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Effectiveness of Balloon Blowing Technique on Peak Expiratory Flow Rate, Exercise Tolerance and Quality of Life of Post Covid-19 Survivors

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ABSTRACT

BACKGROUND AND OBJECTIVES: Severe acute respiratory syndrome Corona virus 2(SARS-COV-2) has infected millions of people worldwide and caused a pandemic that is still ongoing. The virus can cause a disease named as COVID -19, which is composed of multisystem manifestations with a pulmonary system predominance. So, COVID-19 has shown high infection and mortality rates all over the world. After infection survivors are dealing with wide variety of effects and complications. All these issues to be included in a clinical case definition of post COVID -19 condition. Since the lungs are the most involved organs and the post COVID-19 prolonged and persistent effects are mainly related to the pulmonary system. Post COVID-19 complications leads to fibrosis and loss of function of respiratory system. So, early pulmonary rehabilitation and exercise therapy among COVID -19 survivors is very important. The balloon blowing exercise is one of the cost effective, beneficial breathing exercise pattern. The purpose of this study is to find out the effectiveness of balloon blowing technique on Peak expiratory flow rate, Exercise tolerance and Quality of life of Post COVID-19 survivors.
METHODOLOGY: 30 subjects were selected based on inclusion and exclusion criteria, then divided in to two groups. Group A (Experimental group n= 15) received both Balloon blowing technique and Diaphragmatic breathing exercise, Group B (control group n=15) received Diaphragmatic breathing exercise. Exercise program was held for 3 sets per day.10 minutes for Diaphragmatic breathing exercise and 30 minutes for Balloon blowing technique regularly for 8 weeks. The Exercise tolerance, Peak expiratory flow rate and Quality of life were measured at the beginning and eighth week after intervention using Six minute walk test, Peak flow meter and St. George respiratory questionnaire.
RESULT: The results were analysed using paired and independent t test. The significant level was kept as $p< 0.05$. The post test result in case of Peak expiratory flow, $p < 0.05$, shows there is a significant difference in post test scores between experimental and control group.
The post test result in case of Exercise tolerance, $p<0.05$, which shows that there is a significant difference in post test score between experimental and control group.
The post test result in case of Quality of life, $p < 0.05$, which shows that there is significant difference in post test score between experimental and control group.
CONCLUSION: The study concluded that, there is improvement in Peak expiratory flow rate, Exercise tolerance and Quality of life in experimental and control group. The experimental group shows more significant improvement than control group in all the three parameters.

KEYWORDS: Post COVID-19, Balloon blowing technique (BBT), Diaphragmatic breathing exercise, Exercise tolerance, Six minute walk test, Peak expiratory flow rate, Quality of life.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a potentially severe acute respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).Corona virus has infected millions of people worldwide and caused a pandemic that is still ongoing .The virus originated in bats and was transmitted to humans through yet unknown intermediary animals in Wuhan, China in December 2019.The global impact of this new epidemic is yet uncertain [(1)]. Based on WHO estimation, the current COVID-19 situation in India (latest update:17 June 2022) 43,270,577 is the total confirmed cases and 524,817 death cases reported [(2)].

Disease severity in Corona virus disease 2019 can be very heterogenous.40% of COVID-19 subjects develop mild disease (defined as symptomatic patients without evidence of viral pneumonia or hypoxia);another 40% have a moderate disease(with clinical signs of pneumonia);nearly 15%suffer from a severe disease (with severe pneumonia)that requires oxygen therapy ; and 5% develop a clinical disease with complications such as respiratory failure ,acute respiratory distress syndrome, thromboembolism, sepsis and multi organ failure. Older age, smoking and pre-existing comorbidities have been reported to be risk factors for a more severe course of COVID-19 and an increased mortality [(3)].

Corona virus disease 2019 has shown high infection and mortality rates all over the world, and there is so far no specific therapy available for Covid-19[(4)]. Since, the beginning of the COVID-19 pandemic SARS COV-2 has mutated, resulting in variants of the virus, it created series of COVID-19 waves. In first wave more reported cases among above 50 years. When comparing two waves in India, the younger middle age group was effected more in second [(5)]. Happy hypoxia or asymptomatic hypoxemia was one of the new scenario emerging during second wave in young adults[(6)].

Most of patients who suffer from corona virus disease 2019 (COVID - 19) fully recover, but some remain with long term effects on several body system, including pulmonary, cardiovascular and nervous system, as well as psychological effects. All these issues to be included in a clinical case definition of post COVID -19 condition [(7).] Post COVID conditions are referred to by a wide range of names, including Long COVID, Post – acute COVID-19 syndrome, as well as the Post COVID-19 syndrome [(8)].

Based on WHO, Post COVID condition occurs in individuals with a history of probable or confirmed SARS – COV -2 infection, usually 3 months from the onset of covid-19 with symptoms that can last for few months to many years post recovery [(7)]. The most common symptoms of post covid-19 condition include fatigue ,shortness of breath or difficulty breathing ,concentration or sleep problems ,persistent cough ,throat pain ,chest pain ,trouble speaking ,muscle aches ,loss of smell or taste ,depression or anxiety. This condition may affect their ability to perform daily activities such as work or house hold chores [(9)].

Since the lungs are the most involved organs and the Post COVID-19 prolonged and persistent effects are mainly related to the pulmonary system .Viral pneumonia is the most common and the most severe problem in the course of the disease. Along with that the number of studies and reviews written on Post COVID-19 pulmonary fibrosis is increasing day by day .in some acute cases can be complicated by ARDS. Another lung related complications are characterized by alveolar wall damage, edema, hyaline membrane damage, leukocyte infiltration, micro angiopathic changes predominates, and cell damage and uncontrolled inflammatory process may develop afterwards. The development of small airway disease (SAD) in post COVID-19syndrome is a very new clinical condition [(10.)] Lung capacities like FVC, FEV, and TLC etc. will change considerably. The peak expiratory flow rate, exercise tolerance capacity also alters due to the low effort of

expiratory muscles and low lung capacity after COVID -19.

In previous studies, follow up among Post COVID-19 patients had shown that there were statistically significant reduction in exercise capacity (Six minute walk test) and decreased inspiratory and expiratory muscle strength. During acute phase, emotional distress and anxiety were significantly elevated. Severity of symptoms and functional impairment of Post COVID-19 syndrome also will affect the Quality of life of patients [(11)].

Exercise capacity is the maximum amount of physical exertion that a person can sustain. The 6 minute walk test (6MWT) is a validated clinical test to assess the exercise capacity and fundamentally designed for use in adults with chronic respiratory disease, and therefore may be an appropriate test to triage COVID -19 patients .The total distance walked is the primary objective of the test and is compared with reference standards for interpretation. This test evaluate the functional status which is relevant to daily activities of patients with cardiopulmonary disease .The walking distance closely related to gender ,age and height conventionally need a hierarchical analysis according to above parameters[(12)].

Peak expiratory flow rate (PEFR) is a person's maximum speed of expiration. It measures the airflow through bronchi and thus the degree of obstruction in airways .PEFR is the maximum rate of airflow that can be generated during forced expiratory maneuver starting from total lung capacity. The simplicity of the method is in its main advantage .It is measured by using a standard Wright Peak Flow meter .Peak flow measurement which measures the speed at which air is exhaled from our lungs ,giving a measurement of how well your airways are working . Peak expiratory flow is measured in units of liters per minute [(13)].

Post COVID-19 syndrome can heavily affect the health related quality of life .Physical life and quality of life are directly related factors. Because their physical pain and irritabilities leads to higher levels of trait anxiety and difficulty to relax. Having anxiety is strongly associated with respiratory symptoms. It is also known that losing the own job is detrimental to physical and mental health. Their perception of the future has also been negatively affected [(17)].

ST. George respiratory questionnaire can be considered as a reliable quality of life measure for researches. It is widely used to observe patients' improvement, responsiveness to ongoing therapy. Also it is helpful in the selection of most appropriate technique or therapy among broad spectrum of therapeutic interventions [(15)].

Pulmonary rehabilitation is a strongly recommended and beneficial treatment programme for people with chronic lung disease. The COVID-19 pandemic has highlighted the need of pulmonary rehabilitation, with strong quality assurance to ensure optimal patient outcomes. Properly planned pulmonary rehabilitation programme optimizes respiratory muscle function, improve exercise capacity, reduce dyspnea, improve endurance and enhance health related Quality of life .The ultimate role is to help the patient's active participation or return to family and society [(16)].

The aim of the study is to check the effectiveness of balloon blowing technique on exercise tolerance , peak expiratory flow rate and quality of life of post COVID-19 survivors .Some studies shows that balloon blowing exercise will be strengthen the expiratory muscles .Patients who performed balloon blowing exercise increased their FVC ,FEV1 , TLC in chronic lung disease[(17)] . So it may improve the proper lung function and quality of life of post COVID-19 survivors.

Hence the problem of the study is stated as "Effectiveness of Balloon blowing technique on peak expiratory flow rate, exercise tolerance and quality of life of Post COVID-19 survivors".

METHODOLOGY

STUDY DESIGN

Pre and post experimental study

STUDY SETTING

Post COVID-19 clinics (PHC and Travancore rehabs)-Alappuzha

STUDY DURATION

Total study duration: 6 months
Intervention period : 8 weeks
Frequency: daily

SAMPLING

Sampling method : Convenient sampling
Sample size (n) : 30
15 subjects in each group (Group A and Group B)

INCLUSION CRITERIA

- Patients with less than one year of COVID- 19 infection.
- Patients with age of 25 -50.
- Both males & females.
- Those who are able to understand and obey commands.

EXCLUSION CRITERIA

- Patients who are not willing to participate.
- Patient with respiratory, cardiac and neurological pathology
- Oral lesions.
- Cardiac and pulmonary surgeries.
- Patients unable to take deep breath effectively due to pain or diaphragmatic dysfunction.
- Patients who cannot follow the instructions.
- Deaf and Dumb
- Psychiatric patients
- Blind patients
- Chronic diseases like cancer, congestive cardiac failure etc.
- Pregnancy
- Cognitive and memory deficit.
- Thoracic deformities.
- Smokers
- Athletes

SAMPLING PROCEDURE

30 subjects were selected on the basis of inclusion and exclusion criteria from post COVID-19 clinic settings, Alappuzha .Then conveniently divided equally in two groups ; Group A and Group B. Each group consist of 15 subjects.

Group A (Experimental group) - Received Balloon blowing exercise along with Diaphragmatic breathing exercise regularly. Duration was 40 minutes per day for 8 weeks.

Group B (Control group) - Received Diaphragmatic breathing exercise regularly. Duration was10 minutes per day for 8 weeks.

METHODS OF DATA COLLECTION

Outcome measures and tools of data collection:

1. **Peak expiratory flow meter – to assess peak expiratory flow rate**

Peak expiratory flow meter is used to measure peak expiratory flow rate. It is a small, hand-held device. PEFR is the maximal rate that a person can exhale during a short maximal expiratory effort after full inspiration, and is a reliable indicator of ventilation adequacy as well as airflow obstruction. The normal peak flow value can range from person to person and is dependent upon factors such as sex and age PEFR is typically measured in units of liters per minute (L/min). The normal peak flow is 450 - 550 L/m in adults. Peak flow readings are higher when patients are well, and lower when the airways are constricted. Disposable mouth piece was also provided to each subject for prevention of cross infection.

Figure 1: Peak flow meter

2. **Six minute walk test – to assess exercise tolerance**

The six minute walk test is a submaximal exercise test used to assess exercise capacity and endurance. This six minute walk test (6MWT) was developed by the American Thoracic Society and it was officially introduced in 2002.The 6MWT can better reflect the functional exercise level for daily physical activities. The six minute walk test (6MWT) measures the distance an individual is able to walk over a total of six minutes on a hard, flat surface of distance 30 meter.

In healthy subjects, the 6- min walk (6MWD) distance ranges from 400 to 700 m. The subjects' pulse, respiratory rate, blood pressure, oxygen saturation were measured before the test and at test completion. The whole test procedure also well explained to the patient before performing 6 minute walk test. Nicole H.M et.al conducted a study to find out Reliability and construct validity of 6MWT among chronic heart failure patients.

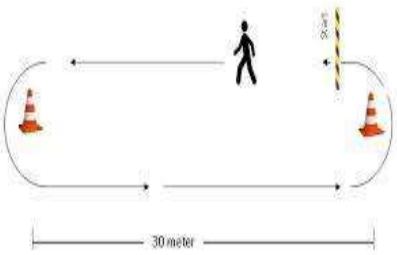


Figure 2: 6MWT

3. St. George Respiratory Questionnaire – to assess quality of life

Standardized questionnaire to measure quality of life of patients with respiratory disorders. It is developed by P.W Jones, F Quirk and C. Baveystock from St. George's university of London. SGRQ has been used successfully in patients with COPD, asthma like respiratory disorders. It appears to be feasible method. The SGRQ questionnaire designed with 14 questions. Here the total scoring is calculated from '0-100'.

0: No health impairment 100: Maximum health impairment

St. Goerge respiratory questionnaire is a valuable and reliable tool. Based on a study conducted among COPD patients, the result was Cronbach alpha coefficient and intra-class correlation coefficients (ICC) for SGRQ were reported as 0.87, and 0.88 respectively[18]. The St. George respiratory questionnaire can be completed manually or with the aid of computer.

Materials Used

Balloon – 7-inch diameter, Peak flow meter, Stop watch, Two cones to mark the distance that need to be covered (6MWT)., Pulse Oximeter, Stethoscope, Chair, Sphygmomanometer, Paper, Pen, Meter measuring tape, Weighing machine, Stadiometer

Figure 3: Balloon (7 inch)

Figure 4: Mouth piece for PEFR

Figure 5: Stop watch

Figure 6: Stethoscope

Figure 7: Pulse oximeter

Figure 8: Chair

Figure 9: Cones

Figure 10: Weighing machine

Figure 11: Sphygmomanometer

Figure 12: paper &pen

Figure 13: Measuring tape

Figure 14: Stadiometer

PRE INTERVENTION PROCEDURE

Ethical approval was obtained from the ethical committee of Medical Trust Hospital, Cochin for conducting the study. After explaining about the objective of the study, test protocol and an informed written consent were obtained from participants. After signing the consent, a total of 30 subjects were taken and divided in to two groups. Instructions were also given to all subjects about how to use peak expiratory flow meter, how to perform 6 minute walk test and method of completion of St. George respiratory questionnaire. Pre- intervention measurements were taken for both groups using peak expiratory flow meter, 6-minute walk test and St George respiratory questionnaire. Peak expiratory flow rate, exercise tolerance and quality of life were recorded prior to the exercise program.

INSTRUCTIONS FOR USING PEAK EXPIRATORY FLOW METER

- Move the marker to the bottom of the number scale of Peak flow meter.
- Sit or stand up straight.
- Take a deep breath.
- Hold the breath while placing the mouth piece in the mouth.
- Blow out as hard and fast as they can in a single blow.
- Should write down the result.

- Move the marker back to the bottom and repeat all these steps 2 more times. The highest of the 3 numbers can consider peak flow rate.

INTERVENTION

CONTROL GROUP

A total of 15 post Covid-19 patients were recruited for control group. The control group received diaphragmatic breathing exercise for 10 minutes per day regularly for 8 weeks.

GUIDELINES

- Patient should be in comfortable and relaxed position.
- Don't perform breathing exercise immediately after meals.
- Patients should focus on the breathing technique and the bodily sensations they feel while practicing it.

PROCEDURE

- Sit comfortably, with knees bent. shoulder, head and neck relaxed.
- Place patients one hand on upper chest and other hand placed over subcostal angle, at the base of rib cage, tips of the fingers approximating just over the dome of the diaphragm. This will allow to feel the movement of diaphragm.
- Breathe in slowly through the nose so that the stomach moves out against the hand. The hand on the chest should remain as still as possible.
- Gentle pressure should be applied to the ribcage and diaphragm by the patient throughout the expiration cycle.
- Exhalation should be done through mouth, pursed lip, slowly in relaxed manner.

EXPERIMENTAL GROUP

A total of 15 post COVID -19 patients were recruited for experimental group. The experimental group received Balloon blowing exercise for 3 sets per day .Three repetition will complete 1 set. Total of three sets should be performed (8-10 repetition /day) .30 minutes for Balloon blowing exercise and 10 minutes for diaphragmatic breathing exercise. Intervention period was 8-weeks.

GUIDELINES

- Patient should be in comfortable and relaxed position.
- Do not perform exercise immediately after meals.
- If the patient experience shortness of breath or any discomfort in between the exercise discontinue the exercise.

PHOTOGRAPHS AND DESCRIPTION

Figure 1: Peak flow meter

figure 2: 6 minute walk test

Figure 3: Balloon blowing technique

Figure 4: Deep breathing exercise

PROCEDURE

In Experimental group in addition to Balloon blowing exercise, patients received Diaphragmatic breathing exercise regularly for 8 weeks. The balloon blowing exercise performed in the upright position with the balloon to the diameter of 7 inches.

- The subjects were instructed to stretch out the balloon. First, they took a deep breath and blow it to the balloon completely.
- Pinch off the balloon and the air shouldn't be allowed to escape from it.
- Then the subjects asked to repeat the same procedure for 2 more times, after taking a normal breath in between.
- Three repetitions will complete 1 set. Total of three sets should be performed (8-10 repetition / day).

The time duration for the exercise program was 40 minutes per day regularly including diaphragmatic breathing exercise for 10 minute and balloon blowing exercise for 30 minutes. Resting time was given between the sets to reduce fatigue.

A recording sheet was maintained and was also provided to the patient for daily documentation.

POST INTERVENTIONAL PROCEDURE

The outcome measurements for Peak expiratory flow rate, Exercise tolerance and Quality of life were taken after 8 weeks using the Peak expiratory flow meter, 6 minute walk test and St. George respiratory questionnaire.

RESULT

The present study was designed to explore the effectiveness of Balloon blowing technique on exercise tolerance, peak expiratory flow rate and quality of life of Post COVID-19 survivors.

DEMOGRAPHIC INFORMATION

AGE

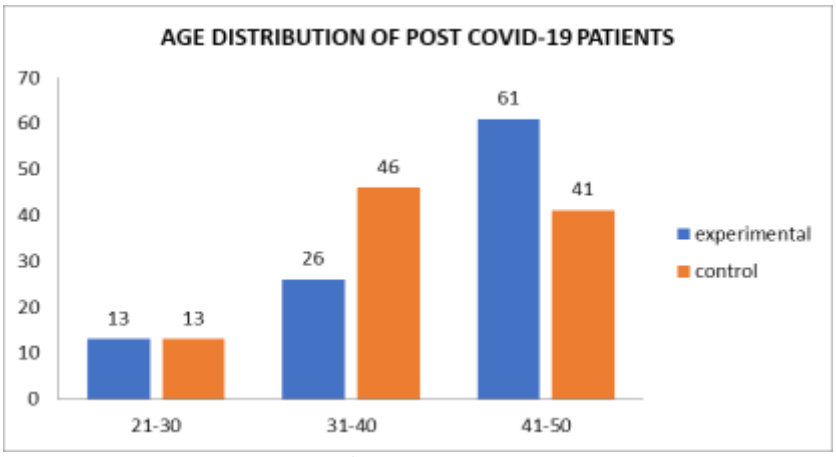
GROUP	Mean age	Standard deviation	Minimum	Maximum
Experimental group	41.4	7.08	28	50
Control group	39.46	6.85	28	50

Table 1Mean age in experimental group and control group

The table 1 shows, the age group taken for the study was between 25-50 years and the mean age of the experimental group was 41.4 with standard deviation of 7.08 and the mean age of control group was 39.46 with standard deviation of 6.85.

AGE	EXPERIMENTAL GROUP		CONTROL GROUP	
	Frequency	percentage	Frequency	Percentage
21-30 years	2	13%	2	13%
31-40 years	4	26%	7	46%
41-50 years	9	61%	6	41%

Table 2 shows the frequency and percentage of age in experimental group and control group.

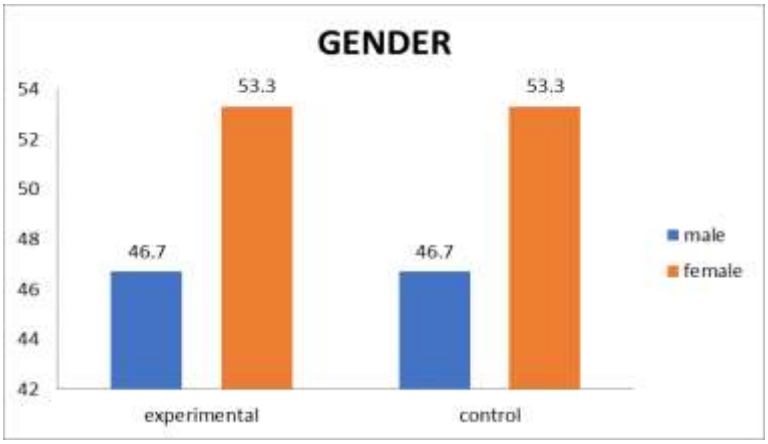


Graph 1 - Graphical representation of mean age in experimental group and control group.

GENDER

GENDER	EXPERIMENTAL GROUP		CONTROL GROUP	
	Frequency	**Percentage**	**Frequency**	**Percentage**
MALE	7	46.7	7	46.7
FEMALE	8	53.3	8	53.3
TOTAL	15	100%	15	100%

Table 3 shows the frequency and percentage of gender in both experimental group and control group.



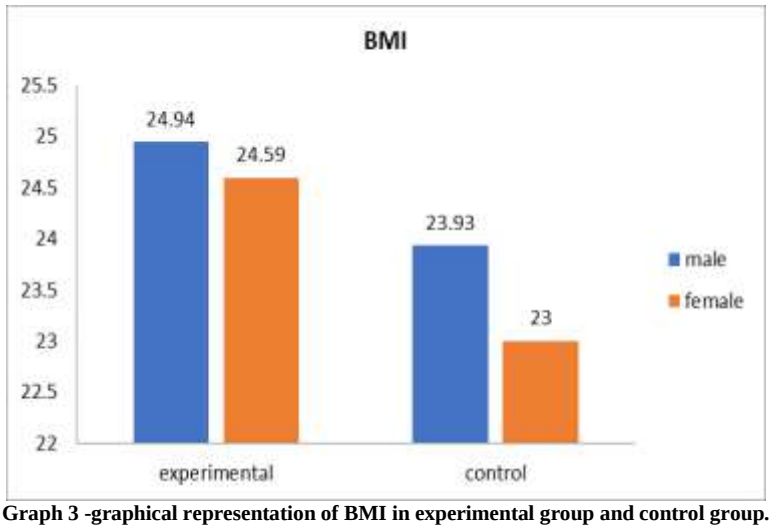
Graph 2 - Graphical representation of gender in experimental group and control group

BODY MASS INDEX

GROUP	GENDER	HEIGHT	WEIGHT	BMI
Experimental	MALE	161.4 ± 7.32	64.57±9.07	24.94±4.57
	FEMALE	162.75±6.84	64.87±8.72	24.59±3.77
Control	MALE	161.42±6.90	62±9.05	23.93±4.10
	FEMALE	163.75±8.90	61.37±11.21	23.00±4.45

Table 4 -Height, Weight and BMI of subjects in experimental and control group

Table 4 shows mean and standard deviation of height, weight and BMI of experimental and control group.



Graph 3 -graphical representation of BMI in experimental group and control group.

DATA ANALYSIS AND INTERPRETATION

The statistical analysis of the results was performed by using the SPSS Software (SPSS.20). Students t - test was used for the calculation of the results. Paired t test was used for the intra group comparison of pre and post test results. Independent t test was used for the inter group comparison. Significant level kept as $p<0.05$.

Equations were used in;

$$\text{Sample } n \geq \frac{2\,\sigma\,(z\beta+z\alpha/2)^2}{\text{difference}^2}$$

- n- Sample size in each group (assumes equal sized groups)
- σ Standard deviation of the outcome variable
- $z\alpha$-Represents the desired level of statistical significance (typically1.96)
- $z\beta$- Represents the desired power (typically 0.84 for 80%power)
- differences- Effect size (the difference in mean)

  Independent Variables: Balloon blowing exercise, Diaphragmatic breathing exercise.

  Dependent Variables: Peak expiratory flow rate, Exercise tolerance, quality of life.

COMPARISON WITHIN GROUP (paired test)

COMPARISON OF PRE –TEST AND POST -TEST VALUES OF TEST PEAK EXPIRATORY FLOW RATE GROUP A - (EXPERIMENTAL GROUP)

TEST	Mean	SD	Mean improvement	n	t	Df	pValue
Pre-test	326.6	46.08	51.33	15	8.908	14	P=0.0000004
Post-test	378	45.70					

Table 5-shows paired t- test for peak expiratory flow rate in group A (experimental group)

The mean column displays the mean pre-test and post-test of peak expiratory flow rate among Post COVID-19 patients in the Experimental group. SD is the standard deviations of the PEFR in pre & post respectively. Mean change 51.33 is the difference between pre-test and post-test mean PEFR scores (326.66 and 378). Since the t-value 8.90 shows $p < 0.001$, there is a significant difference existing between the pre-test and post-test PEFR among Post Covid-19 patients in the experimental group. This proves the effect of Balloon

blowing technique in PEFR among Post COVID-19 patients.

COMPARISON OF PRE- TEST AND POST - TEST VALUES OF PEAK EXPIRATORY FLOW RATE IN GROUP B (CONTROL GROUP)

TEST	Mean	SD	Mean improvement	N	t	Df	p value
Pre-test	313.3	48.35					
Post-test	324	53.55	10.66	15	3.75	14	O.OO21

Table 6-shows paired t test for peak expiratory flow rate in group B (control group)

The mean column displays the mean pre-test and post-test of peak expiratory flow rate among Post COVID- 19 patients in the control group. SD is the standard deviations of the PEFR in pre & post respectively. Mean change 10.66 is the difference between pre-test and post-test mean PEFR scores (313.33 and 324). Since the t-value 3.75 shows p <0.05, there is a significant difference existing between the pre-test and post-test peak expiratory flow rate among post Covid19 patients in the control group. This proves the effect of Diaphragmatic breathing exercise in PEFR among Post COVID-19patients.

COMPARISON OF PRE- TEST AND POST- TEST VALUES OF EXERCISE TOLERANCE IN GROUP A (EXPERIMENTAL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	t	Df	p Value
Pre-test	475	59.88	55.66	15	8.88	14	0.0000004
Post-test	530.66	57.84					

Table 7-shows paired t test for exercise tolerance in group A (experimental group)

The mean column displays the mean pre-test and post-test of exercise tolerance among Post COVID-19 patients in the Experimental group. SD is the standard deviations of the exercise tolerance in pre & post respectively. Mean change 55.66 is the difference between pre-test and post-test mean exercise tolerance scores (475 and 530.66). Since the t-value 8.88 shows p < 0.001, there is a significant difference existing between the pre-test and post-test exercise tolerance among Post COVID-19 patients in the experimental group. This proves the effect of Balloon blowing technique in exercise tolerance among Post COVID-19 patients.

COMPARISON OF PRE-TEST AND POST-TEST VALUES OF EXERCISE TOLERANCE IN GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	t	df	p value
Pre-test	476.33	47.82	10.33	15	5.56	14	0.0069
Post-test	486.66	46.81					

Table 8 – shows paired t test for exercise tolerance in group a (experimental group)

The mean column displays the mean pre-test and post-test of exercise tolerance among Post COVID-19 patients in the control group. SD is the standard deviations of the exercise tolerance in pre & post respectively. Mean change 10.33 is the difference between pre-test and post-test mean exercise tolerance scores (476.33 and 486.66). Since the t-value 5.56 shows p < 0.05, there is a significant difference existing between the pre-test and post-test exercise tolerance among Post COVID-19 patients in the control group. This proves the effect of Diaphragmatic breathing exercise in exercise tolerance among Post COVID-19 patients.

COMPARISON OF PRE - TEST AND POST - TEST VALUES OF QOL IN GROUP A (EXPERIMENTAL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	N	t	df	P value
PRE –TEST	59.89	10.90					
POST- TEST	49.79	10.15	10.10	15	11.16	14	0.000002

Table 9 – shows paired t test for QOL in group A (experimental group)

The mean column displays the mean pre-test and post-test of QOL among Post COVID-19 patients in the experimental group. SD is the standard deviations of the QOL in pre & post respectively. Mean change 10.10 is the difference between pre-test and post-test mean QOL (59.89 and 49.79). Since the t-value 11.16 shows p <0.001, there is significant difference existing between the pre- test and post-test QOL scores among Post COVID-19 patients in the experimental group. This proves the effect of balloon blowing technique in QOL among Post COVID-19patients.

COMPARISON OF PRE- TEST AND POST -TEST VALUES OF QOL IN GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	T	Df	P value
PRE -TEST	58.98	11.19					
POST- TEST	58.37	11.39	0.552	15	3.439	14	0.003

Table 10 – shows paired t test for QOL in group B (control group)

The mean column displays the mean pre-test and post-test of QOL among Post COVID-19 patients in the control group. SD is the standard deviations of the QOL in pre & post respectively. Mean change 0.552 is the difference between pre-test and post-test QOL scores (58.98 and 58.37). Since the t-value 3.439 shows p <0.05, there is a significant difference existing between the pre-test and post-test QOL among Post COVID-19 patients in the control group. This proves the effect of Diaphragmatic breathing exercise in QOL among Post COVID-19 patients.

COMPARISON BETWEEN GROUPS (INDEPENDENT TEST)
COMPARISON OF PRE -TEST PEAK EXPIRATORY FLOW RATE SCORE BETWEEN GROUP A (EXPERIMENTAL GROUP) AND GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	t	Df	p VALUE
EXPERIMENTAL	326.6	46.08					
CONTROL	313.3	48.35	13.333	15	0.701	28	0.445

Table 11 – shows independent t test for pretest Peak expiratory flow rate score between group A (experimental group) and group B (control group)

The Mean column in the t -test table displays the mean pre PEFR scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (13.333) shows the difference between mean in two groups (326.6 and 313.3).Since the t-value 0.701, shows p-value > 0.05, there is no significant difference in pre PEFR scores between the experimental and the control groups .So we can consider the groups as homogenous in the baseline level.

COMPARISON OF POST-TEST PEAK EXPIRATORY FLOW RATE SCORES BETWEEN GROUP A (EXPERIMENTAL GROUP) AND GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	T	df	p value
EXPERIMENTAL	378	45.70	54	15	2.97	28	0.006
CONTROL	324	53.55					

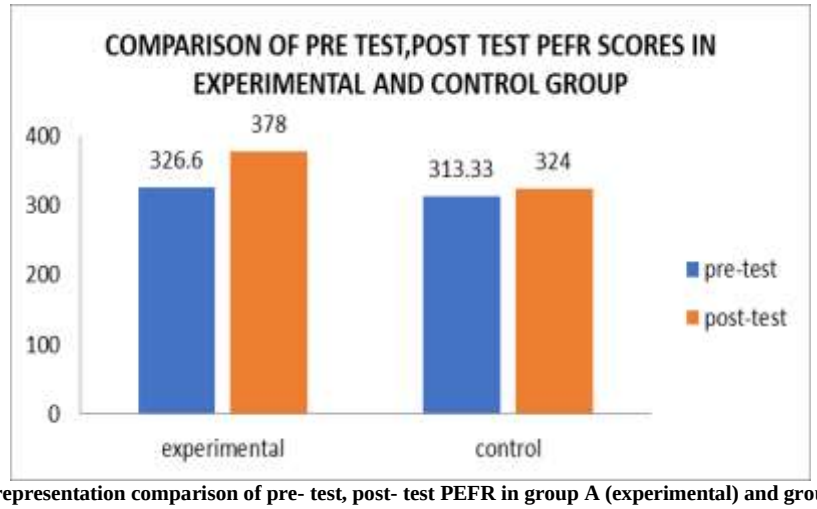
Table 12– shows independent t test for posttest PEFR score between group A (experimental group) and group B (control group)

The Mean column in the t test table displays the mean post-test PEFR scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (54) shows the difference between mean in two groups (378&324). Subsequently the t-value, 2.97shows p value < 0.05, there is a significant difference in post-test PEFR score between the experimental and the control groups. The scores in the experimental group is significantly higher than that in the control group. Hence Balloon blowing technique is effective in PEFR among Post COVID-19 patients

COMPARISON OF PRE-TEST POST-TEST PEFR SCORES IN EXPERIMENTAL AND CONTROL GROUPS

GROUP	PRE TEST MEAN	SD	POST- TEST MEAN	SD
EXPERIMENTAL	326.6	46.08	378	45.70
CONTROL	313.33	48.35	324	53.55

Table 13 – shows comparison of pretest and post-test peak expiratory flow rate in group A (Experimental group) and group B (control group)



Graph 4 graphical representation comparison of pre- test, post- test PEFR in group A (experimental) and group B (control group)

COMPARISON OF PRE- TEST EXERCISE TOLERANCE SCORE BETWEEN GROUP A AND GROUP B (EXPERIMETAL AND CONTROL GROUPS)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	t	Df	p value
EXPERIMENTAL	475	918					
CONTROL	476	968	1.33	15	0.06	28	0.946

Table14 -shows independent t test for posttest exercise tolerance scores between group A (Experimental group) and group B (control group)

The Mean column in the t test table displays the mean pre-test exercise tolerance scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (1.33) shows the difference between mean in two groups (475 and 476).Since the t-value 0.06, shows p-value > 0.05, there is no significant difference in pre- test exercise tolerance scores between the experimental and the control groups .So we can consider the groups as homogenous in the baseline level.

COMPARISON OF POST- TEST EXERCISE TOLERANCE SCORE GROUP A (EXPERIMETAL) AND GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	T	Df	p value
EXPERIMENTAL	530	57.84					
CONTROL	486	46.81	44	15	2.29	28	0.029

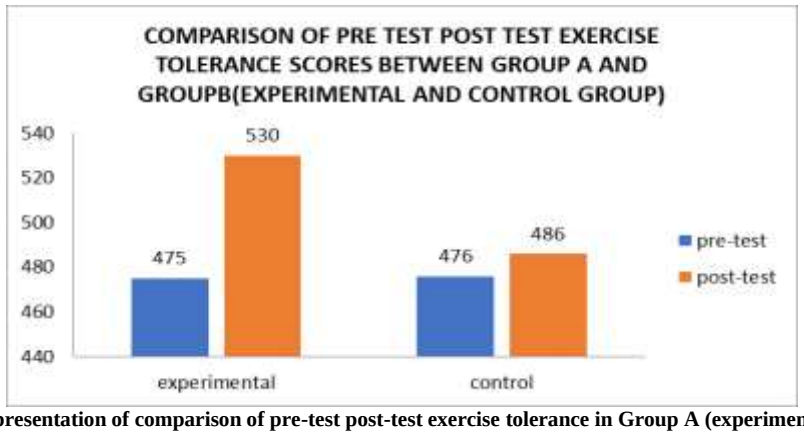
Table15 –shows independent t test for posttest Exercise tolerance between group A (experimental group) and group B (control group)

The Mean column in the t test table displays the mean post-test exercise tolerance scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (44) shows the difference between mean in two groups (530 and 486). Since the t-value, 0.029 shows p-value < 0.05, there is significant difference in post- test exercise tolerance. The exercise tolerance score in the experimental group is significantly higher than that in the control group. Hence Balloon blowing technique is effective in improving exercise tolerance among Post COVID-19 patients.

COMPARISON OF PRE-TEST POST-TEST EXERCISE TOLERANCE SCORES BETWEEN GROUP A (EXPERIMETAL GROUP) AND GROUP B (CONTROL GROUP)

GROUP	PRETEST MEAN	SD	POSTTEST MEAN	SD
EXPERIMENTAL	475	59.8	530	57.8
CONTROL	476	47.82	486	46.81

Table 16 – shows comparison of pre-test post-test Exercise tolerance in Group A (experimental group) and group B (control group).



Graph 5 graphical representation of comparison of pre-test post-test exercise tolerance in Group A (experimental group) and group B (control group).

COMPARISON OF PRE - TEST QOL SCORE BETWEEN GROUP A (EXPERIMETAL GROUP) AND GROUP B (CONTROL GROUPS)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	T	Df	P value
EXPERIMENTAL	59.89	10.90					
CONTROL	58.93	1.19	0.96	15	0.24	28	0.811

Table 17 – shows independent t test for pretest QOL score between group A (experimental) and group B (control group)

The mean column in the t test table displays the mean pre-test QOL scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (0.96) shows the difference between mean in two groups (59.89and 58.93).Since the t-value 0.24, shows p-value > 0.05, there is no significant difference in pre- test QOL scores between the experimental and the control groups .So we can consider the groups as homogenous in the baseline level.

COMPARISON OF POST-TEST QOL SCORE GROUP A (EXPERIMENTAL GROUP) AND GROUP B (CONTROL GROUP)

TEST	MEAN	SD	MEAN IMPROVEMENT	n	T	Df	P value
EXPERIMENTAL	49.79	10.15					
CONTROL	58.37	11.39	8.58	15	2.17	28	0.03

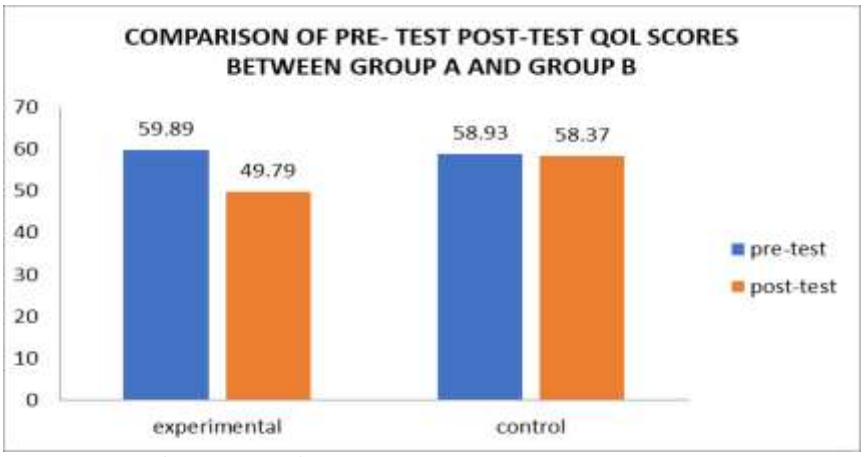
Table 18 – shows independent t test for posttest QOL between group A (experimental group) and group B (control group)

The Mean column in the t test table displays the mean post-test QOL scores in experimental and control group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (8.58) shows the difference between mean in two groups (49.79and0 58.37). Since the t-value 2.17, shows p-value < 0.05, there is significant difference in post- test QOL score between the experimental and the control groups. The scores in the experimental group is significantly higher than that in the control group. Hence Balloon blowing technique is effective in QOL among Post COVID-19 patients.

COMPARISON OF PRE-TEST POST-TEST QOL SCORES BETWEEN GROUP A (EXPERIMETAL GROUP) AND GROUP B (CONTROLGROUP)

GROUP	PRETEST MEAN	SD	POSTTEST MEAN	SD
EXPERIMENTAL	59.89	10.90	49.79	10.15
CONTROL	58.93	11.19	58.37	11.39

Table 19- shows comparison of pretest posttest QOL in group A (Experimental group) and group B (control group)



Graph 6- graphical representation of comparison of pre-test post-test QOL in group A (experimental group) and group B (control group).

DISCUSSION

The COVID-19 infection is caused by the virus known as SARS-CoV-2. The spectrum of disease severity ranges from asymptomatic infection or mild upper respiratory tract illness to severe viral pneumonia with respiratory failure and death. Some people who have been infected with COVID-19 experiences long-term effects. It can include a wide range of ongoing health problems; these conditions can last weeks, months or years. The most common general Post COVID-19 symptoms are tiredness or fatigue that interferes with daily life, fever, cough, chest pain, shortness of breath, heart palpitations, headache, sleep problems, joint or muscle pain, digestive symptoms and depression or anxiety etc.

Douglas Johnson et.al conducted a study on pulmonary function testing and reporting in the COVID -19 era. The data has shown that there is long term reduction in pulmonary function measured by pulmonary function test (PFT). Most significantly diffusion capacity, pulmonary function derangement, decreased DLCO, low lung volumes. During this study 6 minute walk test was also included, the patients performed lower 6MWT distance and felt dyspnea (in some cases low Spo_2 at rest and during 6MWT). COVID-19 directly impacts the lungs and damages the alveoli. The function of the

alveolus is to transfer oxygen to blood vessels. Finally deliver these oxygen to all the internal organs. The virus work by damaging the wall and lining of the alveolus and capillaries. The body system won't get the sufficient oxygen for basic needs. It can impairs the functioning. [19]

Conventional studies of cardiopulmonary exercise testing (example; normal PFT and cardiac ECHO) shows there is persisting exercise limitation in post COVID-19 patients. There is more peripheral exercise limit to exercise due to reduced exercise capacity associated with impaired oxygen extraction. Physical weakness may also have contributed to the short 6 minute walk test.

Amarjyothi Hezarika et al conducted a study on pulmonary function, mental and physical health in recovered COVID -19 patients – A prospective follow-up study post ICU discharge. One of the most frequent findings in the study was reduced FVC and Peak expiratory flow rate (PEFR). As the part of the study Health related quality of life of Post COVID -19 patients also measured. A gradual decrease in quality of life noticed after COVID -19 infection due to physical and mental sufferings. Based on the result of this study identified the greater need of better pulmonary rehabilitation for Post COVID-19 survivors. [20]

The outcome measures used were Exercise tolerance, peak expiratory flow rate and Quality of life.The results were analyzed using t-test. Paired t test was used to compare the results within the group and independent t test was used to compare the results between the groups. Significance level is kept as p value <0.05.

The result in case of peak expiratory flow rate has shown that in paired t test ,since the t value , 8.90 shows p <0.001, there is a significant difference existing between the pre-test and post-test PEFR among post Covid19 patients in Group A (experimental group). The t-value 3.75 shows p <0.01, there is a significant difference existing between the pre-test and post-test peak expiratory flow rate among Post Covid-19 patients in Group B (control group) also. The results showed improvement in both groups. In the independent t test since the t-value, 2.97shows p value < 0.05(p =0.006) there is a significant difference in post-test PEFR score between the experimental and the control groups. The mean difference (54) shows the difference between mean in two groups Group A (378) and Group B (324) respectively. The scores in the experimental group were significantly higher than that of the control group.

Improvement in Peak expiratory flow rate occurred. Balloon blowing exercise (BBE) is a specific example of an exercise that could be useful for integrating co-activation of deep abdominal muscles with pelvic floor and diaphragm during neuromuscular training and a wide variety of stabilizing maneuvers. The BBE is a conservative exercise intended to assist a patient in obtaining optimal posture and respiration Pyeon et al stated that expiration is a passive process which occurs through natural relaxation of diaphragm and intercostal muscles and that when forced expiration is performed the abdominal muscles such as rectus abdominis and transverse abdominis actively contract. The balloon blowing exercises performed in this study, inflation of balloon with air blow in and the elastic force of rubber increased. It create more resistances to abdominal muscles. It was reported that the expiratory muscles and abdominal muscle become more active as the volume of balloon is increased. Peak expiratory flow is mainly based on expiratory phase and strength of expiratory muscles. Therefore the expiratory muscles and abdominal muscles might have been strengthened by the balloon blowing exercise and it may lead to improvement in peak expiratory flow in our study [21].The above reasons might be responsible for the improvement of Peak expiratory flow rate in Experimental group.

The result in case of exercise tolerance, has shown that in paired t test ,since the t value , 8.88 shows p < 0.001, there is a significant

difference existing between the pre-test and post-test exercise tolerance among Post Covid-19 patients in Group A (experimental group). The t-value 5.56 shows $p < 0.05$, there is a significant difference existing between the pre-test and post-test exercise tolerance among Post Covid-19 patients in the control group. The results showed improvement in both groups. In the independent t test, since the t-value, 0.029 shows p-value < 0.05, there is significant difference in post- test exercise tolerance between the experimental and control groups. The mean difference, 44 shows the difference between mean in two groups Group A (530) and Group B (486) respectively. The scores in the experimental group were significantly higher than that of the control group.

This study shows that there is improvement in exercise capacity in experimental and control group .The experimental group showed higher significance than control group .The reason may be the Balloon blowing works out intercostal muscles that are responsible for spreading and elevating our diaphragm and ribcage .This allows our lungs to take in oxygen during inhalation and expel carbon dioxide during exhalation. The more oxygen supply to the body during exercise, the longer we will last without becoming breathless and fatigued. Oxygen restores energy to cells and muscles by breaking down glucose and creating fuel for muscles. When plenty of oxygen is available, our muscles will equip themselves with more energy reserves that will increase lung endurance. Committing to a daily routine of blowing up balloons will steadily increase lung capacity and will also amplify the lungs ability to maintain a sufficient supply of oxygen over time. So Balloon blowing technique effectively increases lung capacity which helps to improve the exercise capacity [(22)].

The result in case of Quality of life , has shown that in paired t test ,since the t value , 11.16 shows $p < 0.001$, there is a significant difference existing between the pre-test and post-test QOL among post Covid19 patients in Group A (experimental group) . The t-value 3.439 shows $p < 0.05$, there is a significant difference existing between the pre-test and post-test QOL among Post Covid-19 patients in Group B (control group). The results showed improvement in both groups.In the independent t test, since the t-value 2.17shows p-value < 0.05, there is significant difference in post- test Quality of life between the experimental and control groups. The mean difference (8.58) shows the difference between mean in two groups Group A (49.79) and Group B (58.37) respectively. The scores in the experimental group were significantly lower than that of the control group.

Physical life and Quality of life are directly related. Post COVID-19 syndrome can seriously affect the health related QOL. Because of their physical pain and irritabilities leads to higher levels of trait anxiety and difficulty to relax. A study conducted by Hepcy F.J revealed that Balloon blowing exercise can improve the respiratory status and quality of life [(23)]. So the Post COVID-19 symptoms also will subside and creates a comfortable life events. Physical and mental strain will come down. Patients can actively participate in their occupational and household activities. Therefore Balloon blowing exercise is beneficial to improve Quality of life of Post COVID-19 survivors.

STRENGTH OF THE STUDY

- Number of participants were equal in both groups.
- Only 30 subjects were taken, easy to conduct within proper time.
- Participants independently committed to the exercise program regularly.
- Cost effective programme.
- No equipment or apparatus needed for exercise

LIMITATIONS OF THE STUDY

- As the measurements were taken manually, this may introduce human error, which could threat the reliability of the study.

- Age group considered only within 25-50 years.
- Both genders were included which may affect the outcome measures.

FUTURE RESEARCH

- The sample size of the study can be increased; hence it may lead to better results.
- Can be administered in other age group populations.
- The treatment duration of the study can be increased.
- A follow-up study could ensure the long-term effect of the treatment programme.
- Balloon blowing exercise can be added to pulmonary rehabilitation program which may be beneficial.

CONCLUSION

From the above study, it was obtained that there is significant difference among the experimental and control group when the values were analyzed. The study concluded that the analysis of Peak expiratory flow rate, Exercise tolerance and Quality of life improvement within the group as well as between the groups. But the experimental group shows significantly higher improvement in the three parameters when compared to the control group.

Hence, the study concluded that a well-planned 8 weeks of Balloon blowing exercise programme is effective in improving PEFR (peak expiratory flow rate), Exercise tolerance and QOL (Quality of life) in Post COVID-19 survivors.

Declaration by Authors

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