphragm efficiency, leading to better oxygenation and reduced respiratory effort during physical activity [11].

The Pilates method is widely used in health clinics, where professionals employ it to support voluntary control of heart rate variability, enhance body control, improve posture, and stabilize core muscles during dynamic activities. It also contributes to overall physical and mental well-being [12, 13]. Although Pilates is commonly practiced for managing various conditions [14, 15, 16], its full potential and applications remain somewhat unclear. Both Yoga and Pilates generally offer a holistic approach that integrates physical, mental, and emotional well-being, making them especially beneficial for this demographic [17, 18].

Despite the recognized potential of these practices, there is a noticeable gap in the literature specifically examining the combined effects of yoga and Pilates on respiratory function in women aged 45-50. Most existing studies focus on the impact of these practices individually, yet the synergy between yoga's emphasis on breathing exercises and Pilates' focus on core strength and posture may offer unique benefits. This lack of research leaves an important question unanswered: could a combined approach provide superior improvements in respiratory function compared to each practice alone? Addressing this gap is crucial for developing more effective intervention programs that can better support the respiratory health and overall well-being of women in this demographic.

The hypothesis of this study is that a combined regimen of Yoga and Pilates training over a six-month period will lead to greater improvements in respiratory function compared to a regimen of Yoga alone in women aged 45-50 years.

The purpose of this study was to assess the impact of a combined yoga and Pilates program on respiratory function in women aged 45-50.

Materials and Methods

Participants

The study involved 38 women who participated in a pedagogical experiment conducted over six months. The average age of the participants was 47.7 ± 2.5 years. The experimental group consisted of 19 women who followed a training regimen aimed at improving respiratory function (Yoga+Pilates group). The control group also included 19 women who participated in a yoga-based training program. Both groups attended an equal number of sessions: 72 classes for the combined Yoga and Pilates program in the experimental group and 72 classes for yoga in the control group. All participants provided written informed consent after being thoroughly briefed on the study's purpose, procedures, and their right to withdraw at any time. The study received approval from the Bioethics Committee for Clinical Research and adhered to the principles of the Declaration of Helsinki.

Research Design

The pedagogical experiment was conducted over six months. Both the experimental and control groups received identical training in general and specific physical fitness. The key difference was the inclusion of combined yoga and Pilates exercises in the experimental group. These exercises were individually tailored based on the participants' specific needs and the functional state of their respiratory systems. The program design considered the initial functional capabilities of the participants, allowing for adjustments in the volume and intensity of physical activities. To improve the functional condition of the autonomic nervous system in the experimental group, the program incorporated specialized Pilates exercises and regulated breathing techniques. These were aimed at balancing the parasympathetic and sympathetic nervous systems. The selection of exercises was specifically tailored to address participants' tendencies toward either obstructive or restrictive respiratory impairments.

The combined yoga and Pilates sessions were conducted three times a week for one hour over a three-month period. Each session was structured into three parts: a preparatory phase (10 minutes), a main phase (40 minutes), and a final phase (10 minutes). The intensity of the exercises was progressively increased from 40-45% to 60-70% of the reserve heart rate, adjusted to match the participants' functional capabilities.

The preparatory phase aimed to prepare the respiratory system and muscles for the main exercises, focusing on enhancing lung capacity and control over breathing. The exercises included Tadasana with arm circles, performed slowly to foster a deep connection between breath and movement, with an emphasis on prolonged exhalation. The Pilates shoulder bridge was also used, engaging the core muscles while emphasizing controlled breathing. Additionally, Surya Namaskar served as a gentle flow that warmed up the body and

synchronized movement with breath, preparing the respiratory system for more intensive exercises.

The main part combined key elements of Pilates and yoga to enhance external respiratory function through physical and breathing exercises. The exercises included:

- The Hundred: Engaged the deep stabilizing muscles of the core while focusing on deep, rhythmic breathing.
- Single-Leg Stretch: Improved coordination of breath with movement and enhanced breath control.
- Virabhadrasana Series: Strengthened the lower body while promoting diaphragmatic breathing.
- Bhujangasana with Spinal Flexion: Opened the chest and improved lung capacity through deep inhalations.
- Spine Twist: Encouraged thoracic mobility and better lung expansion.
- Vrksasana with Arm Lift: Enhanced balance and incorporated slow, deep breathing for better breath control.
- Side-Lying Leg Lift: Focused on stability and breath coordination.

The final part focused on relaxation and breathing exercises tailored to individual needs based on autonomic nervous system activity. The exercises included:

- Alternate Nostril Breathing: Promoted balance between the sympathetic and parasympathetic nervous systems, enhancing respiratory efficiency.
- Supta Baddha Konasana: Relaxed the body and encouraged deep, diaphragmatic breathing.
- Savasana with Guided Breathing: Focused on deep, slow exhalation to promote relaxation and optimize lung function.

For participants showing signs of restrictive impairments, the emphasis was on vigorous inhalations and breath-holding during the inhalation phase to stimulate the respiratory system. For those with obstructive impairments, the focus was on extended, controlled exhalations and breath-holding during exhalation to calm the nervous system and improve breath control.

The program progressively integrated movements and breathing techniques to prevent fatigue and maintain motivation. Each session was designed to harmonize breath with movement, ensuring that every exercise contributed to the overall goal of improving respiratory function. The external respiratory function of the participants was assessed using spirometry at two key points: at the beginning of the study (before the start of the experimental program) and after six months of regular yoga and Pilates sessions. Before performing spirometry, the equipment was calibrated, and standard spirometry instructions were provided to each participant.

The following spirometry parameters were measured using the SpiroCom device (XAI-Medica, Kharkov, Ukraine):

- Vital Capacity (VC): The total volume of air that can be forcibly exhaled after full inhalation.
- Forced Vital Capacity (FVC): The total volume of air that can be forcibly exhaled after full inhalation.
- Forced Expiratory Volume in 1 second (FEV1): The volume of air exhaled in the first second of a forced breath.
- Peak Expiratory Flow (PEF): The maximum speed of exhalation, reflecting the ability of the airways to conduct airflow rapidly.
- Forced Expiratory Flow (FEF25-50%): The average flow rate during the middle half of the FVC maneuver, which is sensitive to changes in the large and medium bronchi.
- Maximum Voluntary Ventilation (MVV): The greatest amount of air that can be inhaled and exhaled within one minute of voluntary effort.
- Inspiratory Reserve Volume (IRV): The additional volume of air that can be inhaled with maximum effort after a normal inhalation.
- Expiratory Reserve Volume (ERV): The additional volume of air that can be exhaled forcefully after the end of a normal exhalation.

After six months of consistent training, a follow-up spirometry test was conducted to evaluate the impact of the integrated yoga and Pilates regimen on the participants' respiratory function.

Statistical Analysis

The analysis of the collected experimental data was performed using Statistica software for Windows (version 10.00). Initially, the data were assessed for normal distribution, homogeneity, and the presence of outliers. The Shapiro-Wilk test was used to verify the normality of the data distribution. This preliminary evaluation was conducted before proceeding with parametric tests for assessing differences. To analyze changes in respiratory parameters within a group from baseline to post-intervention, a paired t-test was applied. For comparing post-intervention heart rate variability parameters between the two groups, independent sample t-tests were used. A p-value of less than 0.05 was considered statistically significant.

Results

This study demonstrated that most respiratory function parameters improved in both groups over the six months of training. The changes in respiratory function parameters for the experimental and control groups are presented in Table 1.

The results presented in Table 1 demonstrate that most lung function indicators in the experimental group improved significantly after six months of combined Yoga and Pilates training

Table 1. Changes in the respiratory function parameters of the experimental and control groups during the study

Indicator, units of measurement		Experimental group (n=19)		P-level	Control group (n=19)		P-level
		Beginning	6 months		Beginning	6 months	
Vital capacity, l	Actual	2.61±0.08	2.88±0.16**	<0.001	2.59±0.13	2.71±0.17	<0.01
	% of predicted	78.68±4.10	92.26±5.66	<0.001	78.33±3.97	87.22±6.59	<0.01
Forced vital capacity, l	Actual	2.38±0.09	2.74±0.21**	<0.001	2.39±0.10	2.44±0.29	>0.05
	% of predicted	79.99±2.88	87.44±3.69	<0.001	80.01±2.78	82.44±3.55	>0.05
Forced expiratory volume in 1 second, l	Actual	2.07±0.09	2.29±0.14**	<0.001	2.07±0.09	2.10±0.16	>0.05
	% of predicted	83.38±4.29	92.77±5.64*	<0.001	83.38±5.29	84.77±6.54	>0.05
Peak expiratory flow, l/sec	Actual	3.27±0.29	4.82±0.32**	<0.001	3.27±0.35	3.99±0.33	<0.001
	% of predicted	57.88±6.61	72.77±7.28*	<0.001	57.88±1.61	66.78±2.17	<0.05
Maximum expiratory flow 25, l/sec	Actual	2.90±0.08	3.91±0.17***	<0.001	2.90±0.08	2.95±0.18	>0.05
	% of predicted	56.52±4.58	74.87±5.42***	<0.001	56.52±5.58	58.86±6,14	>0.05
Maximum expiratory flow 50, l/sec	Actual	2.83±0.17	3.48±0.21***	<0.001	2.83±0.19	2.89±0.23	>0.05
	% of predicted	79.20±6.25	95.96±7.31***	<0.001	79.20±7.25	81.96±9.84	>0.05
Inspiratory reserve, volume, l		1.12±0.13	1.23±0.29	>0.05	1.12±0.13	1.35±0.28	<0.05
Expiratory reserve volume, l		0.70±0.13	1.30±0.29***	<0.001	0.70±0.14	0.83±0.22	>0.05
Maximal voluntary ventilation, l/min		58.86±6.52	81.59±9.94***	<0.001	58.86±6.63	64.59±7.36	>0.05

Notes: Values are expressed as means ± standard deviations. *p<0.05, **p<0.01, ***p<0.001 compared with the data of the experimental group and the control group after 6 months

compared to baseline. Key improvements included significant increases in vital capacity, forced vital capacity, and forced expiratory volume in 1 second (all $p < 0.001$). Additionally, peak expiratory flow, maximum expiratory flow at 25% and 50% of FVC, and maximal voluntary ventilation also showed substantial gains (all $p < 0.001$). These results indicate a marked improvement in lung function following the combined Yoga and Pilates training regimen in the experimental group. The control group also showed improvements in lung function indicators after six months. However, these changes were generally less pronounced than those observed in the experimental group.

The comparison of respiratory function indicators between the experimental and control groups after six months of training revealed significant differences across most parameters. The actual value of vital capacity (VC) was significantly greater in the experimental group compared to the control group ($p < 0.01$). Similar improvements were observed in forced vital capacity ($p < 0.01$), forced expiratory volume ($p < 0.01$), and peak expiratory flow ($p < 0.01$). Additionally, the experimental group showed significant increases in maximum expiratory flow at 25% ($p < 0.001$) and 50% ($p < 0.001$) of FVC, as well as in expiratory reserve volume ($p < 0.001$) and maximal voluntary ventilation ($p < 0.001$).

Overall, the experimental group, which combined Yoga and Pilates training, showed greater improvements in most respiratory function indicators compared to the control group, which focused solely on yoga. The only exception was inspiratory reserve volume, which was higher in the control group participants. The data reveal statistically significant improvements in the experimental group across key respiratory metrics, including vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume in one second (FEV1).

Discussion

The purpose of this study was to assess the impact of a combined yoga and Pilates program on respiratory function in women aged 45-50. The results demonstrated that this combined training regimen led to more significant improvements in various respiratory function indicators compared to a Yoga-only program. Specifically, the experimental group showed notable improvements in vital capacity, forced vital capacity, forced expiratory volume in 1 second, peak expiratory flow, maximum expiratory flow at 25% and 50% of FVC, expiratory reserve volume, and maximal voluntary ventilation after six months of training. The only indicator where the control group showed a better outcome

was inspiratory reserve volume; however, this difference was not statistically significant.

These findings align with previous research that has highlighted the benefits of Pilates and Yoga on respiratory function [19, 20, 21]. However, they provide new insights into the combined effects of these two practices. While Kaminsky et al. [22] observed benefits from Yoga breathing alone, our findings suggest that integrating Pilates, which emphasizes core strength and controlled breathing, can further enhance respiratory function beyond the improvements seen with Yoga alone. Similarly, a study by Cowen and Adams [8] found that Yoga improved lung function, particularly in enhancing FVC and PEF. However, it did not significantly affect FEV1 or MVV, suggesting that Yoga alone might not fully optimize all aspects of respiratory function. Our results indicate that the synergistic effects of Yoga and Pilates may stem from the combination of core stability and respiratory control. Together, these elements enhance overall lung function more effectively.

It should be noted that our study adds to existing research by demonstrating a significant improvement in maximal voluntary ventilation (MVV) in the experimental group. This finding is not as pronounced in previous studies that focused solely on either Pilates or Yoga. In this context, MVV is a critical indicator of respiratory muscle endurance and overall lung function. The results suggest that the combination of Yoga and Pilates may have a synergistic effect, enhancing respiratory endurance more effectively than either practice alone. For women aged 45-50, a combined training regimen may address respiratory limitations more comprehensively than single-modality interventions.

Another contribution of our research is the significant increase in expiratory reserve volume in the experimental group. This result suggests that the combined Yoga and Pilates regimen may enhance the strength and flexibility of the respiratory muscles more effectively than Yoga alone. These findings align with prior research emphasizing the role of muscle flexibility and strength in optimizing respiratory function [23]. However, unlike some studies that primarily focused on FVC or PEF [19, 20], our study offers a broader perspective by highlighting the importance of multiple respiratory indicators.

This study has several limitations that should be acknowledged. First, the sample size was relatively small, with only 38 participants, which may limit the generalizability of the findings to a broader population. Second, the study focused exclusively on women aged 45-50, so the findings may not apply to other age groups or to men. Additionally, the participants were all healthy individuals without underlying respiratory conditions, meaning the results might differ for populations with pre-existing respiratory issues. Finally, while the study used standard spirometry measures to assess respiratory function, it did not explore other potential benefits of the intervention, such as changes in overall physical fitness, psychological well-being, or quality of life. Future research should include a more comprehensive assessment of these factors to fully understand the impact of combined Yoga and Pilates training.

Conclusions

This study demonstrated that a combined Yoga and Pilates program leads to significant improvements in respiratory function in women aged 45-50, surpassing a Yoga-only program in most parameters. Key improvements were observed in vital capacity (VC), forced vital capacity (FVC), forced expiratory volume (FEV1), and peak expiratory flow (PEF). These findings support the hypothesis that integrating Pilates with Yoga provides greater benefits for respiratory health than practicing Yoga alone.

Conflicts of interest

Author declares that there is no conflict of interests.

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