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COMPARISON OF UPPER EXTREMITY MUSCLE STRENGTH BETWEEN PATIENTS WITH STABLE AND EXACERBATED CHRONIC OBSTRUCTIVE PULMONARY DISEASE AT A HOSPITAL IN MEDAN

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ABSTRAK

Salah satu komplikasi utama pada penderita PPOK adalah kelemahan atau atrofi yang lebih signifikan terjadi selama eksaserbasi yang memperburuk kualitas hidup, prognosis dan resiko eksaserbasi berikutnya. Penelitian ini bertujuan membandingkan kekuatan otot ekstremitas atas antara pasien PPOK stabil dan pasien yang mengalami eksaserbasi. Penelitian ini menggunakan desain potong lintang (cross-sectional) dengan uji t sampel independen untuk membandingkan nilai rata-rata dari dua kelompok yang tidak berpasangan. Pengambilan sampel non-probabilitas dengan teknik consecutive sampling. Peneliti melakukan pemeriksaan kekuatan otot ekstremitas atas dengan jumlah sampel yang telah ditentukan dan memenuhi kriteria inklusi dan eksklusi dengan Handgrip Dynamometer. Hasil penelitian didapatkan Secara korelasi ditemukan ada hubungan antara riwayat eksaserbasi dalam setahun terhadap PPOK pada kedua kelompok PPOK (p<0,05). Kekuatan otot ekstremitas atas PPOK eksaserbasi lebih rendah dibandingkan PPOK stabil. Dengan menggunakan uji T Independent diperoleh p-value sebesar 0,001, artinya ada hubungan kekuatan otot ekstremitas atas antara kelompok PPOK stabil dengan PPOK eksaserbasi.

ABSTRACT

Comparison Of Upper Extremity Muscle Strength Between Patients with Stable and Exacerbated Chronic Obstructive Pulmonary Disease at a Hospital in Medan. One of the main complications in patients with COPD is muscle weakness or atrophy, which becomes more pronounced during exacerbations, leading to a decline in quality of life, prognosis, and an increased risk of future exacerbations. This study compared upper limb muscle strength between stable COPD patients and those experiencing exacerbations. A cross-sectional study design was used, with an independent sample t-test to compare the mean values of two unpaired groups. Sampling was conducted using a non-probability consecutive sampling technique. Researchers assessed upper limb muscle strength using a Hand-grip Dynamometer on a predetermined sample size that met the inclusion and exclusion criteria. The results showed a significant correlation between the history of exacerbations within the past year and COPD in both groups ($p < 0.05$). Upper limb muscle strength in the exacerbation group was lower than in the stable COPD group. The independent t-test yielded a p-value of 0.001, indicating a significant difference in upper limb muscle strength between the stable and exacerbation COPD groups.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive lung disease characterized by non-reversible airflow obstruction due to chronic inflammation of the respiratory tract and lungs[1] Based on WHO data, COPD is the third leading cause of death in the world, with an increasing prevalence due to exposure to risk factors such as smoking, air pollution, and exposure to industrial chemicals. In addition to respiratory distress, COPD affects the musculoskeletal system, particularly decreased upper limb muscle strength[2] This muscle weakness is caused by various factors, including chronic hypoxemia, systemic inflammation, and oxidative stress that impairs muscle metabolism[3] In COPD, the patient's upper limb muscle atrophy directly impacts daily activities, such as eating, dressing, and using breathing apparatus.

COPD exacerbations exacerbate muscle weakness through increased systemic inflammation, more severe hypoxemia, and prolonged immobilization. These conditions accelerate the decline in muscle function and impact patients' quality of life. Unfortunately, most studies have focused on lower extremity muscle weakness, while the effect of COPD on upper extremity muscles has not been studied in depth[4] This study compares upper limb muscle strength between stable COPD patients and patients with COPD exacerbations. The results of this study are expected to provide new insights into the rehabilitation management of COPD patients and develop more effective intervention strategies to maintain muscle function and improve patients' quality of life[5]

METHOD

This cross-sectional study compared upper-extremity muscle strength between clinically stable COPD patients and those with acute exacerbation[6]. At least 55 subjects per group were recruited consecutively from the Pulmonology Clinic and Emergency Department of Prof. Dr. Chairuddin P. Lubis Hospital, Medan (July – November 2024). Inclusion criteria were COPD patients ≥ 40 years of age (male or female) with a history of active/passive smoking who consented to hand-grip testing. Exclusion criteria were comorbid conditions affecting upper-limb strength (stroke, peripheral neuropathy, major musculoskeletal injury) or inability to follow study procedures[7]. The grip strength of the dominant hand was measured three times with a calibrated Jamar® hydraulic hand-grip dynamometer following the standardized protocol of the American Society of Hand Therapists[8] The mean value (kgf) was recorded. The researchers checked data normality using the Shapiro–Wilk test. They analyzed normally distributed variables with an independent-sample t-test and applied the Mann–Whitney U test for non-normally distributed data. They performed all analyses in SPSS v26 and considered $p < 0.05$ statistically significant. The Health Research Ethics Committee of Universitas Sumatera Utara (No. 1181/KEPK/USU/2024) granted ethical approval. The team assessed upper-limb muscle strength using a Jamar hand-grip dynamometer based on the standard protocol[9,] and analyzed the results using an independent t-test after confirming normality.

The analysis followed two stages: descriptive and inferential. The team summarized demographic characteristics (age, gender) and upper extremity muscle strength in each group through descriptive analysis. Inferential analysis compared upper extremity muscle strength between stable and exacerbated COPD patients.

The Shapiro-Wilk test assessed data normality. When data followed a normal distribution, analysts applied an Independent T-test; otherwise, they used the Mann-Whitney U Test. SPSS or R software processed the data, maintaining completeness and consistency[10].

The analysis identified significant differences in upper extremity muscle strength between the two groups, using a significance threshold of $p < 0.05$.

RESULT

Table 1. Respondent Characteristics

Demographic Characteristics	Stable (n,%)	Exacerbation (n,%)
Age		
40-60 years	23(41,8)	16(29,1)
>60 years	32(58,2)	39(70,9)
Gender		
Male	48(87,3)	31(56,4)
Female	7(12,7)	24(43,6)
Degree of Smoking (Brinkman Index)		
Lightweight	8(14,5)	17(30,9)
Medium	17(30,9)	13(23,6)
Heavy	30(54,5)	25(45,5)
Upper Extremity Muscle Strength		
Normal	37(67,3)	15(27,3)
Weak	17(30,9)	40(72,7)
Strong	1(1,8)	-
COPD		
A	8(14,5)	7(12,7)
B	21(38,2)	19(34,5)
E	26(47,3)	29(52,7)
History of exacerbation within a year		
<2 exacerbations	42(76,4)	39(70,9)
≥2 exacerbations	13(23,6)	16(29,1)

From Table 1 above, based on age in both groups, there are more people aged> 60 years, namely in the stable COPD group, as many as 32 (58.2), and in the COPD exacerbation group, as many as 39 (70.9). Gender is mostly male, namely in the stable COPD group, as many as 48 (87.3%), and in COPD exacerbations, as many as 31 (56.4%). The degree of smoking in both groups was classified as severe, namely, in the stable COPD group, as many as 30 (54.5%) and COPD exacerbations of as many as 25 (45.5%). Upper limb muscle strength in the stable COPD group was mainly normal at 37(67.3%), while the exacerbated COPD group was mostly weak at 40(72.7%). In the division of COPD groups, most were in Group E COPD, namely 26(47.3%) in stable COPD and 29(52.7%) in exacerbated COPD. The history of exacerbations in a year in both groups mainly occurred less than two exacerbations, namely in the stable COPD group, as many as 42 (76.4%), and in the exacerbated COPD group, as many as 39 (70.9%).

Table 2 shows that in the stable COPD group, most respondents aged >60 years had normal muscle strength, namely 22 (40.0%) respondents, while in the COPD exacerbation group, most respondents aged >60 years had weak muscle strength, namely 27 (49.1%) respondents. The gender of both COPD groups was mainly male. In the stable COPD group, most had normal muscle strength, namely 30 (54.5%) respondents, and in the exacerbation, the COPD group had weak muscle strength, namely 30 (54.5%)—degree of smoking (Brinkman index) in both COPD groups.

Table 2. Frequency of Upper Extremity Muscle Strength in Patients with Stable COPD and COPD Exacerbation

Demographic Characteristics	COPD Muscle Strength Stable			P-value	Muscle Strength COPD Exacerbation			p-value
	Normal (n=37)	Weak (n=17)	Strong (n=1)		Normal (n=15)	Weak (n=40)	Strong (n=1)	
Age (n,%)								0,363
40-60 years	15(27,3)	7(12,7)	1(1,8)	0,492	3(5,5)	13(23,6)	-	
>60 years	22(40,0)	10(18,2)	0(0,0)		12(21,8)	27(49,1)	-	
Gender (n,%)								
Male	30(54,5)	17(30,9)	1(1,8)	0,142	1(1,8)	30(54,5)	-	0,000
Female	7(12,7)	0(0,0)	0(0,0)		14(25,5)	10(18,2)	-	
Degree of smoking (Brinkman Index) (n,%)								
Lightweight	7(12,7)	1(1,8)	0(0,0)	0,404	9(16,4)	8(14,5)	-	0,001
Medium	13(23,6)	4(7,3)	0(0,0)		5(9,1)	8(14,5)	-	
Heavy	17(30,9)	12(21,8)	1(1,8)		1(1,8)	24(43,6)	-	
COPD								
A	7(12,7)	1(1,8)	0(0,0)	0,129	4(7,3)	3(5,5)	-	0,901
B	17(30,9)	4(7,3)	0(0,0)		6(10,9)	13(23,6)	-	
E	13(23,6)	12(21,8)	1(1,8)		5(9,1)	24(43,6)	-	
History of exacerbation within a year (n,%)								
<2x exacerbation	30(54,5)	11(20,0)	1(1,8)	0,276	14(25,5)	25(45,5)	-	0,043
≥2x exacerbation	7(12,7)	6(10,9)	0(0,0)		1(1,8)	15(27,3)	-	

Brinkman index) in both COPD groups mainly were classified as severe. In the stable COPD group, 17(30.9%) had muscle strength, and 24(43.6%) in the exacerbated COPD group. Most stable COPD patients had normal muscle strength, namely 17 (30.9%) respondents, and in the COPD exacerbation group, most Group E COPD had weak muscle strength, namely 24 (43.6%) respondents. The history of exacerbations in a year in the stable COPD group, mostly 2 exacerbations had muscle strength classified as normal, namely 30 (54.5%) respondents. In contrast, in the COPD exacerbation group, mostly 2 exacerbations had muscle strength classified as weak, namely 25 (45.5%). There was no relationship between age, gender, smoking degree (Brinkman index), COPD diagnosis, and history of exacerbation on upper limb muscle strength in the stable COPD group ($p>0.05$). Whereas in the COPD exacerbation group, there was an association between gender, degree of smoking (Brinkman index), and history of exacerbation within a year ($p<0.05$), but no association between the COPD group and upper limb muscle strength ($p>0.05$).

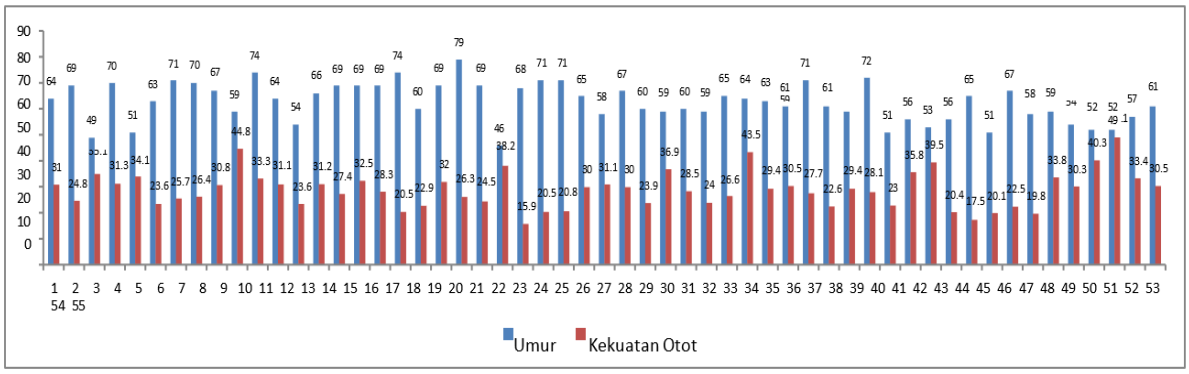
Table 3. Upper Extremity Muscle Strength between Patients with Stable COPD and COPD Exacerbation

Muscle Strength	Mean±SD	P-value
Stable COPD	28,99±6,89	0,001
COPD Exacerbation	19,51±5,13	

Independent Sample T-Test

Table 3 above shows that upper limb muscle strength in the COPD exacerbation group is lower (19.51 ± 5.13) compared to stable COPD limb muscle strength (28.99 ± 6.89). With the t-dependent test, the p-value is 0.000, meaning a relationship exists between upper limb muscle strength in the stable COPD group and COPD exacerbation.

Stable



Exacerbation

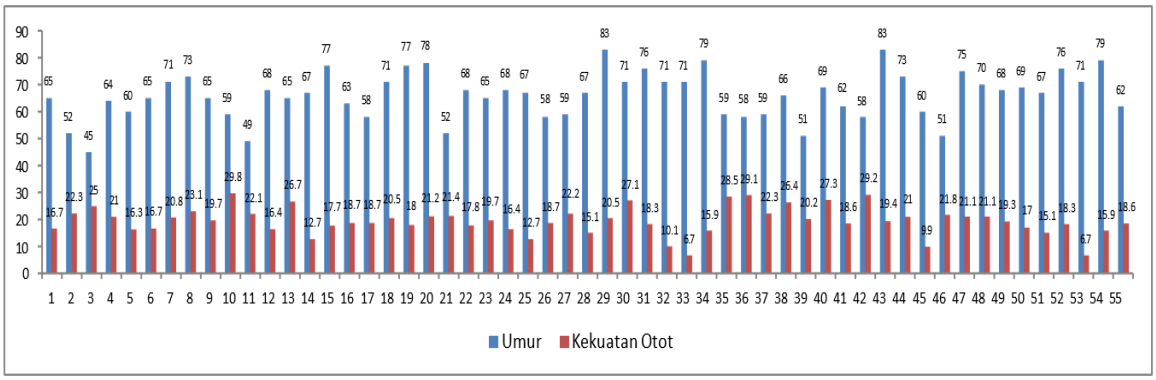


Figure 1. Upper Extremity Muscle Strength Between Patients with Stable COPD and COPD Exacerbation

These results confirm that patients with COPD exacerbations significantly reduce upper limb muscle strength compared with stable COPD patients. This weakness could be attributed to increased systemic inflammation, chronic hypoxemia, and longer immobilization during exacerbation episodes, contributing to muscle atrophy and decreased muscle strength.

In the analysis of the relationship between demographic variables and upper limb muscle strength, it was found that in the stable COPD group, there was no significant relationship between age, gender, smoking severity, and history of exacerbation with upper limb muscle strength ($p>0.05$). However, in the COPD exacerbation group, there was a significant association between gender smoking severity and history of exacerbations within a year with decreased upper limb muscle strength ($p<0.05$). This fact suggests that in exacerbation conditions, factors such as smoking and a history of previous exacerbations have a greater impact on upper limb muscle weakness than in stable COPD conditions. This indicates that repeated exacerbations can accelerate the process of muscle degeneration and further reduce the functional capacity of patients. This study showed that patients with COPD exacerbations had a more significant decrease in upper limb muscle strength than patients with stable COPD. Factors such as gender, smoking habits, and history of exacerbations had a stronger association with muscle weakness in patients with exacerbations. Thus, targeted interventions to reduce the frequency of exacerbations and improve muscle rehabilitation must be a significant concern in COPD management. Further research is needed to explore further the mechanisms underlying the association between COPD and exacerbations of upper limb muscle weakness and to evaluate the effectiveness of rehabilitation interventions that can be implemented to improve the quality of life of COPD patients[11]

DISCUSSION

COPD is a chronic disease that causes decreased lung function. Respiratory muscle training may not fully repair lung damage and takes time to show results. COPD is characterized by airflow limitation due to abnormalities of the airways or alveoli, often due to exposure to harmful substances. COPD exacerbations are characterized by dyspnoea, cough, and sputum that worsen within 14 days[12]. The results showed that all respondents were over 60 years old, male, heavy smokers, and experienced exacerbations less than twice a year. The stable COPD group was dominated by group B COPD, while exacerbated COPD was dominated by group E. Research shows that male COPD patients are more prone to sarcopenia than females. Sarcopenia is associated with poor lung function and limited activity[13]. Acute COPD patients have lower maximum inspiratory pressure than stable COPD. Risk factors for COPD exacerbations include demographic and clinical characteristics, with the highest rates in patients with very severe COPD[14]. COPD is caused by chronic lung inflammation due to smoking, which causes breathing difficulties. In the placebo group, more frequent exacerbations were associated with worsening respiratory scores.

COPD causes skeletal muscle dysfunction that is influenced by comorbidities such as malnutrition, heart failure, and pulmonary hypertension, which can reduce the exercise capacity and quality of life of patients[15] The results of this study showed no association between age, gender, smoking degree, COPD diagnosis, and exacerbation history on upper limb muscle strength in the stable COPD group ($p>0.05$). However, in the COPD exacerbation group, there was an association between gender, degree of smoking, and history of exacerbations within a year ($p<0.05$), but not with COPD diagnosis[16]. In line with Turan's study, patients with COPD exacerbations had lower hand-grip strength than those with stable COPD, which may be due to physical inactivity and steroid use during exacerbations. Hand grip strength was also associated with a 6-minute walking distance[17]. There were no differences in quality of life-based on gender, age, duration of illness, and smoking habits. COPD has a systemic impact on quality of life and survival[18] The results showed lower upper limb muscle strength in the COPD exacerbation group (19.51 ± 5.13) compared to stable COPD (28.99 ± 6.89), with a p-value of 0.000, indicating a significant difference. [19]stated that respiratory muscle training (RMT) can increase maximal inspiratory pressure in stable COPD patients, although it has little effect in improving lung function and quality of life. Upper limb exercises are recommended despite limited data on their applicability[20].

COPD patients have lower lung function, muscle strength, and physical performance than healthy individuals. Non-invasive ventilation (NIV) therapy combined with pulmonary rehabilitation can improve physical performance in stable COPD patients[21] Structured physical exercise programs have been proven effective in improving muscle strength and quality of life in patients with COPD. These programs typically include strength training (Examples include weight lifting, squats, and push-ups), aerobic exercises (Such as walking, cycling, or swimming), and flexibility exercises (Such as yoga or Pilates). Physical training can help enhance functional capacity, reduce dyspnea, and improve patients' ability to perform daily activities[22]. Pursed lip breathing exercises can reduce shortness of breath after 3 days. This exercise can be applied independently by COPD patients. Differences in respiratory muscle strength between stable and exacerbated COPD patients, with practical respiratory muscle training increasing maximal inspiratory pressure in stable COPD[23].

One potential limitation of this study is the variability in patient characteristics, such as comorbidities, nutritional status, and physical activity levels, which may influence upper extremity muscle strength independently of COPD status. Additionally, the cross-sectional design limits the

ability to establish causal relationships between disease status (stable vs. exacerbated) and muscle strength differences. Furthermore, conducting the study in a single center, Prof. Dr. Chairuddin Panusunan Lubis Hospital may limit the generalizability of the findings to broader COPD populations in different regions or healthcare settings.

CONCLUSION

Both have stable and exacerbated COPD; the majority are over 60 years old, male, have a heavy smoking degree, and experience exacerbations less than 2 times a year. In the stable COPD group, the majority belonged to group B with normal muscle strength, while in the exacerbated COPD group, the majority were in group E with weaker muscle strength. Correlation analysis results showed that there was no significant association between age (all respondents were above 40 years old), gender, degree of smoking (Brinkman index), and upper limb muscle strength on COPD in both groups ($p>0.05$). However, there was a significant association between a history of exacerbation within a year and COPD in both groups ($p<0.05$). In addition, this study also showed that upper limb muscle strength in the COPD exacerbation group was lower (19.51±5.13) than in the stable COPD group (28.99±6.89). The T-independent test obtained a p-value of 0.000, indicating a significant relationship between upper limb muscle strength and COPD condition, where COPD exacerbation patients had lower muscle strength than stable COPD patients.

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