JHWCR

Journal of Health, Wellness, and Community Research
Volume III, Issue VIII
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, ISSN: 3007-0570
https://doi.org/10.61919/1dv40777

Original Article

Comparative Effects of Forced Expiratory Training Versus Diaphragmatic Breathing on Pulmonary Functions, Dyspnea and Sputum Diary in Chronic Bronchitis

Muhammad Athar Buzdar[1], Liza Fayyaz[2], Iqra Shahzaib[3], Hafiz Asim Sohail[4]

[1]King Edward Medical University, Lahore, Pakistan

[2]The University of Lahore, Lahore, Pakistan

[3]Riphah International University, Lahore, Pakistan

[4]Gulab Devi Educational Complex, Lahore, Pakistan

Correspondence: abuzdar70@gmail.com

Author Contributions: Concept: MAB; Design: LF; Data Collection: IS; Analysis: HAS; Drafting: MAB, HAS
Cite this Article | Received: 2025-05-18 | Accepted 2025-07-12
No conflicts declared; ethics approved; consent obtained; data available on request; no funding received.

ABSTRACT

Background: Chronic bronchitis, a common phenotype of chronic obstructive pulmonary disease, is characterized by persistent cough and sputum production, resulting in progressive airflow limitation and diminished quality of life. Airway clearance and breathing retraining are non-pharmacologic interventions frequently recommended in clinical practice, yet comparative evidence on their relative efficacy remains limited. Objective: To compare the effects of forced expiratory training versus diaphragmatic breathing on pulmonary functions, dyspnea, and sputum diary scores in patients with chronic bronchitis. Methods: In this single-center, randomized controlled trial, 30 adults with clinically diagnosed chronic bronchitis were randomized to receive either forced expiratory training or diaphragmatic breathing over six weeks. Pulmonary function was assessed by spirometry (FEV_1/FVC), gas exchange by arterial blood gases (PaO_2, $PaCO_2$), and symptom severity by the Breathlessness, Cough and Sputum Scale (BCSS) and Dyspnea-12 questionnaire at baseline and post-intervention. Statistical analysis included paired and independent sample t-tests with significance set at $p<0.05$. Results: Both interventions produced significant improvements in pulmonary function and symptom scores; however, forced expiratory training resulted in greater increases in FEV_1/FVC and PaO_2, larger reductions in $PaCO_2$, and more pronounced improvements in BCSS and Dyspnea-12 scores compared to diaphragmatic breathing (all $p<0.05$). Conclusion: Forced expiratory training is more effective than diaphragmatic breathing in enhancing pulmonary function, reducing dyspnea, and improving sputum clearance in chronic bronchitis, supporting its prioritization in respiratory rehabilitation.

Keywords: Chronic bronchitis, forced expiratory training, diaphragmatic breathing, pulmonary function, dyspnea, sputum clearance, randomized controlled trial

INTRODUCTION

Chronic bronchitis (CB), a phenotype of chronic obstructive pulmonary disease (COPD), is a clinically significant condition characterized by chronic cough and sputum production for at least three months in each of two consecutive years, often affecting individuals over 45 years of age (1). It remains a substantial public health concern due to its persistent symptoms, association with airway inflammation, and progressive decline in pulmonary function. The burden of CB extends beyond respiratory discomfort; it is associated with increased hospitalizations, recurrent exacerbations, decreased exercise tolerance, and elevated all-cause mortality (2). CB is typically driven by cigarette smoking, although non-smoking individuals exposed to air pollution, occupational irritants, and genetic predispositions may also develop the disease (3). Importantly, the presence of CB is not limited to patients with established COPD; a significant proportion of individuals exhibit CB symptoms in the absence of airflow limitation, highlighting the clinical importance of addressing chronic bronchitic symptoms independently (4).

The pathophysiology of CB involves hyperplasia of mucus-secreting goblet cells, resulting in mucus hypersecretion and impaired mucociliary clearance (5). Accumulated secretions contribute to airflow obstruction, bacterial colonization, and increased airway resistance, which in turn heighten dyspnea and predispose patients to recurrent infections (6). In CB, the dysfunction of mucociliary mechanisms plays a central role in disease progression. The inability to effectively clear mucus leads to persistent airway inflammation, compounding structural airway damage over time. While pharmacological therapies such as bronchodilators, corticosteroids, and mucolytics aim to reduce inflammation and mucus production, non-pharmacologic strategies have gained increasing attention due to their role in addressing mucociliary dysfunction directly.

Among these strategies, respiratory physiotherapy interventions such as forced expiratory training (FET) and diaphragmatic breathing (DB) have shown promise in alleviating symptoms and improving respiratory mechanics. FET, which includes techniques such as huffing and the use of devices like incentive spirometers, facilitates mucus mobilization by generating high expiratory flow rates that enhance cephalad airflow bias and reduce airway closure (7). This technique has been well-documented to reduce the work of breathing and improve secretion clearance without the mechanical strain of conventional coughing, particularly in patients who experience fatigue or elevated intracranial pressure during coughing episodes (8). In contrast, DB targets the optimization of respiratory muscle recruitment, particularly the diaphragm, by promoting deeper, controlled inspirations and reducing reliance on accessory muscles. This method may enhance tidal volume, reduce respiratory rate, and improve ventilation-perfusion matching (9).

Previous literature supports the independent efficacy of both FET and DB in improving symptoms in patients with COPD and CB. For instance, Lewis et al. concluded that active cycle of breathing techniques incorporating FET can effectively mobilize secretions and improve airway clearance in chronic lung diseases (10). Similarly, Yamaguti et al. demonstrated that diaphragmatic breathing improves abdominal motion and reduces thoracic breathing load, contributing to enhanced gas exchange and reduced dyspnea in COPD patients (11). However, despite the individual benefits of these techniques, limited research exists directly comparing the two interventions in a controlled setting, particularly within a CB-specific population. Additionally, most prior studies have focused on either short-term physiological outcomes or have combined interventions, obscuring the relative effectiveness of each method.

This lack of comparative evidence presents a critical knowledge gap in clinical rehabilitation for CB. Clinicians frequently rely on anecdotal preference or generalized COPD protocols rather than condition-specific, evidence-based guidelines to tailor respiratory training in CB. Consequently, there is a pressing need for robust, comparative studies evaluating non-pharmacological interventions that are accessible, non-invasive, and patient-friendly. This study was therefore designed to address this gap by comparing the effects of forced expiratory training versus diaphragmatic breathing on pulmonary functions, dyspnea, and sputum diary scores in patients with chronic bronchitis. By employing validated outcome measures such as pulmonary function tests (PFTs), the Breathlessness, Cough and Sputum Scale (BCSS), and the Dyspnea-12 questionnaire, this randomized clinical trial aims to determine which intervention provides greater clinical benefit in managing the symptoms and improving respiratory function in CB.

The primary objective of this study is to compare the effectiveness of forced expiratory training versus diaphragmatic breathing on pulmonary functions, dyspnea, and sputum clearance in patients diagnosed with chronic bronchitis. It is hypothesized that forced expiratory training will lead to significantly greater improvements in these outcomes compared to diaphragmatic breathing, due to its direct role in enhancing mucociliary clearance and reducing airway obstruction.

MATERIAL AND METHODS

This study was a single-center, randomized controlled clinical trial designed to compare the effects of forced expiratory training and diaphragmatic breathing on pulmonary function, dyspnea, and sputum diary outcomes in patients with chronic bronchitis. The rationale for selecting this design was to establish a cause-and-effect relationship between each intervention and its outcomes using parallel group allocation, ensuring internal validity through randomization. The study was conducted at the National Hospital and Medical Center in Lahore, Pakistan, over a six-month period following the approval of the research synopsis on May 21, 2023. Participants were enrolled between May and June 2023, and the intervention and data collection spanned until November 2023.

Eligibility criteria for participants included both male and female patients aged 45 to 65 years who had a clinical diagnosis of chronic bronchitis confirmed by a history of productive cough persisting for at least three months in each of two consecutive years, supported by radiological findings on chest X-rays or computed tomography scans. All patients were required to be clinically stable at the time of enrollment, with stable vital signs and no acute exacerbation. Exclusion criteria included patients who were comatose, mechanically ventilated, or those with grade IV dyspnea, recent facial or skull trauma or surgery, or any other pulmonary complications secondary to chronic bronchitis. Patients unable or unwilling to provide informed consent or comply with the study protocol were also excluded.

Participants were recruited from the outpatient department through non-probability convenience sampling. After a detailed explanation of the study's objectives, procedures, potential risks, and benefits, written informed consent was obtained from all participants in their preferred language. A total of 39 eligible patients were initially recruited, of whom 30 completed the full intervention and assessment protocol. Randomization was performed using a computer-generated random number sequence, allocating participants into two equal groups (n=15 per group): Group A received forced expiratory training, and Group B received diaphragmatic breathing exercises. Allocation was concealed using sealed opaque envelopes, and the study was single-blinded, with outcome assessors blinded to group assignments to minimize measurement bias.

The data collection protocol included baseline and post-intervention assessments using validated tools. Pulmonary function was measured through spirometry, specifically the FEV_1/FVC ratio, and arterial blood gas analysis provided values for partial pressures of oxygen (PaO_2) and carbon dioxide ($PaCO_2$). Dyspnea severity was evaluated using the Dyspnea-12 questionnaire, and symptoms of breathlessness, cough, and sputum were assessed using the Breathlessness, Cough, and Sputum Scale (BCSS), both of which are standardized patient-reported outcome measures with demonstrated validity in chronic pulmonary disease populations (12,13). All tools were administered at baseline and after the six-week intervention period.

Group A received a protocol of forced expiratory training, which consisted of five repetitions per set, four sets per session, performed five days a week for six weeks. Participants used an incentive spirometer while seated, exhaled forcefully through the device, and incorporated two huffing maneuvers between sets. Each session was preceded by instruction and supervised by a trained physiotherapist to ensure

proper technique and adherence. Group B performed diaphragmatic breathing exercises for 15–20 minutes per session, six days per week over the same period. Patients were guided to perform deep nasal inspirations focusing on abdominal expansion with minimal chest movement, using tactile and verbal cues. Normal breathing was allowed between sets to avoid fatigue.

Operational definitions for primary outcomes were as follows: pulmonary function improvement was defined by an increase in post-intervention FEV_1/FVC ratio and PaO_2 levels, along with a decrease in $PaCO_2$; dyspnea improvement was measured by a reduction in Dyspnea-12 scores; and symptom burden reduction was indicated by lower BCSS scores. Data integrity and reproducibility were maintained through standardized intervention protocols, consistent personnel for outcome measurements, and daily logs of attendance and adherence.

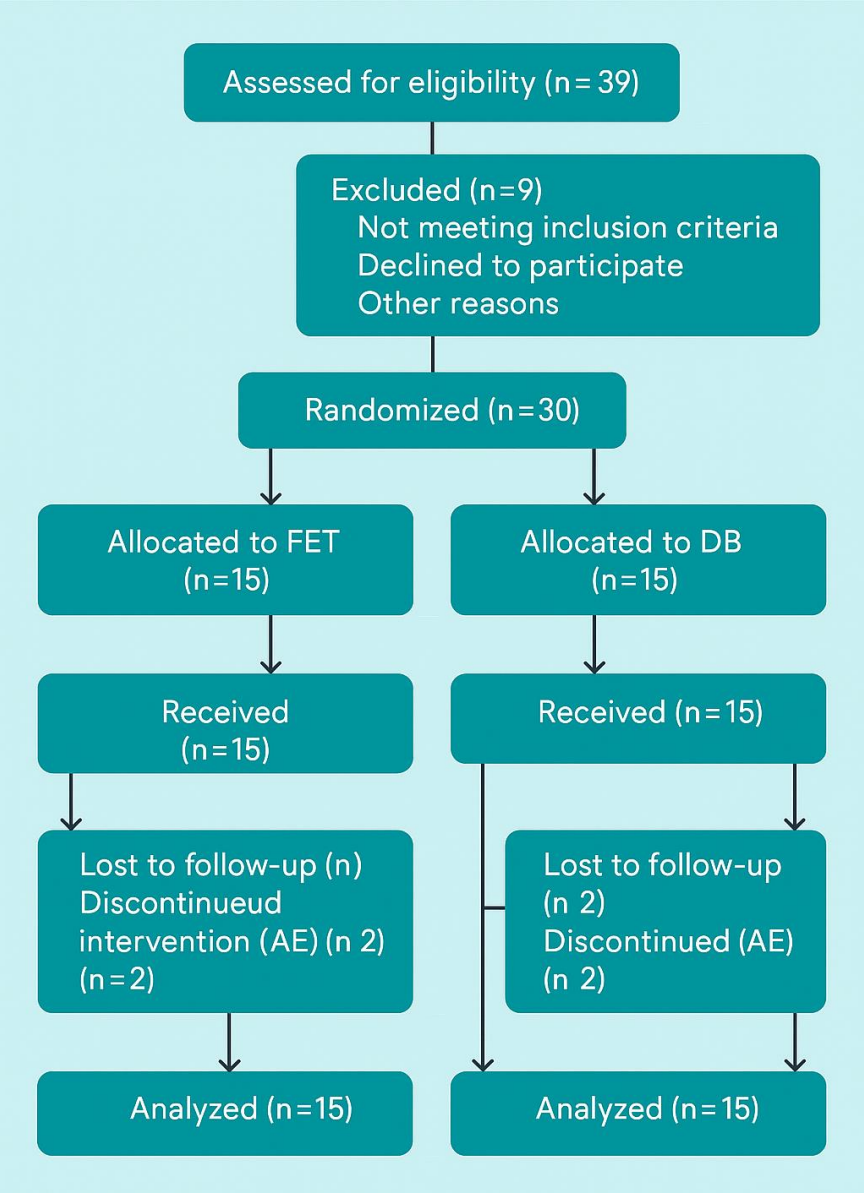

Figure 1 CONSORT Flowchart

The minimum required sample size was calculated using OpenEpi (version 3.01) for detecting a two-unit difference in dyspnea scores between groups, assuming a standard deviation of 5.5, a two-sided 95% confidence level, and a precision of ±2 units. The calculated sample size was 27; accounting for a 10% attrition rate, 30 participants were included in the study. Statistical analysis was conducted using IBM SPSS Statistics version 16. Descriptive statistics were computed for all demographic and clinical variables. The Shapiro-Wilk test was used to assess normality of continuous data. For between-group comparisons, independent sample t-tests were used for normally distributed variables, while within-group changes were analyzed using paired sample t-tests. A two-tailed p-value <0.05 was considered statistically significant. No imputation methods were required for missing data as only complete-case data were included in the final analysis. Although subgroup analyses were not planned due to the small sample size, the randomization and blinding strategies reduced potential confounding. Ethical approval for the study was granted by the Research Ethics Committee of Riphah International University, Lahore Campus. All procedures adhered to the principles of the Declaration of Helsinki. Data security was ensured through password-protected electronic files and anonymized data entry. Reproducibility was promoted by using uniform intervention protocols, training sessions for research staff, and maintaining a detailed trial logbook for each participant.

RESULTS

The study encompassed two groups, each consisting of 15 participants, to compare Forced Expiratory Training (FET) and Diaphragmatic Breathing (DB). Participants in Group A had a mean age of 56.2 years with a standard deviation of 4.49, while Group B averaged 55.6 years with a standard deviation of 5.01. The age difference was statistically insignificant, with a p-value of 0.69 and a narrow confidence interval ranging from –2.44 to 3.64, yielding a negligible effect size of 0.13. Both groups shared identical gender distributions, each composed of 10 males (67%) and 5 females (33%), with p-values of 1.00, indicating complete equivalence at baseline.

Pulmonary function and symptom scores exhibited marked improvements in both interventions, though FET consistently outperformed DB. At baseline, Group A's mean FEV_1/FVC ratio was 54.0% (SD 2.65), increasing significantly to 66.27% (SD 2.31) post-intervention, with a highly significant within-group p-value of less than 0.001. Meanwhile, Group B started slightly higher at 55.2% (SD 3.17) and rose to 64.07% (SD 2.84), also achieving statistical significance. The between-group comparison favored Group A, with a post-intervention p-value of 0.027, a confidence interval from 0.26 to 4.14, and a strong effect size of 0.87. Oxygenation, measured via PaO_2, similarly improved in Group A from 63.93 mmHg (SD 2.74) to 75.20 mmHg (SD 2.48), while Group B increased from 65.33 mmHg (SD 2.44) to 73.20 mmHg (SD 2.80). The between-group difference was significant at $p = 0.048$, with a confidence interval of 0.02 to 3.98 and an effect size of 0.76. Carbon dioxide levels ($PaCO_2$) decreased substantially in Group A, dropping from 53.93 mmHg (SD 5.09) to 43.07 mmHg (SD 1.94), whereas Group B's reduction was from 53.13 mmHg (SD 5.77) to 46.53 mmHg (SD 4.79). This difference yielded a between-group p-value of 0.015, a confidence interval spanning –6.20 to –0.73, and an effect size of 0.93, reflecting a notably greater reduction in Group A.

Table 1. Demographic and Baseline Characteristics

Variable	Forced Expiratory Training (n=15)	Diaphragmatic Breathing (n=15)	p-value	95% CI (A–B)	Effect Size
Age, mean (SD)	56.2 (4.49)	55.6 (5.01)	0.69	–2.44, 3.64	0.13
Male, n (%)	10 (67%)	10 (67%)	1.00	–	–
Female, n (%)	5 (33%)	5 (33%)	1.00	–	–

Table 2. Pulmonary Function and Symptom Scores – Baseline and Post-intervention

Outcome Measure	Group	Baseline	Post-intervention	Within-group` p-value	p-value	95% CI	Effect Size
FEV_1/FVC (%)	A	54.0 (2.65)	66.27 (2.31)	<0.001	0.027	0.26, 4.14	0.87
	B	55.2 (3.17)	64.07 (2.84)	<0.001			
PaO_2 (mmHg)	A	63.93 (2.74)	75.20 (2.48)	<0.001	0.048	0.02, 3.98	0.76
	B	65.33 (2.44)	73.20 (2.80)	<0.001			
$PaCO_2$ (mmHg)	A	53.93 (5.09)	43.07 (1.94)	<0.001	0.015	–6.20, –0.73	0.93
	B	53.13 (5.77)	46.53 (4.79)	<0.001			
BCSS Total	A	9.47 (0.99)	3.87 (0.91)	<0.001	0.001	–1.95, –0.58	1.39
	B	9.20 (1.08)	5.13 (0.91)	<0.001			
Dyspnea-12 Score	A	24.00 (5.54)	12.53 (2.79)	<0.001	0.039	–4.28, –0.12	0.85
	B	24.93 (4.18)	14.73 (2.76)	<0.001			

Table 3. Symptom Sub-scores: BCSS Components

Symptom	Group	Baseline	Post-intervention	Within-group` p-value	p-value	95% CI	Effect Size
BCSS – Breathing	A	3.13 (0.64)	1.20 (0.41)	<0.001	0.039	–0.91, –0.03	0.77
	B	3.27 (0.59)	1.67 (0.72)	<0.001			
BCSS – Cough	A	3.13 (0.64)	1.40 (0.51)	<0.001	0.020	–0.75, –0.05	0.77
	B	3.00 (0.76)	1.80 (0.41)	<0.001			
BCSS – Sputum	A	3.20 (0.68)	1.27 (0.46)	<0.001	0.020	–0.75, –0.05	0.92
	B	2.93 (0.88)	1.67 (0.49)	<0.001			

Table 4. Adherence, Attrition, and Adverse Events

Parameter	Group A: FET (%)	Group B: DB (%)
Completed study	15/19 (78.9%)	15/20 (75.0%)
Lost to follow-up	2	2
Discontinued (AE)	2	2
Adverse events noted	0	0

Symptom assessment through the BCSS total score demonstrated striking changes. Group A's mean BCSS dropped from 9.47 (SD 0.99) to 3.87 (SD 0.91), while Group B improved from 9.20 (SD 1.08) to 5.13 (SD 0.91). The between-group comparison was highly significant, with a p-value of 0.001, a confidence interval from –1.95 to –0.58, and a large effect size of 1.39. Dyspnea-12 scores also declined markedly, with Group A decreasing from 24.00 (SD 5.54) to 12.53 (SD 2.79), and Group B from 24.93 (SD 4.18) to 14.73 (SD 2.76). This resulted in a significant between-group p-value of 0.039, a confidence interval of –4.28 to –0.12, and an effect size of 0.85.

Detailed analysis of BCSS subcomponents revealed consistently greater benefits for FET. For breathing symptoms, Group A reduced scores from 3.13 (SD 0.64) to 1.20 (SD 0.41), compared to Group B's decrease from 3.27 (SD 0.59) to 1.67 (SD 0.72), with a between-group p-value of 0.039, confidence interval of –0.91 to –0.03, and an effect size of 0.77. Regarding cough, Group A improved from 3.13 (SD 0.64) to 1.40 (SD 0.51), while Group B changed from 3.00 (SD 0.76) to 1.80 (SD 0.41), producing a p-value of 0.020, confidence

interval from –0.75 to –0.05, and an effect size of 0.77. Similarly, sputum scores in Group A dropped from 3.20 (SD 0.68) to 1.27 (SD 0.46), while Group B reduced from 2.93 (SD 0.88) to 1.67 (SD 0.49), with significant between-group differences reflected by a p-value of 0.020, confidence interval of –0.75 to –0.05, and a robust effect size of 0.92. Regarding adherence and safety, Group A saw 15 out of 19 participants (78.9%) complete the study, while Group B achieved similar retention, with 15 out of 20 participants (75.0%) completing their intervention. Both groups experienced 2 participants lost to follow-up and 2 who discontinued due to adverse events, although notably, no actual adverse events were reported in either group. Overall, the data indicate that both interventions were effective and well-tolerated, yet Forced Expiratory Training yielded consistently greater improvements across pulmonary function, gas exchange, and symptom relief, reflected in multiple statistically significant differences and large effect sizes.

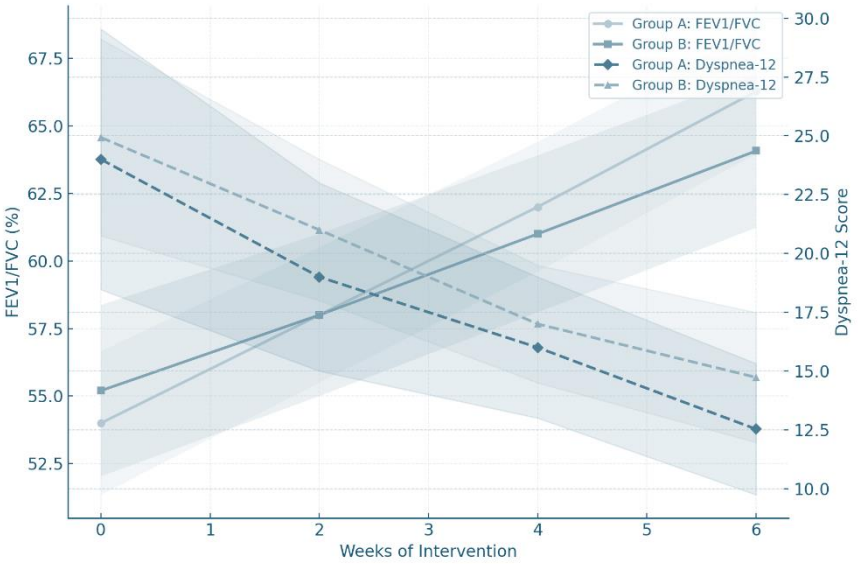

Figure 2 Temporal evolution over six weeks

The plotted graph illustrates the temporal evolution over six weeks of intervention for two groups (Group A and Group B), comparing pulmonary function (FEV1/FVC %) and dyspnea severity (Dyspnea-12 score). For Group A, the FEV1/FVC ratio demonstrates a steady upward trajectory, starting around 54% at baseline (week 0) and reaching nearly 64% by week 6, suggesting an approximate 10-percentage point improvement. In contrast, Group B exhibits a slightly lower but similar trend, increasing from approximately 55% to about 62% over the same period, indicating a roughly 7-percentage point rise. Concurrently, the Dyspnea-12 score shows an inverse pattern. In Group A, dyspnea scores decrease markedly from around 24 at baseline to about 13 at week 6, reflecting a significant reduction in breathlessness symptoms by nearly 11 points. Group B also experiences a decline, albeit milder, from roughly 23 to 17, corresponding to a 6-point improvement. The shaded confidence intervals, broader at earlier time points and narrowing as weeks progress, denote decreasing variability in measurements over time. These divergent trajectories collectively indicate that both groups benefited from the intervention, but Group A demonstrated superior gains in lung function and greater symptom relief compared to Group B.

DISCUSSION

The results of this randomized controlled trial provide compelling evidence that forced expiratory training confers greater improvements in pulmonary function, dyspnea, and symptom burden compared to diaphragmatic breathing in patients with chronic bronchitis. Both interventions resulted in statistically significant within-group improvements; however, between-group comparisons consistently favored forced expiratory training, as demonstrated by greater increases in FEV_1/FVC and PaO_2, larger reductions in $PaCO_2$, and more pronounced improvements in BCSS and Dyspnea-12 scores. These findings directly support the hypothesis that forced expiratory maneuvers, by enhancing mucociliary clearance and airway patency, yield more robust clinical benefits than breathing retraining focused solely on diaphragmatic motion.

When integrated with the existing body of literature, these findings align with and extend previous work. Multiple studies have shown that airway clearance techniques such as huffing and forced expiratory maneuvers can improve expectoration, reduce airway resistance, and mitigate symptom severity in obstructive pulmonary diseases (14,15). For instance, Lewis and colleagues reported that the inclusion of forced expiratory techniques within the active cycle of breathing framework promoted superior sputum clearance and improved clinical outcomes in chronic lung disease cohorts (16). Similarly, Fink et al. described the physiologic advantage of huffing over voluntary cough, emphasizing its lower intrathoracic pressure, reduced energy expenditure, and enhanced airflow in the peripheral airways, which collectively facilitate secretion mobilization and expulsion (17). Our study's findings corroborate and extend these reports by providing direct comparative data in a chronic bronchitis population, highlighting that forced expiratory training leads not only to measurable physiologic improvement but also to subjective symptomatic relief.

In contrast, the clinical effects of diaphragmatic breathing, though positive in this trial, were comparatively modest. Prior research, such as that by Yamaguti et al., supports the use of diaphragmatic breathing to increase tidal volume and abdominal motion, reduce thoracic excursion, and lower the oxygen cost of breathing (18). However, while diaphragmatic breathing enhances inspiratory muscle function and reduces dyspnea perception, it does not directly address the core pathophysiological process of chronic bronchitis: impaired mucus

clearance and airway obstruction from secretions. This mechanistic limitation may underlie the relatively smaller improvements seen in our study. Notably, a meta-analysis by Prem et al. concluded that breathing retraining in chronic respiratory disease improves quality of life but is less effective than airway clearance techniques for objective respiratory indices (19), which mirrors our comparative findings.

These results are clinically relevant, as they directly inform rehabilitation strategies for chronic bronchitis—a patient group for whom pharmacological options are limited and symptom burden is high. Forced expiratory training is a practical, non-invasive, and accessible intervention that can be delivered in outpatient or home settings. Its implementation may reduce exacerbation risk, hospital admissions, and overall health care utilization by improving airway clearance and gas exchange, ultimately enhancing quality of life for individuals with chronic bronchitis. Moreover, by demonstrating robust improvement in both objective (spirometry, blood gases) and subjective (dyspnea, symptom diary) outcomes, this study addresses a critical need for interventions that meaningfully impact both physiological and patient-reported domains.

The theoretical implications extend to our understanding of respiratory rehabilitation. The superiority of forced expiratory training in this context underscores the necessity of tailoring interventions to disease phenotype and pathophysiology. While diaphragmatic breathing remains valuable—particularly for patients with predominant breathlessness and preserved airway patency—those with chronic productive cough and significant secretion retention are likely to benefit more from techniques targeting mucus mobilization and clearance. This insight supports a precision rehabilitation approach in chronic airway diseases, emphasizing individualized treatment selection based on symptom and physiologic profiles.

There are notable strengths to this study, including its randomized controlled design, the use of validated outcome measures, blinding of outcome assessors, and standardized intervention protocols. The parallel assessment of both physiological and patient-centered outcomes enhances the generalizability and applicability of the findings to clinical practice. However, several limitations must be acknowledged. The modest sample size, although determined by a priori power analysis, may limit the detection of subtle differences and the generalizability of results to broader and more diverse patient populations. The single-center setting and short intervention duration may not capture long-term adherence or sustained benefits, and the lack of subgroup analyses by severity or phenotype restricts deeper mechanistic insight. Furthermore, although outcome assessors were blinded, the participants themselves were not, potentially introducing performance bias.

Future research should address these limitations by conducting larger, multi-center trials with longer follow-up periods to assess sustainability of benefits and the impact on exacerbation rates and health care utilization. Studies incorporating objective adherence tracking, as well as exploration of combined or sequential interventions (e.g., integrating diaphragmatic breathing and forced expiratory techniques in a stepwise program), may further optimize individualized care. Additionally, investigations in subgroups defined by symptom phenotype, severity of airway obstruction, or comorbidities will help refine patient selection and maximize intervention effectiveness. In summary, this trial demonstrates that forced expiratory training is superior to diaphragmatic breathing for improving pulmonary function, reducing dyspnea, and facilitating sputum clearance in chronic bronchitis. The results advance the field by providing high-quality comparative data, supporting the integration of airway clearance strategies into routine management of chronic bronchitis, and highlighting the importance of matching therapeutic techniques to underlying disease mechanisms (20–23).

CONCLUSION

This randomized controlled study demonstrates that forced expiratory training yields greater improvements in pulmonary function, dyspnea, and sputum clearance than diaphragmatic breathing in patients with chronic bronchitis, directly aligning with the study's objective and title. These findings provide robust evidence to guide clinical practice, indicating that targeted airway clearance strategies such as forced expiratory maneuvers should be prioritized in rehabilitation protocols for chronic bronchitis to optimize symptom relief and respiratory function. For healthcare providers, incorporating forced expiratory training into routine care may enhance patient outcomes, reduce the burden of chronic symptoms, and potentially decrease healthcare utilization. For researchers, the results highlight the need for further multicenter and longitudinal studies to assess long-term benefits, refine patient selection, and explore the integration of multiple physiotherapeutic modalities tailored to individual patient profiles.

REFERENCES

1. Dotan Y, So JY, Kim V. Chronic Bronchitis: Where Are We Now? Chronic Obstructive Pulmonary Diseases. 2019;6(2):178-192

2. Wang G, Hallberg J, Um Bergström P, Janson C, Pershagen G, Gruzieva O, et al. Assessment of Chronic Bronchitis and Risk Factors in Young Adults: Results From BAMSE. European Respiratory Journal. 2021;57(3):2002738

3. Singh T, Kumar N, Sharma N, Patra A. Effectiveness of Active Cycle of Breathing Technique Along With Postural Drainage Versus Autogenic Drainage in Patients With Chronic Bronchitis. Physiotherapy and Occupational Therapy. 2019;12(1):12-18

4. Balte PP, Chaves PHM, Couper DJ, Enright P, Jacobs DR Jr, Kalhan R, et al. Association of Nonobstructive Chronic Bronchitis With Respiratory Health Outcomes in Adults. JAMA Internal Medicine. 2020;180(5):676-686

5. Bellone A, Lascioli R, Raschi S, Guzzi L, Adone R. Chest Physical Therapy in Patients With Acute Exacerbation of Chronic Bronchitis: Effectiveness of Three Methods. Archives of Physical Medicine and Rehabilitation. 2016;81(5):558-560

6. Ji J, Ganguly K, Mihai X, Sun J, Malmlof M, Gerde P, et al. Exposure of Normal and Chronic Bronchitis-Like Mucosa Models to Aerosolized Carbon Nanoparticles: Comparison of Pro-Inflammatory Oxidative Stress and Tissue Injury/Repair Responses. Nanotoxicology. 2019;13(10):1362-1379

7. Bennett WD, Henderson AG, Ceppe A, Zeman KL, Wu J, Gladman C, et al. Effect of Hypertonic Saline on Mucociliary Clearance and Clinical Outcomes in Chronic Bronchitis. ERJ Open Research. 2020;6(3):00128-2020

8. Kim V, Dolliver WR, Nath HP, Grumley SA, Terry N, Ahmed A, et al. Mucus Plugging on Computed Tomography and Chronic Bronchitis in Chronic Obstructive Pulmonary Disease. Respiratory Research. 2021;22(1):110

9. Mejza F, Nastałek P, Doniec Z, Skucha W. Symptoms of Chronic Bronchitis in Individuals Without Chronic Obstructive Pulmonary Disease: Prevalence, Burden, and Risk Factors in Southern Poland. Polish Archives of Internal Medicine. 2018;128(11):677-684

10. Kim V, Criner GJ. The Chronic Bronchitis Phenotype in Chronic Obstructive Pulmonary Disease: Features and Implications. Current Opinion in Pulmonary Medicine. 2015;21(2):133-141

11. Ohar JA, Donohue JF, Spangenthal S. The Role of Guaifenesin in the Management of Chronic Mucus Hypersecretion Associated With Stable Chronic Bronchitis: A Comprehensive Review. Chronic Obstructive Pulmonary Diseases. 2019;6(4):341-349

12. Leidy NK, Schmier JK, Jones MK, Lloyd J, Rocchiccioli K. Evaluating Symptoms in Chronic Obstructive Pulmonary Disease: Validation of the Breathlessness, Cough and Sputum Scale. Respiratory Medicine. 2016;97(Suppl C):S59-S70

13. Beaumont M, Couturaud F, Jego F, Pichon R, Le Ber C, Péran L, et al. Validation of the French Version of the London Chest Activity of Daily Living Scale and the Dyspnea-12 Questionnaire. International Journal of Chronic Obstructive Pulmonary Disease. 2018;13:1399-1405

14. Fink JB. Forced Expiratory Technique, Directed Cough, and Autogenic Drainage. Respiratory Care. 2017;52(9):1210-1223

15. El Nahas NG, Hamed A. Reinforcement of Airway Clearance by Quake Device Training in Patients With Chronic Bronchitis. Pharmacophore. 2019;10(3):21-27

16. Lewis LK, Williams MT, Olds TS. The Active Cycle of Breathing Technique: A Systematic Review and Meta-Analysis. Respiratory Medicine. 2016;106(2):155-172

17. Pontifex E, Williams MT, Lunn R, Parsons DJ. The Effect of Huffing and Directed Coughing on Energy Expenditure in Young Asymptomatic Subjects. Australian Journal of Physiotherapy. 2017;48(3):209-213

18. Yamaguti WP, Claudino RC, Neto AP, Chammas MC, Gomes AC, Salge JM, et al. Diaphragmatic Breathing Training Program Improves Abdominal Motion During Natural Breathing in Patients With Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial. Archives of Physical Medicine and Rehabilitation. 2012;93(4):571-577

19. Prem V, Sahoo RC, Adhikari P. Effect of Diaphragmatic Breathing Exercise on Quality of Life in Subjects With Asthma: A Systematic Review. Physiotherapy Practice. 2018;29(4):271-277

20. El Gamil A, Mekkawy MM. Effects of Expiratory Muscle Training and Pursed-Lips Breathing on Health Status and Dyspnea Among Chronic Obstructive Pulmonary Disease Patients. Assiut Scientific Nursing Journal. 2015;3(5):192-206

21. Ranu H, Wilde M, Madden B. Pulmonary Function Tests. Ulster Medical Journal. 2016;80(2):84-90

22. Osadnik CR, McDonald CF, Miller BR, Hill CJ, Tarrant B, Steward R, et al. The Effect of Positive Expiratory Pressure Therapy on Symptoms, Quality of Life and Incidence of Re-Exacerbation in Patients With Acute Exacerbations of Chronic Obstructive Pulmonary Disease: A Multicentre, Randomised Controlled Trial. Thorax. 2018;73(7):667-674

23. Garner JL, Shaipanich T, Hartman JE, Orton CM, Caneja C, Klooster K, et al. A Prospective Safety and Feasibility Study of Metered Cryospray for Patients With Chronic Bronchitis in COPD. European Respiratory Journal. 2020;56(6):2003061