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COMPARISON OF RESISTIVE BREATHING VERSUS INSPIRATORY HOLD TECHNIQUE IN PATIENTS WITH CHRONIC BRONCHITIS

Original Article

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ABSTRACT

Background: Chronic bronchitis, a subtype of chronic obstructive pulmonary disease (COPD), is a progressive condition characterized by persistent airway inflammation, excessive mucus production, and airflow limitation. Its global burden continues to rise due to environmental pollution, occupational hazards, and smoking. While pharmacological interventions provide symptomatic relief, pulmonary rehabilitation remains a cornerstone in disease management. Various respiratory training techniques have been utilized to improve lung function and prevent exacerbations, yet comparative research on their efficacy remains limited.

Objective: This study aimed to compare the effects of resistive breathing and inspiratory hold techniques on pulmonary function in patients with chronic bronchitis.

Methods: A total of 26 participants were recruited using non-probability consecutive sampling. After screening and obtaining informed consent, they were randomly allocated into two intervention groups: the resistive breathing group (n=13) and the inspiratory hold technique group (n=13). Participants performed assigned breathing exercises for six weeks, with measurements taken at baseline and post-intervention. Pulmonary function parameters, including forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, and peak expiratory flow rate (PEFR), were assessed using a digital spirometer. Dyspnea severity was evaluated using the Modified Borg Scale. Statistical analysis was conducted using the Mann-Whitney U test for inter-group comparisons and the Wilcoxon Signed Rank test for intra-group analysis.

Results: The mean age of participants was 52.8±5.6 years. PEFR showed a statistically significant improvement in the resistive breathing group (mean rank: 17.81, sum rank: 231.50, p=0.004), while the inspiratory hold technique group demonstrated no significant change (mean rank: 9.19, sum rank: 119.50). No significant differences were observed in FEV1 (p=0.105), FVC (p=0.190), FEV1/FVC ratio (p=0.798), or dyspnea scores (p=0.275) between the two groups.

Conclusion: Resistive breathing demonstrated greater efficacy in improving peak expiratory flow rates in chronic bronchitis patients, indicating its potential role in enhancing airway clearance. However, no significant changes were observed in other pulmonary parameters. Inspiratory hold technique did not produce measurable improvements, suggesting that its role in pulmonary rehabilitation for chronic bronchitis requires further investigation.

Keywords: Airway clearance, Bronchitis, Chronic obstructive pulmonary disease, Dyspnea, Inspiratory hold technique, Peak expiratory flow rate, Resistive breathing.

INTRODUCTION

Chronic bronchitis, a subtype of chronic obstructive pulmonary disease (COPD), is a progressive and debilitating condition characterized by persistent cough and sputum production for at least three months annually over two consecutive years. It is a major contributor to global respiratory morbidity and mortality, often resulting in decreased lung function and compromised quality of life. The pathophysiology of chronic bronchitis revolves around chronic airway inflammation, mucus hypersecretion, and impaired mucociliary clearance, leading to airway obstruction and recurrent respiratory infections. Over time, this inflammatory response results in structural lung changes, worsening airflow limitation, and increased susceptibility to acute exacerbations (1,2). Among the primary etiological factors, exposure to cigarette smoke remains the most significant, whether through active smoking or passive inhalation. Additional risk factors include inhaled pollutants, such as toxic industrial chemicals and environmental smog, as well as recurrent respiratory infections caused by bacterial and viral pathogens. Individuals with a history of predisposing respiratory conditions, including asthma, cystic fibrosis, and bronchiectasis, are also at a heightened risk. Socioeconomic disparities and occupational exposure to airborne irritants further contribute to the prevalence of this chronic disease (3.4).

The clinical presentation of chronic bronchitis is dominated by persistent productive cough, variable sputum characteristics, dyspnea, and episodes of airway inflammation. Patients may experience exacerbations marked by worsening symptoms, often triggered by infections or environmental pollutants. While fever is uncommon in stable cases, its presence may indicate an underlying infection such as influenza or pneumonia. Wheezing and airflow obstruction are notable in complicated cases, with advanced disease states potentially leading to emphysema and respiratory failure. Diagnosis primarily relies on a thorough clinical history, alongside diagnostic investigations such as pulmonary function tests, chest imaging, and sputum analysis to rule out alternative respiratory disorders (5,6). Management of chronic bronchitis focuses on symptom control, minimizing disease progression, and preventing complications. Pharmacological interventions include bronchodilators, inhaled corticosteroids, phosphodiesterase-4 inhibitors, and antibiotic therapies in cases of bacterial exacerbations. However, long-term medication use poses potential side effects, necessitating cautious administration under medical supervision. Smoking cessation is the most effective non-pharmacological intervention, leading to reduced mucus production and improved airway function. Pulmonary rehabilitation programs, encompassing patient education, lifestyle modifications, and targeted breathing exercises, play a pivotal role in enhancing respiratory function and overall well-being (7,8).

Pulmonary rehabilitation incorporates a variety of breathing techniques aimed at optimizing lung capacity and airway clearance. Among these, resistive breathing and inspiratory hold techniques are widely utilized. Resistive breathing is a structured technique employing inspiratory pressure threshold loading to strengthen respiratory muscles, improve endurance, and enhance overall pulmonary function. The use of inspiratory resistive devices allows patients to train against controlled resistance, facilitating improvements in inspiratory muscle performance. Proper posture and breathing mechanics are essential for maximizing therapeutic benefits. In contrast, the inspiratory hold technique is a non-device-dependent maneuver that focuses on airway clearance by promoting prolonged inspiratory effort, aiding in mucus mobilization and lung expansion. This technique can be easily taught and performed independently by patients, making it a cost-effective and accessible approach to symptom management (9,10). While both techniques are integral components of pulmonary rehabilitation, limited comparative research has explored their relative efficacy in chronic bronchitis management. Understanding their individual and comparative benefits could provide valuable insights into optimizing treatment strategies for chronic bronchitis patients. Given the increasing global burden of this condition, research aimed at refining rehabilitation techniques is crucial to improving patient outcomes and reducing healthcare burdens (11,12). This study aims to compare the effects of resistive breathing techniques and inspiratory hold techniques in patients with chronic bronchitis, specifically assessing their impact on pulmonary function as measured by spirometry. The findings will contribute to the ongoing efforts in optimizing non-pharmacological management strategies, ultimately improving the quality of life for individuals affected by chronic bronchitis.

METHODS

The study was designed as a randomized clinical trial to compare the effects of resistive breathing techniques and inspiratory hold techniques in patients diagnosed with chronic bronchitis. The research was conducted at Nishtar Hospital, Multan, over six months following the approval of the research synopsis. Ethical approval was obtained from the institutional review board, and all participants provided informed consent before enrollment in the study (13). Clinically stable individuals diagnosed with chronic bronchitis for at least two years were included in the study. The inclusion criteria encompassed both male and female patients between the ages of 45 and 60 years who were willing to participate. To ensure a well-defined clinical representation, patients with a confirmed history of

chronic bronchitis without complications such as emphysema were included. Conversely, individuals with genetic disorders such as cystic fibrosis, recent spinal or chest surgeries, cardiac conditions, or vertebral fractures caused by osteoporosis were excluded from the study to eliminate confounding variables that could impact pulmonary function outcomes (14).

A sample size of 26 participants was determined using an online sample size calculator, incorporating a 95% confidence interval and 80% power, with an additional 10% attrition rate to ensure statistical validity. Participants were randomly assigned to one of two interventional groups through simple random sampling. Thirteen participants were allocated to the resistive breathing group, while the remaining thirteen were assigned to the inspiratory hold technique group. Data collection followed a non-probability consecutive sampling approach, ensuring that all eligible patients within the designated timeframe were enrolled (15). Pulmonary function parameters were assessed using validated measurement tools, including a digital spirometer for pulmonary function tests, a peak expiratory flow meter for peak expiratory flow rate (PEFR), and the Modified Borg Scale for dyspnea evaluation. The pulmonary function test measured forced expiratory volume (FEV), forced vital capacity (FVC), and the FEV/FVC ratio to provide objective indices of lung function. The peak expiratory flow meter was used to quantify the maximum rate at which air could be forcefully exhaled, serving as a sensitive indicator of airway obstruction and respiratory muscle strength. The Modified Borg Scale, ranging from 0 to 10, was utilized to assess dyspnea severity and track exercise tolerance (16). Participants followed a structured rehabilitation protocol over six weeks, involving two 15-minute intervention sessions per day, conducted four days per week. Baseline measurements were recorded before the intervention, with follow-up assessments at three-week and six-week intervals to monitor therapeutic progress. A standardized baseline treatment was implemented for all participants before beginning their allocated interventions. This consisted of diaphragmatic breathing exercises performed in three sets of ten repetitions each, with one-minute rest intervals between sets (17). In the resistive breathing group, participants performed inspiratory resistive breathing using a specialized inspiratory resistive device. Under the supervision of a physiotherapist, they were instructed to maintain an upright posture and engage in slow, controlled inspiratory efforts against the device's resistance, aiming to strengthen inspiratory muscles and enhance pulmonary function (18).

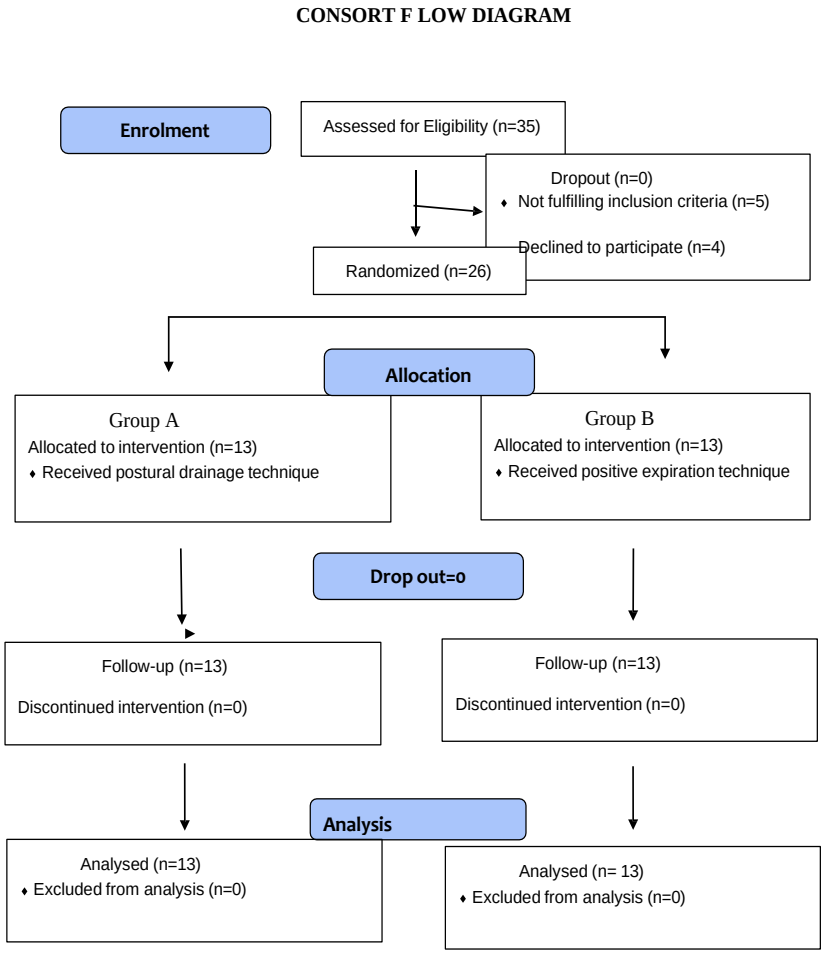

Figure 1: Consort flow diagram

Participants in the inspiratory hold technique group performed controlled breathing exercises as part of an active cycle of breathing. They were instructed to sit in a comfortable position, inhale deeply through the nose, and hold their breath for two to three seconds before exhaling. This technique was performed for three to five minutes, followed by huffing and coughing maneuvers to promote airway clearance and optimize lung expansion (19). All data were systematically recorded to ensure accuracy and reproducibility. Statistical analysis was conducted using appropriate tests to determine significant differences between the two interventions. Ethical considerations were rigorously maintained throughout the study, in compliance with institutional guidelines. Participants' confidentiality was ensured, and all data were securely stored for analysis. The study aimed to contribute valuable insights into optimizing pulmonary rehabilitation strategies for chronic bronchitis patients, particularly regarding the comparative efficacy of resistive breathing and inspiratory hold techniques in improving lung function and respiratory health (20).

RESULTS

A total of 23 participants were recruited and divided into two groups: the resistive breathing group and the inspiratory hold technique group. Among them, 22 (84.6%) were male, with 12 (92.3%) assigned to the resistive breathing group and 10 (76.9%) to the inspiratory hold technique group. The remaining 4 (15.4%) were female, with 1 (7.7%) in the resistive breathing group and 3 (23.1%) in the inspiratory hold technique group. Age distribution showed that in the resistive breathing group, 7 (53.8%) participants were aged 45-50 years, 2 (15.4%) were aged 51-55 years, and 4 (30.8%) were aged 56-60 years. In the inspiratory hold technique group, 9 (69.2%) participants were aged 45-50 years, 3 (23.1%) were aged 51-55 years, and 1 (7.7%) was aged 56-60 years. Normality of the data was assessed using the Shapiro-Wilk test, which indicated that the data was not normally distributed. Consequently, non-parametric tests were used for statistical analysis. Inter-group comparisons were performed using the Mann-Whitney U test, while intra-group comparisons were analyzed using the Wilcoxon Signed Rank test.

FEV1 analysis between groups demonstrated that the mean rank for the resistive breathing group at baseline was 11.46, with a sum rank of 149.00, while the inspiratory hold technique group had a mean rank of 15.54 and a sum rank of 202.00, yielding a p-value of 0.173. After six weeks, the resistive breathing group had a mean rank of 11.08 and sum rank of 144.00, while the inspiratory hold technique group had a mean rank of 15.92 and sum rank of 207.00, with a p-value of 0.105, indicating no statistically significant difference. FVC analysis showed that at baseline, the resistive breathing group had a mean rank of 11.54 and sum rank of 150.00, while the inspiratory hold technique group had a mean rank of 15.46 and sum rank of 201.00, with a p-value of 0.190. The six-week measurements remained similar, with a mean rank of 11.54 in the resistive breathing group and 15.46 in the inspiratory hold technique group, and a p-value of 0.190, indicating no statistically significant difference.

FEV1/FVC ratio analysis revealed that at baseline, the mean rank for the resistive breathing group was 13.73 with a sum rank of 178.50, while the inspiratory hold technique group had a mean rank of 13.27 and sum rank of 172.50, yielding a p-value of 0.878. At the six-week mark, the mean rank for the resistive breathing group was 13.12 and 13.88 for the inspiratory hold technique group, with sum ranks of 170.50 and 180.50, respectively, and a p-value of 0.798, showing no statistically significant difference. PEFR analysis between groups showed a mean rank of 17.69 and sum rank of 230.00 for the resistive breathing group at baseline, while the inspiratory hold technique group had a mean rank of 9.31 and sum rank of 121.00, yielding a p-value of 0.005. At the six-week interval, the resistive breathing group had a mean rank of 17.81 and sum rank of 231.50, while the inspiratory hold technique group had a mean rank of 9.19 and sum rank of 119.50, with a p-value of 0.004, demonstrating a statistically significant difference favoring the resistive breathing group.

Borg scale of dyspnea analysis showed that at baseline, the mean rank for the resistive breathing group was 13.00, with a sum rank of 169.00, while the inspiratory hold technique group had a mean rank of 14.00 and sum rank of 182.00, with a p-value of 0.626. After six weeks, both groups had a mean rank of 13.50 and a sum rank of 175.50, with a p-value of 0.275, indicating no statistically significant difference. The study results indicate a significant difference in peak expiratory flow rate (PEFR) between groups, favoring the resistive breathing technique, while no statistically significant differences were observed in FEV1, FVC, FEV1/FVC ratio, or Borg dyspnea scores. This suggests that resistive breathing may have a more pronounced impact on enhancing expiratory flow rates, though its effect on overall lung function and dyspnea relief remains comparable to inspiratory hold techniques.

Table 1: Demographic Distribution of Participants

Group	Male n(%)	Female n(%)	45-50 years n(%)	51-55 years n(%)	56-60 years n(%)	Total n(%)
Resistive Breathing	12 (92.3%)	1 (7.7%)	7 (53.8%)	2 (15.4%)	4 (30.8%)	13 (100%)
Inspiratory Hold	10 (76.9%)	3 (23.1%)	9 (69.2%)	3 (23.1%)	1 (7.7%)	13 (100%)
Total	22 (84.6%)	4 (15.4%)	16 (61.5%)	5 (19.2%)	5 (19.2%)	26 (100%)

Table 2: Shows the Pre & Post mean rank and sum of rank score of FEV1 between resistive breathing group and inspiratory hold technique group. * (P < 0.001); there is a significant difference between groups.**

	Group	N	Mean rank	Sum of rank	P-value
FEV1 baseline	Resistive breathing group	13	11.46	149.00	0.173
	Inspiratory hold technique	13	15.54	202.00	
FEV1 after 6 weeks	Resistive breathing group	13	11.08	144.00	0.105
	Inspiratory hold technique	13	15.92	207.00	

Table 3: Shows the Pre & Post mean rank and sum of rank score of FVC between resistive breathing group and inspiratory hold technique group. * (P < 0.001); there is a significant difference between groups.**

	Group	N	Mean rank	Sum of rank	P-value
FVC baseline	Resistive breathing group	13	11.54	150.00	0.190
	Inspiratory hold technique	13	15.46	201.00	
FVC after 6 weeks	Resistive breathing group	13	11.54	150.00	0.190
	Inspiratory hold technique	13	15.46	02.00	

Table 4: Shows the Pre & Post mean rank and sum of rank score of FEV1/FVC between resistive breathing group and inspiratory hold technique group. * (P < 0.001); there is a significant difference between groups.**

	Group	N	Mean rank	Sum of rank	P-value
FEV1/FVC baseline	Resistive breathing group	13	13.73	178.50	0.878
	Inspiratory hold technique	13	13.27	172.50	
FEV1/FVC after 6 weeks	Resistive breathing group	13	13.12	170.50	0.798
	Inspiratory hold technique	13	13.88	180.50	

Table 5: Shows the Pre & Post mean rank and sum of rank score of PEFR between resistive breathing group and inspiratory hold technique group. * (P < 0.001); there is a significant difference between groups.**

	Group	N	Mean rank	Sum of rank	P-value
PEFR baseline	Resistive breathing group	13	17.69	230.00	0.005
	Inspiratory hold technique	13	9.31	121.00	
PEFR after 6 weeks	Resistive breathing group	13	17.81	231.50	0.004
	Inspiratory hold technique	13	9.19	119.50	

Table 6: Shows the Pre & Post mean rank and sum of rank score of Dyspnea between resistive breathing group and inspiratory hold technique group. * (P < 0.001); there is a significant difference between groups.**

	Group	N	Mean rank	Sum of rank	P-value
Dyspnea score baseline	Resistive breathing group	13	13.00	169.00	0.626
	Inspiratory hold technique	13	14.00	182.00	
Dyspnea score after 6 weeks	Resistive breathing group	13	13.50	175.50	0.275
	Inspiratory hold technique	13	13.50	175.50	

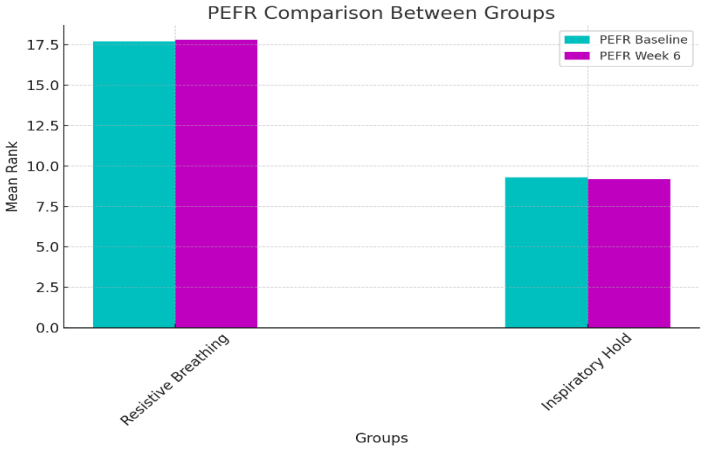

Figure 2 PEFR Comparison Between Groups

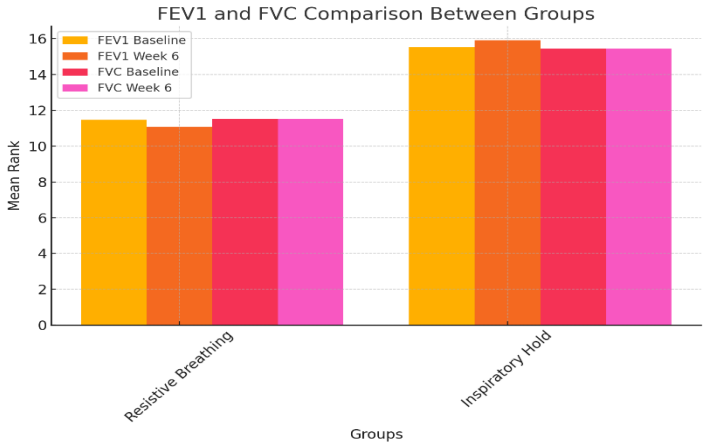

Figure 1 FEV1 and FVC Comparison Between Groups

DISCUSSION

Chronic bronchitis is a progressive obstructive pulmonary disease with a growing global burden due to environmental pollution, exposure to chemical irritants, smoking, and occupational hazards. Despite advancements in medical research, there is no definitive cure, and management primarily focuses on symptom reduction and prevention of exacerbations. Pulmonary rehabilitation remains a cornerstone in managing chronic bronchitis, incorporating various physiotherapeutic techniques aimed at improving pulmonary function and airway clearance. While existing literature supports the efficacy of pulmonary rehabilitation, there is limited comparative research evaluating the effects of resistive breathing and inspiratory hold techniques in chronic bronchitis patients. The current study sought to address this gap by assessing their impact on pulmonary parameters, including forced expiratory volume (FEV1), forced vital capacity (FVC), the FEV1/FVC ratio, peak expiratory flow rate (PEFR), and dyspnea scores (21). The findings indicated no statistically significant improvements in FEV1, FVC, or the FEV1/FVC ratio following either intervention. However, PEFR showed a significant increase in the resistive breathing group compared to the inspiratory hold technique, highlighting its potential superiority in enhancing airway clearance and expiratory function. These results align with previous studies that demonstrated varying degrees of effectiveness of different pulmonary rehabilitation techniques in chronic bronchitis patients, particularly in improving expiratory flow parameters. Research exploring the effects of active cycle breathing techniques in chronic obstructive pulmonary disease reported mild improvements in FEV1/FVC ratio and arterial oxygenation but found no significant changes in sputum viscosity or volume, reinforcing the challenges in achieving consistent improvements across pulmonary function parameters. Similar trends were observed in studies comparing active cycle breathing techniques with positive expiratory pressure devices, where intra-group improvements in dyspnea scores and oxygen saturation were noted, but no significant inter-group differences were reported (22).

The lack of significant improvements in FEV1, FVC, and dyspnea scores in the present study may be attributed to multiple factors, including the intervention duration, patient adherence, and the presence of environmental irritants. A study conducted in a controlled mountain environment, where exposure to external pollutants was minimized, reported significant improvements in FEV1 and dyspnea scores in chronic bronchitis patients, further emphasizing the role of environmental factors in pulmonary rehabilitation outcomes. The findings contrast with another study evaluating inspiratory muscle training combined with inspiratory hold techniques in bronchial asthma patients, which demonstrated significant improvements in FEV1, FVC, and the FEV1/FVC ratio after 12 weeks of intervention.

The differences in results could be explained by the longer intervention period, the combination of techniques, and the assessment of inspiratory muscle strength, which was not measured in the present study (23). The effectiveness of inspiratory hold techniques has also been explored in studies evaluating the impact of positive expiratory pressure devices in home-based pulmonary rehabilitation programs. Such studies have reported improvements in sputum production, dyspnea scores, and quality of life, with greater efficacy observed in positive expiratory pressure device-assisted interventions compared to inspiratory hold techniques alone. While the present study did not incorporate such devices, the findings suggest that resistive breathing may provide a greater benefit in improving expiratory flow rates, particularly in the absence of external airway clearance aids (24).

A major strength of the study is its focus on a direct comparison of two widely used pulmonary rehabilitation techniques, providing valuable insights into their relative efficacy in chronic bronchitis management. The findings contribute to existing literature by highlighting the potential advantages of resistive breathing in improving PEFR, an essential indicator of airway obstruction and expiratory muscle function. However, several limitations must be acknowledged. The study did not account for environmental irritants, which may have influenced pulmonary function outcomes. The relatively short intervention duration may have been insufficient to observe significant changes in FEV1, FVC, and dyspnea scores, particularly in chronic conditions where long-term rehabilitation is often necessary. Additionally, the study did not explore the effects of different resistive breathing devices or variations in inspiratory hold techniques, which could have provided further insights into optimizing these interventions (25,26). Future research should investigate the effects of inspiratory hold techniques with and without the use of positive expiratory pressure devices to determine their combined efficacy in improving airway clearance. Comparative studies should also be conducted on various resistive breathing devices to establish the most effective modality for enhancing pulmonary function. Furthermore, studies eliminating environmental confounders and extending intervention durations may yield more definitive conclusions regarding the long-term benefits of these techniques in chronic bronchitis patients. The findings reinforce the need for personalized rehabilitation approaches tailored to individual patient needs, emphasizing the importance of optimizing non-pharmacological interventions in managing chronic bronchitis.

CONCLUSION

The study concluded that resistive breathing demonstrated greater effectiveness in enhancing airway clearance by improving expiratory flow rates in patients with chronic bronchitis. In contrast, the inspiratory hold technique did not produce noticeable improvements in pulmonary function parameters. These findings highlight the potential of resistive breathing as a valuable rehabilitation approach for optimizing respiratory function in chronic bronchitis management. Given the progressive nature of the disease, incorporating targeted pulmonary rehabilitation strategies can play a crucial role in improving patient outcomes and quality of life.

AUTHOR CONTRIBUTIONS

Author	Contribution
Makhdoom Muhammad Hamza*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Abdullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zarish Younas	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Maira Sarfaraz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aleeta Ali	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Farah Khalid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Sidra Faisal	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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