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Effect of Pilates Exercise on Post Covid 19 Interstitial Lung Disease

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Abstract

Background: Severe acute respiratory syndrome coronavirus 2 is a coronavirus strain originally found in December 2019 in Wuhan, Hubei province, China. We aim to ascertain the possible implications of Pilates exercise on persons with Interstitial Lung Disease resulting from a prior coronavirus disease 2019 infection. ***Patients and methods:*** This study included sixty individuals from both sexes diagnosed with post-coronavirus disease 2019 interstitial lung disease. Participants were assigned randomly to the Study Group: Participants received standard care for post-coronavirus disease 2019 Interstitial Lung Disease, which may include pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine), pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercise and a supervised Pilates exercise program for 12 weeks with three sessions per week. Each session lasted approximately 30 minutes. The exercises were tailored to the individual needs and abilities of the participants. Control Group: Participants received standard care for post-coronavirus disease 2019 interstitial lung disease, which may include pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine) and pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercises only. ***Results:*** In the study group, forced expiratory volume in 1 second and forced vital capacity and forced expiratory volume in 1 second/forced vital capacity exhibited significant elevations post-contrasted with pre-treatment (P values <0.001, <0.001, and 0.014, respectively), but they did not exhibit significant variations in pre and post-treatment in the control group. In both (the study and control groups), SpO2 was significantly increased post than pre-treatment (P value <0.001 and 0.007 respectively), but the study group exhibited a significantly greater post-spO2 than the control group (P value =0.019).

In the study group, the 6-minute Walking distance was significantly increased post than pre-treatment (P value =0.038), while it was insignificantly different between pre and post-treatment in the control group. In the study group, St. George's Respiratory Questionnaire score (symptoms, activity, impacts, and total score) was significantly decreased post than pre-treatment (P value <0.001), while in the control group, only total score was decreased post than pre-treatment (P value =0.013) while symptoms, activity, and impacts were insignificantly different between pre and post-treatment. ***Conclusion:*** Pilates exercise may enhance exercise capacity and quality of life in persons with post-coronavirus disease 2019 interstitial lung disease.

Keywords: Pilates Exercise, Covid 19, Interstitial Lung Disease

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Introduction

The severe acute respiratory syndrome coronavirus 2, or SARS-CoV-2, a coronavirus strain, was initially established in December 2019 in Wuhan, Hubei province, China (1). SARS-CoV-2 is a member of the coronavirus family, a vast

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virus category that may induce ailments spanning from the ordinary cold to more serious respiratory disorders. This strain is highly contagious and mostly spreads via respiratory droplets when an infected person coughs, sneezes, talks, or breathes (2).

The worldwide pandemic induced by the SARS-CoV-2 has profoundly impacted the health of humans globally. While the primary focus has been on acute respiratory distress and mortality linked to COVID-19, there is increasing recognition of the long-term consequences experienced by individuals who have recovered from the infection (3).

One of the conditions that have emerged as a consequence of COVID-19 is post-COVID interstitial lung disease (ILD) (4). ILDs are progressive lung diseases that cause structural changes, leading to decreased lung function. Infections, especially viral ones like COVID-19, can disrupt lung cells and contribute to fibrosis. Post-COVID syndrome is a chronic condition with persistent symptoms, including lung-related issues like shortness of breath (5).

In recent years, Pilates exercise has gained immense popularity as a highly effective form of physical activity, renowned for its emphasis on core strength, flexibility, and overall body conditioning (6). By combining controlled movements with proper breathing techniques, Pilates promotes body awareness, improved posture, and enhanced muscular control (7).

Given the multifaceted nature of Pilates exercise, it holds promise as a potential therapeutic intervention for individuals with post-COVID ILD. By targeting core strength, flexibility, and breathing control, Pilates may promote pulmonary function, alleviate breathlessness, and improve general physical health in this particular demographic (8).

We aim to ascertain the potential implications of Pilates exercise on individuals who have developed ILD resulting from prior COVID-19 infection.

Materials and methods

Study design

This study included sixty individuals from both sexes diagnosed with post-COVID ILD who voluntarily agreed to participate. The participants were recruited from Hamiaat Ismailia Hospital.

Inclusion criteria were individuals aged 55-65 years, confirmed diagnosis by CT scan of ILD resulting from a previous COVID-19 infection referred by pulmonary physicians, medically stable and cleared for physical activity by a healthcare professional, willing to be involved in a structured Pilates exercise program for the duration of the study, with grade 1 and 2 of post covid 19 ILD, and with post covid 19 from 3 to 12 month from last injury.

Exclusion criteria were individuals with severe respiratory compromise, as determined by a healthcare professional, a history of significant cardiovascular or musculoskeletal conditions that would contraindicate participation in Pilates

Print ISSN 2636-3224
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exercise, uncontrolled medical conditions that may interfere with participation in the study, inability to understand and follow instructions for the Pilates exercises.

Participants were randomized into the Study Group: Participants received standard care for post-COVID ILD: Pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine), pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercises and a supervised Pilates exercise program for 12 weeks with three sessions per week. Each session lasted about 30 minutes. The exercises were customized to the specific requirements and capabilities of the participants. Control Group: Participants received standard care for post-COVID ILD: Pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine) and pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercises only.

Evaluation Instruments

1. Spirometer: used to assess pulmonary Function Tests (PFTs) as Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC). It quantifies the amount and flow of air that can be inhaled and exhaled (9).

2. Pulse oximeter: A non-invasive, small, clip-like device often affixed to a finger that measures oxygen saturation levels (SpO2) by using differential light absorption by oxygenated and deoxygenated blood (10).

3. 6-Minute Walk Test (6MWT): A standardized test implemented to ascertain exercise tolerance and functional capacity. It provides valuable information about a person's ability to perform daily physical activities and can be used to evaluate changes in exercise tolerance over time (11).

4. the St. George's Respiratory Questionnaire (SGRQ): Confirmed quality of life (QoL) Questionnaire implemented to assess the ILD implications on participants' QoL to capture the physical, social, and psychological aspects of living with a respiratory condition. It consists of a series of questions related to three different health components: symptoms, activity, and impacts (12).

Treatment Instruments

The primary treatment instrument in this study was a structured Pilates exercise program. The exercises focused on improving strength, flexibility, and posture. All participants undergo assessment Before and after intervention:

Pulmonary Function Test (PFT): Perform spirometry to assess PFTs (13).

Blood Oxygen Saturation (SpO2): Use a pulse oximeter, typically attached to a finger, to measure the SpO2 in the participant's blood.

6-Minute Walk Test: to estimate exercise tolerance and functional capacity.

SGRQ: to estimate symptoms, activity limitation and impacts on patient's QoL to monitor Pilates exercise effectiveness in post-covid ILD patients.

Print ISSN 2636-3224
Online ISSN 2636-3232

Treatment Procedures

Treatment group

Patients with post-COVID ILD engaged in Pilates exercises, starting with a 10-minute warm-up, focusing on strengthening, flexibility, and posture improvement. The following are some appropriate Pilates exercises that were used in the treatment:

Pilates Wall push-up exercise: Pilates wall push-up exercise targets chest wall muscles, improving respiratory cycle and posture. Start by placing hands on a wall, lowering, and pushing back up **(Fig. 1)**.

Fig. 1. Pilates Wall push-up exercise

Modified Pilates Roll-Up: This exercise improves core strength and spinal mobility by engaging core muscles, rolling the head, neck, and shoulders off the mat, and reversing the movement. Maintain a neutral spine position and focus on deep breathing. Repeat for desired repetitions and rest before moving on to the next exercise **(Fig. 2)**.

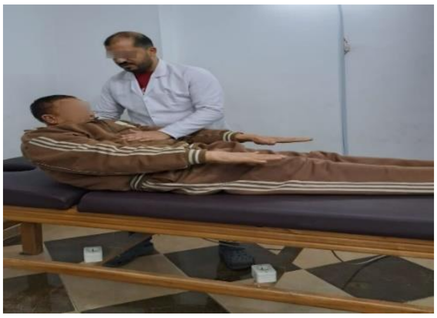

Fig. 2. Modified Pilates Roll-Up

Modified Pilates Hundred: The Pilates Hundred is a classic exercise that targets core muscles and improves overall body endurance. Begin by lying on a mat, bending knees, and engaging core muscles. Lift your head and shoulders, and pump your arms in a steady rhythm. Maintain a stable core and relaxed shoulders **(Fig. 3)**.

Print ISSN 2636-3224
Online ISSN 2636-3232

Fig. 3. Modified Pilates Hundred

Modified Pilates Bridge: Perform a bridge exercise on a mat with knees bent and feet flat. Engage core muscles, relax arms, and lift hips. Maintain a stable core, breathe, and repeat for desired repetitions. Use a towel or cushion for support **(Fig. 4)**.

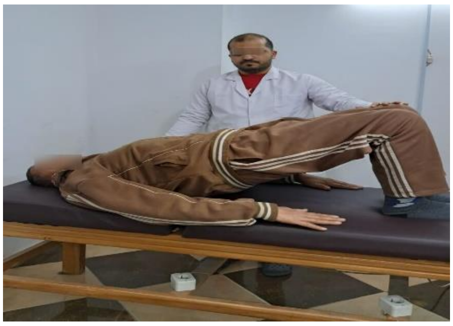

Fig. 4. Modified Pilates Bridge

Pilates chest opening exercise: Start lying on a mat, raise your arms, stretch your chest, and inhale, then return to the starting position **(Fig. 5)**.

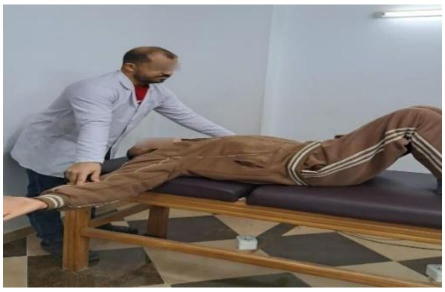

Fig. 5**.** Pilates chest opening exercise

Control group

The control group receives standard medical care for post-COVID ILD, which may include pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine) and pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercises only. They also receive educational materials, resources, and support groups to address psychological and emotional concerns.

Print ISSN 2636-3224
Online ISSN 2636-3232

Statistical Analysis

Statistical analysis was done by SPSS v25 (IBM Inc., Chicago, IL, USA). Calculated descriptive statistics (mean, standard deviation, median, etc.) for demographic characteristics, baseline measures, and outcomes for both the Pilates exercise and the control groups. Independent and paired t-tests were implemented for inter- and intra- groups comparisons, respectively. A two-tailed P value < 0.05 was deemed significant.

Results

The age, gender, and BMI exhibited no significant variations across the tested groups **Table 1**.

Table 1. Demographic data of the investigated groups

		Study group (n=30)	Control group (n=30)	P value
Age (years)	**Mean ± SD**	59.53 ± 2.99	60.13 ± 2.87	0.431
	Range	55 - 65	55 - 65	
Gender	**Male**	15 (50%)	12 (40%)	0.436
	Female	15 (50%)	18 (60%)	
BMI (kg/m^2)	**Mean ± SD**	25.16 ± 6.47	27.31 ± 6.12	0.193
	Range	15.09 - 36.29	17.51 - 41.74	

Data are presented as mean ± SD or frequency (%). BMI: Body mass index,

Pre FEV1, FVC, and FEV1/FVC were insignificantly different between both groups. Post FEV1 was significantly increased in the study group from (2.18 ± 0.2) to (2.94 ± 0.27) than the control group, which increased from (2.2 ± 0.08) to (2.28 ± 0.2). Post FVC was significantly increased in the study group from (2.79 ± 0.2) to (3.52 ± 0.24) than the control group, which increased from (2.8 ± 0.19) to (2.88 ± 0.2). Post FEV1/FVC was significantly increased in the study group from (78.48 ± 7.72) to (83.89 ± 8.79) than the control group, which increased from (79.06 ± 6.6) to (79.28 ± 8.5).

In the study group, FEV1, FVC, and FEV1/FVC exhibited significant elevations post-treatment contrasted with pre-treatment (P values <0.001, <0.001, and 0.014, respectively), but the control group did not exhibit significant variations between pre-and post-treatment **(Table 2)**.

Print ISSN 2636-3224
Online ISSN 2636-3232

Table 2. Pulmonary function tests of the studied groups.

		Study group (n=30)	Control group (n=30)	P value†
Pre FEV1 (L)	**Mean ± SD**	2.18 ± 0.2	2.2 ± 0.08	0.675
	Range	1.9 - 2.5	2.1 - 2.3	
Post FEV1 (L)	**Mean ± SD**	2.94 ± 0.27	2.28 ± 0.2	**<0.001***
	Range	2.5 - 3.4	1.4 - 2.5	
	% of change	**34.86**	**3.64**	
P value‡		**<0.001***	0.052	
Pre FVC (L)	**Mean ± SD**	2.79 ± 0.2	2.8 ± 0.19	0.895
	Range	2.5 - 3.1	2.5 - 3.1	
Post FVC (L)	**Mean ± SD**	3.52 ± 0.24	2.88 ± 0.2	**<0.001***
	Range	3.1 - 4	2.6 - 3.2	
	% of change	**26.16**	**2.86**	
P value‡		**<0.001***	0.095	
Pre FEV1/FVC (%)	**Mean ± SD**	78.48 ± 7.72	79.06 ± 6.6	0.756
	Range	63.33 - 96	67.74 - 92	
Post FEV1/FVC (%)	**Mean ± SD**	83.89 ± 8.79	79.28 ± 8.5	**0.043***
	Range	65.79 - 100	51.85 - 92.59	
	% of change	**6.89**	**0.28**	
P value‡		**0.014***	0.913	

Data are presented as mean ± SD, FEV1: Forced Expiratory Volume in 1 second, FVC: functional vital capacity, *: significant as P value ≤ 0.05, †: P value between study and control groups, ‡: P value between pre and post.

Pre-SpO2 was insignificantly different between both groups. Post SpO2 was significantly increased in the study group from (90.6 ± 2.01) to (93.57 ± 2.05) while in the control group increased from (90.8 ± 2.11) to (92.3 ± 2). The study group reported a significant elevation in the post SpO2 levels contrasted with the control group (P value = 0.019, **Table 3**).

Table 3. Oxygen saturation (SpO2) (%) of the studied groups.

		Study group (n=30)	Control group (n=30)	P value†
Pre	**Mean ± SD**	90.6 ± 2.01	90.8 ± 2.11	0.708
	Range	88 - 94	88 - 94	
Post	**Mean ± SD**	93.57 ± 2.05	92.3 ± 2	**0.019***
	Range	91 - 98	89 - 96	
	% of change	**3.28**	**1.65**	
P value‡		**<0.001***	**0.007***	

Data are presented as mean ± SD, *: significant as P value ≤ 0.05, †: P value between study and control groups, ‡: P value between pre and post.

Print ISSN 2636-3224
Online ISSN 2636-3232

Pre-6MWD was insignificantly different between both groups. Post 6MWD was significantly increased in the study group from (475 ± 112.41) to (536.8 ± 113.18) than the control group, which increased from (466.2 ± 104.73) to (476.73 ± 104.91). In the study group, 6MWD was significantly increased post-treatment than pre-treatment (P value =0.038) while it was insignificantly different between pre- and post-treatment in the control group **(Table 4).**

Table 4. 6-Minute Walking distance (6MWD) (meter) of the studied groups.

		Study group (n=30)	Control group (n=30)	P value†
Pre	**Mean ± SD**	475 ± 112.41	466.2 ± 104.73	0.755
	Range	298 – 630	308 - 644	
Post	**Mean ± SD**	536.8 ± 113.18	476.73 ± 104.91	**0.037***
	Range	359 – 700	318 - 656	
	% of change	**13.01**	**2.26**	
P value‡		**0.038***	0.699	

Data are presented as mean ± SD, 6MWD: 6-minute walking distance, *: significant as P value ≤ 0.05, †: P value between study and control groups, ‡: P value between pre and post.

Pre-symptoms, activity, impacts, and total score were insignificantly different between both groups. Post symptoms were significantly decreased in the study group from (39.8 ± 6.53) to (29.27 ± 6.11) than in the control group, which decreased from (40.63 ± 7.45) to (37.8 ± 7.48). Post activity was significantly decreased in the study group from (47.03 ± 7.62) to (36.77 ± 7.2) than in the control group, which decreased from (45.67 ± 7.9) to (43.13 ± 8.12). Post impacts were significantly decreased in the study group from (46.6 ± 6.31) to (35.47 ± 5.88) than in the control group, which decreased from (47.37 ± 7.35) to (45.1 ± 7.39). Post total score was significantly decreased in the study group from (44.48 ± 3.82) to (33.83 ± 3.67) than in the control group, which decreased from (44.56 ± 3.84) to (42.01 ± 3.85).In the study group, symptoms, activity, impacts, and total score were significantly decreased post-treatment than pre-treatment (P value <0.001), while in the control group, only total score was decreased post-treatment than pre-treatment (P value =0.013) while symptoms, activity, and impacts were insignificantly different between pre-and post-treatment **(Table 5)**.

Print ISSN 2636-3224
Online ISSN 2636-3232

Table 5. St. George's Respiratory Questionnaire (SGRQ) of the studied groups.

		Study group (n=30)	Control group (n=30)	P value†
Pre symptoms	**Mean ± SD**	39.8 ± 6.53	40.63 ± 7.45	0.647
	Range	28 – 51	28 - 52	
Post symptoms	**Mean ± SD**	29.27 ± 6.11	37.8 ± 7.48	**<0.001***
	Range	20 – 40	25 - 49	
	% of change	**26.46**	**6.97**	
P value‡		**<0.001***	0.147	
Pre activity	**Mean ± SD**	47.03 ± 7.62	45.67 ± 7.9	0.498
	Range	35 – 60	34 - 61	
Post activity	**Mean ± SD**	36.77 ± 7.2	43.13 ± 8.12	**0.002***
	Range	26 – 48	32 - 57	
	% of change	**21.82**	**5.56**	
P value‡		**<0.001***	0.226	
Pre impacts	**Mean ± SD**	46.6 ± 6.31	47.37 ± 7.35	0.666
	Range	35 – 58	35 - 57	
Post impacts	**Mean ± SD**	35.47 ± 5.88	45.1 ± 7.39	**<0.001***
	Range	26 – 44	33 - 55	
	% of change	**23.88**	**4.79**	
P value‡		**<0.001***	0.238	
Pre total score	**Mean ± SD**	44.48 ± 3.82	44.56 ± 3.84	0.938
	Range	36.33 – 55	38 - 52.33	
Post total score	**Mean ± SD**	33.83 ± 3.67	42.01 ± 3.85	**<0.001***
	Range	27.67 - 42.33	34.33 - 50.33	
	% of change	**23.94**	**5.72**	
P value‡		**<0.001***	**0.013***	

Data are stated as mean ± SD, SGRQ: St. George's Respiratory Questionnaire, *: significant as P value ≤ 0.05, †: P value between study and control groups, ‡: P value between pre and post.

Discussion

We designed to ascertain the benefits of Pilates exercise in the setting of post-COVID ILD.

This investigation was conducted on 60 patients diagnosed with post-

Print ISSN 2636-3224
Online ISSN 2636-3232

COVID ILD. They were randomized into Study group: 30 patients received standard care for post-COVID ILD, which may include pharmacological interventions like Corticosteroid (prednisone) and Anti-fibrotic drugs (azathioprine), pulmonary rehabilitation exercises like pursed lip and diaphragmatic breathing exercise and a supervised Pilates exercise program. For 12 weeks, with three sessions per week. Each session will last approximately 30 minutes. The exercises were customized to the specific requirements and capabilities of the participants. Control group: 30 patients received standard care for post-COVID ILD, which may include pharmacological interventions and pulmonary rehabilitation exercises: Pursed lip and diaphragmatic breathing exercises only.

The present study focused on the Pulmonary Function Test (PFT), Blood Oxygen Saturation (SpO2), Exercise Tolerance, and Functional Capacity by 6-minute Walk Test and QoL by SGRQ.

The demographic data of the studied groups revealed an equal distribution of participants between the study and control groups, aligned with the outcomes of Sciriha et al.(14) who conducted their research on 120 ILD patients. These patients were randomized into 60 patients comprised of the active group (30 male and 30 female), while the inactive group also consisted of 60 patients, including 32 males and 28 females, to ascertain the implication of a 12-week pulmonary rehabilitation program on individuals with ILD.

Our first finding was that post FEV1, FVC, and FEV1/FVC were significantly increased in the study group than control group. This data aligns with Bagherzadeh-Rahmani et al. (15), who observed significant improvements in FVC, FEV1, and FEV1/FVC in the experimental groups but not in the control group among individuals with a history of COVID-19. We aimed to estimate the consequence of 8 weeks of Pilates and Aqua-Pilates training on pulmonary function and QoL in individuals with a history of COVID-19.

Also, a study by Shen et al. (16) confirmed that pulmonary rehabilitation exercise improved lung function parameters (FVC and FEV1) in the exercise group contrasted with the control group in patients with idiopathic pulmonary fibrosis.

Pilates and diaphragm exercises significantly enhance the lung function of individuals with pulmonary disorders (17). The findings indicated that both exercise modalities enhanced pulmonary function, elevated FEV1/FVC ratios, and reduced dyspnea and respiratory rate per minute in chronic obstructive lung disease patients.

Print ISSN 2636-3224
Online ISSN 2636-3232

The pulmonary function test results in this study were significantly elevated in the study group relative to the control group, contradicting the outcomes of Franco et al. (18), who estimated the impact of Pilates mat exercises on cystic fibrosis patients and found no significant variations in pre- and post-intervention values of FVC or FEV1, either in the overall specimens or among patients of either gender.

This study's significant enhancement in oxygen saturation aligns with findings from research indicating that exercise-based pulmonary rehabilitation may effectively elevate SpO2, reduce dyspnea and pulse rate, and enhance the QoL for patients with severe COVID-19 post-discharge from the intensive care unit (19). Separate research indicates that aerobic, strength, and respiratory activities enhance inhalation and exhalation of pulmonary function and oxygen saturation in post-COVID-19 women (20).

In the study group, the 6MWD exhibited a significant increase post-treatment compared to pre-treatment, corroborating the outcomes of (21), who reported a significant improvement in 6MWD within the rehabilitation group; no significant change was detected in the control group throughout the assessment of the effectiveness of outpatient physical therapy for post-COVID patients with lung damage.

Our outcomes align with the outcomes of (22), which reported a significantly greater mean in the 6MWT and a significant improvement in dyspnea within the rehabilitation group compared to the control group while examining the impact of home-based pulmonary rehabilitation on exercise capacity in post-COVID-19 syndrome patients.

The findings of the present study regarding the SGRQ of the examined groups align with those of (23), a review on pulmonary rehabilitation for ILD, which indicated that pulmonary rehabilitation likely enhances health-related QoL. Improvements were observed across all four domains of the Chronic Respiratory Disease Questionnaire (CRQ) and the SGRQ for ILD participants, including the subgroup of IPF patients. Five studies indicated that longer-term results demonstrated sustained improvements in exercise capacity, dyspnea, and health-related QoL six to 12 months post-intervention. Pulmonary rehabilitation may be conducted safely in individuals with ILD. Pulmonary rehabilitation likely enhances functional exercise capacity, alleviates dyspnea, and improves QoL in the near term, with potential benefits, especially in IPF. Enhancements in functional exercise capacity, dyspnea, and QoL were maintained over an extended period.

The current study corroborates the findings of (24), who conducted research

Print ISSN 2636-3224
Online ISSN 2636-3232

involving 72 subjects, of whom 36 received respiratory rehabilitation while the remainder did not. They indicated that a six-week respiratory rehabilitation program may improve respiratory function and QoL and alleviate anxiety in older individuals with COVID-19. Furthermore, exercise endurance, assessed by the six-minute walk test, demonstrated significant enhancements in exercise capacity after the six-week intervention.

The current study's findings on SGRQ activity are inconsistent with those of (25), who assessed the impact of pulmonary rehabilitation on exercise capacity in ILD following a 6-month program and after one year. They reported significant improvements in exercise capacity, QoL, and muscle strength contrasted with the control group, while physical activity remained unchanged. The significant advantages after pulmonary rehabilitation in ILD did not result in measurable improvements in physical activity. Some studies demonstrated an increase in physical activity after pulmonary rehabilitation, whereas others did not provide such results. The unfavorable findings indicated a lack of change despite improvements in physiological function and health status.

Conclusion

Pilates exercise may enhance exercise capability and QoL in persons with post-COVID ILD. This investigation was performed to investigate the implications of Pilates exercise especially in the setting of post-COVID ILD.

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Availability of data and material

The data are available upon request.

Consent for publication

Not applicable.

Conflict of interest

No conflicts of interest.

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