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Hubungan *Peak Expiratory Flow Rate* (PEFR) dengan Kualitas Tidur pada Pasien PPOK di Rumah Sakit Paru Provinsi Sumatera Utara

The Relationship Between Peak Expiratory Flow Rate (PEFR) and Sleep Quality in Patients with COPD at the Provincial Pulmonary Hospital of North Sumatera

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ABSTRACT / ABSTRAK

Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory disorder that can be prevented and treated, primarily characterized by persistent and progressive airway obstruction as well as increased airway inflammation due to exposure to toxic gases or particulate matter. This study aims to analyze the relationship between Peak Expiratory Flow Rate (PEFR) and sleep quality among COPD patients hospitalized at the North Sumatra Provincial Lung Hospital. The research method used was observational analytic with a cross-sectional design, and the data were analyzed using univariate, bivariate, and multivariate approaches. The results of the Pearson correlation test showed a very strong and significant correlation between PEFR and sleep quality among COPD patients, with a correlation coefficient of 0.672, a coefficient of determination (R^2) of 0.452, and a p-value of 0.000 (<0.05). Further analysis using the General Linear Model (GLM) indicated that demographic factors such as age, gender, and occupation did not have a significant effect on sleep quality ($p > 0.05$; $R^2 = 0.029$). These findings confirm that decreased pulmonary function has a more dominant influence on the sleep quality of COPD patients compared to demographic factors.

Keywords: *Peak Expiratory Flow (PEF), Sleep Quality, Chronic Obstructive Pulmonary Disease (COPD).*

Penyakit Paru Obstruktif Kronik (PPOK) merupakan penyakit pernapasan kronik yang dapat dicegah dan diobati, terutama ditandai dengan obstruksi saluran napas yang menetap dan progresif serta peningkatan peradangan saluran napas akibat paparan gas atau partikulat beracun. Penelitian ini bertujuan untuk menganalisis hubungan *Peak Expiratory Flow Rate* (PEFR) dengan kualitas tidur pasien PPOK yang dirawat di Rumah Sakit Paru Provinsi Sumatera Utara. Metode yang digunakan adalah observasional analitik dengan desain potong lintang, dan dianalisis secara univariat, bivariat, dan multivariat. Hasil uji korelasi Pearson menunjukkan adanya korelasi yang sangat kuat dan signifikan antara PEFR dan kualitas tidur pada pasien PPOK dengan koefisien korelasi sebesar 0,672, koefisien determinasi (R^2) sebesar 0,452, dan nilai p sebesar 0,000 ($<0,05$). Analisis General Linear Model (GLM) lebih lanjut menunjukkan bahwa faktor demografis pasien seperti usia, jenis kelamin, dan pekerjaan tidak berpengaruh signifikan terhadap kualitas tidur ($p > 0,05$; $R^2 = 0,029$). Temuan ini menegaskan bahwa penurunan fungsi paru lebih dominan memengaruhi kualitas tidur pasien PPOK dibandingkan faktor demografis.

Kata kunci: Aliran Puncak Ekspirasi (APE), Kualitas Tidur, Penyakit Paru Obstruktif Kronis (PPOK).

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory disorder that is actually preventable and treatable, characterized by persistent airflow limitation that tends to worsen, along with an increased chronic inflammatory response in the airways due to exposure to irritating particles or gases. The development of COPD is influenced by various risk factors, including smoking habits, exposure to chemicals and dust, air pollution, history of infections, genetic factors, age, sex, lung maturation, and socioeconomic conditions. Among all these factors, smoking is the primary cause that contributes most significantly to the occurrence of COPD. In Indonesia, the prevalence of smoking remains very high, with an average daily consumption of about one pack or 20 cigarettes per person. Therefore, the most effective efforts to prevent and control COPD are through smoking cessation, as it has been proven to prevent the onset of the disease as well as slow its progression (Najihah et al. 2023).

Chronic Obstructive Pulmonary Disease (COPD) represents a significant health burden as it not only affects physical function but also impacts the bio-psycho-social aspects of patients. This condition often leads to problems such as shortness of breath, anxiety, depression, and an overall decline in quality of life. The presence of anxiety and depression in COPD patients has been shown to increase morbidity rates, worsen health status, and prolong hospitalization. This raises global concerns regarding the high prevalence of psychological disorders among individuals with COPD. Data from the World Health Organization (WHO) show that approximately 350 million people worldwide suffer from depression, and among COPD patients, depression is recorded as one of the leading causes of disability, ranking third overall. These findings emphasize the importance of a comprehensive approach that not only focuses on physical management but also addresses mental and social aspects in the care of COPD (Satria, Suza & Tarigan 2022).

The systematic review conducted primarily focused on a limited selection of breathing techniques or exercises. However, there remain various additional methods that have not been widely explored or discussed in those reviews. Therefore, this systematic review aims to integrate a broader range of breathing techniques or exercises that may be utilized to alleviate dyspnea in individuals with COPD, thereby providing a more comprehensive overview of potential non-pharmacological interventions to improve patients' quality of life (Rahmi, Irawati & Waluyo 2023).

Given the high prevalence of COPD driven largely by smoking and environmental exposure, there is an urgent need to strengthen non-pharmacological interventions that can be implemented alongside medical therapy. Breathing exercises represent a simple, cost-effective, and evidence-based approach to improve pulmonary function, reduce dyspnea, and enhance overall quality of life among COPD patients. Nevertheless, existing studies have predominantly focused on limited breathing techniques, leaving gaps in understanding regarding the comparative effectiveness and applicability of other methods in diverse clinical settings. Therefore, this systematic review is essential to provide an updated, comprehensive synthesis of various breathing exercises used in COPD management, aiming to guide clinicians and policymakers in optimizing patient-centered rehabilitation strategies (Prasetya et al. 2019).

Therefore, this study aims to examine the association between Peak Expiratory Flow Rate (PEFR) and sleep quality among patients with Chronic Obstructive Pulmonary Disease

(COPD) admitted to the North Sumatra Provincial Lung Hospital, in order to provide empirical evidence on how pulmonary function decline contributes to sleep disturbances in COPD.

MATERIALS AND METHODS

This study employed an observational analytic design with a cross-sectional approach to examine the relationship between Peak Expiratory Flow Rate (PEFR) as the independent variable and sleep quality as the dependent variable among patients with Chronic Obstructive Pulmonary Disease (COPD). Both variables were measured simultaneously at a single point in time, without any intervention or manipulation by the researchers, to reflect real clinical conditions. The study was conducted at the North Sumatra Provincial Lung Hospital, a tertiary referral center specializing in pulmonary diseases, from March to August 2025.

The study population included all hospitalized COPD patients, with a total of 70 respondents selected through total sampling. Inclusion criteria were patients aged ≥ 18 years with confirmed COPD who provided informed consent, while those with acute infections or severe comorbidities were excluded. PEFR was measured using a Mini-Wright peak flow meter, and sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). Data were collected through structured interviews and direct measurement. Statistical analyses were performed using Pearson's correlation test and the General Linear Model (GLM) with a significance level of $p < 0.05$. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Prima Indonesia (No. 176/KEPK/UNPRI/IV/2025), and all participants signed informed consent forms.

RESULTS

Table 1. Frequency Distribution of Respondent Characteristic

Characteristic		Frequency	Percentage
Age	0-12	3	4.3
	12-18	1	1.4
	18-59	44	62.9
	>59	22	31.4
Gender	Male	40	57.1
	Female	30	42.9
Occupation	Employed	45	64.3
	Unemployed	25	35.7

Source: Primary Data (processed), 2025

The majority of COPD patients fall within the 18–59 years age group (44 patients, 62.9%), followed by the >59 years age group (22 patients, 31.4%). The 0–12 years and 12–18 years age groups consist of only 3 patients (4.3%) and 1 patient (1.4%), respectively. This distribution indicates that, in general, the disease occurs predominantly in adults and the elderly, while cases among children and adolescents are very limited. This finding is consistent with previous documentation stating that COPD patients are usually over 40 years old, as lung damage is a progressive problem that develops through long-term exposure to risk factors such as smoking, air pollution, and recurrent respiratory infections.

The majority of COPD patients were male, totaling 40 individuals (57.1%), while females accounted for 30 individuals (42.9%). This distribution indicates that COPD is more prevalent among males compared to females. This finding aligns with previous research and literature, which state that men have a higher risk of developing COPD due to higher smoking rates, longer exposure to cigarette smoke, and greater exposure to environmental risk factors such as dust and air pollution compared to women.

The majority of COPD patients were employed, totaling 45 individuals (64.3%), while 25 patients (35.7%) were unemployed. This distribution indicates that most COPD patients remain actively employed, which is likely associated with exposure to environmental risk factors in the workplace, such as cigarette smoke, industrial dust, vehicle emissions, and other air pollutants. This finding is consistent with the literature, which notes that long-term exposure to pulmonary irritants in occupational settings can increase the risk of developing COPD.

Table 2. Frequency Distribution of Peak Expiratory Flow among COPD Patients

Variable	Mean	Median	Modus	Minimum	Maximum
Peak Expiratory Flow	54.2 L/menit	54.25 L/menit	47 L/menit	11 L/menit	113 L/menit
Sleep Quality	10.61	9	15	1	21

Source: Primary Data (processed), 2025

Based on the measurement results of Peak Expiratory Flow (PEF) among respondents, the mean value was 54.2 L/min, the median was 54.25 L/min, and the mode was 47 L/min, with a minimum of 11 L/min and a maximum of 113 L/min. These results indicate that the respondents' peak expiratory capacity was generally within the moderate range, with most PEF values concentrated around 47–54 L/min.

The relatively wide range reflects variations in expiratory ability among respondents. The close proximity of the mean, median, and mode suggests that the data distribution tends to be normal, although the presence of a high maximum value indicates a slight right skew (positively skewed). Overall, the majority of respondents demonstrated a relatively moderate peak expiratory capacity, with a few individuals showing extreme values, either low or high.

Based on the measurement of respondents' sleep quality, the mean score was 10.61, the median was 9, and the mode was 15, with a minimum value of 1 and a maximum value of 21. These results indicate that, on average, respondents experienced moderate sleep quality, while the most frequently observed score was 15. The wide range of scores (1–21) reflects substantial variability in sleep quality among respondents, spanning from very good sleep quality (lower scores) to very poor sleep quality (higher scores).

Table 3. The Relationship Between Peak Expiratory Flow (PEF) and Sleep Quality in COPD Patients at the COPD Clinic of the Provincial Government Pulmonary Hospital of North Sumatra in 2025

Percentile	n	p-Value	r-Value
Peak Expiratory Flow	70	0.000	0.672
Sleep Quality	70		

Source: Primary Data (processed), 2025

The Pearson correlation test showed a value of $r = 0.672$ with a p -value = 0.000 ($p < 0.05$). This indicates a strong and statistically significant relationship between Peak Expiratory Flow (PEF) and sleep quality in COPD patients.

The correlation coefficient was positive, meaning that the higher the PEF value, the higher the sleep quality score. In this measurement, a higher sleep quality score indicates poorer sleep quality; therefore, these findings suggest that a decline in PEF is associated with worsening sleep quality in COPD patients.

These results are consistent with respiratory physiology theory in COPD, where reduced lung capacity leads to sleep disturbances due to nocturnal dyspnea, increased respiratory muscle effort, and the risk of nocturnal hypoxia. Hence, interventions aimed at maintaining or improving lung capacity in COPD patients have the potential to enhance their sleep quality.

Table 4. Linear Regression of the Relationship Between Peak Expiratory Flow (PEF) and Sleep Quality in COPD Patients at the COPD Clinic of the Provincial Government Pulmonary Hospital of North Sumatra in 2025

Model					
Model Summary	R	R Square	Adjusted R Square	Std. Error of the Estimate	
1	.672 ^a	0.452	0.444	3.888	

Model ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Regression	846.664	1	846.664	56.009	.000 ^b
1 Residual	1027.921	68	15.116		
Total	1874.586	69			

Source: Primary Data (processed), 2025

The simple linear regression analysis revealed a moderate positive correlation between Peak Expiratory Flow (PEF) and sleep quality in COPD patients, with an R value of 0.672. The coefficient of determination ($R^2 = 0.452$) indicates that PEF accounts for 45.2% of the variance in sleep quality, while the remaining 54.8% is likely influenced by other factors not examined in this study (Table 4).

The ANOVA results showed $F = 56.009$ with a significance level of $p = 0.000$ ($p < 0.05$), indicating that the regression model is statistically significant. This suggests that PEF values have a significant effect on the sleep quality of COPD patients attending the COPD Clinic at the Provincial Pulmonary Hospital of North Sumatra in 2025 (Table 4).

Based on the results of the General Linear Model (GLM) analysis, age ($F = 44.986$, $p = 0.000$) and gender ($F = 69.234$, $p = 0.000$) were found to have a significant effect on sleep quality among COPD patients, whereas occupation ($F = 0.496$, $p = 0.611$) and interaction terms (age $\times$ gender, age $\times$ occupation, gender $\times$ occupation) did not show significant effects. The model explains a small proportion of the variance in sleep quality, with $R^2 = 0.025$, indicating that these variables account for only 2.5% of the total variation. This suggests that other factors—such as COPD severity, smoking history, nutritional status, and treatment adherence—are likely more influential in determining patients' sleep quality (Table 5).

Table 5. The Relationship between Age, Gender, and Occupation with Sleep Quality in COPD Patients at the COPD Clinic of the Provincial Lung Hospital of North Sumatra, 2025

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	50.513 ^a	6	8.419	0.291	0.939
Intercept	971.617 ^b	6	161.936	0.220	0.969
Age	1302.497	1	1302.497	44.986	0.000
Gender	51018.003	1	51018.003	69.234	0.000
Occupation	28.734	2	14.367	0.496	0.611
Age * Gender	517.274	2	258.637	0.351	0.705
Age * Occupation	0.650	1	0.650	0.022	0.881
Gender * Occupation	85.421	1	85.421	0.116	0.735
Age * Gender * Occupation	0.000	0			
Error	0.000	0			
Total	6.282	1	6.282	0.217	0.643
Corrected Total	210.047	1	210.047	0.285	0.595

Source: Primary Data (processed), 2025

DISCUSSIONS

The Relationship Between Peak Expiratory Flow (PEF) Value and Sleep Quality in COPD Patients

The results of the study showed a very strong and significant relationship between Peak Expiratory Flow (PEF) values and sleep quality in COPD patients, with a Pearson correlation coefficient of $r = 0.672$ and $p\text{-value} = 0.000$ ($p < 0.05$). This positive correlation indicates that the higher the PEF value, the higher the sleep quality score. In this measurement, a higher sleep quality score reflects poorer sleep quality, meaning that a decrease in PEF is closely related to worsening sleep quality in COPD patients.

Physiologically, this finding can be explained through the pathophysiological mechanisms of COPD. A decrease in PEF reflects airway obstruction and reduced lung elasticity, which affect expiratory difficulty, particularly at night. This condition leads to nocturnal dyspnea, recurrent coughing, increased respiratory muscle workload, and nocturnal hypoxemia, ultimately disrupting patients' sleep continuity. This aligns with the concept of sleep-related breathing disorders in COPD, where impaired lung function directly affects sleep quality (Putri Setyaningrum et al., 2024).

The findings of this study align with those of Dai and Kwok (2025), who reported that pulmonary rehabilitation (PR) significantly improves sleep quality in patients with chronic obstructive pulmonary disease (COPD). Their meta-analysis emphasized that the optimization of PR components—such as exercise intensity, duration, and frequency—plays a crucial role in enhancing sleep outcomes, although further research is warranted to determine the most effective intervention design. Similarly, Mazzola et al. (2025) identified a significant association between impaired lung function and symptoms of sleep disorders in community-based populations without prior respiratory diagnoses. This supports the hypothesis that reduced pulmonary function may contribute to sleep disturbances through physiological pathways such as nocturnal hypoxemia and systemic inflammation.

The findings of this study are supported by Alharbi et al. (2025), who reported that COPD/OSA overlap syndrome causes more severe cognitive impairment due to nocturnal hypoxemia and systemic inflammation. These mechanisms may also explain the link between lower Peak Expiratory Flow (PEF) values and poor sleep quality in COPD patients, as reduced lung function can lead to oxygen desaturation and sleep fragmentation.

Moreover, a previous nationwide survey in Korea demonstrated that impaired lung function is closely linked to metabolic syndrome components, including increased waist circumference, elevated triglycerides, and higher systolic blood pressure (Kim et al., 2023). These findings indicate that metabolic dysregulation and respiratory impairment share overlapping pathophysiological mechanisms, particularly insulin resistance and systemic inflammation, which may further exacerbate sleep quality deterioration in COPD patients. Taken together, these studies underscore a multidimensional relationship between lung function, metabolic health, and sleep quality, suggesting that integrated management strategies—targeting both pulmonary and metabolic risk factors—may yield the most substantial benefits for improving sleep and overall patient outcomes.

The Relationship of Age, Gender, and Occupation with Sleep Quality among COPD Patients at the COPD Clinic of the Pulmonary Hospital, Provincial Government of North Sumatra, 2025

Based on the analysis using the General Linear Model (GLM) with a univariate ANOVA approach, the overall model yielded $F = 0.291$ with $p = 0.939$ ($p > 0.05$). This indicates that, simultaneously, the variables of age, gender, and occupation did not have a significant effect on sleep quality in COPD patients at the COPD Clinic of the Pulmonary Hospital, Provincial Government of North Sumatra in 2025. The R^2 value of 0.029 shows that these three demographic variables could only explain 2.9% of the variation in sleep quality scores, while the remaining 97.1% is influenced by other factors not included in this study, such as patients' clinical conditions, lifestyle, sleep environment, and adherence to COPD therapy.

Individually, the age variable ($p = 0.000$) showed a significant effect on sleep quality. This means that although age groups were categorized into children, adolescents, adults, and the elderly, there was a significant difference in sleep quality among these groups. This finding can be explained by the chronic and progressive nature of COPD, where sleep quality is more determined by the severity of respiratory symptoms rather than age. In COPD patients, symptoms such as chronic cough, nocturnal dyspnea, and increased sputum production tend to be the primary factors disrupting sleep, regardless of age group.

The gender variable ($p = 0.000$) also showed a significant effect on sleep quality. In other words, male and female patients in this study population had significantly different sleep quality. This aligns with previous studies indicating that differences in sleep quality in COPD patients are not determined by gender but rather by clinical factors such as exacerbation frequency, nocturnal hypoxemia, and the severity of airway obstruction. Although, in general, women are more susceptible to sleep disturbances such as insomnia, in COPD, this effect may be overshadowed by the dominant influence of pulmonary pathophysiology affecting both genders differently.

Similarly, the occupation variable ($p = 0.611$) did not significantly influence sleep quality. The analysis showed almost no difference in mean sleep quality scores between

employed and unemployed patients, resulting in an F value of 0.496. This phenomenon likely occurs because employment status in COPD patients more reflects age and physical capacity rather than a direct factor affecting sleep quality. Additionally, in this study, the distribution of occupation was relatively homogeneous: most respondents were of working age, while unemployed patients were generally elderly with reduced physical capacity. This also introduced collinearity with the age variable, making the effect of occupation in the statistical model non-significant.

The present study investigated the relationship between age, gender, and occupation with sleep quality among COPD patients at the COPD Clinic of the Pulmonary Hospital, Provincial Government of North Sumatra in 2025. The findings revealed that none of these demographic variables showed a statistically significant association with sleep quality. This suggests that, within this study population, variations in sleep quality were more likely influenced by disease-related clinical factors rather than sociodemographic characteristics.

The results are consistent with the study by Du et al. (2023), who reported that sleep disorders are prevalent among COPD patients regardless of gender, and tend to increase with advancing age, primarily due to respiratory symptom severity rather than demographic differences. Similarly, Bouloukaki et al. (2024) found that sleep impairment in COPD patients was strongly associated with disease severity, fatigue, depression, and anxiety levels, indicating that physiological and psychological aspects of COPD play a dominant role in determining sleep quality, independent of age.

Regarding gender, Milne et al. (2024) emphasized sex-related differences in COPD pathophysiology, where females exhibit smaller airway calibers, greater dyspnea, and higher symptom burden compared to males. However, despite these anatomical and functional disparities, our findings showed no significant difference in sleep quality between male and female patients. This may suggest that pulmonary dysfunction exerts a more uniform impact on sleep across genders, potentially overshadowing the effects of biological sex differences.

The absence of a significant relationship between occupation and sleep quality aligns with Wang et al. (2025), who found that occupational physical activity (OPA) level influences sleep disturbances primarily among younger, healthy working adults. In COPD populations, however, occupational status may not directly influence sleep, as most patients have limited physical capacity due to chronic respiratory impairment. Consequently, occupational variation in this cohort was likely insufficient to produce measurable differences in sleep outcomes.

Additionally, Dai and Kwok (2025) demonstrated that pulmonary rehabilitation (PR) improves sleep quality in COPD patients through enhanced respiratory function and physical endurance. This supports the notion that clinical management and physiological recovery—rather than static demographic factors—play a key role in determining sleep outcomes in COPD.

Practically, these results emphasize that efforts to improve sleep quality in COPD patients should focus on controlling nocturnal respiratory symptoms, optimizing pharmacological and non-pharmacological therapies, and educating patients about sleep hygiene. Interventions targeting clinical factors are expected to be more effective than those based on demographic variables, such as workload adjustments or age- and gender-specific programs. Therefore, this study provides important information for clinicians and COPD

service managers that strategies for improving patients' sleep quality should prioritize disease control and pulmonary rehabilitation (Asyrofy, Arisdiani & Aspihan, 2021).

CONCLUSION

This study provides compelling evidence that reduced Peak Expiratory Flow (PEF) is independently associated with poorer sleep quality in patients with Chronic Obstructive Pulmonary Disease (COPD). These findings suggest that respiratory impairment and sleep dysregulation share common physiological pathways, emphasizing the importance of comprehensive management that integrates pulmonary rehabilitation and sleep optimization. Future multicenter studies are warranted to confirm these associations and explore targeted interventions to enhance overall patient outcomes.

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