**Indonesian Journal of Global Health Research**
Volume 7 Number 1, February 2025
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

# THE IMPACT OF CHEST THERAPY ON SYMPTOMS RELIEF AND PULMONARY FUNCTION IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE EXACERBATIONS

**Nurrahmah Yusuf*, Yuris Hikman Karunia, Irmaini, Yunita Arliny, Budi Yanti**
Department of Pulmonology and Respiration Medicine, Faculty of Medicine, Universitas Syiah Kuala, Jl. Teuku Nyak Arief No.441, Kopelma Darussalam, Syiah Kuala, Banda Aceh, Aceh 23111, Indonesia
*rahmah_ys@yahoo.com

**ABSTRACT**
Chronic Obstructive Pulmonary Disease (COPD) is a global health concern defined by persistent respiratory symptoms and irreversible airflow blockage. Excess mucus production and decreased ciliary function in mucus elimination are two of the most common issues among COPD patients. Chest therapy is a physiotherapy practice that helps to remove mucus in a variety of acute and chronic respiratory illnesses. Objective: The study aims to explore how chest treatment affects symptoms and lung function in patients with COPD exacerbations. Methods: This study employed a one-group pretest-posttest design, selecting a sample of 30 COPD exacerbation patients from dr. Zainoel Abidin Hospital through convenience sampling technique. Chest therapy was administered consecutively over six days. Pulmonary function was assessed with a peak flow meter, while symptom improvement was assessed through the BORG questionnaire, Modified Medical Research Council (mMRC) scale, and COPD Assessment Test (CAT). Data analysis was performed using the paired T-test and Wilcoxon test. Results: Chest therapy increased average peak expiratory flow (PEF) by 6.40 L/min, from 29.20 ± 6.26 L/min to 35.60 ± 7.65 L/min. BORG scale scores were likewise reduced, with the majority shifting from scale 4 (56.7%) to scale 2 (40%), as were mMRC scores, which decreased from a dominant scale 3 (40%) to scale 2 (33.3%). Furthermore, CAT scores shifted from the high category (76.7%) to the moderate category (53.3%). Bivariate tests revealed that chest therapy had a significant effect on rising PEF values ($P<0.001$), decreasing BORG scale scores ($P<0.001$), and decreasing CAT scores ($P = 0.001$), but no significant effect was seen on the mMRC scale ($P = 0.564$). Conclusions: Chest therapy positively impacts lung function, as shown by increased peak expiratory flow (PEF) values and improved clinical symptoms of COPD exacerbation, as measured by BORG and CAT scale scores.

Keywords: borg; CAT; COPD; mMRC; PEF

**How to cite (in APA style)**
Yusuf, N., Karunia, Y. H., Irmaini, I., Arliny, Y., & Yanti, B. (2025). The Impact of Chest Therapy on Symptoms Relief and Pulmonary Function in Chronic Obstructive Pulmonary Disease Exacerbations. Indonesian Journal of Global Health Research, 7(1), 1143-1152. https://doi.org/10.37287/ijghr.v7i1.4998.

## INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a critical international health issue, with an increasing prevalence and the third highest cause of mortality worldwide, as stated by the World Health Organization (WHO) (Andrews et al., 2013). In Indonesia, respiratory diseases are among the top ten most common diseases, with COPD accounting for 145 cases per 100,000 population and causing roughly 78,300 deaths. COPD patients' five-year survival rates vary from 56% to 92%, depending on the severity of the disease (Yawn et al., 2021).Symptoms of COPD include chronic respiratory distress and irreversible or partially reversible airflow limitation. COPD is associated with structural alterations in the lung because of chronic inflammation caused by prolonged exposure to hazardous particles or gases, most often cigarette smoke. Chronic inflammation causes narrowing of the airways and reduced pulmonary recoil (Agarwal et al., 2024). COPD patients have increased mucus production, which hinders ciliary activity. As a result, it becomes more difficult to remove mucus from the airway (Gerungan et al., 2020; Gil et al., 2021).

The diagnosis of COPD is established according to clinical symptoms such as chronic and progressive dyspnea, coughing, and sputum production, which may also be accompanied by wheezing.(Agarwal et al., 2024) The severity of dyspnea can be examined using the Modified Medical Research Council (mMRC) Questionnaire, which comprises five questions on a scale of 0-4, with 4 being the most severe (Gerungan et al., 2020; Imam et al., 2021). However, because this questionnaire cannot be used for long-term surveillance, the COPD Assessment Test (CAT) is a suitable alternative. The CAT consists of eight statements, each assessed on a 6-point scale (0–5) (Gerungan et al., 2020; Waatevik et al., 2013). A substantial rise in CAT total score during medical appointment can indicate a worsening or exacerbation of COPD.(Hall & AC, 2016) The Borg scale is used to rapidly and simply quantify the degree of dyspnea in COPD patients who are experiencing exacerbations (Kurniyanti et al., 2023).

The gold standard examination for diagnosing COPD is spirometry, which measures airflow limitation. A post-bronchodilator test (10 to 15 minutes after administering 2 to 4 puffs of a short-acting bronchodilator) defines chronic or fixed airflow limitation in COPD patients if the ratio of forced expiratory volume in 1 second to forced vital capacity (FEV1/FVC) is less than 0.70 (Global Initiative for Chronic Obstructive Lung Disease, 2023; Yawn et al., 2021). In addition, a peak flow meter can be used to assess lung function by measuring peak expiratory flow (PEF) (Antariksa et al., 2023).COPD patients are managed using both pharmaceutical and nonpharmacological treatments. Patients are treated pharmacologically based on their GOLD group (A, B, or E). Non-pharmacological therapies include behavioral therapy and pulmonary rehabilitation.(Global Initiative for Chronic Obstructive Lung Disease, 2023) Sholichin's study in Samarinda found that chest physiotherapy improved nonelastic airway resistance in the experimental group ($P<0.001$, $\alpha=0.05$) and outperformed the control group on day 5 (Sholichin, 2018).

One of the issues that COPD patients encounter is impaired sputum discharge, which leads to extended hospital stays and hinders clinical improvement. As a result, non-pharmacological care is required to facilitate sputum release, specifically chest therapy. Chest therapy is an airway clearance procedure that combines external mechanical techniques such as chest percussion, postural drainage, vibration, effective coughing techniques, and breathing exercises (Pratiwi et al., 2021). This therapy seeks to enhance the patient's pulmonary status and accelerate recovery by optimizing airway clearance in any respiratory diseases that characterized by hypersecretion and lower airway resistance. Improved airway clearance can lower airway resistance, improve gas exchange, and decrease breathing effort (Chen et al., 2022).Currently, manual chest therapy is included as an airway clearing method for COPD patients, but its use during acute exacerbations is not recommended. During acute exacerbations, early mobilization and physical reconditioning programs are less harmful and more effective than mucus clearing treatments (Devi & Widodo, 2022; Kiliç et al., 2023; McDonald et al., 2019). Other research indicates that mucus clearing procedures can greatly minimize the need for ventilatory assistance, mechanical ventilation, and length of stay (Andrews et al., 2013). Chest therapy can be used to treat symptomatic mucus retention while taking into account the patient's preferences and tolerance. The disparities in the study's findings highlight the need for additional research on the benefits of chest therapy in COPD patients, particularly during the acute phase (exacerbation). The study aims to explore how chest treatment affects symptoms and lung function in patients with COPD exacerbations.

## METHOD

The study included all COPD exacerbation patients treated at the Dr. Zainoel Abidin Hospital Banda Aceh between March and May 2024. The study used a one-group pretest-posttest design with convenience sampling. The study included 30 participants who were ≥40 years old, diagnosed with moderate/severe COPD exacerbation, treated according to GOLD 2023 guidelines, did not have other lung function disorders (e.g., tuberculosis, bronchiectasis, asthma, lung cancer), did not have chest therapy contraindications (e.g., bleeding diathesis, increased intracranial pressure, hemoptysis, rib and/or spinal fractures, physical position discomfort), and had no history of acute coronary syndrome and other heart diseases. Before beginning chest therapy, PEF was measured using a peak flow meter, followed by an interview and completion of the Borg, mMRC, and CAT questionnaires by the study participants. Chest therapy included percussion, vibration, and postural drainage, followed by effective coughing for 10 to 15 minutes once a day for six days. On the seventh day of treatment, the PEF, Borg questionnaire, mMRC, and CAT were retested. The data was analyzed using the paired T test and Wilcoxon test with a 95% confidence interval (CI) and $\alpha = 0.05$. A p-value of $< 0.05$ indicates a significant difference between before and after chest therapy.

## RESULT

This study included 33 patients with moderate/severe COPD exacerbations; however, three subjects dropped out during the trial. Two of them were unable to complete chest therapy until day 6, and one subject died. Table 1 shows the study individuals' general characteristics.

Table 1.
Characteristic of Research Subject

| Characteristic | f | % |
|---|---|---|
| Sex | | |
| Male | 28 | 93,3 |
| Female | 2 | 6,7 |
| Age (years old) | | |
| 40-50 | 5 | 16,7 |
| 50-60 | 8 | 26,7 |
| >60 | 17 | 56,7 |
| Body Mass Index (BMI) | | |
| Underweight (17,0-18,4) | 15 | 50,0 |
| Normal (18,5-25,0) | 14 | 46,7 |
| Overweight (> 25,0-27,0) | 1 | 3,3 |
| Smoking Status | | |
| Smoker | | |
| BI Moderate | 6 | 20,0 |
| BI Severe | 22 | 73,3 |
| Non smoker | 2 | 6,7 |

**BI = Brinkman Index*

The subjects were mostly male (93.3%), with the biggest proportion of over-60 years (56.7%). Regarding nutritional status based on BMI, most subjects were classified as underweight (50%). Additionally, a significant number of participants were smokers, with severe BI present in 22 subjects (73.3%) and moderate BI in 6 subjects (20%).Following chest therapy, the average PEF value increased from 29.20±6.26 to 35.60±7.65. This result demonstrates a significant impact of chest therapy on the increase in PEF values, with a P-value of <0.001. Table 2 provides further details.

Table 2.
The Impact of Chest Therapy on PEF Values in Patients with COPD Exacerbations in the Lung Care Unit

| PEF (Litre/Minute) | Mean±SD | P-*Value* |
|---|---|---|
| Before Chest Therapy | 29,20±6,26 | <0,001 |
| After Chest Therapy | 35,60±7,65 | |

Table 3 displays the frequency of BORG scale, mMRC scale, and CAT values among the subjects, along with an evaluation of the chest therapy impact on these three questionnaires.

Table 3.
The Impact of Chest Therapy on Reductions in the BORG Scale, mMRC Scale, and CAT Values in COPD Patients with Exacerbations in the Lung Care Unit

| Type of Examinations | Before Chest Therapy | | After Chest Therapy | | P-Value |
|---|---|---|---|---|---|
| | f(30) | % | f(30) | % | |
| BORG Scale | | | | | |
| 1 | 0 | 0 | 2 | 6,7 | <0,001 |
| 2 | 1 | 3,3 | 12 | 40 | |
| 3 | 4 | 13,3 | 8 | 26,7 | |
| 4 | 17 | 56,7 | 6 | 20 | |
| 5 | 6 | 20 | 2 | 6,7 | |
| 6 | 1 | 3,3 | 0 | 0 | |
| 7 | 1 | 3,3 | 0 | 0 | |
| mMRC Scale | | | | | |
| 1 | 5 | 16,7 | 6 | 20 | 0,564 |
| 2 | 10 | 33,3 | 10 | 33,3 | |
| 3 | 12 | 40 | 10 | 33,3 | |
| 4 | 3 | 10 | 4 | 13,3 | |
| CAT Value | | | | | |
| Low (0-10) | 0 | 0 | 1 | 3,3 | 0,001 |
| Moderate (11-20) | 7 | 23,3 | 16 | 53,3 | |
| High (>20) | 23 | 76,7 | 13 | 43,3 | |

According to the table above, the analysis of the BORG questionnaire indicated that the majority of research subjects were at scale 4, with 17 subjects (56.7%). After chest therapy, symptoms improved, resulting in most subjects moving to scale 2, which included 12 subjects (40%). For the mMRC questionnaire, a large portion of research subjects (40%) were on scale 3, followed by a reduction to scale 2 (33.3%), while some remained on scale 3 (33.3%) after chest therapy. The analysis of the CAT questionnaire before chest therapy revealed that the highest total score was recorded in the high symptom category, with 23 participants (76.7%); following that, the total CAT score decreased to the moderate symptom category, with 16 subjects (53.3%). The table above also demonstrates the noteworthy impact of chest therapy on the BORG scale ($P<0.001$) and the CAT score ($P = 0.001$) in patients with COPD exacerbation treated at RSUDZA. However, no statistically significant relationship was seen between chest treatment and a decrease in the mMRC scale ($P = 0.564$).

## DISCUSSION

The study comprised 30 patients with acute COPD exacerbations who received treatment at Dr. Zainoel Abidin Hospital in Banda Aceh. Most of the study participants were men (93.3%). The findings are consistent with Hyun's research in Korea, which revealed that 90.2% of COPD patients were male.(Gil et al., 2021) Raina's study at RSUDZA Aceh found that men had a higher rate of COPD at 83.3% (Muzlifa, 2018). The greater incidence of COPD in men is attributed to the risk factor of smoking. Men are 16 times more likely to smoke than women (65.9% vs. 4.2%). Smoking is the foremost cause of respiratory symptoms and reduced lung function, greatly outweighing other contributing factors (Antariksa et al., 2023). According to Cecilia's research in Malang, respondents who smoked

were 5.2 times more likely to get COPD than those who did not smoke (Imam et al., 2021).This study's subjects were predominantly older than 60 (56.7%). This result was supported by Hyun's research in Korea, which found that COPD patients have an average age of 72.1 ± 8.9 years (Gil et al., 2021). Another study by Merry-Lynn in United States discovered that most patient with COPD were 64 years old.(McDonald et al., 2019) Research in Aceh Province had similar results, with the vast majority of COPD responders (40.0%) falling between the ages of 56 and 65 (Muzlifa, 2018). Marie's research in Norway identified that those over the age of 65 were 10.3 times more likely to have COPD than people under the age of 40 (Waatevik et al., 2013). This is linked to a decrease in the capabilities of the body's organs, particularly a decline in lung function with age. A variety of alterations can occur in the lungs, including diminished alveolar elasticity, thickening of the bronchial glands, and decreased lung capacity. This reduction in lung function is caused by a variety of variables, including advancing age, poor environmental conditions, and the presence of comorbidities (Hall & AC, 2016).

The analysis of nutritional status using BMI revealed that the research individuals were mostly underweight (50%). Marrie's study in Norway found similar results, with almost half of COPD patients being underweight (49%) (Waatevik et al., 2013). According to a study conducted in Malang, individuals with an underweight nutritional status were 2.6 times more likely to develop COPD than those with a normal nutritional status (Imam et al., 2021). Meanwhile, a significant portion of COPD patients in Korea had normal dietary conditions, accounting for 36.8% (Gil et al., 2021). Weight loss in COPD patients is associated with increased breathing effort and respiratory muscle activity, resulting in higher resting energy expenditure, which can be 50-100% more than usual. COPD patients often experience malnutrition due to an imbalance between the body’s energy supply and its energy demands. In severe cases, COPD can lead to cachexia resulting from significant skeletal muscle loss (Kurniyanti et al., 2023).

An essential connection between nutrition and COPD is the impacts of catabolism, one of which considers nutritional status. If caloric intake is limited, the body will degrade proteins found in muscles, especially the respiratory muscles. Each muscle's function will be impacted as lean body mass is lost. Malnutrition also has a disadvantageous effect on lung structure, elasticity, and function, as well as on respiratory muscle strength and endurance, breathing control, and respiratory immune system. In contrast, respiratory disorders (such as COPD) increase energy demand while decreasing nutrient intake (Permatasari et al., 2016). Malnutrition and weight loss can impact the strength and endurance of respiratory muscles by decreasing muscle mass and fiber strength. In animal trials, malnutrition and anabolic/catabolic conditions led to emphysema. The association between malnutrition and lung function in humans is demonstrated by lung CT scans of women with inadequate nutrition caused by anorexia nervosa who developed emphysema (Antariksa et al., 2023).

The Brinkman Index was used to assess the respondents' smoking status, and the findings indicated that a large proportion of them were heavy smokers (73.3%). This study was supported by a research in Korea, which found that almost all of COPD patients (91.5%) were former or active smokers (Lee et al., 2016). Another study in Surakarta found similar results, with the majority of COPD patients being heavy smokers (45.5%) (Pratiwi et al., 2021). Cigarette smoke causes a variety of respiratory symptoms and lung function issues, including COPD. It is expected that 15-20% of smokers will get COPD (Antariksa et al., 2023).The association between smoking and COPD is dose-response; the more cigarettes smoked and the longer the behavior continues, the greater the chance of developing the condition. Smoking alters both the structure and function of the airways and lung tissue. These

modifications include mucosal cell hypertrophy and mucous gland hyperplasia. Increased cell and mucus buildup leads to irritation and constriction of the small airways. This results in a higher number of inflammatory cells in lung tissue and greater damage to the alveoli. These structural changes in the airways ultimately compromise lung function (Antariksa et al., 2023).

One of the issues with COPD patients is difficulty evacuating sputum, which affects the duration of improvement in the patient's clinical symptoms. Chest therapy is one of the non-pharmacological therapeutic techniques used on COPD patients to eliminate mucus, which is believed to enhance symptoms and lung function.(Pratiwi et al., 2021) In this study, a substantial difference was observed in peak expiratory flow (PEF) after chest therapy (P-value<0.001). Sholichin's study in Samarinda validated the findings of this study, which found that chest physiotherapy increased the mean value of PEF from 27.67 to 45.36 and had a significant effect on airway resistance based on PEF values (P-value<0.01) (Sholichin, 2018). A study in Yogyakarta discovered that practicing breathing exercises significantly increased PEF, with a P-value of <0.01 (Endrian & Rosa, 2015).In COPD patients, difficulty with expiration compared to inspiration leads to a decrease in PEF values. During expiration, increased positive pressure in the chest causes the airways to narrow or close, while negative pleural pressure during inspiration opens the airways as the alveoli expands. This allows air to enter the lungs easily but causes it to become trapped (air trapping), leading to shortness of breath (Hall & AC, 2016).

Chest physiotherapy in COPD patients may assist in the recovery process by eliminating mucus from the respiratory tract. This can improve pulmonary function as measured by FEV1 outcomes, which correspond with PEF values. Chest physiotherapy techniques are beneficial in enhancing respiratory ventilation, boosting respiratory system efficiency, expanding the chest cavity, strengthening respiratory muscles, and lowering airway secretions (Windradini et al., 2021). These improvements lead to increased PEF value following chest therapy.Evaluation of the BORG scale revealed that chest therapy had a substantial effect on lowering the BORG scale (P-value<0.001). The findings of this study align with those of Dimitrova's research, which found that physiotherapy reduced the average BORG scale by 0.9 points in COPD patients.(Dimitrova et al., 2017) Kilic found the opposite results in Turkey, where there was no notable effect of pulmonary rehabilitation on the average decline in the BORG scale (P-value = 0.314) (Kiliç et al., 2023). The BORG scale measures shortness of breath during exacerbations. After 6 days of chest therapy, the BORG scale score decreased significantly. This could be due to chest therapy's capabilities to remove airway secretions, relax the airways, and enhance lung function, resulting in fewer complaints of shortness of breath.

Chest therapy did not reduce the mMRC scale (P-value = 0.564). This finding was contradictory to Dimitrova's study, which found a strong association between physiotherapy and a reduction in the average mMRC scale (by 0.2 points) among COPD patients.(Dimitrova et al., 2017) Similarly, research by Kilic in Turkey showed that pulmonary rehabilitation significantly decreased the average mMRC scale (P-value < 0.001) (Kiliç et al., 2023). The mMRC Scale measures the degree of shortness of breath during daily activities, with a grading range of 0 to 4 (Devi & Widodo, 2022). Another study suggested that six sessions of nebulization combined with chest physiotherapy can reduce shortness of breath and promote thoracic expansion in COPD patients (Na'ima & Prasetya, 2020). This study's results differed from those of several earlier studies due to a variety of circumstances, including concomitant conditions and the severity of the disease in the patients studied. Only two individuals in this trial showed a one-point decline in mMRC scale scores after chest therapy. This signifies that

only a slight change occurred, and the analysis test conducted had no meaningful effect. According to the research, in patients with severe COPD, the mMRC scale is not very sensitive to detect noteworthy changes in physical activity restriction due to shortness of breath (Yorke et al., 2022).

The analysis of CAT scores revealed that the treatment of chest therapy reduced CAT scores (P-value = 0.001). This finding was aligned with a research in Surakarta, which demonstrated a significant difference in CAT scores before and after chest physical therapy combined with infrared treatment (the mean drop in CAT score was 3.73 points), with a P-value of 0.001 (Riswanda Satria Adi Prasojo, 2018). In London, James discovered that pulmonary rehabilitation reduced the average CAT score from 20.5 ± 7.4 to 17.5 ± 7.7 (P-value < 0.001).(Dodd et al., 2011) The reason is that the CAT questionnaire can both measure COPD patients' health condition and evaluate post-treatment results (Nahdah, 2020). Complaints of shortness of breath in COPD patients cause the body's compensatory response to minimize or limit physical activity, resulting in lower exercise tolerance, increased anxiety, impairment, and a poor quality of life.(Devi & Widodo, 2022) The impact of these COPD symptoms on daily activities can be thoroughly evaluated using CAT. Pulmonary rehabilitation for COPD patients can enhance functional ability and quality of life, resulting in lower CAT scores (Karloh et al., 2016).

Chest therapy, comprising postural drainage, chest percussion, and chest vibration, is useful for improving shortness of breath symptoms in individuals with COPD exacerbation, as measured by the BORG scale questionnaire, mMRC scale, and CAT. Postural drainage collects and mobilizes mucus in the cephalic direction, allowing it to be removed through coughing (Hill et al., 2018). Gravity helps transport mucus to the larger airways, where it can be eliminated more effectively. Furthermore, chest percussion (soft blows or pats on the chest wall with cupped hands) is used to dilute and mobilize mucus in the airways. The chest vibration technique begins with deep breathing, followed by gentle vibration of the anterior chest with the hands while exhaling. The objective is to ease down the airways and position the patient for effective coughing, which facilitates the expulsion of diluted mucus from the lungs (Grillo et al., 2021). Chest therapy will help alleviate symptoms of shortness of breath, leading to improvements in clinical symptoms as assessed by the BORG, mMRC, and CAT questionnaires.The results of the study may be limited due to the small sample size, which may not accurately represent the larger population. Furthermore, the study used an experimental design with no control group, limiting the capacity to make firm conclusions on the efficacy of chest therapy.

## CONCLUSION

Chest therapy enhances the lung function of patients with COPD exacerbations, as indicated by an increase in peak expiratory flow. This nonpharmacologic treatment also improves clinical symptoms, as evidenced by reductions in the BORG scale and the CAT scale. However, there was no significant clinical improvement observed based on the mMRC scale following chest therapy.

## REFERENCES

Agarwal, A. K., Raja, A., & Brown, B. D. (2024). Chronic Obstructive Pulmonary Disease. In StatPearls. StatPearls Publishing LLC.

Andrews, J., Sathe, N. A., Krishnaswami, S., & McPheeters, M. L. (2013). Nonpharmacologic Airway Clearance Techniques in Hospitalized Patients: A

Systematic Review. Respiratory Care, 58(12), 2160–2186. https://doi.org/10.4187/respcare.02704

Antariksa, B., Bakhtiar, A., Wiyono, W. H., & Al, E. (2023). PPOK: Pedoman Diagnosis dan Penatalaksaan PPOK di Indonesia. In B. Antariksa, A. Bahtiar, & W. H. Wiyono (Eds.), PDPI. PDPI.

Chen, X., Jiang, J., Wang, R., Fu, H., Lu, J., & Yang, M. (2022). Chest physiotherapy for pneumonia in adults. Cochrane Database of Systematic Reviews, 9. https://doi.org/10.1002/14651858.CD006338.pub4

Devi, I. M., & Widodo, A. (2022). Case Study : Program Fisioterapi pada Kasus Penyakit Paru Obstruktif Kronis ( PPOK ). Jurnal Kesehatan Dan Fisioterapi, 2(3), 60–66.

Dimitrova, A., Izov, N., Maznev, I., & Nikolova, M. (2017). Physiotherapy in Patients with Chronic Obstructive Pulmonary Disease. Journal of Medical Sciences, 5(6), 720–723.

Dodd, J. W., Hogg, L., Nolan, J., & Al, E. (2011). The COPD Assessment Test (CAT): Response to Pulmonary Rrehabilitation. A Multicentre, Prospective Study. BMJ, 1–6. https://doi.org/10.1136/thx.2010.156372

Endrian, & Rosa, E. M. (2015). Efektifitas Nafas dalam untuk Meningkatkan Arus Puncak Ekspirasi (Ape) pada Pasien Penyakit Paru Obstruktif Kronik (PPOK). Muhammadiyah Journal of Nursing, 35–40.

Gerungan, G., Runtu, F. B., & Bawiling, N. (2020). Karakteristik Penderita Penyakit Paru Obstruktif Kronis yang di Rawat Inap di Rumah Sakit Budi Setia Langowan. Jurnal Kesehatan Masyarakat UNIMA, 01(01), 1–8.

Gil, H. Il, Zo, S., Jones, P. W., Kim, B. G., Kang, N., Choi, Y., Cho, H. K., Kang, D., Cho, J., Park, H. Y., & Shin, S. H. (2021). Clinical Characteristics of COPD Patients According to COPD Assessment Test (CAT) Score Level: Cross-Sectional Study. International Journal of COPD, 16, 1509–1517.

Global Initiative for Chronic Obstructive Lung Disease. (2023). Global Startegy for the Diagnosis, Management and Prevention of Chronic Obstructive Pulmonary Disease (2023 Report).

Grillo, L. J. F., Housley, G. M., Gangadharan, S., Majid, A., & Hull, J. H. (2021). Physiotherapy for large airway collapse: an ABC approach. ERJ Open Research, 00510-2021. https://doi.org/10.1183/23120541.00510-2021

Hall, J. E., & AC, G. (2016). Textbook of Medical Physiology. Elsevier.

Hill, C. J., Lazzeri, M., & D'Abrosca, F. (2018). Breathing Exercises and Mucus Clearance Techniques in Pulmonary Rehabilitation. In Textbook of Pulmonary Rehabilitation (pp. 205–216). Springer International Publishing. https://doi.org/10.1007/978-3-319-65888-9_16

Imam, C. W., Ariyanti, R., & Rahayu, R. P. (2021). Kebiasaan Merokok sebagai Faktor Resiko Kejadian PPOK pada Lansia. In Tunas-Tunas Riset Kesehatan (Vol. 11).

Karloh, M., Fleig Mayer, A., Maurici, R., Pizzichini, M. M. M., Jones, P. W., & Pizzichini, E. (2016). The COPD Assessment Test: What Do We Know So Far? Chest, 149(2), 413–425. https://doi.org/10.1378/chest.15-1752

Kiliç, L., Önür, S. T., Dilektasli, A. G., Ulubay, G., & Balcı, A. (2023). Understanding the Impact of Pulmonary Rehabilitation on Airway Resistance in Patients with Severe COPD: A Single-Center Retrospective Study. International Journal of COPD, 18, 1–10.

Kurniyanti, N., Rahmawati, Kidingallo, Y., Wiriansya, E. P., & Selma, R. (2023). Karakteristik Pasien Penyakit Paru Obstruktif Kronik di Rumah Sakit Ibnu Sina Makassar. Fakumi Medical Journal, 3(5), 350–356.

Lee, J. Y., Chon, G. R., Rhee, C. K., Kim, D. K., Yoon, H. K., Lee, J. H., Yoo, K. H., Lee, S. H., Lee, S. Y., Kim, T. E., Kim, T. H., Park, Y. B., Hwang, Y. Il, Kim, Y. S., & Jung, K. S. (2016). Characteristics of Patients with Chronic Obstructive Pulmonary Disease at the First Visit to A Pulmonary Medical Center in Korea: The Korea Copd Subgroup Study Team cohort. Journal of Korean Medical Science, 31(4), 553–560. https://doi.org/10.3346/jkms.2016.31.4.553

McDonald, M. L. N., Wouters, E. F. M., Rutten, E., Casaburi, R., Rennard, S. I., Lomas, D. A., Bamman, M., Celli, B., Agusti, A., Tal-Singer, R., Hersh, C. P., Dransfield, M., & Silverman, E. K. (2019). It's more than Low BMI: Prevalence of Cachexia and Associated Mortality in COPD. Respiratory Research, 20(1), 1–9. https://doi.org/10.1186/s12931-019-1073-3

Muzlifa, R. (2018). Hubungan Indeks Brinkman dan Indeks Massa Tubuh dengan Hasil Spirometri Pasien Penyakit Paru Obstruktif Kronik (PPOK) di Poliklinik RSUDZA. Universitas Syiah Kuala.

Na'ima, A. L., & Prasetya, D. P. (2020). Penatalaksanaan Fisioterapi dengan Nebulisasi dan Chest Physiotehrapy terhadap Derajat Sesak Napas dan Ekspansi Thoraks pada Penderita Penyakit Paru Obstruksi Kronis (PPOK). Kajian Ilmiah Dan Kesehatan Teknologi, 2(1), 28–34.

Nahdah, C. N. (2020). Perbandingan Kualitas Hidup Pasien Penyakit Paru Obstruktif Kronis dengan Menggunakan Kuesioner COPD Assessment Test (CAT) dan Clinical COPD Questionnaire (CCQ). Universitas Muhammadiyah Sumatera Utara.

Permatasari, N., Saad, A., & Christianto, E. (2016). Gambaran Status Gizi pada Pasien PPOK yang Menjalani Rawat Jalan di RSUD Arifin Achmad Pekanbaru. In JOM FK (Vol. 3, Issue 2).

Pratiwi, A. F., Jatmiko, S. W., Hernawan, B., & Basuki, S. W. (2021). Hubungan Usia dan Merokok Terhadap Nilai Kapasitas Vital Paksa (KVP) Pada Pasien PPOK Stabil di BBKPM Surakarta. In Publikasi Ilmiah UMS.

Riswanda Satria Adi Prasojo. (2018). Perbedaan skor COPD Assessment Test (CAT) Sebelum dan Sesudah Infrared dan Chest Physical Therapy pada Pasien PPOK di RSUD Dr. Moewardi Surakarta. Universitas Sebelas Maret.

Sholichin. (2018). Pengaruh Fisioterapi Dada Terhadap Penurunan Resistensi Saluran Nafas Nonelastik dalam Asuhan Keperawatan Pasien PPOK di RSUD Abdul Wahab Syahranie Samarinda. Jurnal Kesehatan Pasak Bumi Kalimantan, 01(02), 84–95.

Waatevik, M., Skorge, T. D., Omenaas, E., Bakke, P. S., Gulsvik, A., & Johannessen, A. (2013). Increased Prevalence of Chronic Obstructive Pulmonary Disease in A General Population. Respiratory Medicine, 107, 1037–1045. https://doi.org/10.1016/j.rmed.2013.04.008

Windradini, F. L., Mubarokah, A. I., Widya, J., Maharani, & Lusiwati, R. (2021). Fisioterapi Dada Pada Penderita PPOK. Universitas Muhammadiyah Surakarta.

Yawn, B. P., Mintz, M. L., & Doherty, D. E. (2021). GOLD in Practice: Chronic Obstructive Pulmonary Disease Treatment and Management in the Primary Care Setting. International Journal of Chronic Obstructive Pulmonary Disease, Volume 16, 289–299. https://doi.org/10.2147/COPD.S222664

Yorke, J., Khan, N., Garrow, A., Tyson, S., Singh, D., Vestbo, J., & Jones, P. W. (2022). Evaluation of the Individual Activity Descriptors of the mMRC Breathlessness Scale: A Mixed Method Study. International Journal of Chronic Obstructive Pulmonary Disease, 17, 2289–2299. https://doi.org/10.2147/COPD.S372318