

# Comparison of Diaphragmatic Stretch Technique and Proprioceptive Neuromuscular Facilitation in Patients with Mild to Moderate Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial

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**Abstract:** *Background of the study:* COPD is a chronic respiratory condition characterized by persistent airflow limitation and progressive breathing difficulty. COPD causes airflow limitation, dyspnea, and reduced functional capacity. Manual physiotherapy interventions may improve respiratory mechanics. Air trapping and hyperinflation further impair respiratory mechanics, reducing functional capacity and quality of life. Pulmonary rehabilitation is essential in COPD management. Along with pharmacological treatment, physiotherapy interventions improve ventilation, strengthen respiratory muscles, and reduce symptoms. Manual therapy techniques enhance chest wall mobility and thoracic expansion, improving breathing efficiency. Among these, Proprioceptive Neuromuscular Facilitation (PNF) and diaphragmatic stretching are used to optimize respiratory function. *Aim:* To determine whether diaphragmatic stretch technique or PNF technique produces better outcomes in mild to moderate COPD patients. *Objectives:* 1) To compare diaphragmatic stretch technique and proprioceptive neuromuscular facilitation in mild to moderate COPD. 2) To examine the effect of Diaphragmatic Stretch Technique on patients with mild to moderate COPD with respect to PEFr, Breathlessness, Cough and sputum. 3) To examine the effect of Proprioceptive Neuromuscular Facilitation Technique on patients with mild to moderate COPD with respect to PEFr, Breathlessness, Cough and sputum. *Methodology:* A randomized controlled trial was conducted in 70 patients with mild to moderate COPD from the pulmonology OPD were randomly divided into two groups of 35 each. Group 1 received diaphragmatic stretch technique, and Group 2 received chest Proprioceptive Neuromuscular Facilitation Technique, three sessions weekly for four weeks. Outcomes included Peak Expiratory Flow Rate (PEFR), Borg's RPE scale for breathlessness, and CASA-Q, assessed pre- and post-intervention. Appropriate nonparametric statistical tests were applied to determine significance. *Results:* Both groups showed significant improvement in all measured outcomes. Greater improvement was observed in the PNF group for PEFr, dyspnea, and CASA-Q scores. *Conclusion:* Both interventions were beneficial, with chest PNF demonstrating superior short-term outcomes in this sample.

**Keywords:** COPD; pulmonary rehabilitation; diaphragmatic stretch; proprioceptive neuromuscular facilitation; dyspnea; peak expiratory flow rate; manual therapy.

## 1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous respiratory disorder characterized by persistent symptoms such as cough, sputum production, dyspnea, and recurrent exacerbations. It results from structural and functional abnormalities in the airways and alveoli, including emphysema, chronic bronchitis, and bronchiolitis, leading to progressive airflow limitation. Air trapping and lung hyperinflation are hallmark features that impair breathing mechanics and reduce pulmonary function. (1)

In India, the prevalence of COPD ranges from approximately 6.5% to 7%. Major risk factors include environmental exposure, genetic susceptibility, tobacco smoking, household air pollution, prior tuberculosis, and recurrent childhood respiratory infections. Among these, active smoking is the most significant contributor, accounting for 40–70% of cases. Occupational exposure to dust, chemicals, and fumes contributes to nearly 19% of overall risk. (14)

Pathophysiological changes in COPD include airway obstruction, bronchoalveolar instability, increased residual volume, increased end-expiratory lung volume, and reduced inspiratory capacity. These alterations increase the workload on respiratory muscles, leading to reduced muscle efficiency, altered rib positioning, and development of a barrel-shaped chest. Postural adaptations such as forward head posture, thoracic kyphosis, and rounded shoulders may further compromise respiratory function, increase dyspnea, and limit activity. (11), (12), (13)

Manual therapy techniques, including stretching and proprioceptive neuromuscular facilitation (PNF), are used in pulmonary rehabilitation to improve chest wall mobility, respiratory muscle function, and ventilatory efficiency. These interventions may help reduce hyperinflation, improve breathing mechanics, and enhance functional capacity. (5), (6), (15)

The diaphragmatic stretch (doming technique) is a manual therapy intervention aimed at improving diaphragmatic mobility and respiratory function by reducing muscle tightness and facilitating diaphragmatic excursion. The

technique involves applying gentle upward pressure below the costal margin during exhalation while the patient performs deep breathing. Outcomes are commonly assessed using measures such as Peak Expiratory Flow Rate (PEFR). (4), (5).

## 2. Methodology

**Study design:** Use Randomized Controlled Trial

**Blinding:** Single Blinded Study

**Study area:** Mazumdar Shaw Hospital- Pulmonology OPD, Narayana Hrudayalaya health city, Bangalore.

**Study Duration:** 3 months

**Study population:** Subjects with Mild to Moderate COPD Patients are selected according to the criteria of the study from the department of Pulmonology OPD.

**Sampling:** Simple random Sampling

**Randomization:** Randomizing patients into treatment groups was done to prevent researchers, clinicians, and patients from predicting and, thus, influencing which patients will receive which treatment technique. This important source of bias was eliminated by concealing the upcoming allocation sequence from researchers and participants. The sequentially numbered, opaque, sealed envelope (SNOSE) is effective. To ensure allocation concealment, the patients and the research unit were unaware of the allocation sequence before recruitment. Treatment allocation was revealed only after patients had been allocated.

**Concealment:** Concealment of allocation was done as the participant entered the trial. Concealment secures randomization and prevents "selection bias." To avoid bias, the following allocation of concealment technique was used: Sequentially numbered, opaque, **Sealed envelope (SNOSE) technique:** the randomization group was written on a paper and was kept in an opaque, sealed envelope. The envelope was labeled with a serial number. The investigator opened the sealed envelope once the patient had consented to participate and then assigned the treatment group accordingly

**Sample size (with justification):** Total sample size = 70

According to the study by **Premkumar. K et.al (2019)**, the mean and standard deviation of Breathlessness measured using Borg's scale between Group 1 (Retraining Diaphragm by Proprioceptive Neuromuscular Facilitation) and Group 2 (Diaphragmatic Breathing Exercises) are  $1.0 \pm 0.56$  and  $1.4 \pm 0.80$ .

Expecting a similar difference, the sample size was calculated with a 90% confidence interval and 80% Power.

$$n \geq \frac{\left(\frac{z_{1-\alpha} + z_{1-\beta}}{2}\right)^2 \left(\frac{\sigma_1^2 + \sigma_2^2}{r}\right)}{(\mu_1 - \mu_2)^2}$$

Here,

Type I error ( $\alpha$ ) = 0.1

Type II error ( $\beta$ ) = 0.2

Mean in Group 1 = 1

Standard Deviation in Group 1 = 0.5

Mean in Group 2 = 1.4

Standard Deviation in Group 2 = 0.8

Ratio (Group1/Group 2) = 1

The minimum sample size needed is 70

The minimum sample size needed for group 1 is 35.

The minimum sample size needed for control group is 35.

### Eligibility Criteria and Participants recruitment procedure:

#### **Inclusion Criteria:**

- Patients having complaint of breathlessness, cough, and sputum production.
- Mild to Moderate COPD patients according to GOLD criteria (Mild FEV1 >80% Moderate FEV1 50% – 79%>), 2016.
- Patients >40 years old, BMI: 18-36 kg/m<sup>2</sup>.
- Patients of both Genders
- Patients with stable clinical condition without any changes of dosage and medications in 1 month.

#### **Exclusion Criteria:**

- Patients with unstable hemodynamic parameters, neuromuscular or restrictive disease pathology.
- Patient with Tuberculosis, Pneumonia or any infections associated with lungs.
- Patients with Respiratory impairment or injury to the phrenic nerve, Diaphragmatic weakness.
- Patients with Acute onset Exacerbation of COPD.
- Patients not willing to cooperate for the study.
- Patients with recent history of Cardiothoracic or Abdominal surgery.
- Patients with any chest wall/ abdominal trauma or chest wall deformity.

## 3. Procedure

Subjects who fulfilled the eligibility criteria and were willing to participate in the study were recruited for the study.

Using Simple random sampling through computer-generated tables the subjects were allocated into Group 1 and Group 2

Informed Consent was obtained from the participant before the onset of the study

Techniques applied in the study was of standard of care.

**Group I:** This group received the **Diaphragmatic Stretch Technique**. The Diaphragmatic Stretch Technique was given 3 days per week for 4 weeks. The PEFR, Breathlessness scale, and Cough and Sputum Questionnaire were the outcome measures that were used and were assessed pre- and post-intervention. Basic vital signs of the patients were monitored. The patient was positioned supine with relaxed abdominal muscles. The therapist stood at the head of the bed. Hands were placed along the inferior costal margins, with fingers pointing toward the patient's feet and

thumbs resting on the lower ribs. As the patient exhaled, a firm but comfortable downward and inward pressure was applied, following the angle of the ribs to tension the diaphragmatic attachments. The stretch was held for 2–3 seconds briefly at end-exhalation to allow tissue lengthening. As the patient inhaled, the pressure was slowly eased off while maintaining hand contact. This was performed for 6–10 breaths across several respiratory cycles until rib cage mobility improved.

**Group II:** This group received the **Proprioceptive Neuromuscular Facilitation Technique**. The exercises were performed 3 times per week for 4 weeks. The PEFR, Breathlessness scale, Cough and sputum questionnaire, these outcome measures were assessed pre and post-intervention. Basics Vital signs of the patients were monitored. **Lateral Costal Expansion (PNF Diagonal Breathing):** Hands on lateral lower ribs. During inhalation: give outward/upward resistance to facilitate rib expansion. During exhalation: guide ribs down and in with light pressure. Helps improve chest wall mobility and reduce accessory muscle overuse. **Anterior Basal Expansion:** Hands placed on lower anterior ribs. Cue patient to send breath down to your hands. Resist inhalation lightly; assist downward movement during exhalation. Good for lower-lobe recruitment, often restricted in COPD. **Posterior Basal Expansion:** Patient slightly forward-leaning. Hands on posterior lower ribs. Encourage breath to the back; resist expansion gently. Useful when posterior lung movement is limited due to kyphosis or poor mechanics. **Intercostal Stretching Technique:** Apply a quick stretch at end-exhalation along the rib direction to trigger better contraction during next inhalation. Enhances proprioceptive drive and improves rhythm of breathing.

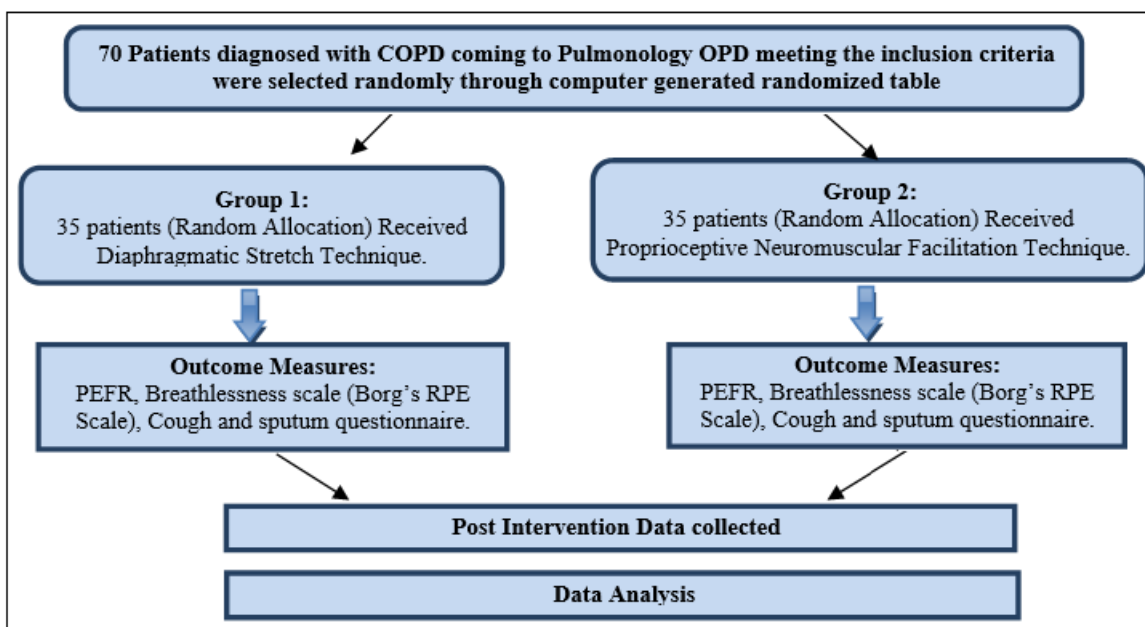
**Perioral Stimulation (PNF for Respiratory Facilitation):** Improve lip control, breathing coordination and activation of upper-airway muscles. Often used when COPD patients show poor pursed-lip control or weak expiratory patterns. **Co-Contraction of Abdomen:** Facilitates abdominal muscle activation during expiration. The therapist applied gentle manual pressure on the abdomen to assist expiratory effort and improve breathing coordination. Often used in COPD patients with weak expiratory muscles.

**Ethical Clearance/Consideration:**

- Ethical clearance was obtained from Narayana Health Academic Ethics Committee, No. NHH/AEC-CL-2015-1516 prior to the study from the ethics committee of the institution.
- **Informed consent was obtained from patients before the onset of study.**
- The subjects were informed that their participation was on voluntary basis and they can withdraw from the study at any time.
- No Ethical issue arose during the study.

**Statistical analysis Rationale:** Was performed using SPSS version 25. Data normality was assessed using the Shapiro–Wilk test. To compare pre-operative and post-operative outcome measures (PEFR, Breathlessness scale (Borg’s RPE Scale), Cough and sputum questionnaire). within the groups, Wilcoxon signed-rank test and Mann–Whitney U test were used. A p-value <0.05 was considered statistically significant.

**Flow of Participants:**



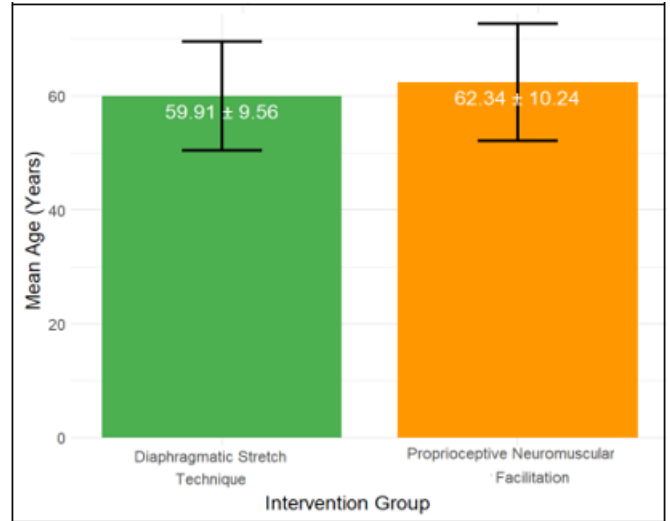
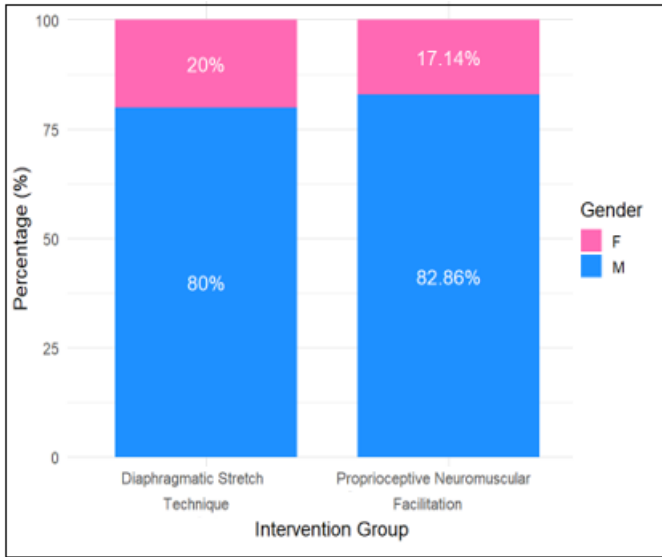
**Data Analysis:**

The pre-test and post-test values were analyzed and the Data were managed using Microsoft Word 2011 and analyzed by using SPSS Version 27. Shapiro -Wilk Test was used for the Normality Test. For within the group Wilcoxon Signed Rank Test was used and for between the groups comparison Mann-Whitney U test was used for statistical analysis.

**Descriptive/ Demographic Statistics: Table 1:**

S. No	Parameter	Group 1 (n=35)	Group 2 (n=35)
1	Gender		
	Female	7 (20.00%)	6 (17.10%)
	Male	28 (80.00%)	29 (82.90%)
2	Age	59.90 ± 9.56	62.30 ± 10.20

The Mean Age of population for Group 1 is  $59.90 \pm 9.56$  and for Group 2 is  $62.30 \pm 10.20$ . Group 1 had 20.00% Females and 17.10% Males. Whereas Group 2 had 80% females and 82.90% Males.



Graph 1 & 2: Gender & Age Distribution Graph:

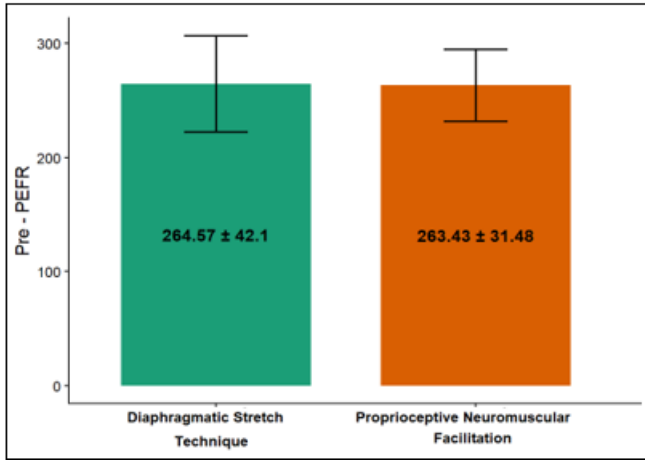
Both groups showed comparable baseline characteristics. Male participants predominated in both Group 1 (80%) and Group 2 (82.86%). Female participants constituted 20% and 17.14%, respectively. The mean age was  $59.91 \pm 9.56$  years in Group 1 and  $62.34 \pm 10.24$  years in Group 2. Overall, both groups were well matched in terms of age and gender distribution.

**Wilcoxon Signed Rank Test: Within Group Comparison between Group 1 and Group 2 Table-2:**

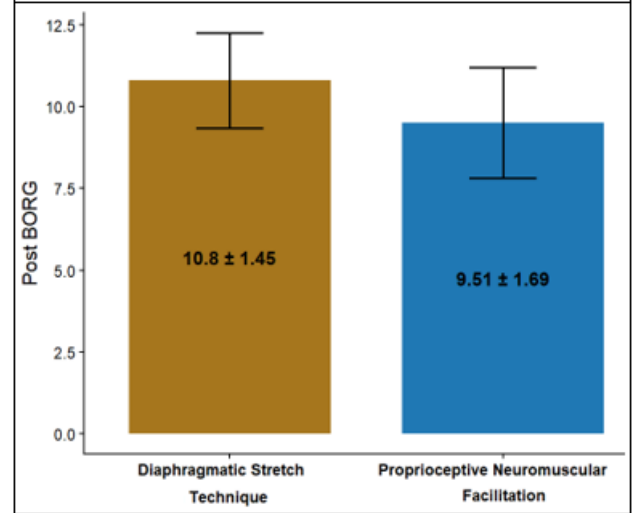
Sl. No.	Parameter	Mean ± Standard Deviation	Mean difference	SD Difference	P-Value
<b>GROUP 1</b>					
1.	<b>PEFR</b>				
	Pre Test	264.57 ± 42.1	61.29	14.77	<0.001*
	Post Test	325.86 ± 46.15			
2.	<b>BORG'S</b>				
	Pre Test	14.46 ± 1.44	-3.66	1.60	<0.001*
	Post Test	10.80 ± 1.45			
3.	<b>CASA-Q</b>				
	Pre Test	52.63 ± 8.83	10.88	10.22	<0.001*
	Post Test	63.51 ± 10.67			

Sl. No.	Parameter	Mean ± Standard Deviation	Mean difference	SD Difference	P-Value
<b>GROUP 2</b>					
1.	<b>PEFR</b>				
	Pre Test	263.43 ± 31.48	90.14	18.65	<0.001*
	Post Test	353.57 ± 36.93			
2.	<b>BORG'S</b>				
	Pre Test	14.83 ± 1.25	-5.32	1.32	<0.001*
	Post Test	9.51 ± 1.69			
3.	<b>CASA-Q</b>				
	Pre Test	51.23 ± 6.80	16.17	10.99	<0.001*
	Post Test	67.40 ± 11.77			

Statistical Software: SPSS Version 27; Normality Test: Shapiro -Wilk Test; Statistical Test: Wilcoxon Signed Rank Test; P value <0.05 – Significant\*



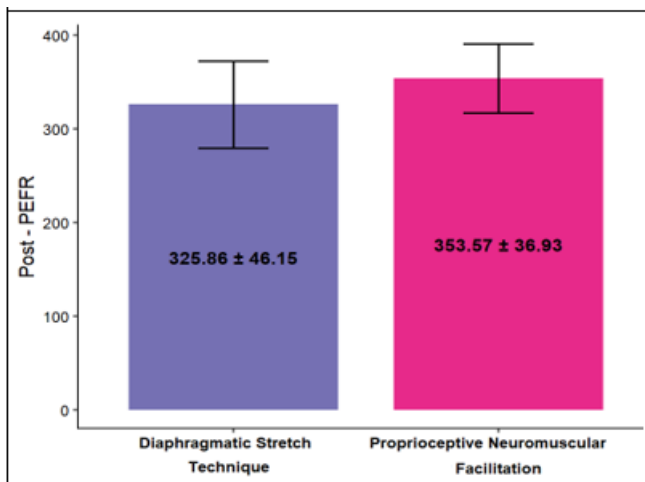
Pre- PEFR:



Post BORG

Graph 5 & 6: Comparison of Pre Test and Post Test Mean Values ± Standard Deviation of BORG'S RPE Scale (Breathlessness) for Group 1 and Group 2

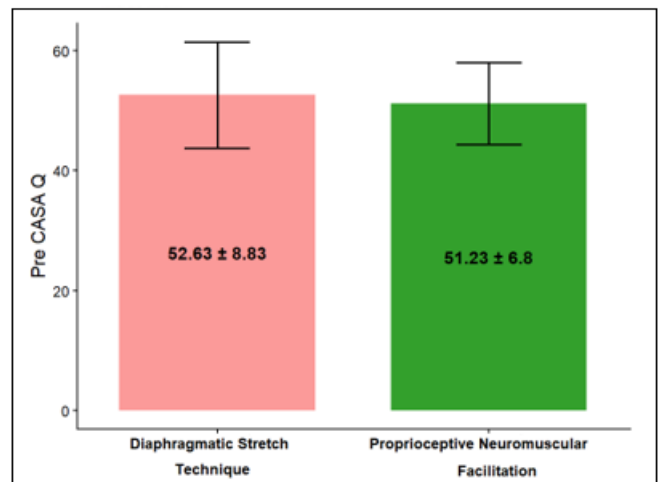
The BORG Scale had a change from pre- test value of 14.46 to post- test value of 10.8 with a mean difference of 3.66 in Group 1. In Group 2 the change was higher from a Pre- test value of 14.83 to a post-test value of 9.51 with a mean difference of 5.32.



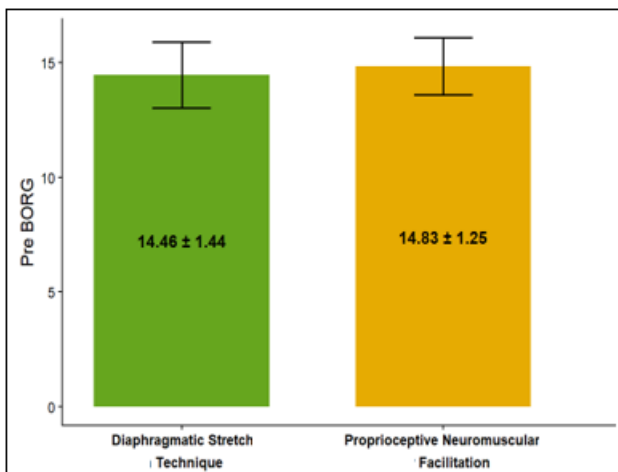
Post- PEFR

Graph 3 & 4: Comparison of Pre Test and Post Test Mean Values ± Standard Deviation of Peak Expiratory Flow Rate (PEFR) For Group 1 And Group 2:

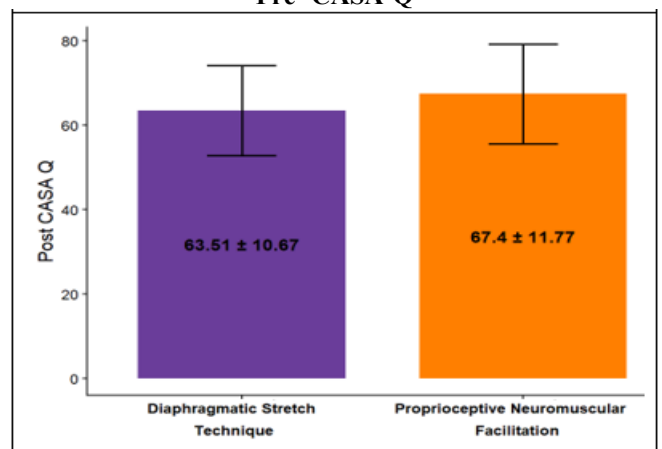
The PEFR had a change from pre- test value of 264.57 to post- test value of 325.86 with a mean difference of 61.29 in Group 1. In Group 2 the change was higher from a Pre- test value of 263.43 to a post-test value of 353.57 with a mean difference of 90.14.



Pre- CASA-Q



Pre- BORG



Post- CASA-Q

Graph 7 & 8: Comparison of Pre Test and Post Test Mean Values ± Standard Deviation of Cough and Sputum Questionnaire (Casa-Q Scale) for Group 1 And Group 2

The CASA-Q Scale had a change from pre- test value of 52.63 to post- test value of 63.51 with a mean difference of 10.88 in Group 1. In Group 2 the change was higher from a Pre- test value of 51.23 to a post-test value of 67.4 with a mean difference of 16.17.

#### 4. Results

This interventional study was conducted to compare the effects of Diaphragmatic Stretch Technique and Proprioceptive Neuromuscular Facilitation Technique in patients with Mild to Moderate Chronic Obstructive Pulmonary Disease. A total of 70 patients diagnosed with Mild to Moderate COPD were selected using simple random sampling and allocated into two groups. Group 1 (n=35) received Diaphragmatic Stretch Technique, while Group 2 (n=35) received Proprioceptive Neuromuscular Facilitation Technique.

At baseline, there were no statistically significant differences between the groups in PEFR, Borg's RPE Scale, and CASA-Q scores, indicating comparability before intervention. Following the intervention, both groups demonstrated statistically significant improvements in all outcome measures ( $p < 0.001$ ).

Between-group comparison showed greater improvement in Group 2 compared to Group 1. The post-test PEFR was higher in Group 2 (353.57) than in Group 1 (325.86). Similarly, Borg's RPE scores showed greater reduction in Group 2 (9.51) compared to Group 1 (10.80), indicating reduced breathlessness. CASA-Q scores also improved more in Group 2 (67.40) than in Group 1 (63.51), suggesting better improvement in cough and sputum production.

The mean differences in PEFR, Borg's RPE Scale, and CASA-Q scores between the groups were 28.85, 1.66, and 5.29 respectively, favoring Group 2. These findings suggest that Proprioceptive Neuromuscular Facilitation Technique was more effective than Diaphragmatic Stretch Technique in improving pulmonary function, reducing dyspnea, and improving cough and sputum symptoms in patients with Mild to Moderate COPD.

A study conducted by Nair et al. compared Diaphragmatic Stretch Technique and Manual Diaphragm Release Technique on diaphragmatic excursion in patients with Chronic Obstructive Pulmonary Disease. The study demonstrated that both techniques significantly improved diaphragmatic mobility and respiratory mechanics, with manual diaphragm release showing slightly greater improvement in diaphragmatic excursion. (4) These findings are consistent with the present study, which also demonstrated improvement in respiratory parameters following diaphragmatic interventions.

Liu et al. evaluated the effects of proprioceptive neuromuscular facilitation (PNF) stretching combined with aerobic training in COPD patients and reported significant improvements in pulmonary function and exercise performance. (3) The authors suggested that PNF techniques may improve respiratory muscle flexibility and neuromuscular coordination, thereby contributing to

improved ventilatory efficiency. These findings support the results of the present study, where the PNF group demonstrated greater improvement in PEFR, dyspnea, and CASA-Q scores.

Knott and Voss described the role of proprioceptive neuromuscular facilitation techniques in facilitating respiratory muscle activity through manual resistance, stretch reflex stimulation, and diagonal movement patterns. (7) The principle of irradiation was proposed to enhance activation of respiratory musculature and improve chest expansion. These physiological mechanisms may explain the improvements observed in the present study following PNF intervention.

Ghosh et al. conducted a pretest–posttest feasibility study evaluating the effects of PNF on lung function in COPD patients and reported significant improvement in pulmonary function parameters following intervention. (8) Their findings further support the role of PNF techniques in respiratory rehabilitation.

Chilhate and Lalwani reviewed manual therapy interventions in COPD and reported that techniques such as diaphragmatic release, soft tissue mobilization, and chest wall mobilization may improve chest wall mobility, reduce respiratory muscle tightness, and enhance pulmonary function. (9) The review also highlighted the potential benefits of manual therapy in reducing dyspnea and improving functional capacity in individuals with COPD.

Malpani, Paul, and Thakre compared respiratory PNF and chest wall mobilization in COPD patients and observed improvement in pulmonary function and dyspnea in both groups, with respiratory PNF demonstrating comparatively greater improvement in ventilatory parameters. (10) These findings are in agreement with the present study, where the PNF group demonstrated greater improvement compared to the Diaphragmatic Stretch Technique group.

#### 5. Conclusion

The study concludes that the Proprioceptive Neuromuscular Facilitation Technique can be a useful technique, which can be used along with other manual therapy techniques along with Conventional PT for patients with mild to moderate COPD patients.

***“There was a significant improvement in PEFR, Reduction of Dyspnea and Reduced cough and sputum production with respect to, PEFR, Borg's RPE and CASA-Q in Group 2 who received Proprioceptive Neuromuscular Facilitation Technique as compared to Group 1 who received Diaphragmatic Stretch Technique in mild to moderate COPD patients”.***

Both diaphragmatic stretch technique and chest proprioceptive neuromuscular facilitation improved PEFR, dyspnea, and cough sputum related outcomes in patients with mild to moderate COPD over four weeks. Greater short term improvement was observed in the PNF group. Larger well controlled studies with longer follow up are needed to confirm clinical superiority and generalizability.

**“The Proprioceptive Neuromuscular Facilitation Technique is comparatively better than the Diaphragmatic Stretch Technique in mild to moderate COPD patients”**

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