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RESEARCH ARTICLE
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COMBINED EFFECT OF DIAPHRAGMATIC BREATHING AND CONTROLLED COUGHING ON LUNG FUNCTION IN COPD PATIENTS

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Abstract:
Chronic Obstructive pulmonary disease COPD means progressive obstructions form within the pulmonary system.COPD reduces the efficiency of the gas exchange process and causes the impairmentof parts of the lungs,mucus blocking the airways, and inflammation of the airway lining.COPD is the 3rd leading cause of death worldwide, having caused 3.23 million deaths in 2019. Spirometry is the diagnostic test used to monitor pulmonary functions, particularly in COPD patients. Breathing exercises like diaphragmatic breathing and controlled coughing are important contributor in patients having COPD.Diaphragmatic breathing deals with chronic pain management and enhances pulmonary functions in COPD patients. The force of an effective or controlled cough which originates from deep within the lung is just enough to loosen and move mucus through the airways without narrowing and collapsing them. Certain studies report the beneficial effect of Diaphragmatic breathing and Controlled coughing. The objectiveof the study was to evaluate the combined effectiveness of diaphragmatic breathing and controlled coughing on lung functions by improving pain and pulmonary functions (FEV1, FVC, FEV1\FVC) in COPD patients. Controlled coughing control conserves oxygen and energy.**Material and Methodology:**Asample of 30 males and femalesaged 35 to 60 years with diagnosed COPD was evaluated for the effectiveness of the given treatment by using spirometry for lung function and a numeric rating scale for pain. It was a quasi-experimental study including diaphragmatic breathing and controlled coughing exercises comprises 2 sets of 5-10 repetitions per day, for a total interval of 6 weeks**.** Spirometry readings were taken once before the interventions applied. Follow up was taken after three weeks. And the final spirometry readings were taken at the end of 6th week**Data Analysis**: the data was analyzed by using SPSS version 20 and Descriptive statistics.

Keywords: COPD, diaphragmatic breathing, controlled coughing, lung function, spirometry, pulmonary function.

Introduction

The term Chronic Obstructive Pulmonary Disease (COPD) denotes a condition in which the pulmonary system (the word "pulmonary" refers to the lungs and respiratory system) gradually develops blockages that obstruct the flow of essential gases. A person with COPD has blocked bronchi or alveoli, which reduces the amount of air that their lungs can hold. This further lowers the gas exchange mechanism' effectiveness. The airways can constrict due to a number of causes. Parts of the lungs may be damaged, mucus may obstruct the airways, and the lining of the airways may become inflamed.3.23 million deaths from COPD, the third-leading cause of death globally, were recorded in 2019.(WHO, 2022)The fourth most common cause of death in the United States. According to estimates, nearly 30 million Americans suffer with COPD. (Siafakas et al., 2021)

Common breathing difficulties can be attributed to COPD, or chronic obstructive pulmonary disease. This illness is also known as emphysema and chronic bronchitis. Lung damage and sputum blockage are two potential complications for people with COPD. The symptoms include a hacking cough (often with sputum), shortness of breath, wheezing, and exhaustion. The leading causes of COPD are cigarette smoking and air pollution. COPD patients are more prone to experience the effects of other medical diseases. Smoking cessation, reducing exposure to air pollution, and immunizations for infection prevention can all help reduce COPD symptoms, but the disease itself cannot be treated. Medication, oxygen therapy, and physical therapy for the lungs can all help with this condition.(Criner, 2013)

A chronic cough that produces phlegm as a result of airway irritation is referred to as chronic bronchitis. An inflammation of the bronchi in the lungs is known as bronchitis. Less air flows through than usual because the bronchial walls swell up and the diameter of the bronchi reduces. This inflammatory process encourages the overproduction of mucus, which clogs the airways and reduces lung capacity since it is thicker in consistency and harder to cough out than usual. (McCullagh et al., 2020)

Emphysema affects the alveoli, particularly their delicate membranes through which the process of gas exchange occurs Emphysema is a condition that often refers to the devastation of the little air sacs at the end of the airways in the lungs.Alveolar membranes suffer from emphysema, which makes them inflexible, weaker, and ultimately prone to rupture. More surface area necessary for gas exchange is lost each time alveolar membranes breach. As the condition worsens, these weaker airways run the risk of collapsing even more when patients attempt to breath**.** If a person has the typical signs of COPD, spirometry, a breathing test that measures lung function, should be used to prove the diagnosis. Most low- and middle-income countries don't have spirometry, so it's possible that the diagnosis won't be found. Most people with COPD have been smoking at some point in their lives and are at least 40 years old. The longer and more often you use tobacco, the more likely it is that you will get COPD. (Andrianopoulos et al., 2021)

Diaphragmatic breathing is also known as abdominal, deep, or belly breathing. It modifies how the diaphragm, the primary breathing muscle, is used. Stress, anxiety, and other psychological impacts are caused by shallow breathing, also known as thoracic chest breathing. Typically, this is the outcome of the "fight or flight response." The fight-or-flight response is reduced by diaphragmatic breathing, which also improves quality of life. Additionally, this improves pulmonary functioning and aids in the management of chronic discomfort. (Mirgainand Singles, 2016)

Additional research has demonstrated that the diaphragmatic breathing technique is used to enhance exercise capacity, decrease dyspnea, strengthen the diaphragm, increase oxygenation of the body, nourish the brain and muscles and improve quality of life. (Premand Rubenfire, 2013)

The method of controlled coughing can support your body's natural mucus-clearing processes. This is beneficial if you have chronic obstructive pulmonary disease (COPD), since it may help you cough more easily. This is because long-term exposure to an irritant, usually cigarette smoke, may have damaged your cough reflex.Coughing has several beneficial effects: It serves as a defense system against any foreign or hazardous compounds that you may have inhaled from the environment in addition to maintaining the health of your airways. However, excessive or violent coughing can cause the airways to spasm and even collapse, which prevents expectoration. Additionally, it can make you tired, which makes coughing harder.The warm, moist environment of the lungs can become a breeding ground for bacteria when mucus is allowed to accumulate there, increasing the risk of an infection and a COPD exacerbation. Coughing under control enables you to safely and efficiently reduce these hazards.

MATERIALS AND METHODOLOGY :

It was an Quasi-experimental study with 30 patients of Chronic obstructive pulmonary disease (COPD) patients.we collected data from all Public and private hospitals in Faisalabad on the basis of Inclusion criteria which included Age group 35-60,Males and females both included having mild to moderate COPD and Patients having oxygen saturation less than or equal to 90%

Exclusion criteria:Patients suffering from cardiac disorders (angina, MI, etc.),Patients suffering from a traumatic injury of the lungs and pulmonary edema,Patients with mental disability (dementia, CVA etc.),Patients suffering from thoracic kyphoscoliosis,Patients suffering from spinal disorders (spinal stenosis, spinal infections, etc.),Patients having history of breast cancer Other malignancies

Data collection

Patients who met the inclusion criteria were recruited for the study. Baseline assessments were conducted to illustrate the patient's pulmonary functions and pain. The preventive interventions were then implemented, tailored to each patient's specific needs, with the duration and intensity determined accordingly 2 sets of 5-10 repetitions per day, for a total interval of 6 weeks**.** Spirometry readings were taken once before the interventions applied. And the final spirometry readings were taken at the end of 6th week). After the completion of the interventions, post-reading assessments were conducted to measure any improvements in patients. To maintain consistency, the same data collection tools used during the pre-reading assessments were employed during the post-reading assessments. All collected data were recorded in a secure and confidential manner, ensuring the privacy and anonymity of the patients.Data collection tools:

- Spirometer
- Numeric rating scale

Data analysis : the pair t test was used to analyze data.a p value of 0.05 was deemed statistically significant

RESULTS

The total sizes of 30 patients were included in this study after meeting the inclusion and exclusion criteria. The patients were asked to perform diaphragmatic breathing combined with controlled coughing to improve lung function. The findings of the present study are presented below, together with appropriately labeled tables and figures. Mean and standard deviation was calculated for Quantitative Variable (Age, gender etc.). Assumption for the normality of the data was assessed by Shapiro wilk test. The data fulfilled the normality then parametric tests were applied. Paired sample t-test was used to determine the effectiveness of pre-treatment and post-treatment values for outcome variable (NPRS, FVC, FEV1, FEV1/FVC). P-value ≤ 0.05 was considered as significant

Demographics Data

4.1.1 Age Distribution

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	35	7	23.3	23.3	23.3
	36	2	6.7	6.7	30.0
	37	2	6.7	6.7	36.7
	40	1	3.3	3.3	40.0
	41	1	3.3	3.3	43.3
	43	2	6.7	6.7	50.0
	45	3	10.0	10.0	60.0
	49	1	3.3	3.3	63.3
	55	2	6.7	6.7	70.0
	58	3	10.0	10.0	80.0
	59	1	3.3	3.3	83.3
	60	5	16.7	16.7	100.0
	Total	30	100.0	100.0	

Table 4.1Age Distribution

The table 4.1 shows the age distribution of the participants. The data showed that there were total 30 numbers of participants. The minimum age of the participants was 35years and the maximum age was 60 years.

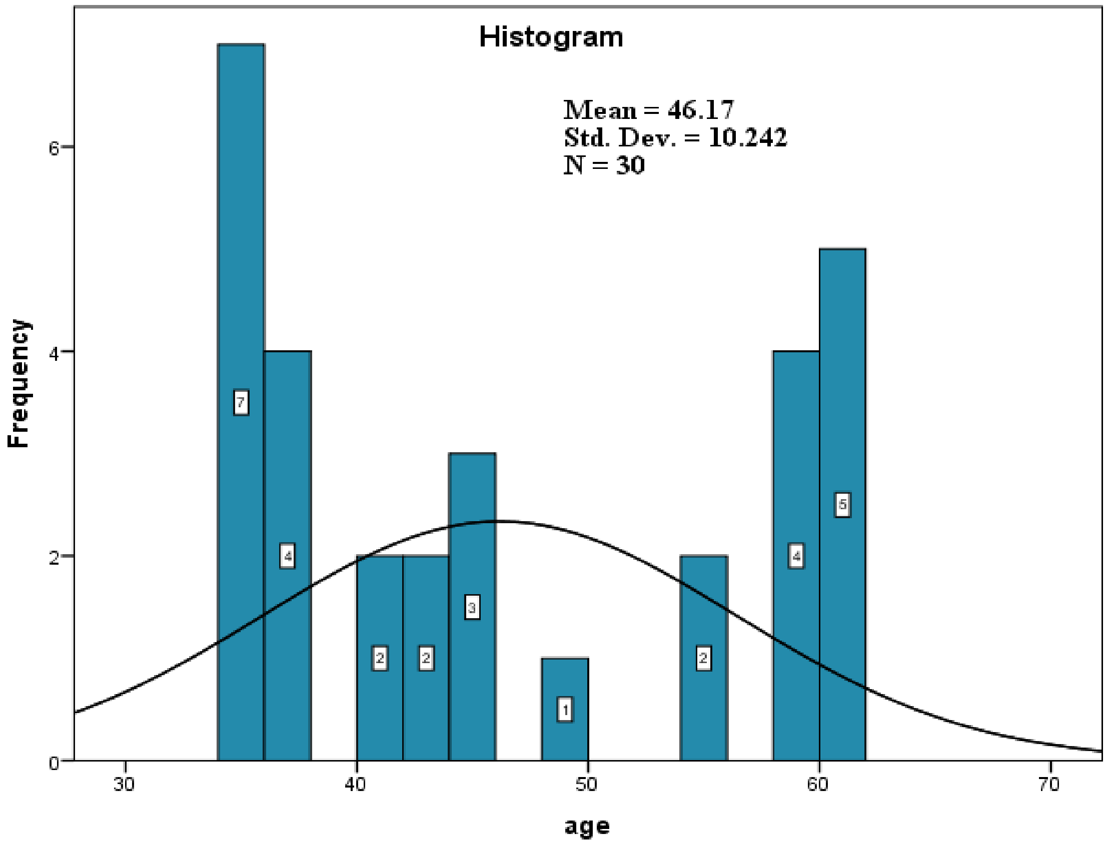

Figure 1Age Distribution

The histogram above shows the age distribution of the participants. The mean age of the participants was 46.17 and standard deviation 10.24.

4.1.2 Gender Distribution

The distribution for gender is given below.

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	22	73.3	73.3	73.3
	Female	8	26.7	26.7	100.0
	Total	30	100.0	100.0	

Table 4.2Gender Distribution

This table 4.2 shows the gender distribution of the participants. The data showed that there were 22 males and 8 females.

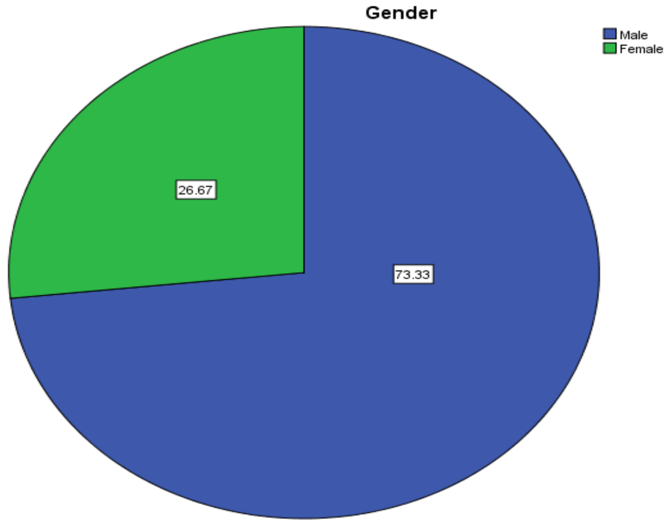

Figure 2Gender Distribution

The Pie chart above shows the Gender distribution of the participants. The data showed that there were 73.33% were males and 26.67% were females.

4.1.3 Height of the participants

The distribution ofthe height of the participants is given below:

Height					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	150	1	3.3	3.3	3.3
	152	3	10.0	10.0	13.3
	155	6	20.0	20.0	33.3
	157	2	6.7	6.7	40.0
	160	3	10.0	10.0	50.0
	162	2	6.7	6.7	56.7
	164	1	3.3	3.3	60.0
	165	5	16.7	16.7	76.7
	169	1	3.3	3.3	80.0
	170	2	6.7	6.7	86.7
	177	1	3.3	3.3	90.0
	178	1	3.3	3.3	93.3
	180	1	3.3	3.3	96.7
	185	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Table 4.3Height of the participants

This table 4.3 shows the distribution of the height of the participants. The minimum height of the participants was 150cm and the maximum height was 185cm.

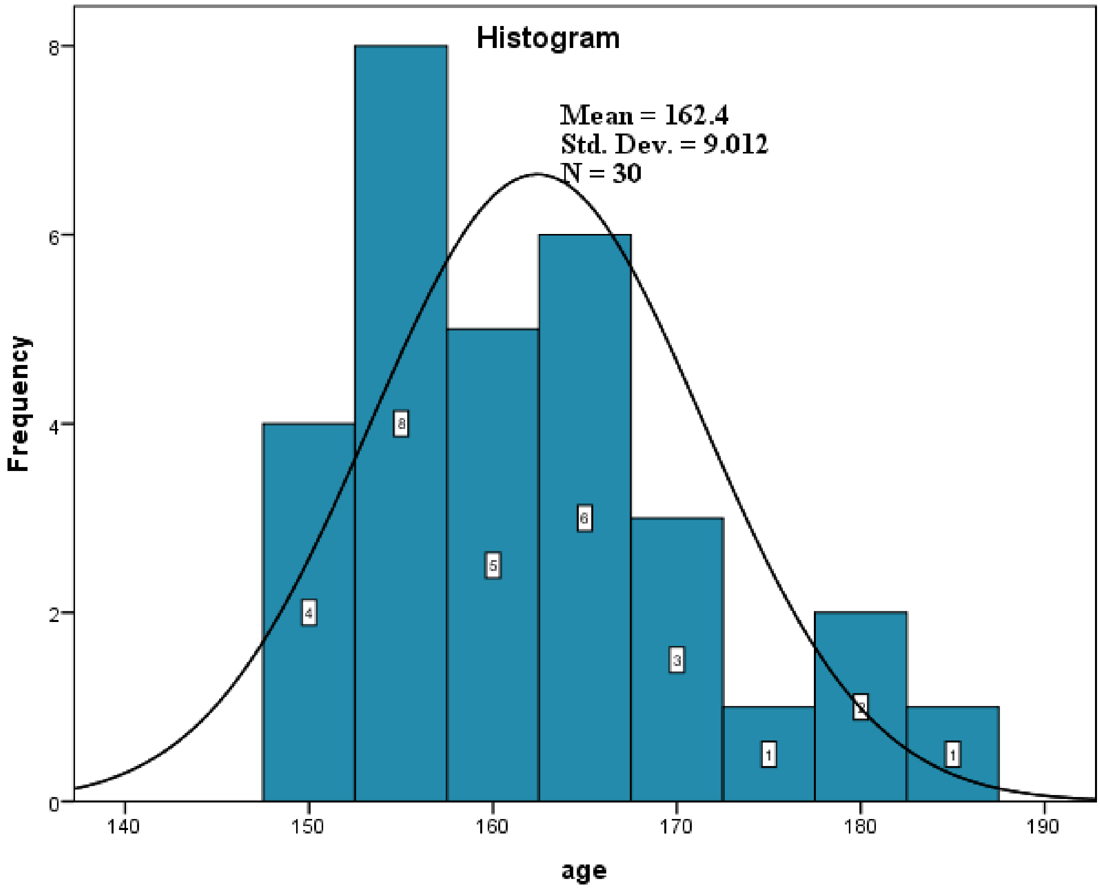

Figure 3Height of the participants

The histogram above shows the distribution of the height of the participants. The mean height of the participants was 162.4 and standard deviation 9.01.

4.1.4Weight of the participants

The distribution ofthe weight of the participants is given below:

Weight					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	48	1	3.3	3.3	3.3
	50	1	3.3	3.3	6.7
	52	2	6.7	6.7	13.3
	55	1	3.3	3.3	16.7
	56	1	3.3	3.3	20.0
	60	1	3.3	3.3	23.3
	61	2	6.7	6.7	30.0
	62	2	6.7	6.7	36.7
	63	1	3.3	3.3	40.0
	64	1	3.3	3.3	43.3

	65	1	3.3	3.3	46.7
	66	1	3.3	3.3	50.0
	67	1	3.3	3.3	53.3
	68	1	3.3	3.3	56.7
	70	3	10.0	10.0	66.7
	73	1	3.3	3.3	70.0
	75	1	3.3	3.3	73.3
	76	1	3.3	3.3	76.7
	78	1	3.3	3.3	80.0
	83	1	3.3	3.3	83.3
	85	1	3.3	3.3	86.7
	86	1	3.3	3.3	90.0
	88	1	3.3	3.3	93.3
	91	1	3.3	3.3	96.7
	96	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Table 4.4 Weight of the participants

This table 4.4 shows the distribution of the weight of the participants. The minimum weight of the participants was 48kg and the maximum height was 96kg.

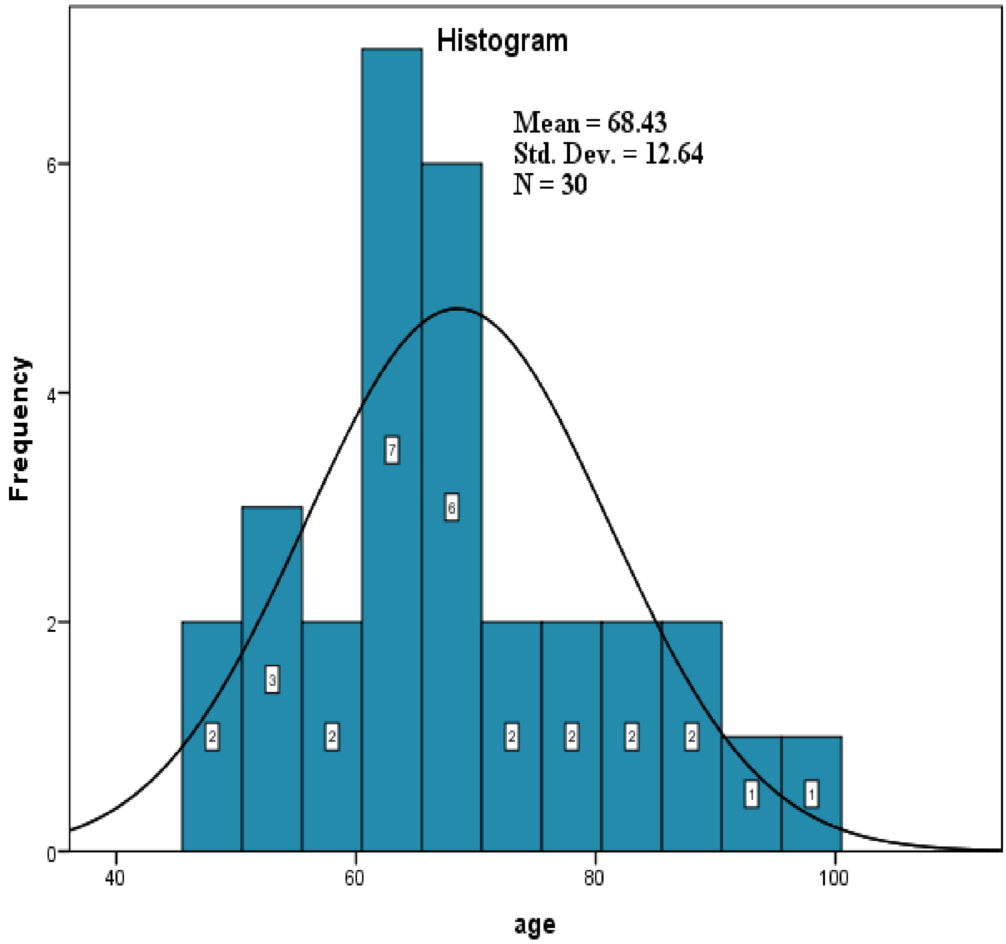

Figure 4 Weight of the participants

The histogram above shows the distribution of the weight of the participants. The mean height of the participants was 68.43 and standard deviation 12.64.

4.1.5BMI of the participants

The distribution ofthe BMI of the participants is given below:

BMI					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under-weight (Less than 18.5)	2	6.7	6.7	6.7
	Normal (18.5 - 24.9)	14	46.7	46.7	53.3
	Over-weight (25-29.9)	7	23.3	23.3	76.7
	Obese (30 and above)	7	23.3	23.3	100.0
	Total	30	100.0	100.0	

Table 4.5 BMI of the participants

This table 4.5 shows the distribution of the BMI of the participants. The data showed that there were 2 participants who were under-weight, 14 were with normal BMI, 7 were over-weight and 7 participants were obese.

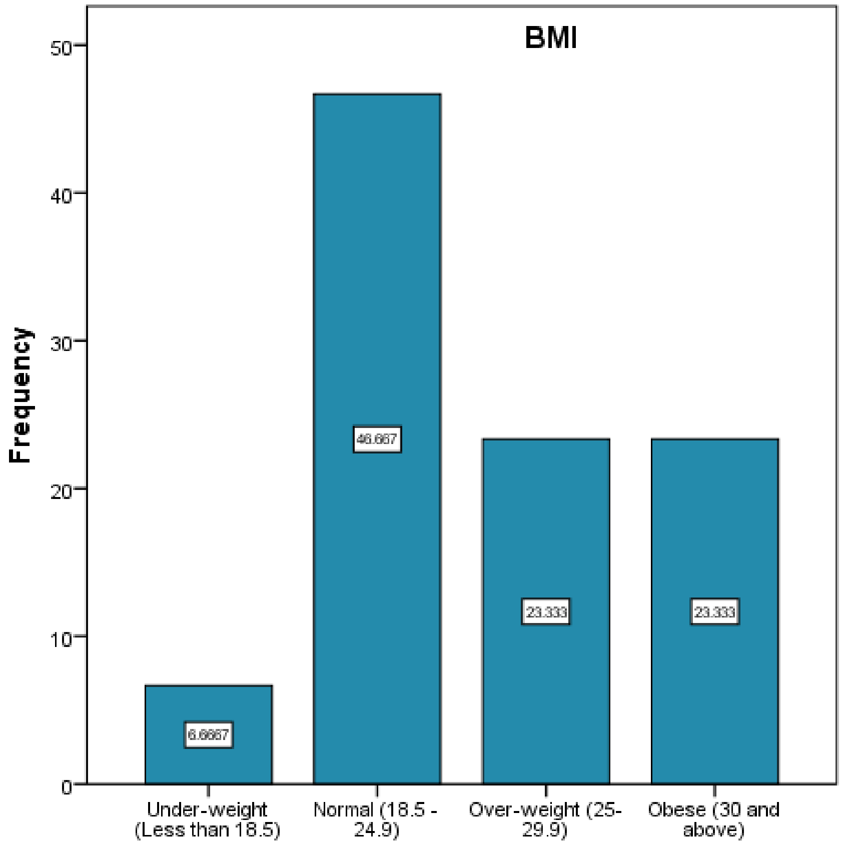

Figure 5 BMI of the participants

The bar chart above shows the distribution of the BMI of the participants The data showed that there were 6.7% participants who were under-weight, 46.7% were with normal BMI, 23.3% were over-weight and 23.3% participants were obese.

4.1.6 Smoking

The distribution ofsmoking status is given below:

Smoking					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	16.7	16.7	16.7
	No	25	83.3	83.3	100.0
	Total	30	100.0	100.0	

Table 4.6 Smoking

This table 4.6 shows the distribution of smoking status of the participants. The data showed that there were 5 participants who were smokers while 25 participants were non-smokers.

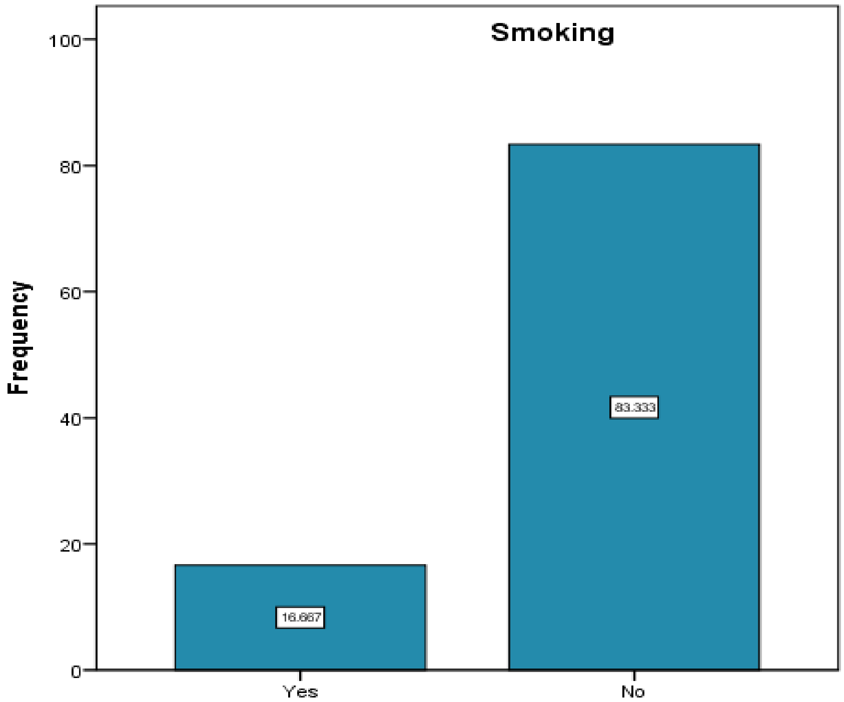

Figure 6Smoking

This bar chart shows the distribution of smoking status of the participants. The data showed that there were 5 participants who were smokers while 25 participants were non-smokers.

4.2 Normality of Data

Firstly Normality of the data was examined before application of tests, by using Shapiro-Wilk's test (p>0.05), skewness and kurtosis test (Z value between -1.96 and +1.96) and normal Q-Q plots, which presented that all the parameters were almost normally distributed. As the data was normally distributed so parametric test including paired sample t-test was used for data analysis.

4.2.1Tests of Normality (Shapiro-Wilk)

Tests of Normality (Shapiro-Wilk)			
Variables	**Statistic**	**df**	**Sig.**
NPRS pre- treatment	.943	30	0.112
FVC pre- treatment	.971	30	0.565
FEV1 pre- treatment	.976	30	0.705
FEV1/FVC pre-treatment	.935	30	0.067

Table 4.7Tests of Normality (Shapiro-Wilk)

The table 4.7 shows that the sig p-value of NPRS, FVC, FEV1, FEV1/FVC pre-treatment was 0.112, 0.565, 0.705 and 0.067 on Shapiro-Wilk which mean the sig p-value was greater than 0.05 and satisfying the rules of normality and this data was normally distributed.

Tests of Normality (Skewness)

Tests of Normality (Skewness)			
Variables	**Skewness**	**Std. error**	**Z (skewness)**
NPRS pre- treatment	.060	.427	0.14
FVC pre- treatment	.519	.427	1.22
FEV1 pre-treatment	.448	.427	1.05
FEV1/FVC pre-treatment	.215	.427	0.50

Table 4.8Tests of Normality (Skewness)

The table 4.8 shows that the Z-value of skewness that was drawn from the table by dividing the statistical value by std. error of skewness of both groups, lied between -1.96 to + 1.96 which concluded that data was Normally Distributed on the basis of NPRS, FVC, FEV1, FEV1/FVC.

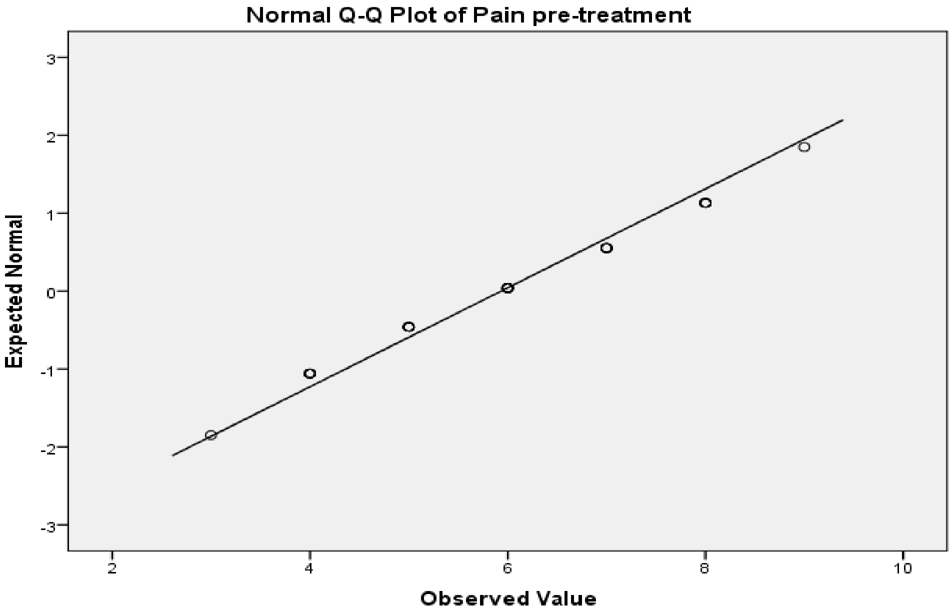

Figure 7 Normal Q-Q Plot of NPRS pre-treatment

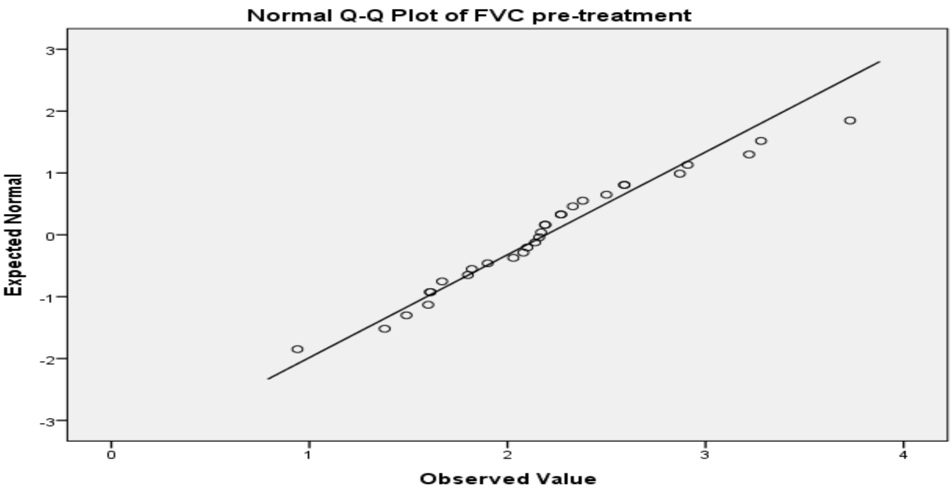

Figure 8 Normal Q-Q Plot of FVC pre-treatment

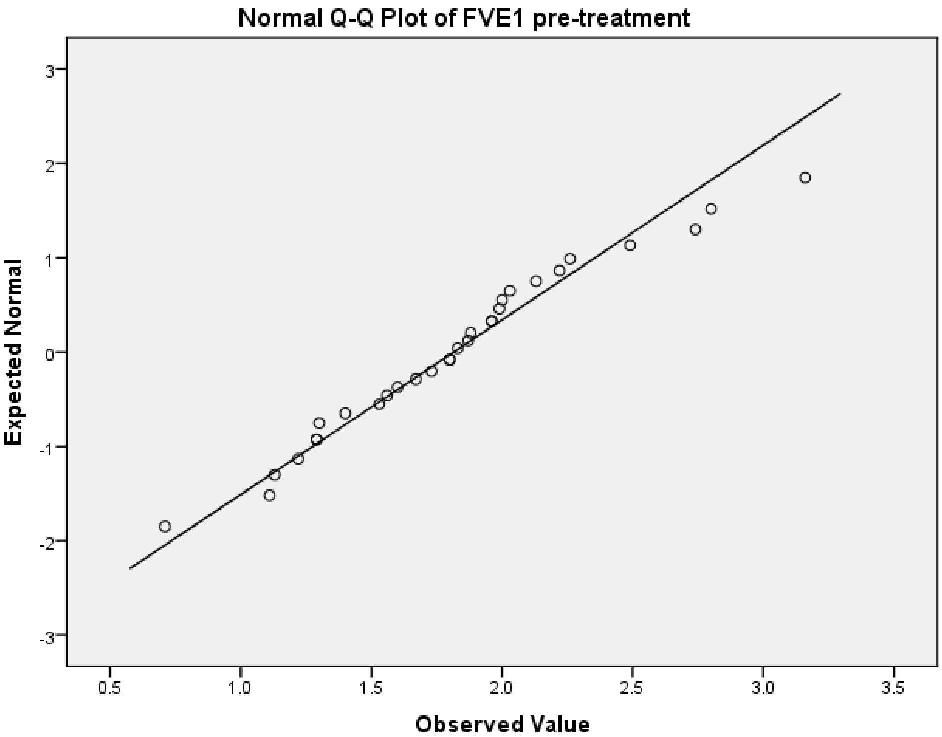

Figure 9 Normal Q-Q Plot of FEV1 pre-treatment

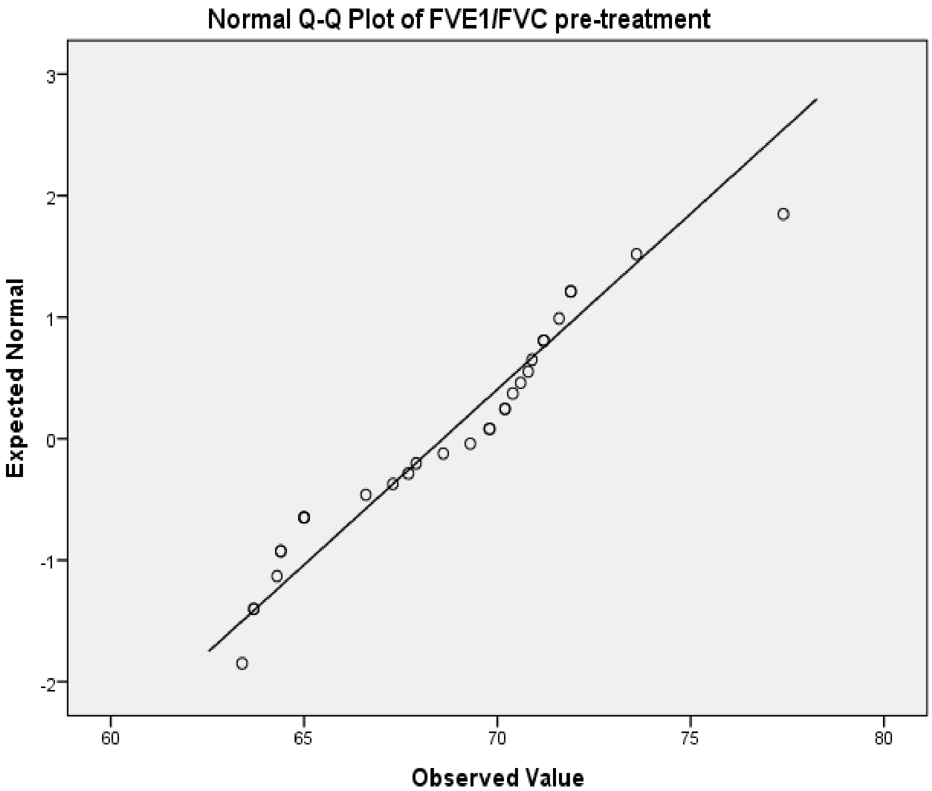

Figure 10 Normal Q-Q Plot of FEV1/FVC pre-treatment

4.3Paired T-Test

It is used to find the effects of treatment in the group. The paired t-test compared the pre and post score of NPRS, FVC, FEV1, FEV1/FVC to assess the combined effects of diaphragmatic breathing and controlled coughing on lung function in COPD patients.

4.3.1NPRS

Intervention	Mean±S.D		t value	Sig. (2- tailed)
	Pre	Post		
Diaphragmatic breathing and controlled coughing	5.93 ± 1.57	4.10 ±1.37	12.04	0.00

Table 4.9 Comparison of NPRS values, pre, and post-treatment

The table 4.9 showed the comparison of the pre-treatment and the post-treatment NPRS score. The mean of the pre-treatment NPRS value was 5.93 with the standard deviation of 1.57 while the mean of post-treatment NPRS was 4.10 with the standard deviation of 1.37. The level of significance was set at 0.05. The p-value is statistically significant as the p-value is of 0.00. Comparisons of NPRS score pre and post treatment showed that mean NPRS in the post-treatment is lower than the mean NPRS score in the pre-treatment.

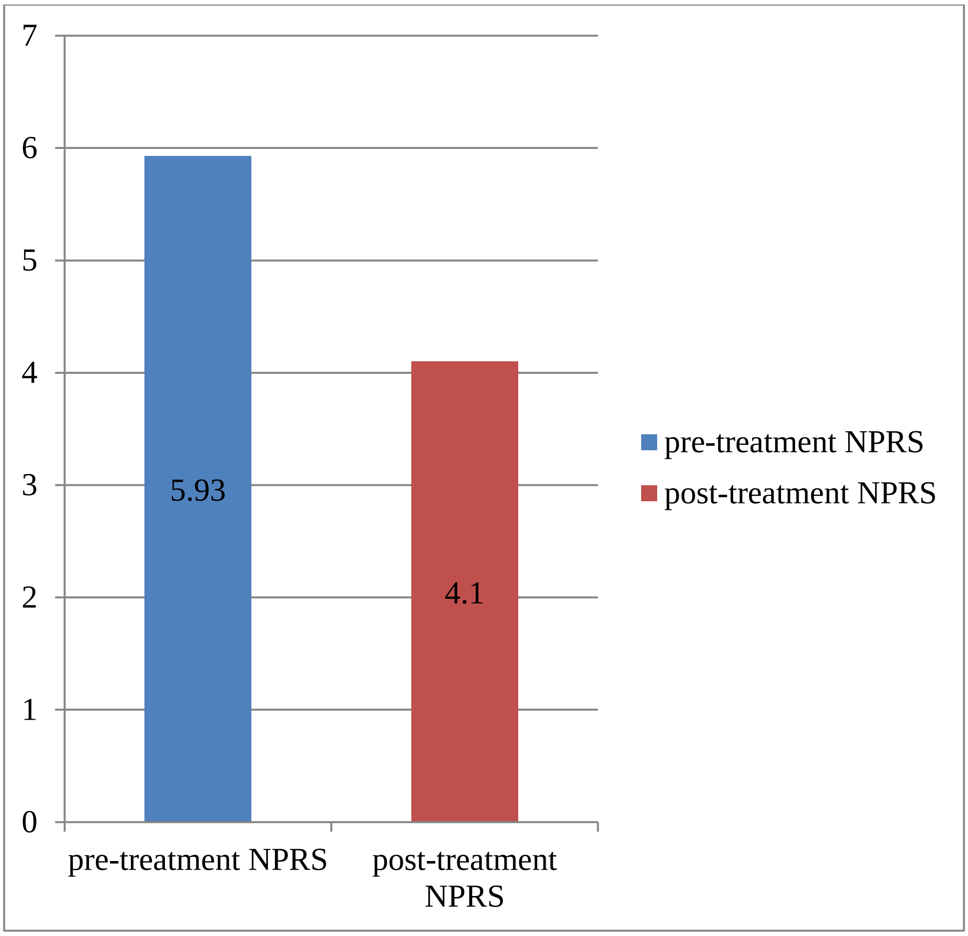

Figure 11comparison of NPRS values, pre, and post-treatment

4.3.2FVC

Intervention	Mean±S.D		t value	Sig. (2- tailed)
	Pre	Post		
Diaphragmatic breathing and controlled coughing	2.19 ±.60	3.12 ± .60	7.64	0.00

Table 4.10comparison of FVC values, pre, and post-treatment

The table 4.10 showed the comparison of the pre-treatment and the post-treatment FVC score. The mean of the pre-treatment FVC value was 2.19 with the standard deviation of 0.60 while the mean of post-treatment FVC was 3.12 with the standard deviation of 0.60. The level of significance was set at 0.05. The p-value is statistically significant as the p-value is of 0.00. Comparisons of FVC score pre and post treatment showed that mean FVC in the post-treatment is higher than the mean FVC score in the pre-treatment.

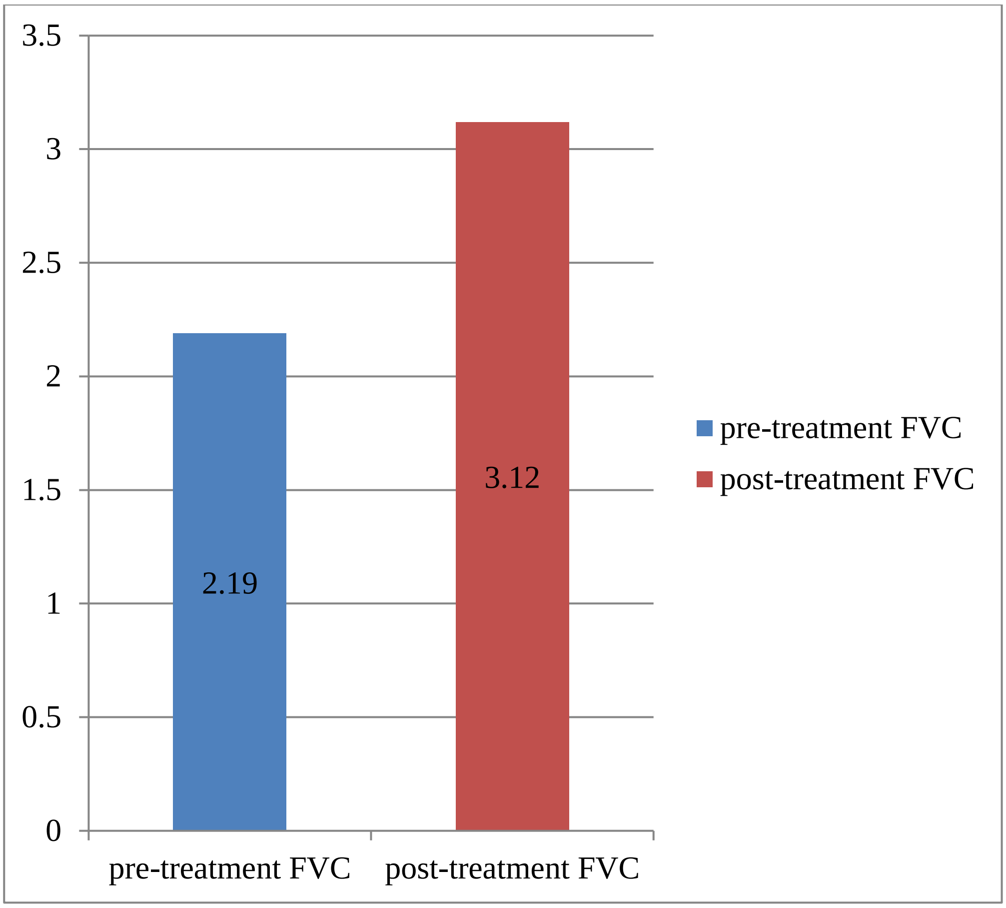

Figure 12 Comparison of FVC values, pre, and post-treatment

4.3.3FEV1

Intervention	**Mean±S.D**		**t value**	**Sig. (2-tailed)**
	Pre	**Post**		
Diaphragmatic breathing and controlled coughing	1.82 ±.54	2.71 ± .99	5.77	0.00

Table 4.11 Comparison of FEV1 values, pre, and post-treatment

The table 4.11 showed the comparison of the pre-treatment and the post-treatment FEV1 score. The mean of the pre-treatment FEV1 value was 1.82 with the standard deviation of 0.54 while the mean of post-treatment FEV1 was 2.71 with the standard deviation of 0.99. The level of significance was set at 0.05. The p-value is statistically significant as the p-value is of 0.00. Comparisons of FEV1 score pre and post treatment showed that mean FEV1 in the post-treatment is higher than the mean FEV1 score in the pre-treatment.

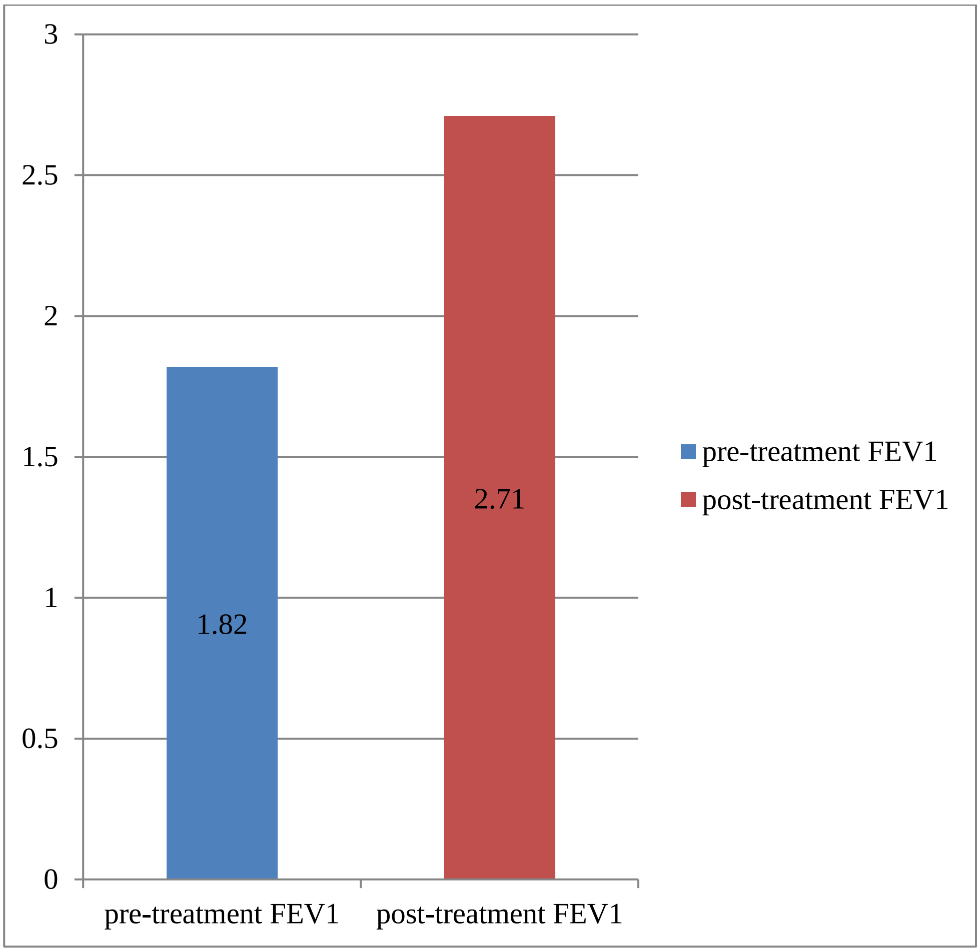

Figure 13 a comparison of FEV1 values, pre, and post-treatment

4.3.4FEV1/FVC

Intervention	Mean±S.D		t value	Sig. (2- tailed)
	Pre	Post		
Diaphragmatic breathing and controlled coughing	68.59 ± 3.46	73.41 ± 3.15	11.25	0.00

Table 4.12 Comparison of FEV1/FVC values, pre, and post-treatment

The table 4.12 showed the comparison of the pre-treatment and the post-treatment FEV1/FVC score. The mean of the pre-treatment FEV1/FVC value was 68.59 with the standard deviation of 3.46 while the mean of post-treatment FEV1/FVC was 73.41 with the standard deviation of 3.15. The level of significance was set at 0.05. The p-value is statistically significant as the p-value is of 0.00. Comparisons of FEV1/FVC score pre and post treatment showed that mean FEV1/FVC in the post-treatment is higher than the mean FEV1/FVC score in the pre-treatment.

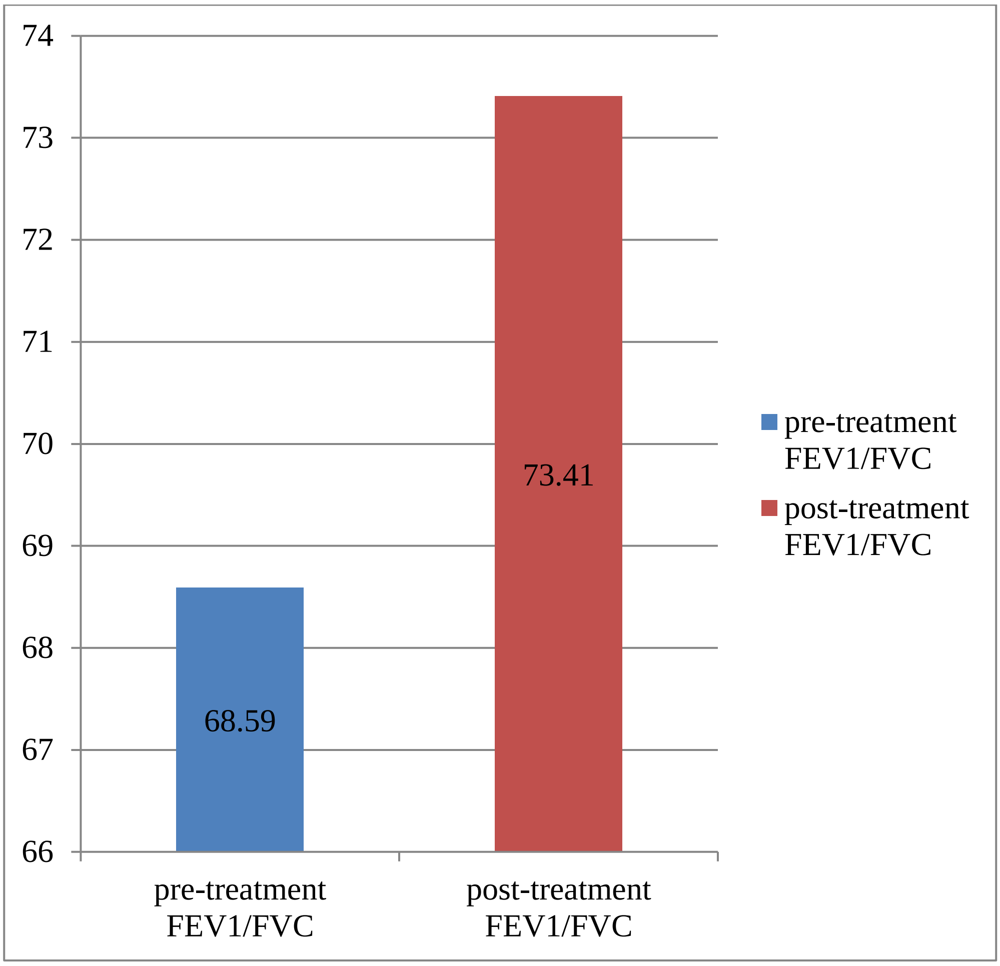

Figure 14 Comparison of FEV1/FVC values, pre, and post-treatment

DISCUSSION

This study was conducted on 30 patients of COPD to evaluate the effects of diaphragmatic breathing combined with Controlled Coughingon lung function.35 to 60 years old males and females were included in the study. Data was analyzed by SPSS 20. Mean and standard deviation was calculated for Quantitative Variable (Age, gender etc.). Assumption for the normality of the data was assessed by Shapiro wilk test. The data fulfilled the normality then parametric tests were applied. Paired sample t-test was used to determine the effectiveness of pre-treatment and post-treatment values for outcome variable (NPRS, FVC, FEV1, FEV1/FVC). P-value ≤ 0.05 was considered as significant.

Results showed that the sig p-value of NPRS, FVC, FEV1, FEV1/FVC pre-treatment was 0.112, 0.565, 0.705 and 0.067 on Shapiro-Wilk which mean the sig p-value was 14 greater than 0.05 and satisfying the rules of normality and this data was normally distributed.

The mean of the pre-treatment FVC value was 2.19 with the standard deviation of 0.60 while the mean of post-treatment FVC was 3.12 with the standard deviation of 0.60. The mean of the pre-treatment FEV1 value was 1.82 with the standard deviation of 0.54 while the mean of post-treatment FEV1 was 2.71 with the standard deviation of 0.99. The mean of the pre-treatment FEV1/FVC value was 68.59 with the standard deviation of 3.46 while the mean of post-treatment FEV1/FVC was 73.41 with the standard deviation of 3.15.

Comparison of pre-treatment and post treatment values showed that combined treatment of diaphragmatic breathing and Controlled Coughingon lung function were effective in COPD patients.Results of this study was supported by many previous researches.In this study, we observed and investigated combined effect of diaphragmatic breathing and Controlled Coughing on lung function.

Data was normally distributed as assessed by Shapiro wilk test. Graphical presentation was done by means of normal Q-Q plots. The data showed that there were 22 males and 8 females.The minimum height of the participants was 150cm and the maximum height was 185cm. The minimum weight of the participants was 48kg and the maximum height was 96kg. There were 5 participants who were smokers while 25 participants were non-smokers.The sig p-value of NPRS, FVC, FEV1, FEV1/FVC pre-treatment was 0.112, 0.565, 0.705 and 0.067 on Shapiro-Wilk which mean the sig p-value was greater than 0.05 and satisfying the rules of normality and this data was normally distributed.The Z-value of skewness that was drawn from the table by dividing the statistical value by std. error of skewness of both groups, lied between -1.96 to + 1.96 which concluded that data was Normally Distributed on the basis of NPRS, FVC, FEV1, FEV1/FVC.

Paired t-test was used to find the efficacy of treatment. Comparisons of NPRS score pre and post treatment showed that mean NPRS in the post-treatment is lower than the mean NPRS score in the pre-treatment.Comparisons of FVC score pre and post treatment showed that mean FVC in the post-treatment is higher than the mean FVC score in the pre-treatment.Comparisons of FEV1 score pre and post treatment showed that mean FEV1 in the post-treatment is higher than the mean FEV1 score in the pre-treatment.Comparisons of FEV1/FVC score pre and post treatment showed that mean FEV1/FVC in the post-treatment is higher than the mean FEV1/FVC score in the pre-treatment.

Conclusions:

This study was Quasi-experimental study. This study investigated the combined effect of diaphragmatic breathing with controlled coughing in patients with COPD. This study concluded that pain was improved in patients with COPD after treatment with diaphragmatic breathing and controlled coughing techniques.

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