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The Effects of Squatting Intervention on Post-acute COVID Syndrome

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KEYWORDS

Post COVID Syndrome, Squatting Exercises, Breathing Exercises, Functional capacity, Quality of life

ABSTRACT:

This study is conducted to evaluate the effects of squatting exercises on lower limb muscle strength, cardio-pulmonary endurance and quality of life in post-acute COVID subjects. The study was conducted on 30 post-acute COVID subjects and were randomly assigned into 2 groups for 6 weeks of intervention program for 3 days a week. Group-A performed an individualized tailored squatting exercise program along with breathing exercises and Group-B performed 20 to 30 minutes of brisk walking along with breathing exercises. After 6 weeks of intervention program, both groups demonstrated significant improvements in lower limb muscle strength, cardiorespiratory functional capacity and quality of life. However, Group-A exhibited statistically significant improvement when compared to Group-B.

The objective of this study was to evaluate the effects of squatting intervention on lower limb muscle strength, cardio-pulmonary endurance and quality of life in subjects with post-acute COVID syndrome and to compare the effects of lower limb muscle strength, cardio-pulmonary endurance and quality of life in post-acute COVID subjects of Squatting exercise intervention group and Conventional exercise group.

The results of the study showed that after 6 weeks of intervention program, both groups demonstrated significant improvements in lower limb muscle strength, cardiorespiratory functional capacity and quality of life. However, Group-A exhibited statistically significant more improvement when compared to Group-B.

Background

In COVID-19 patients, it has been reported that there is only partial recovery of symptoms following three months, with the most commonly reported persistence of symptoms such as fatigue and dyspnoea seen in 'mild' COVID-19 patients as well. The persistence of multiple symptoms even at three months in both hospitalized and non-hospitalized patients suggests the presence of a 'post-COVID-19 syndrome,' implying long-term healthcare needs in patients with both 'mild' and 'severe' COVID-19. [1] The exact mechanisms causing the post-acute sequelae of SARS-CoV-2 (long COVID) are not well understood. However, this is consistent with cardiorespiratory deconditioning, exercise intolerance, which is a characteristic feature of chronic fatigue syndrome. [2]

Furthermore, it is observed that COVID-19 patients, even after receiving early mobilization/bedside physiotherapy, still experienced impaired physical functioning post-discharge from the hospital. [3]

As observed in chronic respiratory diseases due to physical de-conditioning, there is high energy expenditure during activity, resulting in increased perceived exertion and breathlessness which leads to a decline in functional capacity. [4, 5]

In chronic respiratory diseases, alongside an array of systemic symptoms, it often manifests as skeletal muscle dysfunction, with a notable prevalence of quadriceps weakness in the majority of patients. [6] Peripheral muscle dysfunction, in addition to dyspnoea, stands as a primary factor contributing to reduced functional capacity. This dysfunction affects muscle strength, endurance, and the experience of fatigue, with particular emphasis on the observation of weakness, notably in the lower limb muscles, particularly the quadriceps muscle.[7] A decrease in muscle strength and endurance, coupled with impaired muscle metabolism efficiency, results in an elevated oxygen consumption rate for a given workload and an increased production of lactate. [8] These factors along with the lower limb muscle

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dysfunction could directly impact the functional and exercise capacity of these patients. [4]

Exercise training is known to improve functional capacity and improve health-related quality of life by enhancing exercise capacity and strengthening peripheral muscles. [9]

The body-weight squat is an excellent whole-body exercise that engages major muscles in the lower limbs and trunk. [9] Squatting is recognized for its ability to enhance leg, hip, and back strength, as well as overall functional performance. [9, 10,11] Body-weight squats are widely used in various rehabilitation protocols to enhance muscle strength and endurance in individuals with musculoskeletal dysfunction.

Though large muscle group aerobic exercises are a part of cardiorespiratory fitness, squatting exercises are generally not used as an integral part of pulmonary rehabilitation as required in post-acute COVID syndrome.

Methodology

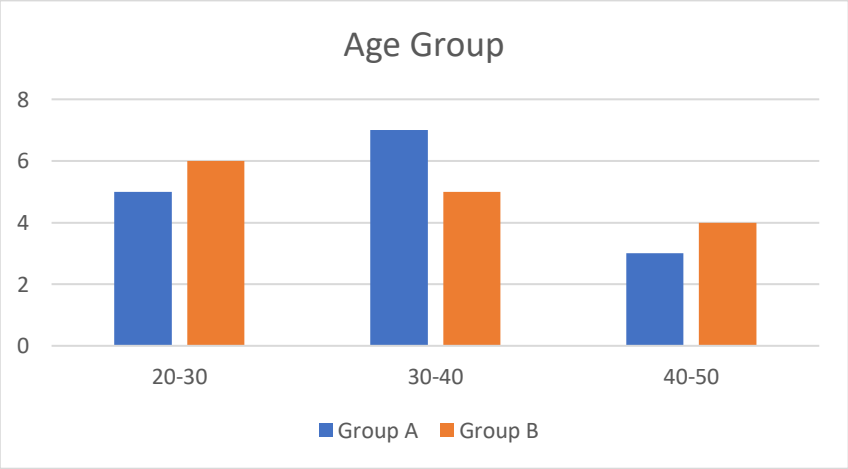
Based on the inclusion and exclusion criteria 30 subjects were randomly assigned into 2 groups for 6 weeks of intervention program for 3 days a week. While Group-A received an individualized tailored squatting exercise program and Group-B was engaged in 20 to 30 minutes of brisk walking. Breathing exercises were commonly performed by both groups.

Thirty subjects were randomly assigned using a lottery method to either Group A -Squatting exercise with breathing exercises (n= 15) or Group B -Conventional exercises with breathing exercises(n=15) based on the predefined inclusion and exclusion criteria. Both groups underwent a supervised exercise program three times a week for a duration of 6 weeks. Subjects in Group A received breathing exercises and an individualized squatting exercise, determined by their performance in the 30-second squat test. On the other hand, subjects in Group B engaged in endurance training, involving 20 to 30 minutes of walking along with breathing exercises.

Results

After the six-week intervention program, both groups demonstrated significant improvements in cardiorespiratory functional capacity and quality of life. However, Group A exhibited statistically significant improvement in the 30-second Sit to Stand test, Peak Expiratory Flow Rate (PEFR), and the 6-Minute Walk test when compared to Group B. This implying that after 6 weeks of intervention program, both groups demonstrated significant improvements in lower limb muscle strength, cardiorespiratory functional capacity and quality of life. However, Group A exhibited statistically significant improvement when compared to Group B.

Age Group	Group A	Group B
20-30	5	6
30-40	7	5
40-50	3	4
Mean age	33.4	33.1



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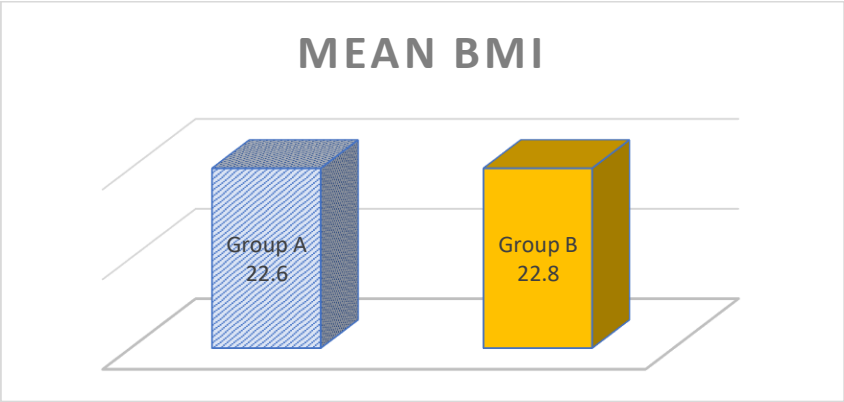
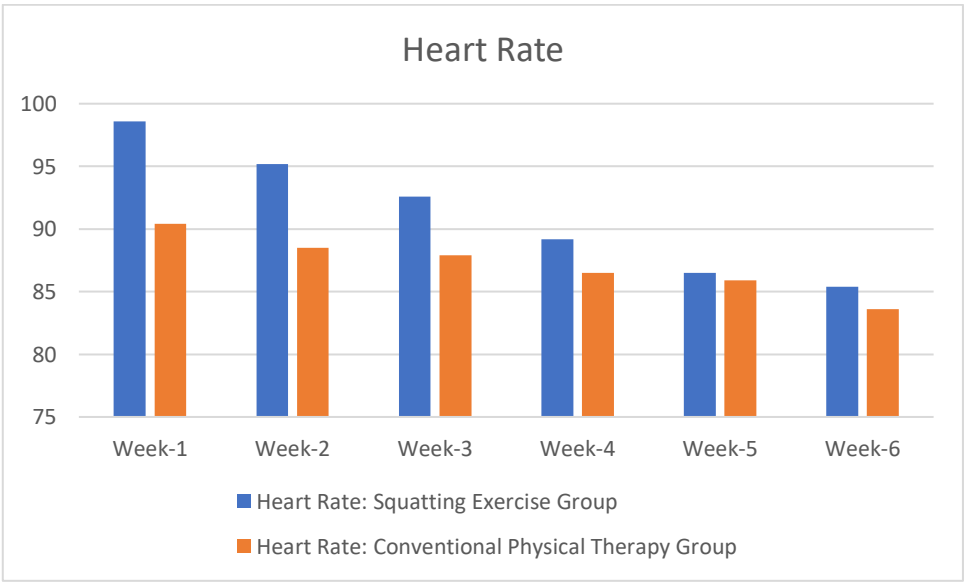
Variables BMI(kg/m2)	Group A		Group B
20-30	22.04		22.2
30-40	22.3		23.06
40-50	23.7		23.02
Mean BMI	22.6		22.8



Heart rate variations per week in both groups		
	Squatting Exercise Group	Conventional Physical Therapy Group
Week-1	98.6	90.4
Week-2	95.2	88.5
Week-3	92.6	87.9
Week-4	89.2	86.5
Week-5	86.5	85.9
Week-6	85.4	83.6



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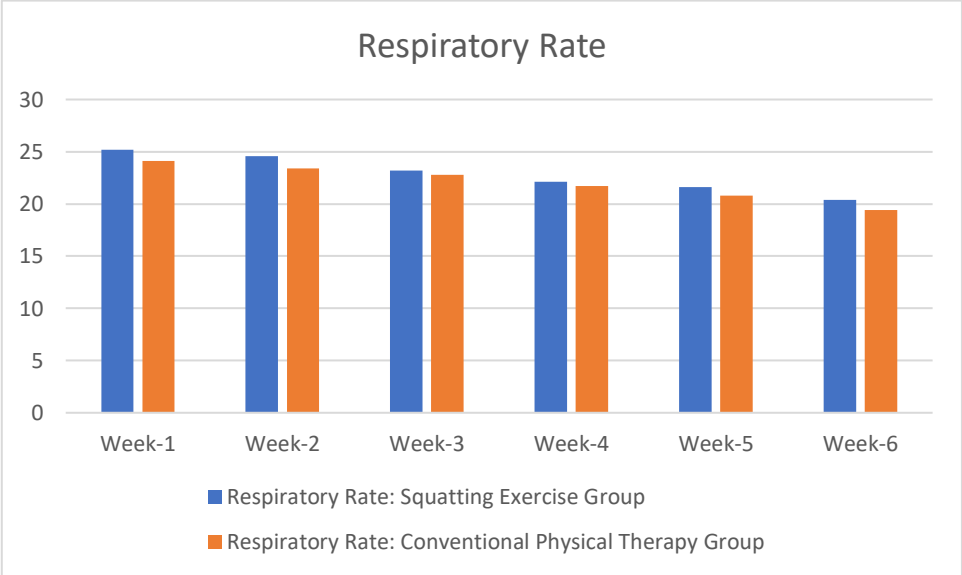
Respiratory rate variations per week		
	Squatting Exercise Group	Conventional Physical Therapy Group
Week-1	25.2	24.1
Week-2	24.6	23.4
Week-3	23.2	22.8
Week-4	22.1	21.7
Week-5	21.6	20.8
Week-6	20.4	19.4



Oxygen Saturation per week		
	Squatting Exercise Group	Conventional Physical Therapy Group
Week-1	95.8	95.6
Week-2	96.2	96.2
Week-3	96.8	96.6
Week-4	97.4	97.3
Week-5	98.3	98.4
Week-6	98.8	98.9

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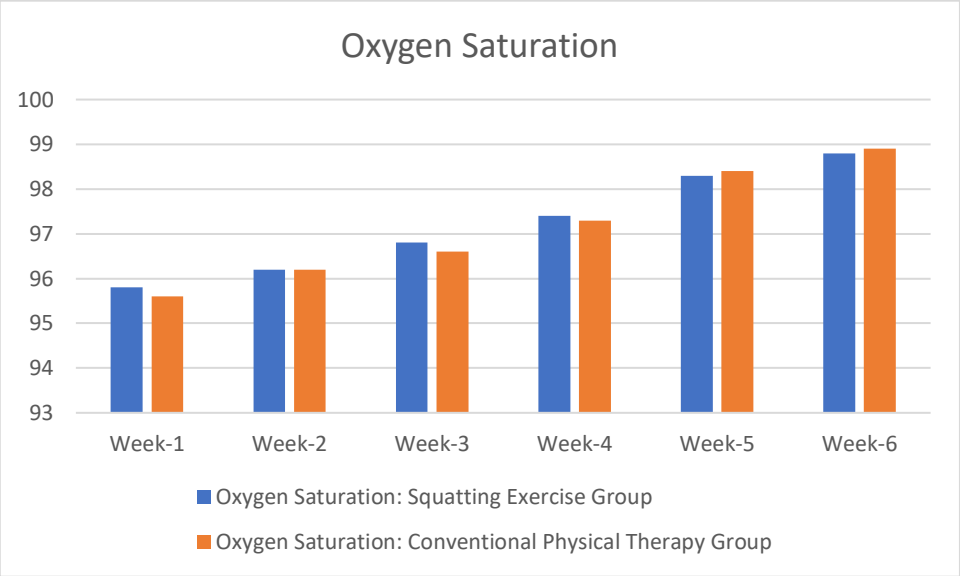

Group-A (Squatting exercise Group)		
Variables	**Pre-Intervention Mean (SD)**	**Post Intervention Mean (SD)**
PEFR (Litres/min)	220.6 (82.1)	292.6 (85.5)
30 sec sit to stand test (reps)	10.1 (2.4)	12.8 (1.9)
Six minute Walk test (metres)	377.3 (100.5)	437.9 (91.6)
SF12 Physical Component	35.7 (10.9)	48.1 (9.4)
SF12 Mental Component	47 (8.5)	57 (8.9)
IPAQ	1.8 (0.4)	2.7 (0.4)
All the variables showed $p \leq 0.05$		

Group-B(Conventional physical therapy Group)		
Variables	**Pre-Intervention Mean (SD)**	**Post Intervention Mean (SD)**
PEFR (Litres/min)	189.3 (67.8)	205.3 (69.5)
30 sec sit to stand test (reps)	10.9 (1.4)	11.3 (1.2)

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Six minute Walk test (metres)	299.3 (99.6)	314.3 (103.8)
SF12 Physical Component	39.7 (9.5)	43 (8.6)
SF12 Mental Component	52.3 (8)	54.3 (8)
IPAQ	1.4 (0.5)	2.3 (0.5)
All the variables showed p≤ 0.05		

Comparison Between Groups			
Variables	**Group-A**	**Group-B**	**p Value**
	Difference following Intervention Mean (SD)	**Difference following Intervention Mean (SD)**	
PEFR (Litres/min)	72 (3.4)	16 (1.7)	<0.005
30 sec sit to stand test (reps)	2.8 (0.5)	0.5 (0.2)	<0.05
Six minute walk test (metres)	59.7 (8.9)	15 (1.5)	<0.05
SF12 Physical Component	12.4 (1.5)	3.3 (0.9)	0.136
SF12 Mental Component	10 (0.4)	2 (0)	0.091

Conclusion:

This study aims to assess the effectiveness and safety of a squatting intervention on lower limb muscle strength, cardiorespiratory functional capacity and health-related quality of life in patients with post-acute COVID period.

The squatting activity imposes a physiological load on the cardiovascular system, leading to increased cardiac output and arterial blood pressure. This is primarily caused by the increased venous return resulting from the compression of leg veins, which is then followed by an immediate decrease in heart rate, triggered by the activation of cardiopulmonary and arterial baroreflexes. [12]

Squatting engages the quadriceps, hamstrings, calves, abdominals, back and gluteus muscles, fostering an anabolic environment that enhances muscle strength. [13] Peripheral adaptations in skeletal muscle resulting from strength training involve increased mitochondrial oxidative capacity and muscle capillarization, leading to the conversion of Type IIb to Type IIa muscle fibers. [7]

Intervention with squatting exercises contribute to enhancing the strength and endurance of lower extremity muscles, subsequently improve walking distances and reduce fatigue levels and alleviates the sensation of dyspnea. [14] The improvement in muscle capillarization and myoglobin concentrations supports enhanced oxygen extraction by skeletal muscles. Additionally,

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enhanced cardiac-respiratory capacity and increased oxygen delivery to muscles contribute to a reduction in exercise-induced lactic acidosis [15] resulting in reduced fatigue and improved walking distance.

It is observed that both groups benefit from the breathing exercises, as they contribute to improved ventilation and the correction of breathing patterns. [16]

Although specific respiratory muscle training was not included, deep squat exercises engage the abdominal muscles [17] potentially enhancing expiratory pressures, as seen in the peak expiratory flow rate (PEFR). Furthermore, the passive pushing of abdominal contents during the full descent of the deep squat stretches the diaphragm, resulting in increased inspiratory activity during ascent. Consequently, this leads to an improvement in the rate and depth of respiration. [18]

The study's conclusion supports the safety and effectiveness of integrating squatting interventions alongside traditional breathing and endurance exercises in the treatment protocol for individuals with post-acute COVID syndrome. Post-COVID patients demonstrated a high level of safety and tolerance in response to the combination of squat exercises and conventional physical therapy training.

Clinical Implication: Enhanced exercise tolerance helps patients achieve greater functional ability, ultimately leading to an improved quality of life. Incorporating squatting into the program could enable individuals to create an effective short-duration exercise program that engages the major muscles of the body. Improving peripheral muscle strength also alleviates the symptoms of dyspnea and fatigue, thus aiding in the management of the primary manifestations of post-acute COVID syndrome.

Thus the inclusion of squatting exercises can be considered as a complementary approach alongside traditional breathing and endurance exercises in the treatment protocol for individuals with Post-COVID Syndrome.

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