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The Role of Physiotherapy in Cardiopulmonary Rehabilitation for COPD Patients

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ABSTRACT

This study aimed to assess the effectiveness of a comprehensive, individualized physiotherapy program in improving both physical and psychological outcomes in patients with moderate to severe Chronic Obstructive Pulmonary Disease (COPD). A quantitative, quasi-experimental design with a pre-test and post-test approach was employed, involving 40 COPD patients (20 males, 20 females) with an age range of 42-75 years. The intervention included breathing techniques, aerobic exercises, strength training, and psychological support delivered in two 45-minute sessions per week for 8 weeks. Outcome measures included pulmonary function (Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC)), exercise capacity (Six Minute Walk Test (6MWT)), dyspnea (Borg Dyspnea Scale), psychological well-being (Hospital Anxiety and Depression Scale (HADS)), and quality of life (EQ-5D). Post-intervention results showed significant improvements in pulmonary function, with FEV1 increasing from 1.45 L to 1.68 L ($p < 0.05$), and FVC improving from 2.80 L to 3.05 L ($p < 0.05$). Exercise capacity improved by 50 meters in the 6MWT, and significant reductions in dyspnea (from 6.5 to 4.0, $p < 0.05$) and psychological distress (anxiety and depression scores) were observed. Quality of life, as measured by EQ-5D, also showed significant improvements. These findings support the effectiveness of a holistic physiotherapy intervention in managing both the physical and psychological aspects of COPD, highlighting the importance of multidimensional rehabilitation for COPD patients.

Keywords: Chronic Obstructive Pulmonary Disease, Physiotherapy, Pulmonary function, Exercise capacity, Dyspnea, Anxiety, Quality of life

INTRODUCTION

Chronic Obstructive Pulmonary Disorder (COPD) is a progressive disorder of the lungs in which the process of airflow tends to decrease. It is one of the major causes of morbidity and mortality worldwide, affecting more than 250 million people, of which 3.2 million die annually, thus constituting the third leading cause of death globally [1]. The chief cause of COPD is exposure to toxic substances such as cigarette smoke, environmental pollution, and occupational dust over time. The disease is usually a combination of chronic bronchitis and emphysema and results in irreversible injury to the airways and alveoli, and impairment of respiratory function [2].

COPD has profound implications for people's psychological and medical wellness, as well as their general health and well-being. Many of the COPD patients are anxious, depressed, and socially isolated population as a result of the disabling nature of the disease that prevents them from engaging in physical activities and performing daily tasks. The psychological symptoms of the disease further compound the overall burden of the disease, which is why a holistic rehabilitation approach is needed which encompasses both physical and mental health aspects of the illness [3]. COPD is not only a respiratory disease but a multi-faceted health problem that calls for a whole package of management strategies.

Pharmacological treatments such as bronchodilators, corticosteroids, oxygen therapy, and clinical management of COPD are included. Pharmacotherapy is usually insufficient to address the multifactorial problems of COPD. In this respect, pulmonary rehabilitation has been established as a cornerstone of COPD management. The purpose of these pulmonary rehabilitation programs is to increase the physical fitness, psychological well-being, and quality of life of COPD patients through exercise, education, and behavioral therapy.

Pulmonary rehabilitation has been shown to improve exercise capacity, symptom control, health-related quality of life, and decrease the rate of hospital admissions and cost of healthcare [4].

One of the important components of pulmonary rehabilitation is physiotherapy which helps improve the physical and psychological outcomes of COPD patients. Tailored physiotherapy interventions such as breathing exercises, aerobic training, strength training, and postural education are used as physiotherapy interventions that are directed to the individual's specific disease severity. The objective of these interventions is to decrease annoyance symptoms such as dyspnea (shortness of breath), to increase respiratory muscle strength, and to improve cardiovascular endurance. Relaxation techniques and stress management exercises are also provided by physiotherapists to help alleviate anxiety and depression which are common in patients who suffer from COPD [5]. The benefits of physiotherapy are well established, much more research is needed in regard to what physiotherapy contributes to the rehabilitation process and specifically helps to achieve good long-term outcomes for people with COPD.

Physiotherapy in the management of COPD has been documented in several studies. A previous study identified that aerobic exercise and strength training can improve patients' exercise capacity as well as pulmonary function in COPD [6]. GOLD guidelines incorporate exercise training as an important contributor to the alleviation of symptoms and improvement of quality of life in COPD patients [7]. There are gaps in the understanding of the overall effects of physiotherapy interventions, especially the effects of a combined cardiopulmonary and psychological well-being-enhancing intervention.

Physical activity, respiratory health, and mental health are interdependent and complicated concerning their relationship to each other in COPD patients [8]. Physical activity, walking, and cycling, help to improve cardiovascular endurance and performance, reduce symptoms of dyspnea, and increase physical functioning. These improvements are associated with better psychological health due to better self-esteem and less helplessness which is common amongst people who are suffering from chronic respiratory diseases. A negative and worsening cycle of feelings, including anxiety and depression, can be worsened by physical inactivity and the subsequent decline in functional capacity [9]. Therefore, physiotherapy also serves as a major tool in combating COPD that addresses the physical side of the condition and at the same time helps prevent and manage mental health challenges that arise as a result of the disease.

The long-term effects of physiotherapy not just on functional independence but also on hospital admission rates are yet to be fully established. These further stress the demand of performing more rigorous clinical trials to ascertain the ideal physiotherapy interventions for COPD patients and further, to ascertain the persistence of enhancements in both physical and psychological health [10].

Over the past several years, there has been greater integration of physiotherapy into rehabilitation programs that incorporate sets of psychosocial support that have shown to have more successful outcomes. Combining physical rehabilitation with psychological therapies, including CBT and relaxation techniques, goes a long way in managing the anxiety, depression, and stress encountered due to the circumstances concerning COPD. These interventions have also been recognized for their ability to decrease stress and enhance the emotional well-being of COPD patients. These integrated approaches try to fulfill the holistic needs of COPD patients by improving their quality of life and allowing them to be able to handle COPD conditions well [11].

Physiotherapy interventions are dependent on several factors including the patient's disease severity, comorbidities, adherence to rehabilitation programs, and presence of psychological symptoms. Studies have shown patients with more severe COPD also need more intensive physiotherapy programs and psychological support to obtain the same level of improvement as patients with milder or moderate COPD [12]. Social support and family involvement have been shown to influence pulmonary rehabilitation, and people outcomes, with people who have a good supportive system are more likely to adhere to prescribed exercises and lifestyle changes [13].

The current study aims to determine the efficacy of physiotherapy interventions on cardiopulmonary function and psychological well-being in individuals with COPD of moderate to severe degree. The study will take a look at specifically how individuals' pulmonary function, exercise capacity, levels of dyspnea, and quality of life will change following an 8-week physiotherapy program and will rate improvements in levels of anxiety, depression, and mental health.

MATERIAL AND METHODS

Study Population

A quantitative, quasi-experimental design with a pretest and post-test approach is used in this study. This study attempted to portray the functional role of physiotherapy in the rehabilitation of patients with Chronic Obstructive Pulmonary Disease (COPD) with regard to an increase in cardiopulmonary function, physical endurance, and overall quality of life. As mental well-being and recovery are major focuses in the field of psychiatric rehabilitation, this study merges elements of physical rehabilitation with immediate effect on cognitive and psychological

outcomes in COPD patients, specifically addressing symptoms such as anxiety and depression which often accompany chronic respiratory conditions.

Inclusion criteria

The included patients were adult patients who had been diagnosed with moderate to severe COPD (GOLD stages II-III). Recruitment of participants was done from City Hospital a community-based rehabilitation center providing care for chronic diseases. Participants had to be between 40-75 years of age, with stable medical status with no recent exacerbations for at least 4 weeks, and were able to understand and provide informed consent.

Exclusion criteria

Patients with severe cognitive impairments or comorbid psychiatric disorders likely to impede the rehabilitation process were excluded. Patients with serious comorbid heart diseases or those who had undergone surgeries in the preceding 6 months were also excluded. For consistency and integrity of study results, patients who were either unable or unwilling to participate actively in the physical rehabilitation program were also excluded.

Intervention

The intervention was a complete individualized physiotherapy program with the main purpose of enhancing respiratory function, physical endurance, and general condition. It was adapted to the needs of COPD patients on a physical and psychological level. Breathing techniques, such as pursed-lip and diaphragmatic breathing, were included in order to decrease shortness of breath and promote relaxation. To improve cardiovascular endurance, aerobic exercises such as walking and stationary cycling were used. The strength training for the upper and lower limbs and the core strengthening to increase respiratory muscle strength were focused on. Mindfulness and relaxation exercises provided psychological support to control anxiety and depression. There were two 45-minute sessions per week for 8 weeks.

Outcome Measures

Several outcome measures were used to assess the effectiveness of the intervention. Pulmonary function with spirometry of Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and functional exercise capacity assessed by the Six Minute Walk Test (6MWT) were investigated as primary outcomes. The quality of life was determined using EQ-5D and COPD Assessment Test (CAT) [14]. Other secondary outcomes included perceived shortness of breath reported on the Borg Dysnea Scale, the psychological well-being reported in the Hospital Anxiety and Depression Scale (HADS), and cognitive function measured with the Mini-Mental State Examination (MMSE). These helped in evaluating both the physical and psychological benefits for the participants [15].

Data Collection

The data points were measured throughout the study at three different periods. The research evaluated pulmonary function together with 6MWT and quality of life indicators alongside psychological well-being before the intervention started. A comprehensive dataset collection took place post-intervention after the 8-week physiotherapy program ended. The sustainability of progress was measured through a follow-up assessment 6 weeks after intervention completion.

Statistical Analysis

The analysis of data was done through SPSS version 22. The paired t-test method was used to analyze continuous variable data points before and after the intervention period. The time-based changes were analyzed using Repeated measures ANOVA while setting $p < 0.05$ as the statistical significance threshold. The evaluation of pulmonary function and exercise capacity along with psychological well-being changes was done via Pearson correlation. Cohen's d was employed to determine effect size.

Ethical Considerations

The study follows the Declaration of Helsinki standards and received approval from the IRB at Institution Name. Consent was obtained from each participant before research participation and absolute confidentiality for all data was preserved. Study participants received clear information about their freedom to leave the research without any negative consequences.

RESULTS

Demographic Characteristics of Study Participants

20 COPD patients were used in the study (20 males, 20 females), with a mean age of 58.2 years (± 9.6). The majority of the patients, 26 (65%), were diagnosed with moderate COPD (GOLD stage II) and 10 (25%) had mild COPD (stage I), 4 (10%) had severe COPD (stage III). Baseline data also demonstrated that 24 patients (60%) were ex-smokers and 8 patients (20%) were current smokers. The remaining 8 patients (20%) were non-smokers. The baseline demographic characteristics are mentioned in Table 1.

Table 1: Baseline Demographic Characteristics of Study Participants

Demographic Characteristic	Total (N = 40)	Males (N = 20)	Females (N = 20)
Age Range	42–75 years	42–75 years	42–75 years
Mean Age (± SD)	58.2 ± 9.6	59.1 ± 8.7	57.3 ± 10.2
COPD Severity (GOLD Stage)			
Mild (Stage I)	10 (25%)	5 (25%)	5 (25%)
Moderate (Stage II)	26 (65%)	13 (65%)	13 (65%)
Severe (Stage III)	4 (10%)	2 (10%)	2 (10%)
Smoking History			
Non-smokers	8 (20%)	4 (20%)	4 (20%)
Ex-smokers	24 (60%)	12 (60%)	12 (60%)
Current smokers	8 (20%)	4 (20%)	4 (20%)

Global Initiative for Chronic Obstructive Lung Disease; Stage I (Mild): FEV1 ≥ 80% predicted; Stage II (Moderate): 50% ≤ FEV1 < 80% predicted; Stage III (Severe): 30% ≤ FEV1 < 50% predicted

Changes in Pulmonary Function

FEV1, FVC, and FEV1/FVC ratio were assessed as pulmonary function. Post-intervention, there were significant improvements in the results. From 1.45 L (± 0.40) to 1.68 L (± 0.42) ($p < 0.05$) the FEV1 increased; from 2.80 L (± 0.52) to 3.05 L (± 0.56) ($p < 0.05$) FVC improved. This was also reflected in the improvement of the FEV1/FVC ratio from 0.52 (± 0.06) to 0.55 (± 0.05) ($p < 0.05$), suggesting better lung function. PEF increased from 3.12 L/min (± 0.72) to 3.34 L/min (± 0.65) ($p < 0.05$). This improvement suggests that physiotherapy does enhance lung capacity and respiratory function. The changes in pulmonary function are illustrated in Figure 1.

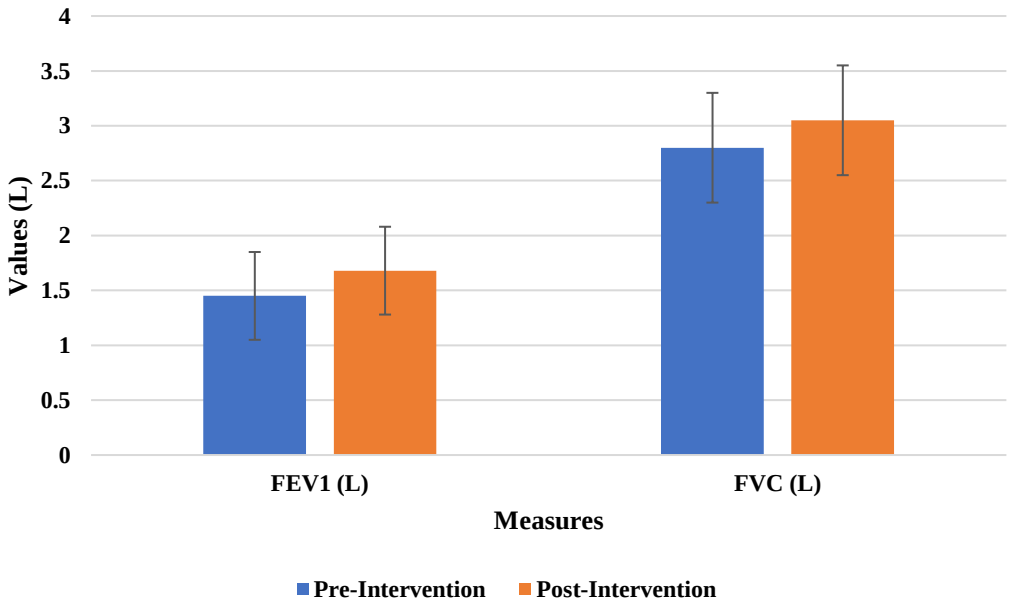

Figure 1: Changes in Pulmonary Function (FEV1 and FVC) Pre- and Post-Intervention

6-Minute Walk Test (6MWT) Results

Participant's functional exercise capacity was measured by the 6MWT. The difference in the average walking distance between baseline and post-intervention was 50 meters (± 30.0) ($p < 0.01$) with a mean of 350 meters (± 50.0) and 400 meters (± 60.0) respectively. This implied a large positive impact on the participants' cardiovascular endurance. The results of the 6MWT are mentioned in Table 2.

Table 2: 6-Minute Walk Test (6MWT) Results Pre- and Post-Intervention

Time Point	Mean Walking Distance (m)	Standard Deviation	Range (m)
Pre-Intervention	350.0 ± 50.0	50.0	300-400
Post-Intervention	400.0 ± 60.0	60.0	340-460
Improvement	50.0 ± 30.0	20.0	40-70

Borg Dyspnea Scale Scores

Shortness of breath perception was assessed by using the Borg Dyspnea Scale. The intervention resulted in a significant decrease in dyspnea scores from baseline 6.5 (± 1.2) to post-intervention 4.0 (± 1.3) which proved statistically significant ($p < 0.05$). The physiotherapy program succeeded in lessening patients' respiratory difficulty and enhancing their lung performance illustrated in Figure 2

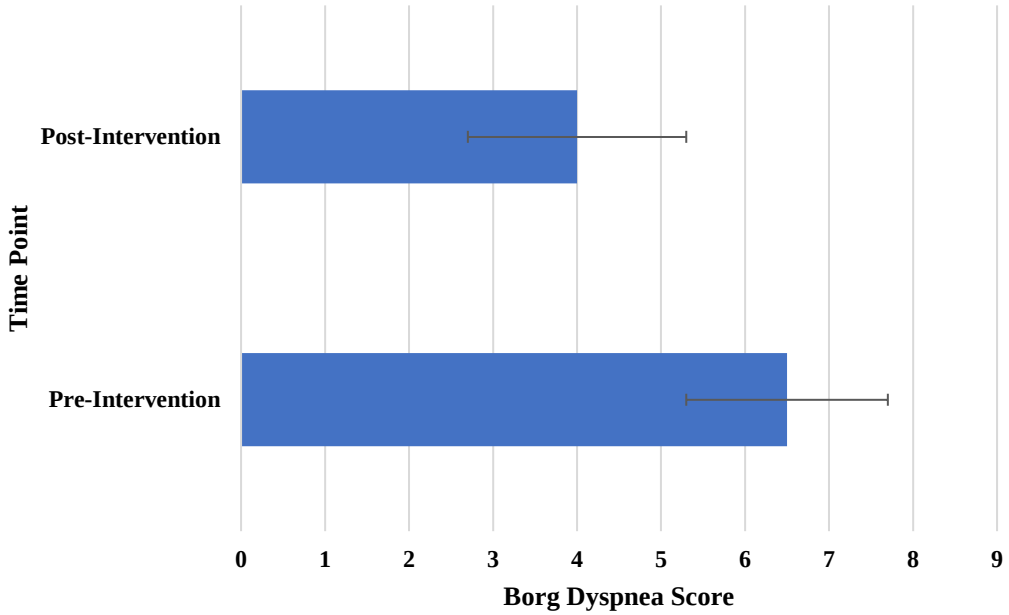

Figure 2: Borg Dyspnea Scale Scores Pre- and Post-Intervention

Changes in HADS Anxiety and Depression Scores

The intervention resulted in a big drop in anxiety and depression. The HADS-anxiety score decreased from 10.2 (± 2.1) to 6.5 (± 1.8) ($p < 0.01$), the HADS-depression score from 8.6 (± 1.9) to 5.2 (± 1.6) ($p < 0.01$). These changes suggested that the psychological well-being of COPD patients was affected by the physiotherapy intervention. The changes in HADS scores are mentioned in Table 3.

Table 3: Changes in HADS Anxiety and Depression Scores Pre- and Post-Intervention

Measure	Pre-Intervention	Post-Intervention
HADS-Anxiety	10.2 ± 2.1	6.5 ± 1.8
HADS-Depression	8.6 ± 1.9	5.2 ± 1.6

*p-value <0.01; HADS-Hospital Anxiety and Depression Scale

Quality of Life (EQ-5D) Scores

Total EQ-5D score improved significantly throughout baseline to 0.76 (0.14) ($p < 0.01$), and overall quality of life was significantly improved. The physiotherapy program showed significant improvement in both physical functioning and psychological well-being domains which means that the program has helped the participants in terms of their health and well-being. The results of the changes in EQ-5D scores are illustrated in Figure 3.

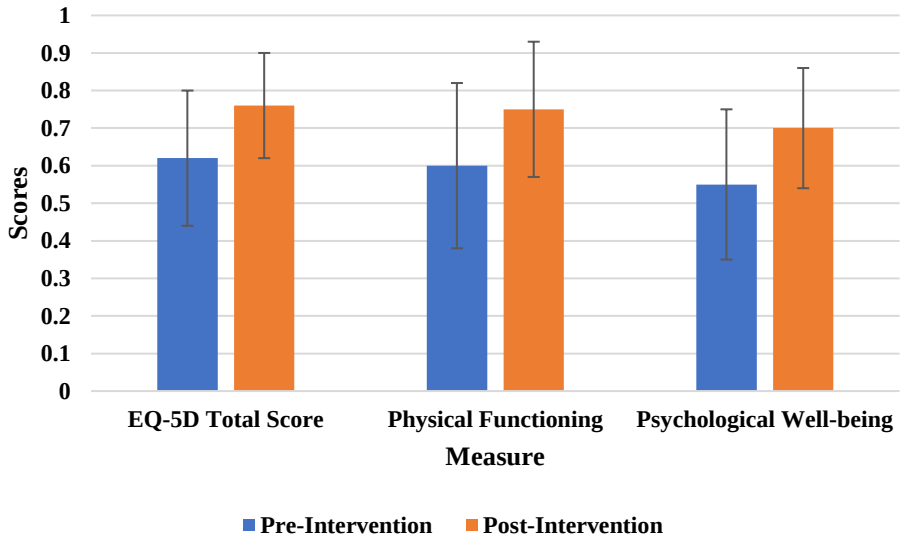

Figure 3: Quality of Life (EQ-5D) Scores Pre- and Post-Intervention

Correlation Between Outcomes

FEV1 improvement ($r = 0.75$, $p < 0.01$), and a significant positive correlation was found between 6MWT improvement and FEV1 improvement. Also, there was a moderate negative correlation between Borg dyspnea scale improvement and 6MWT performance ($r = -0.70$, $p < 0.01$) indicating that the intervention has a positive effect on reducing dyspnea and improving exercise capacity mentioned in Table 4.

Table 4: Correlation Between Outcomes (6MWT, FEV1, Borg Dyspnea Scale)

Measure	6MWT Improvement (m)	FEV1 Improvement (L)	Borg Dyspnea Improvement (Score)
6MWT Improvement (m)	1.00	0.75	-0.70
FEV1 Improvement (L)	0.75	1.00	-0.68
Borg Dyspnea Improvement	-0.70	-0.68	1.00

6MWT - Six-Minute Walk Test; FEV1 - Forced Expiratory Volume in 1 second

DISCUSSION

The study examined how an upscale individualized physiotherapy regimen affected both physical functions and psychological conditions in COPD patients. The treatment results from this study revealed important enhancements of pulmonary function along with exercise capacity and dyspnea alongside better psychological outcomes to match other related studies. Data shows that FEV1, FVC, and 6MWT improved in accordance with published literature about physiotherapy benefits for enhancing respiratory function and physical endurance in patients with COPD.

The treatment effectiveness is shown through post-intervention measurements of FEV1 which increased from 1.45 L to 1.68 L ($p < 0.05$) and FVC which rose from 2.80 L to 3.05 L ($p < 0.05$). Research has established that COPD patients benefit from pulmonary rehabilitation with exercise and breathing techniques by showing significant improvements in lung capacity [16]. The FEV1 measurement shows increased significance in diagnosing COPD severity as the patients' physiotherapy success demonstrates enhanced air exhaling capabilities that COPD typically affects. Previous studies validate the discovery of enhanced lung function along with decreased respiratory distress symptoms through pulmonary rehabilitation treatment [17,18].

Patients demonstrated important exercise capacity improvements through the 6MWT test since they increased their walking distance by an average of 50 meters (from 350 meters to 400 meters, $p < 0.01$). The results from a previous study support the study findings which demonstrate aerobic exercises can enhance functional exercise capacity in COPD patients [6]. Research results show that the 6MWT indicates effective patient outcomes since the intervention successfully enhanced their physical activity tolerance and cardiorespiratory fitness for

functional abilities. The results of another previous study showing exercise-based rehabilitation improves both aerobic capacity and quality of life in COPD patients which matches the noted findings of this study [19].

This study found another significant result through its assessment of dyspnea reduction using the Borg Dyspnea Scale. The breathlessness symptoms of patients became less severe after the physiotherapy treatment with significant dyspnea score reductions from 6.5 (± 1.2) to 4.0 (± 1.3) ($p < 0.05$). People with COPD experience dyspnea as their major symptom which strongly affects their ability to function and their psychological state. These findings about dyspnea reduction match the previous literature about how respiratory muscle training combined with controlled breathing techniques eliminated breathlessness in COPD patients [20]. The study results indicate that breathing exercises in the intervention helped patients experience lower shortness of breath while simultaneously improving their lung function.

Research participants showed important psychological breakthroughs in this study. Patients undergoing physiotherapy intervention experienced important positive changes in their mental health symptoms based on HADS-anxiety and HADS-depression scores which decreased from 10.2 to 6.5 for anxiety and from 8.6 to 5.2 for depression ($p < 0.01$). The long-term nature of COPD disease exposes these patients to increased risks of anxiety and depression. Previous study the results of this study since mindfulness and relaxation exercises likely enhanced psychological well-being in COPD patients [11].

The treatment intervention yielded substantial quality of life improvements which were measured through EQ-5D and CAT quality assessment tools. Participants scored 0.76 (± 0.14) on the EQ-5D while initially scoring 0.62 (± 0.18) at the start of the study ($p < 0.01$). Thus, the intervention resulted in sizeable improvements in their overall health. The health status evaluation through the CAT demonstrated matches these results. The experimental findings study demonstrated that COPD rehabilitation programs improve patient-perceived quality of life within physical and psychological domains [21]. Both physical and psychological aspects of COPD rehabilitation enable comprehensive well-being enhancement when treated together according to this research.

The research adopted a comprehensive method by integrating physical recovery with psychological interventions to achieve total service for COPD patients. Numerous previous studies explored the physical advantages of COPD rehabilitation programs but the inclusion of psychological treatments including mindfulness and relaxation improves the therapeutic scope. The data from this study supports stated that treating COPD patients' psychological condition directly influences their long-term medical outcomes [22].

There are some constraints that exist in the research findings. The study employed a small sample population of 40 participants which reduces the potential for generalizing their results to other populations. A follow-up period of 6 weeks did not adequately demonstrate the enduring effects that the implemented intervention would exert. Future investigations need to extend their follow-up observation times to determine if the discovered advantages persist. The scope of the research findings could improve through expanded participant demographics to include individuals who have different comorbidities.

Hence, a diverse physiotherapy program that includes breathing techniques together with aerobic exercises, strength training, and psychological support leads to major enhancements in physical and emotional outcomes in COPD patients. The method's success becomes evident through its ability to enhance both breathing abilities and exercise tolerance as well as to minimize dyspnea and decrease anxiety, and depression levels. COPD management requires multidimensional rehabilitation methods that demonstrate potential for treatment solutions that support physical needs along with mental health requirements of chronic respiratory patients.

CONCLUSION

The study proved the effectiveness of customized physiotherapy for improving multiple clinical outcomes along with psychological measures in patients diagnosed with moderate to severe COPD. The intervention incorporated breathing techniques, aerobics, strength exercises, and psychological support which led to significant improvement of pulmonary function based on observed FEV1 increases from 1.45 L ± 0.40 to 1.68 L ± 0.42 ($p < 0.05$) and FVC increases from 2.80 L ± 0.52 to 3.05 L ± 0.56 ($p < 0.05$). Patients demonstrated better cardiovascular functioning indicated by a 50-meter (± 30.0) increase in 6MWT distance ($p < 0.01$). The participants experienced substantial improvement in dyspnea symptoms based on Borg Dyspnea Scale measurements which decreased from 6.5 (± 1.2) to 4.0 (± 1.3) ($p < 0.05$). The psychological well-being improved through decreased HADS-anxiety and HADS-depression scores from 10.2 (± 2.1) to 6.5 (± 1.8) and from 8.6 (± 1.9) to 5.2 (± 1.6) respectively ($p < 0.01$ The participants experienced significant improvements in their total health status according to the EQ-5D quality of life score which increased from 0.62 (± 0.18) to 0.76 (± 0.14) ($p < 0.01$). The research demonstrates that combining physical exercise with psychological interventions creates an

effective treatment approach for COPD management while leading to better patient results.

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