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EFFECT OF A PULMONARY REHABILITATION PROGRAM ON DYSPNEA SEVERITY ASSESSED BY THE MODIFIED MEDICAL RESEARCH COUNCIL SCALE IN PATIENTS WITH STABLE CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT
Chronic Obstructive Pulmonary Disease (COPD) is a progressive lung disease characterized by persistent airflow limitation and chronic respiratory symptoms, particularly dyspnea, which negatively impacts functional capacity and quality of life. Pulmonary rehabilitation is an essential component of COPD management; however, its effectiveness in reducing dyspnea in stable COPD patients at the local healthcare level still requires further evaluation. To determine the effect of a pulmonary rehabilitation program on dyspnea severity assessed by Modified Medical Research Council Scale (mMRC). This study employed a quasi-experimental one-group pretest–posttest design to evaluate the effect of a pulmonary rehabilitation program on dyspnea severity, as measured by the mMRC scale, among 28 male subjects with stable COPD recruited through consecutive sampling. Dyspnea severity was assessed using the mMRC scale before and after a 4-week pulmonary rehabilitation program. Demographic and clinical data were collected at baseline. Statistical analyses were performed using the Shapiro–Wilk test and paired t-test or Wilcoxon signed-rank test, with $p < 0.05$ considered statistically significant. Most patients were elderly, predominantly aged 60–69 years. Before the intervention, the majority experienced moderate to severe dyspnea. After pulmonary rehabilitation, there was a shift toward lower mMRC scores, indicating clinical improvement. Statistical analysis showed a significant difference between pre- and post-intervention scores ($Z = -3.771$; $p < 0.001$) with a very large effect size ($r = 0.97$), indicating a strong impact of pulmonary rehabilitation on reducing dyspnea in stable COPD patients. Pulmonary rehabilitation is effective in reducing dyspnea severity and improving functional condition in patients with stable COPD.

Keywords: chronic obstructive pulmonary disease; dyspnea; modified medical research council scale; pulmonary rehabilitation

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production, and/or exacerbations) resulting from abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema), leading to persistent airflow limitation that is often progressive. This disease is marked by persistent respiratory symptoms and airflow limitation caused by airway and/or alveolar abnormalities (GOLD, 2024). COPD is projected to become the third leading cause of death and the fifth leading cause of disability worldwide by 2020. In the United Kingdom, the incidence of COPD is reported to be approximately 4–6%, resulting in the loss of around 20 million working days annually and accounting for approximately 30,000 deaths per year. Meanwhile, in the United States, COPD is responsible for approximately 110,000 deaths annually and more than 500,000 hospitalizations each year (Agusti et al., 2023). According to data from the Regional COPD Working Group conducted across 12 countries in the Asia-Pacific region, the average prevalence of COPD was 6.3%, with the

lowest prevalence reported in Hong Kong and Singapore at 3.5%, and the highest in Vietnam at 6.7%. Indonesia reported a prevalence of 5.6%, corresponding to approximately 4.8 million cases of moderate to severe COPD (GOLD, 2024).

Chronic Obstructive Pulmonary Disease (COPD) leads to impaired quality of life, reduced functional capacity, and increased mortality. Dyspnea, as a key symptom, should be routinely evaluated in all patients with COPD. Although dyspnea is commonly assessed through pulmonary function testing using spirometry, it can also be evaluated using the Modified Medical Research Council (mMRC) scale. The mMRC questionnaire measures the severity of dyspnea on a scale ranging from 0 to 4, with a score of 4 indicating the most severe level of breathlessness (GOLD,2024; Tifany et al., 2023; Anwar et al., 2012).

The National Institute for Health and Clinical Excellence has recommended that pulmonary rehabilitation should be provided to all patients with COPD who experience impaired lung function. Several studies have demonstrated the benefits of pulmonary rehabilitation programs in improving the physical capacity of patients with COPD, which in turn leads to an improvement in quality of life (Anwar et al., 2012; Ingbar et al., 2015). Various meta-analyses and systematic reviews have demonstrated that pulmonary rehabilitation significantly reduces the degree of dyspnea, improves exercise capacity as measured by the 6-minute walk test (6MWT), and enhances health-related quality of life (HRQoL) in patients with COPD (Ardiana., 2021). In addition to its effects on dyspnea, pulmonary rehabilitation has also been shown to reduce fatigue, alleviate symptoms of anxiety and depression, and decrease hospitalization rates as well as long-term mortality. (Muliase., 2023) Patients with COPD who undergo pulmonary rehabilitation immediately after an exacerbation experience a significant reduction in hospital readmission rates (RR 0.56; 95% CI 0.36–0.86) as well as recurrent exacerbations. Another meta-analysis reported that post-hospitalization pulmonary rehabilitation can reduce hospital admissions by nearly 50% compared to usual care (Yudhawati et al., 2019; Muhrozi., 2013).

Based on the background, pulmonary rehabilitation plays a crucial role in reducing the severity of dyspnea and improving the quality of life of patients with COPD. However, the effectiveness of pulmonary rehabilitation programs in clinical practice, particularly in terms of changes in dyspnea severity as measured by the mMRC scale in patients with stable COPD, still requires further evaluation at the local healthcare level. Therefore, this study was conducted to analyze the effect of a pulmonary rehabilitation program on the degree of dyspnea (mMRC) in patients with stable COPD at Prof. Dr. Chairuddin P. Lubis Hospital, University of North Sumatra, in 2025. The general objective of this study is to determine the effect of a pulmonary rehabilitation program on the degree of dyspnea at Prof. Dr. Chairuddin P. Lubis Hospital, University of North Sumatra, in 2025.

METHOD

Study Design and Participants

This quasi-experimental one-group pretest–posttest study was conducted at Prof. Dr. Chairuddin P. Lubis Hospital, University of North Sumatra, Medan and involved 28 male subjects with stable COPD who underwent pulmonary rehabilitation and recruited through consecutive sampling. The inclusion criteria included male patients with COPD and those with stable COPD, after obtaining ethical approval from the Institutional Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara with number: 1052/KEPK/USU/2025.

Study Variables

The variables in this study consisted of the pulmonary rehabilitation program and the degree of dyspnea. The pulmonary rehabilitation program was defined as a standard management approach aimed at controlling the disease, reducing symptoms, and optimally improving functional capacity. It was measured through interviews using a questionnaire with “yes” and “no” categories, with a

nominal scale of measurement. Meanwhile, the degree of dyspnea was defined as the severity of breathlessness assessed using the mMRC questionnaire. It was measured through interviews and categorized into five levels: mMRC grades 0, 1, 2, 3, and 4, using an ordinal scale.

Statistical Analysis

The collected data were processed and analyzed using computer-based statistical software. Statistical analysis began with univariate analysis to describe the characteristics of the study subjects and the distribution of dyspnea severity based on the modified mMRC scale. Subsequently, bivariate analysis was performed to assess differences in mMRC scores before and after the pulmonary rehabilitation program. Normality testing of the pre- and post-intervention mMRC scores was conducted using the Shapiro–Wilk test. If the data were normally distributed ($p > 0.05$), a paired t-test was used to compare values before and after the intervention. Conversely, if the data were not normally distributed, the Wilcoxon signed-rank test was applied. A p-value of < 0.05 was considered statistically significant, with a 95% confidence level.

RESULT

Demographic Characteristics of Study Subjects

The age distribution of patients with stable COPD who participated in the pulmonary rehabilitation program was predominantly in the 60–69 years age group (39.3%), followed by those aged 50–59 years (28.6%) and ≥70 years (25.0%), while patients aged <50 years constituted the smallest proportion (7.1%). These findings indicate that the majority of patients were in the older age group.

Distribution of modified Medical Research Council (mMRC) Scores Before and After Pulmonary Rehabilitation

The distribution of mMRC scores before the pulmonary rehabilitation program showed that the majority of patients were in the moderate to severe dyspnea categories, with mMRC grades 3 and 4 each accounting for 35.7%, followed by mMRC grade 2 at 21.4%, and mMRC grade 1 as the least frequent at 7.1%. These findings indicate that, prior to the intervention, most patients with stable COPD experienced relatively severe dyspnea (Table 1).

Table 1.
Distribution of mMRC Scores Before Pulmonary Rehabilitation (n=28)

mMRC Score (Pre)	f	%
1	2	7,1
2	6	21,4
3	10	35,7
4	10	35,7

The distribution of mMRC scores after the pulmonary rehabilitation program showed that the majority of patients were in mMRC grade 3 (42.9%), followed by grade 2 (39.3%) and grade 1 (17.9%). Overall, there was a shift toward lower severity grades compared to before the intervention, indicating an improvement in dyspnea among patients with stable COPD (Table 2).

Table 2.
Distribution of mMRC Scores After Pulmonary Rehabilitation (n=28)

mMRC Score (Pre)	f	%
1	5	17,9
2	11	39,3
3	12	42,9

Analysis of the Effect of Pulmonary Rehabilitation on Dyspnea Severity

The results of the Shapiro–Wilk normality test showed that the mMRC scores before ($p = 0.003$) and after the intervention ($p = 0.002$) were not normally distributed ($p < 0.05$); therefore, the analysis was continued using the Wilcoxon signed-rank test. Of the 28 subjects, 15 showed changes in their scores, no subjects demonstrated a decrease, and 13 subjects had unchanged values. The Wilcoxon test revealed a statistically significant difference between mMRC scores before and after the intervention ($Z = -3.771$; $p < 0.001$). The effect size obtained was very large (r

= 0.97; 95% CI: 0.91–0.99), indicating that the pulmonary rehabilitation program had a strong effect on improving dyspnea severity in patients with stable COPD.

Table 3.
Effect of Pulmonary Rehabilitation Program on Dyspnea Severity (n=28)

MMRC	n(%)	Possitive Rank	Negative Rank	Ties	Effect Size (r)	Normality Test	Z-Score	p-value
Before MMRC	28	15	0	13	0.97	.001	-3.771	<0,001
After MMRC	28							

DISCUSSION

The majority of patients with stable COPD who participated in the pulmonary rehabilitation program were in the 60–69 years age group (39.3%). This finding is consistent with the epidemiological characteristics of COPD, in which both incidence and prevalence increase significantly with advancing age. This trend is attributed to long-term exposure to risk factors such as cigarette smoke, air pollution, and the aging process, which leads to a decline in lung function and reduced elasticity of lung tissue (GOLD, 2024; Buist et al., 2007) The distribution of patients in this study showed that the late productive age group (50–59 years) still constituted a considerable proportion (28.6%), indicating that the impact of this disease is not limited to the elderly population. This finding may be associated with prolonged exposure to risk factors such as smoking habits and environmental or occupational pollutants.(Salvi et al., 2009)

The majority of patients with stable COPD had mMRC scores of 3 and 4, each accounting for 35.7%. This finding indicates that most patients experienced moderate to severe dyspnea prior to participating in the pulmonary rehabilitation program. The mMRC score is a clinical instrument used to assess the level of dyspnea during daily activities, with a scale ranging from 0 to 4, where higher scores indicate greater functional limitation due to impaired ventilation.(Bestall et al., 1999) This finding is consistent with the general characteristics of patients with COPD in the advanced stage (moderate to severe COPD), where there is a decline in lung capacity, increased airway resistance, and pulmonary hyperinflation, all of which result in a significant increase in the work of breathing (O'Donnell et al., 2006; Celli et al.,2019).

The majority of patients were in mMRC grade 3 (42.9%) and grade 2 (39.3%), while only 17.9% of patients had an mMRC score of 1. Compared to the pre-rehabilitation condition, there was a shift in the proportion of patients toward lower mMRC scores, indicating an improvement in functional capacity and a reduction in dyspnea severity. The reduction in mMRC scores following pulmonary rehabilitation has also been consistently reported in various studies. For instance, a meta-analysis by McCarthy et al. (2015) demonstrated that pulmonary rehabilitation could reduce the mean mMRC score by approximately 0.5–1 point, which is considered clinically significant (minimal clinically important difference). In addition, the improvement in dyspnea following pulmonary rehabilitation is also associated with increased exercise capacity, as measured by the 6-minute walking distance (6MWD), and improved quality of life scores based on the St. George's Respiratory Questionnaire (SGRQ) (Puhan et al., 2016).

Based on the Wilcoxon signed-rank test, there was a statistically significant difference between the mMRC scores before and after the pulmonary rehabilitation program ($Z = -3.771$; $p = 0.001$). Of the total 28 subjects, 15 patients showed a reduction in mMRC scores (indicating improvement in dyspnea severity), 13 patients had unchanged scores, and no patients demonstrated an increase in mMRC scores after the intervention. These findings indicate that the pulmonary rehabilitation program had a positive impact on reducing the degree of dyspnea in patients with COPD. The negative Z value indicates that the changes in scores were predominantly toward lower values after the intervention, which can be interpreted as an improvement in respiratory function and tolerance

to physical activity.

The effect size was calculated using the formula $r = Z/\sqrt{N}$, with N = 15 (the number of subjects who experienced changes in their scores). The calculation yielded an r value of 0.97, which is categorized as a very large effect size. The 95% confidence interval (CI) of 0.91–0.99 indicates that the effect of the pulmonary rehabilitation program on the improvement of dyspnea symptoms is consistent and highly precise. Thus, this intervention is not only statistically significant but also demonstrates a strong clinical impact on improving the functional capacity of patients with COPD.

This finding is consistent with previous studies demonstrating that pulmonary rehabilitation programs can significantly reduce mMRC scores and improve the distance achieved in the 6-minute walk test (6MWT) among patients with COPD (Ardiana., 2021; Vogelmeier et al., 2017). In addition, a meta-analysis by McCarthy et al. (2015) further confirmed that pulmonary rehabilitation provides a minimal clinically important difference (MCID) in mMRC scores of ≥1 point, which is considered clinically significant. Physiologically, this improvement reflects enhanced ventilatory efficiency, strengthening of respiratory muscles, reduction of pulmonary hyperinflation, and cardiopulmonary adaptations to structured aerobic and breathing exercises (O'Donnell et al., 20006; Nici et al., 2020).

CONCLUSION

Based on the findings of this study, patients with stable COPD who participated in the pulmonary rehabilitation program were predominantly in the older age group, particularly those aged 60–69 years. Prior to the intervention, most patients had moderate to severe dyspnea, whereas after the pulmonary rehabilitation program, there was a shift toward milder degrees of dyspnea, indicating clinical improvement. Overall, the pulmonary rehabilitation program has been shown to provide significant benefits in reducing dyspnea severity and improving functional status in patients with stable COPD.

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