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Effects Of Moderate Intensity Aerobic Training Combined With Inspiratory Muscle Training On Selected Physiological Variables And Quality Of Life In Post Covid-19 Population Of Puducherry

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ABSTRACT
Background and rationale: *To the best of our knowledge, no studies have evaluated the Effects of Moderate intensity aerobic training combined with inspiratory muscle training on post COVID-19 recovered populations. Therefore, this study assessed the effect of Moderate intensity aerobic training combined with inspiratory muscle training on Cardio-Respiratory endurance, oxygen saturation and quality of life among post COVID-19 populations of Puducherry.*
Methodology: *Population-Post Covid-19 population, Study setting- Exercise Therapeutics lab COPT, MTPG & RIHS –Puducherry, Duration-12 weeks, independent variable – Moderate intensity Aerobic training and Inspiratory Muscle Training, Dependent variable- Cardio-Respiratory Endurance, Oxygen Saturation and Quality of Life, Outcome measures- Six-minute walk distance, Oxygen Saturation level and Quality of life, Tools- six-minute walk distance, pulse oximeter, COVID-19 QoL questionnaire.*
Result: *Significant effects were observed in the Moderate intensity aerobic exercise combined with Inspiratory muscle training compared to control group. P value is less than 0.0001 (<0.005) showing that there is significant difference in pre and post values of 6-MWD of Group A and B. P value of 0.0001 (<0.005) showing that there is significant difference in pre and post value of Oxygen Saturation level of Group A and B. P value of 0.0001 (<0.005) showing that there is significant difference in pre and post value of COVID-19 QoL Questionnaire Group A and*
Conclusion: *A 12-week Moderate intensity aerobic exercise combined with IMT improves Six-minute walk distance, Oxygen Saturation level and QoL in Post COVID-19 recovered population. Hence moderate intensity aerobic exercise combined with IMT program should be encouraged in the COVID-19 management protocol.*
Keywords: *COVID-19, Inspiratory muscle training, Six-minute walk distance, Oxygen Saturation level, Quality of life, COVID-19 population.*

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I. INTRODUCTION

The Coronavirus disease 2019 (COVID-19), the highly contagious viral illness is referred as newfound COVID-2019 by the WHO. COVID-19 is a novel enveloped RNA beta-coronavirus; it is an infection of the respiratory tract arising from SARS-COV 2, coronavirus manifests itself with a wide spectrum of symptoms, from asymptomatic to life-threatening and fatal disease. COVID-19 first featured in the late December 2019 in Wuhan province of China & emerged as global pandemic disease worldwide.

COVID-19 has had a catastrophic effect on the world's demographic resulting in more than 6 million deaths worldwide, emerging as the most consequential global health crisis since the era of the influenza pandemic of 1918 and currently this pandemic has infected more than 655 million people in nearly 223 countries. According to WHO, Globally, until January 4 2023 around 655,689,115 cases have been confirmed to have COVID-19 and 6,671,624 of them died. Nationally in India, until January 4, 2023, around 44,678,956 cases have been confirmed to have COVID-19 and 530,707 deaths were reported.

There is increasing concern and emerging evidence that a substantial portion of people who suffered from the COVID-19 do not make rapid or full recovery and reporting symptoms that lasts for month after recovery which introduced the novel terms, post -acute sequelae of SARS-COV-2 infection (PASC), long COVID, long haulers, "post-COVID syndrome" (PCS) and chronic COVID-19The overall incidence of long-

COVID features in the 90 to 180 days post-diagnosis. The main widespread reported long-term symptoms in COVID-19 patients were chronic fatigue, dyspnoea, shortness of breath, chest pains, headache, anosmia or ageusia, myalgia, arthralgia. Dyspnoea and decreased exercise capacity are commonly persistent symptoms.

Fatigue is the most debilitating feature and has the greatest impact on post-COVID-19 syndrome patient's quality of life. These long-term symptoms are not only present in severe COVID-19, but also in mild and moderate patients[54]. It is estimated that 10% to 35% of patients not requiring hospitalization develop post-COVID symptoms, regardless of co-morbidities, while incidence rates up to 80% have been reported among hospitalized patients and among patients with severe illnesses. Like acute COVID-19, long covid can involve multiple organs and can affect many systems including, but not limited to, the respiratory, cardiovascular, neurological, gastrointestinal, and musculoskeletal systems but the lungs seem to be the main organs affected by the COVID-19 virus. Abnormal lung functions and structural changes were reported up to 6 months in mild-to critical COVID-19 patients with diffuse alveolar damage, desquamation of alveolar epithelial type II cells, fibrine exudation, hyaline membranes, scattered interstitial inflammation, monocytes, and macrophage.

COVID-19 mainly damages respiratory system; impairments include decreased pulmonary function, reduced six-minute test distance walk, reduced strength of the respiratory muscles and decreased ability to perform activities of daily living. Following numerous reports of COVID-19, the most persistent symptoms are breathlessness and respiratory muscle weakness. Pulmonary rehabilitation (PR) has been advocated as a rehabilitation strategy. Whilst PR is highly effective in a range of chronic respiratory conditions including COVID-19. The main goal of respiratory physiotherapy in COVID-19 is to reduce the symptoms of dyspnoea, improve lung capacity and cardiovascular endurance. The purpose of PR in COVID-19 is to alleviate dyspnoea, relieve anxiety and depression and eventually improve physical functions and quality of life.

There is sufficient evidence suggesting that proper tailored and supervised exercise training may be an effective multisystemic therapy for post-COVID-19 syndrome for mitigating the post-COVID-19 symptoms and helping people in recovering faster and increasing their autonomy, functionality and quality of life.

In light of a fast- increasing disease burden of long COVID, there is a clear need to plan for post-COVID and strategies to improve long-term outcomes of patients recovering from COVID-19Therefore, our present study aims to assess the effect of moderate intensity aerobic exercise training and Inspiratory muscle training on COVID-19 hypothesizing that this approach could improve Cardio-Respiratory endurance, dyspnoea index, and quality of life & add new vision for an improved control of post-COVID-19 populations.

Objectives

Primary Objectives- To assess the effects of Moderate Intensity Aerobic Training combined with Inspiratory Muscle Training on Cardio-respiratory endurance and Oxygen saturation in post COVID-19 population of Puducherry.

Secondary Objectives-To assess the effects of Moderate Intensity Aerobic Training combined with Inspiratory Muscle Training on Quality of Life in post COVID-19 population of Puducherry.

II. METHODOLOGY

It is a Pre and Post Test Experimental study conducted among 100 participants in Exercise Therapeutics lab, COPT, MTPG & RIHS, Puducherry. The participants were selected based upon the inclusion and exclusion criteria. Inclusion criteria were Participants aged between 20 & 50 years both males and females were included, participants who have recovered from COVID-19 and have completed 120 days were included, mild and moderate post recovered COVID population were included in this study, hypertensive & diabetic persons (who are taking medications & under control) were included in this study and the exclusion criteria were Persons below 20 years and above 50 years, pregnant women, persons with cancer, known history of epilepsy, underlying cardiovascular disease, rib fractures, recent injuries, systemic disease (endocrine) & cognitive dysfunction were excluded from the study.

Procedure

118 participants were willing for the study and after obtaining informed consent were selected to do this study. Assessment of the baseline eligibility criteria after fulfilling the inclusion and exclusion parameters was done. The participant information sheet and informed consent was obtained. After obtaining informed consent form, they were allocated randomly into two groups using lottery method. Group A n= 50 control group received diaphragmatic, segmental breathing exercises and thoracic mobility exercises for 40 Minutes/day for 3 days/week for 12 weeks. Group B n=50 experimental group received both diaphragmatic, segmental breathing exercises and thoracic mobility exercises along with moderate intensity aerobic training & inspiratory muscle training for 40 Minutes /day for 3 days /week for 12 weeks. Pre-test measurements was taken at zero week before commencement of intervention and post-test measurements were taken at the end of 12 weeks.

There were 18 dropouts from the original population selected for the study due to participant attrition. The remaining 100 were again randomly allocated to two groups. After completion of the study the control group participants were taught the experimental group exercises demonstration of moderate intensity aerobic and inspiratory muscle training. The outcome measures of 6 Minute Walk Distance, Oxygen Saturation level & COVID-19 Quality of Life scores were measured, documented, compared & statistically analyzed & results were obtained.

FLOW CHART

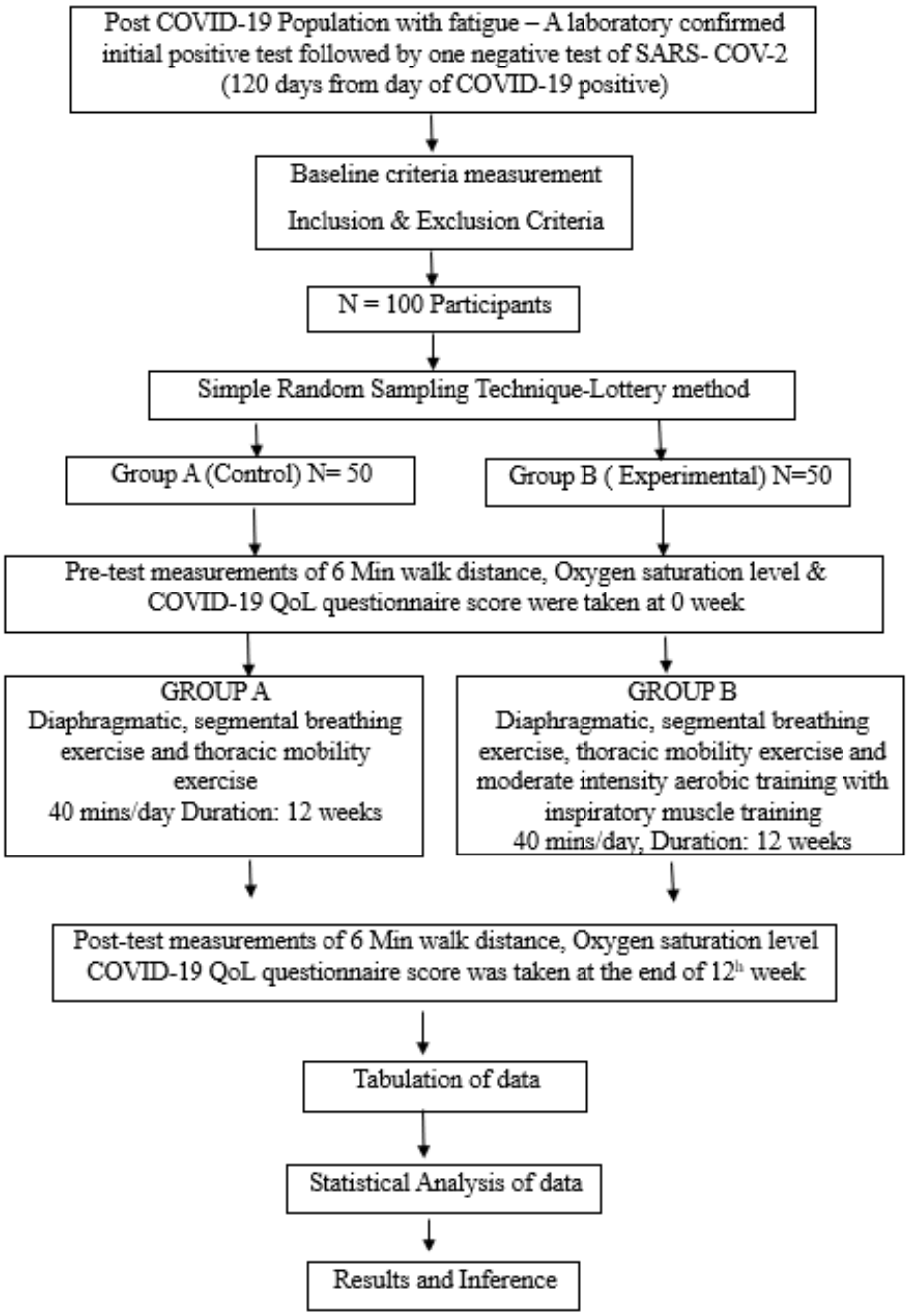
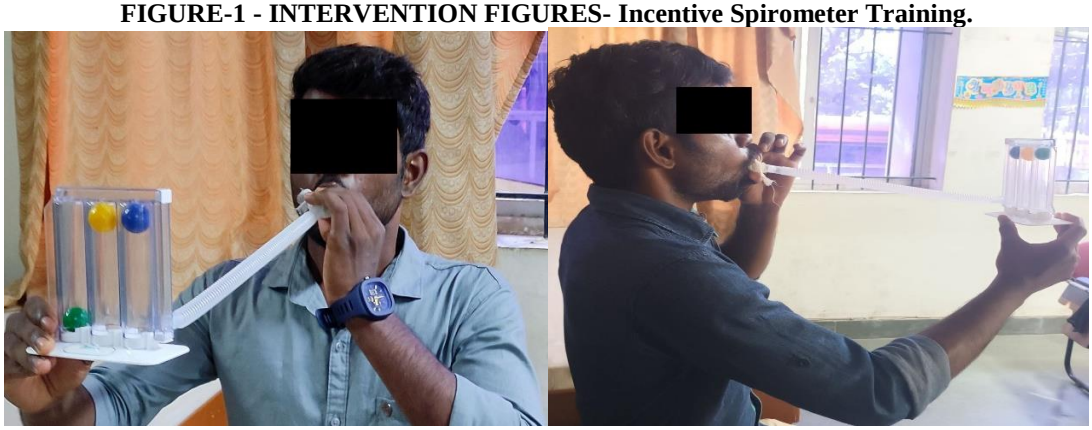


FIGURE-1 - INTERVENTION FIGURES- Incentive Spirometer Training.



AEROBIC TRAINING

STASTITICAL ANALYSIS AND RESULTS

Statistical Analysis by SPSS (Statistical Package for social sciences) Version 25 software tool was used to analyze the data. Chi-Squared test was used to analyze the baseline characteristic of the population (Age & Gender). Dependent 't' test was used to analyze the Pre and posttest values of the each group i.e control group & experimental group. Independent 't' test was used to analyze the posttest values of both groups.

Table 1: General Characteristic of the Participants

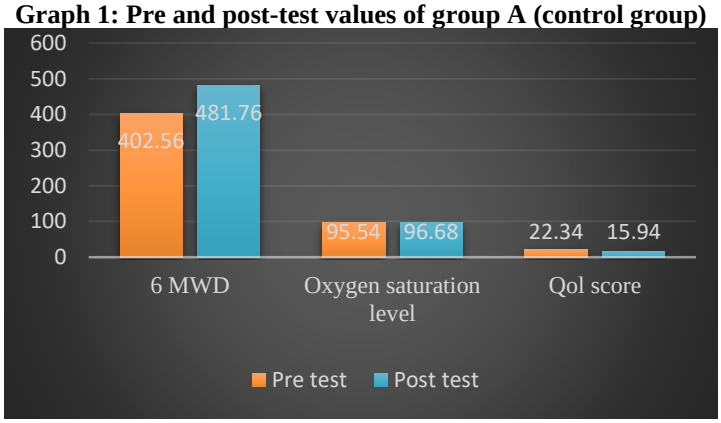
Variables	Age			Gender			
	Mean	S. D	P value	Male	Female	Chi-square value	P value
Group A (Control Group)	30.50	9.780	0.133	24	26	0.364	0.546
Group B (Experimental Group)	29.78	8.074		21	29		

Table 2: Pre and post-test values of group A (control group)

Outcome Measure	Pretest		Post – Test		t-value	P-Value
	Mean	S. D	Mean	S. D		
6 MWD	402.56	17.422	481.76	64.700	-8.584	<0.001

Oxygen Saturation Level	95.54	0.542	96.68	0.471	-19.925	<0.001
QoL Score	22.34	1.649	15.94	1.570	51.389	<0.001

Graph 1: Pre and post-test values of group A (control group)

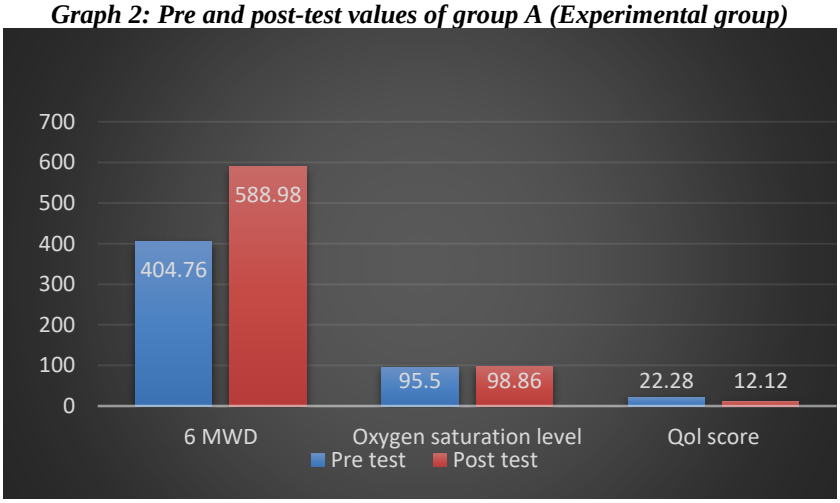


The pre-test & post-test mean value of 6WD in Group A participants is 402.56 (SD 17.422) and 481.76 (SD 64.700) this shows that the 6 MWD scores gradually increased. The pre-test & post-test mean value of oxygen saturation in Group A participants is 95.54 (SD 0.542) & 96.68 (SD 0.471) this shows that the Oxygen Saturation level scores gradually increased. The pre-test & post-test mean value of COVID-19 QoL Questionnaire in Group A participants 22.34 (SD 1.649) & 15.94 (SD 1.570) this shows that the COVID-19 QoL Questionnaire scores gradually decreased P value is less than 0.0001(<0.05) showing that there is significant difference in pre and post values of 6 Minute Walk Distance measure, oxygen saturation value & QoL Questionnaire scores of Group A.

Table 3: Pre and posttest values of Group B (Experimental group)

Outcome Measure	Pretest		Post – Test		t-value	P-Value
	Mean	S. D	Mean	S. D		
6 MWD	404.76	20.839	588.98	22.613	-128.231	<0.001
Oxygen Saturation Level	95.50	.614	98.86	.783	-39.733	<0.001
QoL Score	22.28	1.578	12.12	1.745	101.147	<0.001

Graph 2: Pre and post-test values of group A (Experimental group)



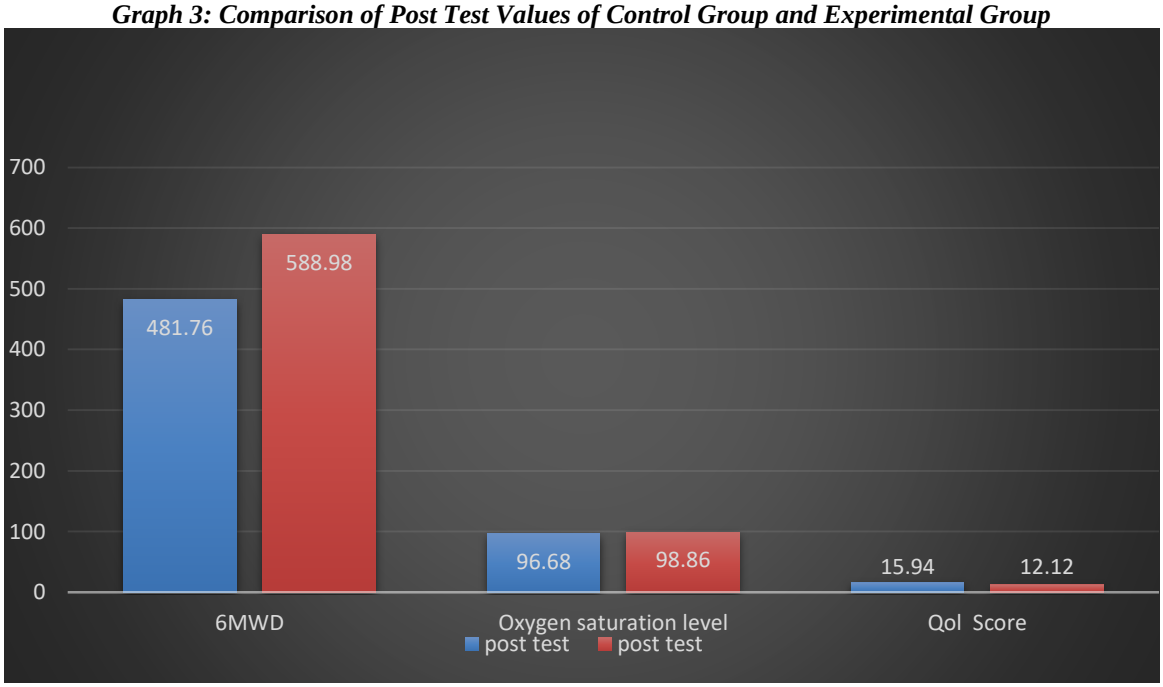
The pre-test & post-test mean value of 6WD in Group B participants is 404.76 (SD 20.839) and 588.98 (SD 22.613) this shows that the 6 MWD scores gradually increased. The pre-test & post-test mean value of

oxygen saturation in Group A participants is 95.50 (SD 0.614) & 98.86 (SD 0.783) this shows that the Oxygen Saturation level scores gradually increased. The pre-test & post-test mean value of COVID-19 QoL Questionnaire in Group A participants 22.28(SD 1.578) & 12.12 (SD 1.745) this shows that the COVID-19 QoL Questionnaire scores gradually decreased P value is less than 0.0001(<0.05) showing that there is significant difference in pre and post values of 6 Minute Walk Distance measure, oxygen saturation value & QoL Questionnaire scores of Group B.

Table 4: Comparison of Post Test Values of Control Group and Experimental Group

Outcome Measure	Post- test (Control Group)		Post–Test (Experimental Group)		t-value	P-Value
	Mean	S. D	Mean	S. D		
6 MWD	481.76	64.700	588.98	22.613	-11.062	<0.001
Oxygen Saturation Level	96.68	0.471	98.86	0.783	-16.872	<0.001
QoL Score	15.94	1.570	12.12	1.745	11.505	<0.001

Graph 3: Comparison of Post Test Values of Control Group and Experimental Group



The pre-test mean value of Group A is 402.56 (SD 17.422) and Group B is 404.76(SD 20.839) and post-test mean value of Group A is 481.76 (SD 64.700) and Group B is 588.98(SD 22.613) P value of post-test is 0.56 (>0.05) showing that there is significant difference in pre-test and post-values of 6 Minute Walk Distance measure of Group A and B.

The pre-test mean value of Group A is 95.54 (SD 0.542) and Group B is 95.50 (SD 0.614) & post-test mean value of Group A is 96.68 (SD 0.471) and Group B is 98.86 (SD 0.783). P value of 0.0001 (<0.05) showing that there is significant difference in pre and post value of Oxygen Saturation levels of Group A and B

The pre -test mean value of Group A is 22.34 (SD 1.649) and Group B is 22.28 (SD 1.578), post-test mean value of Group A is 15.94 (SD 1.570) and Group B is 12.12(SD 1.745). P value of 0.0001 (<0.05) showing that there is significant difference in pre and post value of COVID-19 QoL Questionnaire scores Group A and B.

The above results revealed that statistically significant results were obtained within the comparison of Group A and B for pre-test and midway test, pre-test, and post-test values for Six-minute walk distance measure, Oxygen saturation level and COVID-19 QoL questionnaire scores.

III. DISCUSSION

The pandemic of the Coronavirus disease 2019 has provoked a second pandemic, i.e., symptoms persisting for more than four weeks after the diagnosis of COVID-19 characterize the post-COVID syndrome. Since millions of people have been infected and more will continue to be infected, the number of 'long hauler' is dramatically increasing.

According to Anastasio, F. et al. (2021) "Medium-term impact of COVID-19 on pulmonary function, functional capacity and quality of life" Patients with lung involvement during SARS-CoV-2 infection correlates to the reduction of the pulmonary function test parameters six-minute walk distance, oxygen saturation values and quality of life 4 months after the acute illness

In this study exercises given for Group A received segmental, diaphragmatic breathing exercise and thoracic mobility exercises Group B received segmental, diaphragmatic breathing exercises and thoracic mobility exercises along with moderate intensity aerobic exercise in the form of cycling with frequency of 60-80 revolutions per minute (rpm) with the intensity of 64%-76% of their predicted maximal heart rate (220- age). Cycle ergometer was used for aerobic training. Its model was BH fitness H283 Astra exercise bike (upright Stationary exercise bike) and inspiratory muscle training by using incentive spirometry**.**

In accordance with the findings by Ahmed,I. et al. (2021) who studied the "Effectiveness of aerobic exercise training program on cardio-respiratory fitness and quality of life in patients recovered from COVID-19" reveals that the participants underwent five weeks of moderate to high intensity aerobic training shows significant improvement in measure of cardio-respiratory endurance, dyspnoea and quality of life manifested by a longer 6MWD 667.8 (35.32) metres from patients having below standard 6-min walk test and QoL score at baseline

According to McNarry MA, Berg RMG, Shelley J, Hudson J, Saynor ZL, Duckers J, et al. in their study "Inspiratory Muscle Training Enhances Recovery Post COVID-19" concluded that Inspiratory muscle training elicited clinically meaningful reductions in the severity of dyspnoea and chest-related symptoms, as well as improved respiratory muscle strength and aerobic fitness[37.]

IV. CONCLUSION

In the present study it was inferred that after twelve weeks of exercise program, Group B (Experimental Group) who received i.e. segmental, diaphragmatic breathing exercises & thoracic mobility exercises along with moderate intensity aerobic training and inspiratory muscle training there was a significant improvement in six minute walk distance, oxygen saturation level and COVID-19 QoL Questionnaire than Group A (Control Group) who received segmental, diaphragmatic breathing exercises & thoracic mobility exercises alone.

Therefore, the null hypothesis is rejected and the research hypothesis is accepted and proved. This study concludes segmental, diaphragmatic breathing exercises & thoracic mobility exercises along with moderate intensity aerobic training and inspiratory muscle training is a better strategy to improve cardio-respiratory endurance, oxygen saturation level and quality of life in post-COVID-19 population of Puducherry**.**

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