International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

Effect of Pilates vs. Yoga on Respiratory Muscle Strength in Patients with Chronic Obstructive Pulmonary Disease (COPD)

Dr. Mariam Shahab
Research Scholar, Department of Physiotherapy
People's College of Paramedical Science & Research Center, People's University
Dr. Bushra Khan
Assistant Professor,Department of Physiotherapy
People's College of Paramedical Science & Research Center, People's University

ABSTRACT
Background: Chronic Obstructive Pulmonary Disease (COPD) is commonly associated with respiratory muscle weakness, dyspnoea, and reduced exercise capacity. Pilates and Yoga may help improve respiratory muscle function through controlled breathing and exercise. **Objective:** To compare the effects of Pilates and Yoga on respiratory muscle strength in patients with mild to moderate COPD. **Materials Required:** Digital handheld respiratory pressure meter, spirometry, Six-Minute Walk Test, Modified Medical Research Council (mMRC) Dyspnoea Scale, Visual Analogue Scale (VAS), and COPD Assessment Test (CAT). **Methods:** Sixty clinically stable patients aged 40–55 years were equally divided into Pilates and Yoga groups. Both groups received supervised 45-minute sessions three times per week for eight weeks. MIP and MEP were assessed as primary outcomes, along with FVC, FEV_1, 6MWD, mMRC, VAS, and CAT scores. **Results:** Both groups showed significant improvement in MIP and MEP ($p<0.001$). Yoga showed significantly greater improvement in MIP ($p=0.011$), while no significant between-group difference was observed for MEP or secondary outcomes. **Conclusion:** Both Pilates and Yoga were effective in improving respiratory muscle strength and other clinical outcomes in COPD, with Yoga showing a greater effect on inspiratory muscle strength.

Keywords: COPD; Pilates; Yoga; Respiratory Muscle Strength; MIP; MEP; Pulmonary Rehabilitation.

1. INTRODUCTION
Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterised by persistent airflow limitation associated with structural abnormalities of the airways and lung parenchyma [1]. Apart from airflow obstruction, COPD produces several extrapulmonary and functional consequences, including respiratory muscle dysfunction, exercise intolerance, dyspnoea, and deterioration in health-related quality of life [2,3].

Pulmonary hyperinflation represents an important mechanical consequence of COPD. As lung volumes increase, the diaphragm becomes flattened and operates at a mechanically disadvantageous position, reducing its ability to generate adequate inspiratory pressure [4]. Respiratory muscle dysfunction may be further aggravated by systemic inflammation, oxidative stress, nutritional abnormalities, physical deconditioning, and skeletal muscle dysfunction.

Maximal Inspiratory Pressure (MIP) and Maximal Expiratory Pressure (MEP) are commonly used non-invasive measures for assessment of global inspiratory and expiratory muscle strength, respectively [5]. Reduction in inspiratory muscle strength can increase respiratory effort and contribute to exercise-induced breathlessness, whereas reduced expiratory muscle strength may adversely affect coughing and airway clearance.

Pulmonary rehabilitation is an established component of non-pharmacological COPD management and can improve exercise tolerance, functional performance, symptoms, and quality of life [6,7]. Specific inspiratory muscle training can additionally increase inspiratory muscle strength; however, specialised training devices, supervision requirements, adherence difficulties, and accessibility may limit its routine use in some rehabilitation settings [8].

Mind-body exercise approaches such as Pilates and Yoga may offer practical alternatives because both combine respiratory control with physical activity. Despite this common feature, their respiratory training characteristics differ substantially.

Pilates integrates controlled posterior-lateral breathing with trunk stabilisation, postural alignment, thoracic mobility, abdominal activation, and coordinated movement. Exhalation is commonly performed in association with increased activation of the abdominal and deep core musculature. Consequently, repetitive Pilates training may facilitate respiratory muscle activation while simultaneously improving postural and thoracoabdominal mechanics.

Yoga incorporates physical postures or asanas together with voluntary respiratory control through pranayama. Pranayama techniques such as Ujjayi, Kapalabhati, Bhastrika, and Kumbhaka may provide different forms of inspiratory, expiratory, resistive, and breath-holding respiratory stimuli. Previous studies have demonstrated favourable effects of Yoga on dyspnoea, respiratory muscle performance, exercise capacity, and health-related quality of life in patients with COPD [9-11].

Studies investigating Pilates have similarly reported improvements in respiratory muscle strength, thoracoabdominal mechanics, exercise capacity, and breathlessness among patients with chronic respiratory disease [12-14].

Although both approaches have independently demonstrated therapeutic potential, comparatively fewer studies have directly evaluated Pilates and Yoga using objective measurements of both inspiratory and expiratory muscle strength. The differences between their breathing patterns also raise the possibility that the two modalities may produce different adaptations in the respiratory muscles.

Therefore, the present study was conducted to directly compare the effects of structured Pilates and Yoga programmes on respiratory muscle strength in clinically stable patients with mild to moderate COPD. Pulmonary function, exercise capacity, dyspnoea, and COPD-related health status were additionally evaluated to examine the broader clinical effects of both interventions.

2. AIM AND OBJECTIVES

2.1 Aim

To compare the effect of Pilates and Yoga on respiratory muscle strength in patients with Chronic Obstructive Pulmonary Disease (COPD).

2.2 Objectives

1. To assess baseline respiratory muscle strength in patients with COPD before intervention.
2. To evaluate the effect of Pilates on respiratory muscle strength in patients with COPD.
3. To evaluate the effect of Yoga on respiratory muscle strength in patients with COPD.
4. To compare the effectiveness of Pilates and Yoga in improving respiratory muscle strength.
5. To compare changes in FVC, FEV_1, 6MWD, mMRC dyspnoea grade, VAS dyspnoea score, and CAT score following Pilates and Yoga interventions.

2.3 Hypothesis

Null Hypothesis (H_0): There is no significant difference in the effect of Pilates versus Yoga on respiratory muscle strength in patients with COPD.

Alternate Hypothesis (H_1): There is a significant difference in the effect of Pilates versus Yoga on respiratory muscle strength in patients with COPD.

3. MATERIALS AND METHODS

3.1 Study Design

The study employed an experimental, prospective, randomized, comparative, parallel-group pre-test and post-test design.

3.2 Study Setting and Participants

The study was conducted in the Department of Respiratory Medicine and Outpatient Pulmonary Rehabilitation Clinic of Peoples University, Bhopal.

A total of 60 clinically stable patients with spirometrically confirmed mild to moderate COPD aged 40–55 years were included. Participants fulfilling the predefined eligibility criteria were allocated equally into two groups:

- **Group A – Pilates:** 30 participants
- **Group B – Yoga:** 30 participants

Purposive sampling was used to recruit participants according to the predefined inclusion and exclusion criteria. Following recruitment and baseline assessment, participants were randomly allocated in a 1:1 ratio to either the Pilates group or the Yoga group.

3.3 Study Duration

The total duration of the study was one year, including participant recruitment, baseline assessment, intervention, post-intervention assessment, statistical analysis, and interpretation of findings. The intervention period for each participant was eight weeks.

3.4 Inclusion Criteria

Participants were eligible when they:

1. Were aged 40–55 years.
2. Had spirometrically confirmed mild to moderate COPD according to GOLD criteria, with post-bronchodilator FEV_1/FVC <0.70 and $FEV_1 \geq 50\%$ predicted.
3. Were clinically stable for at least six weeks before recruitment.
4. Were able to understand the study procedure and provide written informed consent.
5. Were willing to participate in supervised sessions three times per week for eight weeks.

3.5 Exclusion Criteria

Patients were excluded in the presence of severe or very severe COPD, recent acute exacerbation or respiratory infection, severe or unstable cardiovascular or systemic comorbidities, resting oxygen saturation below 88% on room air or requirement for long-term oxygen therapy, significant musculoskeletal or neurological limitations, cognitive or psychiatric conditions affecting adherence, pregnancy or lactation, or concurrent participation in another structured exercise programme.

3.6 Ethical Considerations

The study was undertaken after obtaining approval from the Institutional Ethics Committee. Participants were informed about the purpose and procedures of the study, and voluntary written informed consent was obtained before participation. Study procedures were conducted in accordance with applicable ethical principles for biomedical research involving human participants.

3.7 Outcome Measures

Primary Outcomes

1. Maximal Inspiratory Pressure (MIP)
2. Maximal Expiratory Pressure (MEP)

MIP and MEP were measured using a calibrated digital handheld respiratory pressure meter. MIP was measured following maximal expiration to residual volume followed by maximal inspiratory effort against an occluded airway. MEP was measured following inspiration to total lung capacity followed by maximal expiratory effort against an occluded airway. Three reproducible manoeuvres were performed, and the highest acceptable measurement was recorded in cmH_2O.

Secondary Outcomes

1. Forced Vital Capacity (FVC)
2. Forced Expiratory Volume in one second (FEV_1)
3. Six-Minute Walk Distance (6MWD)

4. Modified Medical Research Council (mMRC) Dyspnoea Grade
5. Visual Analogue Scale (VAS) for dyspnoea
6. COPD Assessment Test (CAT) score

Pulmonary function was assessed through spirometry. Functional exercise capacity was measured through the Six-Minute Walk Test. Dyspnoea was evaluated using the mMRC scale and a 10-cm VAS, whereas COPD-related health status was assessed using the eight-item CAT questionnaire.

3.8 Intervention

Both groups received supervised intervention for **eight consecutive weeks**, with **three sessions per week on non-consecutive days**. Each session lasted **45 minutes**, consisting of a 5-minute warm-up, 35-minute main intervention, and 5-minute cool-down.

Group A – Pilates Intervention

Participants performed a structured mat-based Pilates programme incorporating posterior-lateral breathing, controlled movement, postural control, and progressive core stabilisation.

During Weeks 1–2, fundamental exercises such as pelvic curl, chest lift, supine spine twist, leg slides, and half roll back were performed.

During Weeks 3–5, exercises progressed to the Hundred, Roll Up, Single Leg Circles, Rolling Like a Ball, Single Leg Stretch, Double Leg Stretch, Spine Stretch Forward, and side-lying leg exercises.

During Weeks 6–8, progressive exercises including Shoulder Bridge with Leg Extension, Swan Preparation, Supine Spine Twist with extended legs, Saw, Side Kick Series, and Teaser Preparation were introduced.

Posterior-lateral breathing was coordinated with the exercises throughout the intervention, and exercise intensity was progressed according to individual tolerance.

Group B – Yoga Intervention

The Yoga programme included selected asanas, pranayama practices, and relaxation exercises. The asana component included Tadasana, Urdhva Hastasana, Ardha Chandrasana, Virabhadrasana II, Trikonasana, Marjaryasana-Bitilasana, Bhujangasana, Setu Bandhasana, Supta Matsyendrasana, and Viparita Karani.

Each asana was performed for approximately **20 controlled breaths per round**, with emphasis on slow and coordinated breathing and progression according to the participant's tolerance.

The pranayama component comprised:

- **Ujjayi Pranayama:** slow controlled inspiration and expiration with gentle glottic constriction.
- **Kapalabhati:** repeated active expiratory contractions followed by passive inspiration.
- **Bhastrika:** controlled forceful inspiration and expiration.
- **Kumbhaka:** controlled breath retention according to individual tolerance.

The intervention was progressively advanced throughout the eight-week period.

Participants continued their routine medical management during the study period, while attendance, exercise tolerance, and adverse events were monitored throughout the intervention.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

3.8 Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 25.

Continuous variables were presented as mean ± standard deviation for normally distributed data, while categorical variables were expressed as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test.

Within-group pre- and post-intervention changes in normally distributed continuous variables were analysed using paired t-tests. Non-normally distributed or ordinal data were analysed using appropriate non-parametric tests.

Between-group differences in post-intervention MIP, MEP, FVC, FEV_1, 6MWD, VAS, and CAT scores were evaluated using Analysis of Covariance (ANCOVA), with corresponding baseline values entered as covariates. The mMRC grade was analysed using non-parametric statistical procedures, including the Mann-Whitney U test for between-group comparison.

All tests were two-tailed, and **$p<0.05$** was considered statistically significant.

4. RESULTS

A total of 60 participants completed the study, with 30 participants in the Pilates group and 30 in the Yoga group.

4.1 Baseline Characteristics

The groups were comparable before intervention with respect to age, gender distribution, COPD severity, disease duration, smoking exposure, and baseline FEV_1 percentage predicted.

Table 1. Baseline Demographic and Clinical Characteristics of the Study Groups

Characteristic	Pilates Group (n=30)	Yoga Group (n=30)	p-value
Age, years, Mean ± SD	47.77 ± 4.02	47.80 ± 4.28	0.975
Male, n (%)	19 (63.3%)	21 (70.0%)	0.584
Female, n (%)	11 (36.7%)	9 (30.0%)	
Mild COPD, n (%)	8 (26.7%)	8 (26.7%)	1.000
Moderate COPD, n (%)	22 (73.3%)	22 (73.3%)	
COPD Duration, years	4.71 ± 2.05	5.19 ± 2.31	0.401
Smoking History, pack-years	31.28 ± 11.69	28.39 ± 10.27	0.314
FEV_1, % predicted	69.35 ± 12.35	67.63 ± 13.10	0.603

No statistically significant baseline differences were observed between the two groups (all $p>0.05$), supporting appropriate comparability before intervention.

4.2 Primary Outcomes

Table 2. Comparison of Maximal Inspiratory and Expiratory Pressure Before and After Intervention

Outcome	Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Change ± SD	Within-group p-value	Between-group p-value
MIP (cmH_2O)	Pilates	65.66 ± 6.45	73.94 ± 6.41	+8.28 ± 1.97	<0.001	**0.011**
	Yoga	62.60 ± 7.86	72.41 ± 7.59	+9.81 ± 1.95	<0.001	
MEP (cmH_2O)	Pilates	82.12 ± 10.50	91.19 ± 10.59	+9.07 ± 1.94	<0.001	0.980
	Yoga	80.48 ± 10.17	89.51 ± 10.73	+9.03 ± 2.16	<0.001	

For MIP, both groups demonstrated statistically significant improvement from baseline ($p<0.001$). However, ANCOVA showed a significant between-group difference, **$F(1,57)=6.943$, $p=0.011$**, indicating a significantly greater baseline-adjusted improvement in inspiratory muscle strength with Yoga.

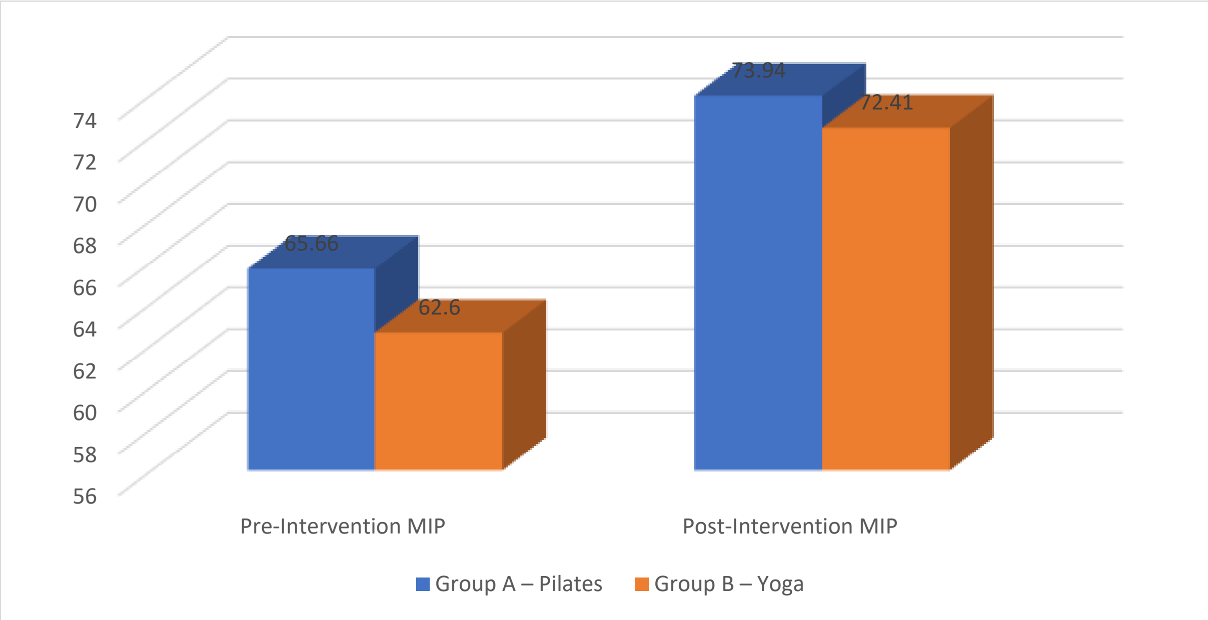

Figure 1. Comparison of Pre- and Post-Intervention Maximal Inspiratory Pressure

MEP also increased significantly within both groups ($p<0.001$). The increases were almost identical: 9.07 cmH_2O with Pilates and 9.03 cmH_2O with Yoga. ANCOVA demonstrated **$F(1,57)=0.001$, $p=0.980$**, indicating no significant difference between the interventions.

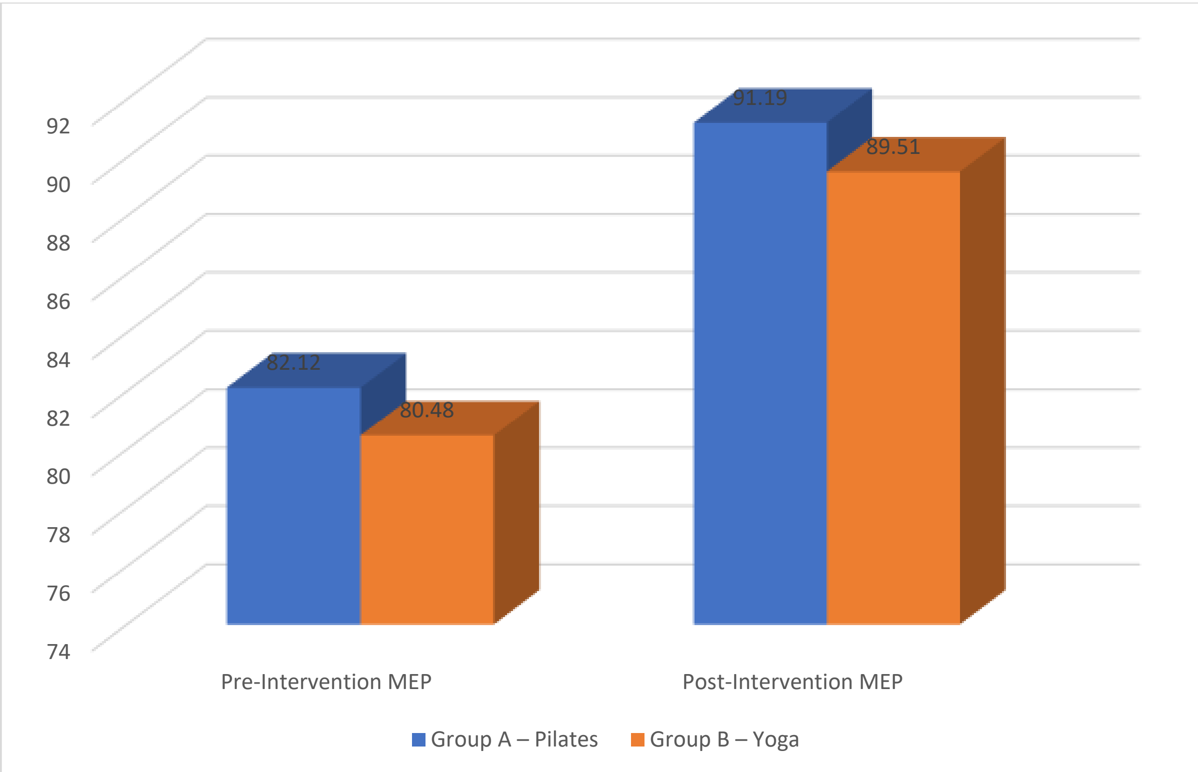

Figure 2. Comparison of Pre- and Post-Intervention Maximal Expiratory Pressure

4.3 Secondary Outcomes

Table 3. Comparison of Secondary Continuous Outcomes Before and After Intervention

Outcome	Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Change ± SD	Within-group p-value	Between-group p-value
FVC (L)	Pilates	3.32 ± 0.52	3.52 ± 0.53	+0.19 ± 0.06	<0.001	0.591
	Yoga	3.32 ± 0.58	3.50 ± 0.59	+0.19 ± 0.07	<0.001	
FEV_1 (L)	Pilates	2.00 ± 0.41	2.15 ± 0.40	+0.15 ± 0.04	<0.001	0.738
	Yoga	1.95 ± 0.34	2.11 ± 0.34	+0.15 ± 0.06	<0.001	
6MWD (m)	Pilates	361.83 ± 46.70	404.07 ± 50.84	+42.23 ± 10.07	<0.001	0.826
	Yoga	373.50 ± 55.18	415.30 ± 54.04	+41.80 ± 8.77	<0.001	
VAS Dyspnoea	Pilates	5.46 ± 1.18	4.01 ± 1.23	−1.45 ± 0.36	<0.001	0.078
	Yoga	5.30 ± 1.17	3.68 ± 1.15	−1.62 ± 0.38	<0.001	
CAT Score	Pilates	19.63 ± 5.06	14.43 ± 5.06	−5.20 ± 1.19	<0.001	0.788
	Yoga	20.97 ± 5.28	15.83 ± 5.41	−5.13 ± 1.33	<0.001	

Both groups demonstrated significant improvements in FVC and FEV_1. However, ANCOVA showed no significant between-group difference for FVC ($F=0.292$, $p=0.591$) or FEV_1 ($F=0.113$, $p=0.738$). Functional exercise capacity improved substantially in both groups. Mean 6MWD increased by 42.23±10.07 m in the Pilates group and 41.80±8.77 m in the Yoga group. The between-group difference was not significant ($F=0.049$, $p=0.826$).

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

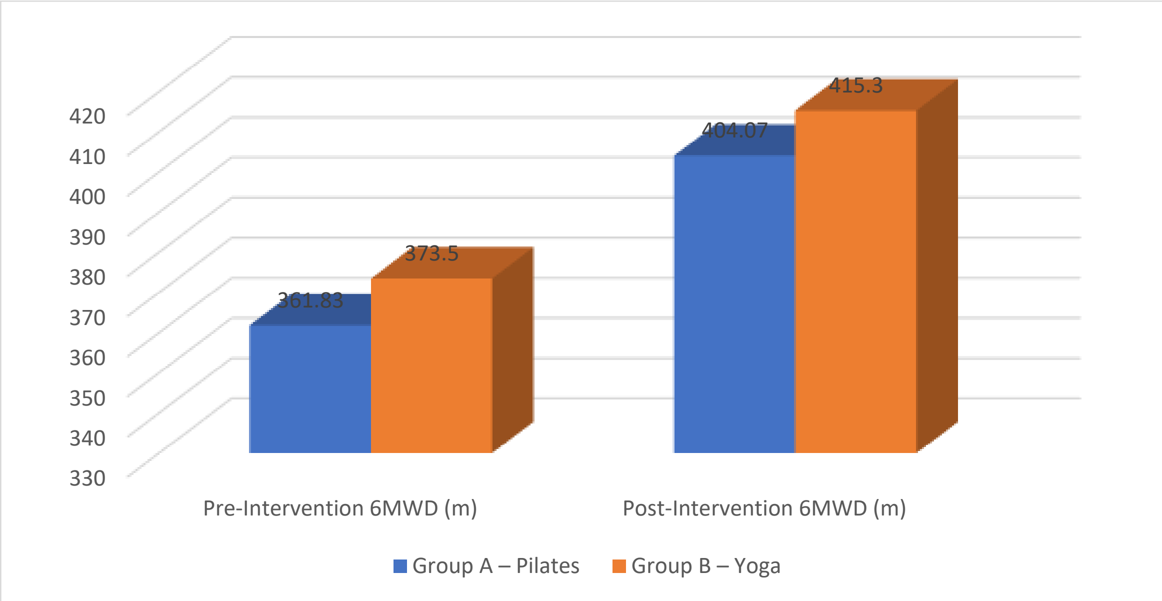

Figure 3. Comparison of Pre- and Post-Intervention Six-Minute Walk Distance

VAS dyspnoea scores decreased significantly in both groups. Although the reduction was numerically greater with Yoga, the between-group comparison did not reach statistical significance (F=3.227, p=0.078).

CAT scores decreased significantly within both groups, demonstrating improvement in COPD-related health status. However, no significant difference was observed between Pilates and Yoga (F=0.073, p=0.788).

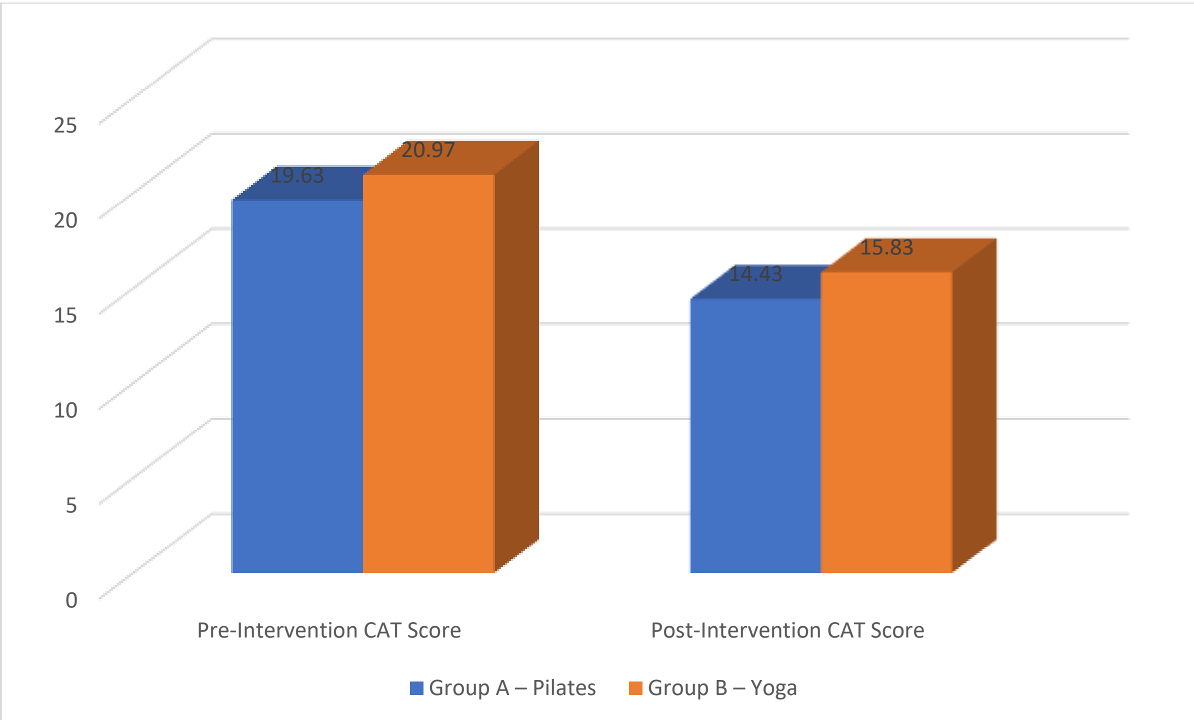

Figure 4. Comparison of Pre- and Post-Intervention COPD Assessment Test Scores

4.4 mMRC Dyspnoea Grade

Table 4. Comparison of mMRC Dyspnoea Grade

Group	Pre-intervention Median (IQR)	Post-intervention Median (IQR)	Within-group p-value
Pilates	2.0 (1.25–2.0)	1.0 (1.0–1.0)	<0.001
Yoga	2.0 (1.0–2.0)	1.0 (1.0–2.0)	<0.001

Between-group comparison: Mann-Whitney U=360.0, p=0.096.

Both interventions significantly reduced mMRC dyspnoea grade. Twenty-four participants in the Pilates group and 18 in the Yoga group demonstrated a one-grade reduction. However, the difference between groups was not statistically significant.

4.5 Adherence and Safety

Each participant was scheduled to attend 24 supervised sessions. Mean attendance was 21.07±1.48 sessions in the Pilates group and 21.47±1.78 sessions in the Yoga group, corresponding to adherence rates of 87.78±6.18% and 89.44±7.38%, respectively.

All 60 participants completed the eight-week intervention programme. Three minor adverse events were recorded in the Pilates group, consisting of transient muscle soreness, temporary fatigue, and brief exercise-related breathlessness resolving with rest. No adverse event was recorded in the Yoga group, and no serious exercise-related adverse event occurred in either group.

4.6 Overall Between-Group Comparison

Table 5. Overall Comparative Effectiveness of Pilates and Yoga

Outcome	Statistical Test	Test Statistic	p-value	Interpretation
MIP	ANCOVA	F=6.943	**0.011**	**Significant; favours Yoga**
MEP	ANCOVA	F=0.001	0.980	Not Significant
FVC	ANCOVA	F=0.292	0.591	Not Significant
FEV_1	ANCOVA	F=0.113	0.738	Not Significant
6MWD	ANCOVA	F=0.049	0.826	Not Significant
mMRC	Mann-Whitney U	U=360.0	0.096	Not Significant
VAS Dyspnoea	ANCOVA	F=3.227	0.078	Not Significant
CAT	ANCOVA	F=0.073	0.788	Not Significant

The overall analysis demonstrated that **MIP was the only measured outcome showing a statistically significant difference between Pilates and Yoga**, with Yoga producing greater improvement. All other outcomes demonstrated statistically comparable effects.

5. DISCUSSION

The present study compared Pilates and Yoga for improving respiratory muscle strength in patients with mild to moderate COPD. Both interventions produced significant improvements in the primary respiratory muscle outcomes and in several secondary respiratory, functional,

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

and symptom-related outcomes. The principal comparative finding was a statistically greater improvement in MIP following Yoga, whereas MEP and all secondary outcomes showed no statistically significant differences between the two approaches.

5.1 Effect on Maximal Inspiratory Pressure

Both Pilates and Yoga significantly improved inspiratory muscle strength. However, the Yoga group demonstrated a mean MIP increase of 9.81±1.95 cmH_2O compared with 8.28±1.97 cmH_2O in the Pilates group, and baseline-adjusted ANCOVA demonstrated a significant difference between interventions.

A possible explanation is the specific respiratory loading created by the pranayama practices included in the Yoga programme. Ujjayi breathing involves slow controlled breathing with partial glottic constriction and may produce resistance to airflow. Bhastrika requires active inspiratory as well as expiratory efforts, while Kumbhaka introduces periods of controlled breath retention. Repeated use of these techniques may impose greater direct loading on the inspiratory muscles, including the diaphragm and accessory inspiratory musculature.

Previous Yoga studies have demonstrated improvements in respiratory muscle strength and functional respiratory outcomes. Behera et al. [9] reported favourable effects of integrated Yoga therapy on respiratory function in COPD. Liu et al. [10] demonstrated improvements following Yoga-based pulmonary rehabilitation, while Ranjita et al. [11] reported benefits of Yoga-based rehabilitation for respiratory symptoms and functional outcomes.

A systematic review and meta-analysis by Cramer et al. [15] also reported favourable effects of Yoga in patients with COPD. The greater MIP response obtained in the present study is therefore physiologically plausible considering the concentrated respiratory control incorporated within the Yoga protocol.

Pilates nevertheless resulted in a significant improvement in MIP. Pilates breathing emphasises posterior-lateral thoracic expansion together with coordinated trunk activation. Previous work by El-Rafie et al. [12], De Oliveira Brito et al. [13], and Malta et al. [14] has similarly suggested beneficial effects of Pilates on respiratory muscle performance and functional capacity.

The present findings therefore indicate that both approaches can strengthen inspiratory muscles, while the specific pranayama-dominant Yoga protocol may offer an additional advantage when inspiratory muscle weakness represents the primary rehabilitation target.

5.2 Effect on Maximal Expiratory Pressure

MEP increased significantly in both intervention groups. Pilates produced an improvement of 9.07±1.94 cmH_2O, whereas Yoga produced an improvement of 9.03±2.16 cmH_2O. The magnitude of improvement was consequently almost identical, and the between-group p-value of 0.980 confirmed the absence of a differential effect.

Pilates provides repeated activation of abdominal and deep trunk muscles during coordinated exhalation. The transversus abdominis, internal and external oblique muscles, and other core stabilisers contribute to forceful expiration, providing a plausible mechanism for increased expiratory muscle strength.

Yoga simultaneously provides substantial expiratory loading. Kapalabhati requires active repetitive abdominal contractions during expiration, while Bhastrika requires forceful respiratory excursions during both inspiration and expiration. These techniques may explain why Yoga generated an expiratory muscle response comparable to that produced through the active abdominal component of Pilates.

Previous Pilates studies have reported improvement in MEP, respiratory mechanics, and cough-related respiratory function [12,14,16]. Similarly, high-frequency pranayama incorporating techniques such as Kapalabhati and Bhastrika has been associated with increased expiratory muscle performance [17].

Thus, while the mechanisms of respiratory loading may differ between Pilates and Yoga, the present study indicates that both produce comparable improvements in expiratory muscle strength.

5.3 Pulmonary Function

Both interventions significantly improved FVC and FEV_1. However, neither FVC nor FEV_1 demonstrated a significant between-group difference.

The improvement in FVC following Pilates may be associated with increased thoracic mobility, posterior-lateral rib cage expansion, improved postural alignment, and better coordination between the abdominal wall and diaphragm. Cancelliero-Gaiad et al. [18] demonstrated that Pilates breathing can modify thoracoabdominal mechanics in COPD, while Pantoni et al. [19] reported favourable respiratory adaptations following Pilates.

Yoga may similarly influence vital capacity through thoracic expansion, controlled deep breathing, spinal mobility, and repeated respiratory excursions. Yoga-based rehabilitation has previously been associated with favourable changes in pulmonary function [11].

FEV_1 also increased significantly within both groups. Because COPD involves persistent structural airflow limitation, exercise interventions would not be expected to completely reverse airway obstruction. The relatively modest spirometric changes may instead reflect improvement in respiratory muscle recruitment, expiratory effort, thoracic movement, and ventilatory coordination.

The absence of significant differences in FVC and FEV_1 therefore indicates that Pilates and Yoga produced broadly comparable effects on pulmonary function during the eight-week intervention period.

5.4 Functional Exercise Capacity

The significant increase in Six-Minute Walk Distance represents an important functional outcome. The Pilates group improved by 42.23 m and the Yoga group by 41.80 m.

Pilates may improve walking capacity through simultaneous enhancement of respiratory muscle performance, trunk stability, postural control, movement coordination, and thoracic mobility. Yoga may improve functional exercise capacity through respiratory control, flexibility, postural stability, relaxation, and improved tolerance to breathlessness.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

Franco et al. [20] reported that both Yoga and Pilates improved functional capacity in COPD without demonstrating clear superiority between the two active interventions. Donesky-Cuenco et al. [21] also observed improved functional performance with Yoga.

The almost identical improvements found in the present study reinforce the conclusion that both approaches can improve functional exercise capacity.

5.5 Dyspnoea

Both mMRC grade and VAS dyspnoea score showed significant improvement after intervention.

The median mMRC grade decreased from 2 to 1 in both groups. Although a larger number of participants in the Pilates group demonstrated a one-grade improvement, the between-group difference was not statistically significant.

Improved respiratory muscle strength may reduce the proportion of maximal respiratory effort required during daily activities, thereby decreasing perceived breathing effort. Pilates may additionally reduce dyspnoea through improved postural alignment, chest-wall mobility, and breathing coordination.

Yoga may influence both the physiological and perceptual components of dyspnoea. Slow controlled breathing and relaxation may improve respiratory control and reduce anxiety associated with breathlessness. The Yoga group demonstrated a numerically larger reduction in VAS score; however, the difference did not reach statistical significance ($p=0.078$). It would therefore be inappropriate to conclude that Yoga was superior for dyspnoea reduction based on the present results.

5.6 COPD-Related Health Status

CAT scores decreased significantly following both interventions. Pilates produced a reduction of 5.20 points and Yoga produced a reduction of 5.13 points.

The CAT assesses multiple consequences of COPD, including cough, sputum, chest tightness, breathlessness, physical activity, confidence in leaving home, sleep, and energy. Improvement in respiratory muscle performance, exercise tolerance, and dyspnoea may therefore collectively contribute to better CAT scores.

The nearly identical magnitude of CAT improvement and non-significant between-group difference indicate that both interventions produced comparable improvements in COPD-related health status.

5.7 Adherence and Safety

Both interventions demonstrated high adherence, with mean adherence rates approaching 90%, and every participant completed the eight-week programme. No serious adverse events were recorded.

These findings are particularly relevant for COPD rehabilitation because long-term effectiveness depends not only on physiological efficacy but also on feasibility and participant adherence. Both Pilates and Yoga can be modified according to functional capacity and may therefore represent practical exercise options for appropriately screened and supervised patients with stable COPD.

International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

5.8 Overall Comparative Effectiveness

The overall pattern of results demonstrates that Pilates and Yoga are both effective mind-body interventions for patients with mild to moderate COPD.

The important distinction lies in inspiratory muscle strength. Yoga demonstrated a statistically greater improvement in MIP, suggesting that repeated pranayama-based respiratory loading may provide a relatively more concentrated stimulus to the inspiratory musculature.

In contrast, MEP improvement was virtually identical between the groups. No comparative advantage was demonstrated for FVC, FEV_1, functional walking capacity, mMRC dyspnoea grade, VAS dyspnoea, or CAT score.

Accordingly, the findings should **not** be interpreted as demonstrating the overall superiority of Yoga over Pilates. Rather, they indicate a **specific comparative advantage of Yoga for inspiratory muscle strength**, while the broader respiratory, functional, symptom-related, and health-status benefits of the two interventions were largely comparable.

6. HYPOTHESIS INTERPRETATION

The statistical findings provided outcome-specific evidence regarding the study hypothesis.

For **Maximal Inspiratory Pressure (MIP)**, the between-group comparison was statistically significant ($F=6.943$, $p=0.011$). Therefore, the **null hypothesis was rejected with respect to MIP**, demonstrating a significant difference between Pilates and Yoga, with greater improvement following Yoga.

For **Maximal Expiratory Pressure (MEP)**, the between-group difference was not statistically significant ($F=0.001$, $p=0.980$). Therefore, the **null hypothesis was retained with respect to MEP**.

Thus, the comparative effect of Pilates and Yoga differed for **inspiratory muscle strength but not for expiratory muscle strength**.

7. CONCLUSION

The present study demonstrated that both Pilates and Yoga were effective in improving respiratory muscle strength among clinically stable patients with mild to moderate COPD following an eight-week supervised intervention programme.

Both interventions significantly increased Maximal Inspiratory Pressure and Maximal Expiratory Pressure. However, Yoga produced a significantly greater baseline-adjusted improvement in MIP, indicating a specific comparative advantage for inspiratory muscle strengthening. No significant difference was observed between Pilates and Yoga for MEP.

Both interventions also significantly improved pulmonary function as represented by FVC and FEV_1, enhanced functional exercise capacity as measured by 6MWD, reduced dyspnoea according to mMRC and VAS assessments, and improved COPD-related health status as demonstrated by reduced CAT scores. Nevertheless, no statistically significant differences were identified between Pilates and Yoga for these secondary outcomes.

Accordingly, Yoga may be particularly useful when improvement in inspiratory muscle strength is a primary rehabilitation objective, whereas both Pilates and Yoga can be considered effective options for improving expiratory muscle strength, pulmonary function, exercise capacity, dyspnoea, and COPD-related health status.

The selection of intervention may therefore be individualised according to the patient's predominant respiratory muscle deficit, physical abilities, preference, availability of trained supervision, and overall rehabilitation goals.

8. LIMITATIONS

The study has several limitations. First, the sample consisted of 60 participants recruited from a single clinical setting, which may limit generalisability. Second, participants were restricted to the age range of 40–55 years and had only mild to moderate COPD; consequently, the findings cannot be directly generalised to older populations or patients with severe and very severe disease.

Third, the intervention period was limited to eight weeks and no extended follow-up was conducted to determine the long-term maintenance of improvements. Fourth, blinding of participants and therapists was not practical because of the nature of the exercise interventions. Fifth, although MIP, MEP, spirometric parameters, and 6MWD represented objective measurements, mMRC, VAS, and CAT included subjective participant-reported components.

Finally, the study compared two active intervention groups without a usual-care or non-exercise control group. The findings therefore establish the comparative effects of Pilates and Yoga but do not directly quantify their effects relative to absence of additional exercise intervention.

9. RECOMMENDATIONS

Future studies should include larger and more diverse samples and adopt multicentre designs to improve the external validity of findings. Research involving wider age ranges and different COPD severity categories would help determine whether intervention effects vary according to disease severity.

Longer intervention periods and follow-up assessments are recommended to evaluate the durability of respiratory muscle and functional improvements. Future controlled trials may include usual-care or conventional pulmonary rehabilitation groups together with Pilates and Yoga groups.

Further research should also examine different frequencies, durations, and intensities of both interventions and investigate individual pranayama techniques to identify the components most responsible for inspiratory and expiratory muscle adaptation.

10. CLINICAL IMPLICATIONS

The findings support the incorporation of structured Pilates and Yoga into pulmonary rehabilitation for appropriately selected patients with stable mild to moderate COPD.

Yoga may be preferentially considered where inspiratory muscle weakness is prominent because the present Yoga protocol produced a significantly greater improvement in MIP. Pilates may be particularly useful where respiratory training is required together with core strengthening, thoracic mobility, postural control, and coordinated movement.

Because both interventions demonstrated favourable adherence and no serious adverse events, they represent potentially accessible, low-cost adjuncts to conventional rehabilitation when delivered under appropriate professional supervision.

REFERENCES

1. Hogg JC, Chu F, Utokaparch S, et al. The nature of small-airway obstruction in chronic obstructive pulmonary disease. *N Engl J Med.* 2004;350(26):2645-53.
2. Miravitlles M, Ribera A. Understanding the impact of symptoms on the burden of COPD. *Respir Res.* 2017;18(1):67.
3. Safiri S, Carson-Chahhoud K, Noori M, et al. Burden of chronic obstructive pulmonary disease and its attributable risk factors in 204 countries and territories, 1990-2019: results from the Global Burden of Disease Study 2019. *BMJ.* 2022;378:e069679.
4. O'Donnell DE, Laveneziana P. The clinical importance of dynamic lung hyperinflation in COPD. *COPD.* 2006;3(4):219-32.
5. American Thoracic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. *Am J Respir Crit Care Med.* 2002;166(4):518-624.
6. Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *Am J Respir Crit Care Med.* 2013;188(8):e13-64.
7. McCarthy B, Casey D, Devane D, Murphy K, Murphy E, Lacasse Y. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2015;(2):CD003793.
8. Gosselink R, De Vos J, van den Heuvel SP, Segers J, Decramer M, Kwakkel G. Impact of inspiratory muscle training in patients with COPD: what is the evidence? *Eur Respir J.* 2011;37(2):416-25.
9. Behera D, Patra S, Mishra B. Effect of integrated yoga therapy on pulmonary function and respiratory muscle strength in patients with chronic obstructive pulmonary disease. *Lung India.* 2020;37(5):394-400.
10. Liu XC, Pan L, Hu Q, Dong WP, Yan J, Dong L. Effects of yoga-based pulmonary rehabilitation on respiratory function and quality of life in patients with COPD. *Respir Med.* 2014;108(11):1641-9.
11. Ranjita R, Hankey A, Nagendra HR, Mohanty S. Yoga-based pulmonary rehabilitation for the management of dyspnea in coal miners with chronic obstructive pulmonary disease: a randomized controlled trial. *J Ayurveda Integr Med.* 2016;7(3):158-66.

12. El-Rafie MM, El-Morsy AM, El-Zayat FM. Effect of Pilates exercises on ventilation, respiratory muscle strength, and dyspnea in patients with chronic obstructive pulmonary disease: a randomized controlled trial. *Egypt J Chest Dis Tuberc.* 2016;65(4):911-6.
13. De Oliveira Brito CA, Costa MAB, Silveira MF, et al. Pilates method improves exercise capacity and respiratory muscle strength in COPD patients. *J Bodyw Mov Ther.* 2017;21(3):679-84.
14. Malta M, Oliveira LM, Silva TM, et al. Effects of Pilates on respiratory muscle strength and thoracoabdominal mechanics in patients with COPD. *Int J Chron Obstruct Pulmon Dis.* 2017;12:2831-40.
15. Cramer H, Lauche R, Haller H, Dobos G. A systematic review and meta-analysis of yoga for chronic obstructive pulmonary disease. *J Altern Complement Med.* 2014;20(5):348-58.
16. Silva IS, Fregonezi GAF, Dias FAL, Ribeiro CD, Resqueti VR. Effects of Pilates on expiratory muscle strength, cough peak flow, and quality of life in severe COPD. *Clin Respir J.* 2021;15(3):287-95.
17. Telles S, Dash M. High-frequency pranayama reduces airway resistance and improves expiratory muscle strength in mild-to-moderate COPD. *Complement Ther Med.* 2018;38:74-80.
18. Cancelliero-Gaiad KM, Ike D, Pantoni CBF, Borghi-Silva A, Costa D. Acute effects of Pilates breathing on thoracoabdominal kinematics in COPD patients. *Respir Care.* 2014;59(9):1378-84.
19. Pantoni CBF, Reis MS, Martins LEB, Borghi-Silva A, Costa D, Catai AM. Effects of mat Pilates on thoracoabdominal kinematics, respiratory muscle strength, and autonomic control in COPD: a controlled study. *Physiother Theory Pract.* 2015;31(6):382-90.
20. Franco MR, Abreu RM, Moreira RF, Silva ALG, Parreira VF. Yoga versus Pilates in elderly patients with COPD: a randomized trial on functional capacity and quality of life. *Respir Med.* 2022;195:106761.
21. Donesky-Cuenco D, Nguyen HQ, Paul S, Carrieri-Kohlman V. Yoga therapy decreases dyspnea-related distress and improves functional performance in people with COPD. *J Cardiopulm Rehabil Prev.* 2009;29(5):335-42.