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Correlation Between Fagerstrom Score and Brinkman Index with Spirometry Results in Lung Cancer Patients at Haji Adam Malik General Hospital and Prof. Dr. Chairuddin Panusunan Lubis Hospital University of North Sumatra Medan

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Lung cancer, Fagerstrom Test, Brinkman Index, Spirometry, Smoking, Nicotine dependence.

Abstract
Lung cancer is one of the leading causes of cancer-related deaths globally. Cigarette smoking remains the primary risk factor. The Fagerstrom Test for Nicotine Dependence (FTND) and the Brinkman Index are used to assess nicotine addiction and smoking intensity, respectively. These indices are associated with pulmonary function, typically assessed through spirometry. The research aims to determine the relationship between Fagerstrom scores and Brinkman Index with spirometry results in lung cancer patients. This quantitative observational study applied a cross-sectional design involving 68 smoking lung cancer patients at RSUP Haji Adam Malik and RS Prof. CPL Universitas Sumatera Utara. Data were collected via FTND and Brinkman Index questionnaires and spirometry testing. Data were analyzed using the Kruskal-Wallis test with a significance level of $p < 0.05$.
Results: Most patients exhibited moderate nicotine dependence (44.1%) and moderate smoking history per Brinkman Index (52.9%). Spirometry results indicated a high prevalence of obstructive and restrictive impairments. There was a significant correlation between FTND/Brinkman Index and lung function ($p < 0.001$). Both Fagerstrom scores and Brinkman Index show a strong relationship with spirometry outcomes, indicating impaired pulmonary function among lung cancer patients.

INTRODUCTION

Lung cancer continues to be a significant public health burden worldwide. It remains the leading cause of cancer-related mortality, accounting for an estimated 1.8 million deaths annually, according to Global Cancer Observatory data from 2020. The disease is characterized by poor prognosis and low five-year survival rates, especially when diagnosed at an advanced stage. The global incidence and mortality of lung cancer are heavily influenced by the

prevalence of cigarette smoking, which is the most well-established and modifiable risk factor for the disease (Aktalina, 2019; Subroto et al., 2022; Frieden, 2010; Nugroho et al., 2023).

According to the latest data from the Indonesian Ministry of Health (2024), lung cancer represents the leading cause of cancer mortality in Indonesia, with an estimated 30,843 new cases and 26,069 deaths annually. The age-standardized incidence rate has increased from 23.1 per 100,000 in 2020 to 25.8 per 100,000 in 2023, representing a concerning 11.7% increase over three years. More alarmingly, Indonesia maintains one of the world's highest smoking prevalence rates, with 2023 data showing that 62.9% of Indonesian men and 4.8% of women are active smokers, representing approximately 69.1 million smokers nationwide (Indonesian Basic Health Research, 2023).

The economic burden of smoking-related diseases in Indonesia reached IDR 596.9 trillion (approximately USD 40 billion) in 2023, with lung cancer accounting for 23.4% of this total cost. North Sumatra Province, where this study was conducted, ranks third nationally in lung cancer incidence with 2,147 new cases in 2023, showing a 15.2% increase from 2022 data (North Sumatra Provincial Health Office, 2024). These statistics underscore the urgent need for comprehensive smoking assessment and intervention strategies in Indonesian healthcare settings.

Tobacco smoke contains more than 7,000 chemicals, of which at least 70 are known carcinogens. Chronic exposure leads to cellular mutations, inflammation, and progressive damage to the respiratory tract. In Indonesia, smoking is a major public health crisis, particularly among adult males. The country is currently ranked among the top three globally in terms of male smoking prevalence. This reality places Indonesia at heightened risk for smoking-related diseases, including chronic obstructive pulmonary disease (COPD), cardiovascular disease, and notably, lung cancer (Aktalina, 2019; Subroto et al., 2022; Nugroho et al., 2023).

Recent Indonesian studies have provided valuable insights into the smoking-lung cancer relationship. Nugroho et al. (2023) conducted a comprehensive analysis of 312 lung cancer patients across three major Indonesian hospitals, demonstrating that patients with Brinkman Index ≥600 showed significantly worse CT scan findings and shorter overall survival (median 8.2 months vs. 14.7 months, $p<0.001$). Similarly, Asmara et al. (2023), in their multi-center Indonesian lung cancer study involving 1,247 patients, found that 89.3% of male lung cancer patients had a smoking history, with 67.8% classified as heavy smokers according to the Brinkman Index.

In the broader Asian context, Kim et al. (2022) conducted a landmark study in South Korea examining 2,891 lung cancer patients and found strong correlations between FTND scores and spirometric abnormalities, with patients scoring ≥6 on FTND showing 3.2 times higher risk of severe pulmonary dysfunction compared to those with lower scores. Wang et al. (2023), in their Chinese cohort study of 1,156 lung cancer patients, demonstrated that combined assessment using both FTND and Brinkman Index provided superior predictive value for post-operative pulmonary complications compared to either tool used independently (AUC 0.847 vs. 0.721 and 0.769, respectively).

These regional studies have established the relevance of smoking assessment tools in Asian populations but have not specifically examined the correlations between these standardized indices and detailed spirometric parameters in the Indonesian context, particularly in North Sumatra where unique genetic and environmental factors may influence these relationships.

The Fagerstrom Test for Nicotine Dependence (FTND) is a validated tool used worldwide to evaluate the intensity of physical addiction to nicotine. It considers behavioral and temporal patterns of cigarette use, making it a useful indicator of the difficulty an individual may experience in quitting smoking. Another useful metric is the Brinkman Index, which calculates smoking exposure by multiplying the number of cigarettes smoked per day by the number of years of smoking. Both tools are simple yet powerful in clinical and research settings to stratify smoking burden (Nugroho et al., 2023; Heatherton et al., 1991; Prokhorov et al., 2017).

Lung function assessment through spirometry is critical in diagnosing and managing both obstructive and restrictive pulmonary diseases. It provides key parameters such as Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and the FEV1/FVC ratio. These indicators help detect patterns of airflow limitation and lung compliance. In patients with lung cancer, spirometry also serves an important role in preoperative evaluation and in predicting treatment tolerance and outcomes (Lamb et al., 2023; Hyatt & Enright, 1987).

Despite the clear link between smoking and pulmonary dysfunction, the direct correlation between standardized smoking indices (FTND and Brinkman Index) and spirometric parameters has not been extensively explored in lung cancer patients in Indonesia. While international studies have examined these relationships in COPD patients and healthy smokers, the unique context of lung cancer patients—who often present with mixed pulmonary pathology from both smoking-induced damage and tumor-related effects—requires specific investigation.

The novelty of this study lies in several key aspects: (1) it represents the first comprehensive analysis in North Sumatra specifically examining the correlation between dual smoking assessment tools (FTND and Brinkman Index) and detailed spirometric parameters in lung cancer patients; (2) it addresses the gap in understanding how these validated smoking indices perform in the Indonesian population, considering genetic, environmental, and behavioral factors unique to this region; and (3) it provides practical clinical insights for Indonesian oncologists and pulmonologists by demonstrating which smoking assessment tools are most predictive of pulmonary dysfunction in local lung cancer patients.

This research is particularly significant for Indonesian healthcare settings where advanced pulmonary function testing may be limited, and simple, validated smoking assessment tools could serve as important screening and monitoring instruments for lung cancer patients.

Therefore, this study seeks to fill this gap by examining the relationship between smoking behavior and pulmonary function in a cohort of lung cancer patients. The insights gained may provide evidence to support early intervention strategies, targeted screening, and more personalized clinical care (Lamb et al., 2023; Hyatt & Enright, 1987).

Nicotine addiction, measured using the Fagerstrom Test for Nicotine Dependence (FTND), and the Brinkman Index, which assesses smoking intensity, are established tools for evaluating smoking behavior. Long-term and intense smoking has been shown to impair lung function, which can be quantified using spirometry—a non-invasive test to evaluate obstructive and restrictive lung patterns.

This study aims to determine the correlation between nicotine dependence and smoking intensity, as assessed by FTND and the Brinkman Index, and pulmonary function outcomes measured through spirometry in lung cancer patients. The findings may offer insights into early detection and monitoring of lung function decline in smokers diagnosed with lung cancer.

RESEARCH METHODS

A cross-sectional study was conducted at Haji Adam Malik General Hospital and Prof. Dr. Chairuddin Panusunan Lubis Hospital University of North Sumatera Medan between November 2024 and June 2025. Inclusion criteria included diagnosed lung cancer patients with a current or prior smoking history who provided informed consent. Exclusion criteria included patients with acute respiratory infections, those unable to perform spirometry due to severe illness, patients with other primary malignancies affecting the lungs, and those who refused to participate or were unable to provide informed consent.

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, University of North Sumatra (No. 045/KEP FK USU-RSUP HAM/2024) and the Ethics Committee of Prof. Dr. Chairuddin Panusunan Lubis Hospital (No. 126/KEPPKD-CL/XI/2024). All participants provided written informed consent after receiving detailed explanation about the study purpose, procedures, potential risks, and benefits. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Patient confidentiality was maintained through the use of coded identifiers, and data were stored securely with access limited to authorized research personnel.

Using correlation sample estimation with $r = 0.4$, $\alpha = 0.05$, and $\beta = 0.20$, the minimum sample size was calculated to be 47. A total of 68 eligible patients were recruited. The sample size calculation was performed using G*Power 3.1.9.7 software, with the correlation coefficient based on preliminary data from similar studies in Asian populations. To account for potential dropouts and ensure adequate power for subgroup analyses, the final sample was increased to 68 patients.

Demographic information, FTND scores, and Brinkman Index values were collected using structured questionnaires administered by trained research assistants. The questionnaires were translated into Bahasa Indonesia and back-translated to ensure linguistic validity. A pilot study with 10 patients was conducted to verify questionnaire comprehensibility and cultural appropriateness before the main data collection.

The Fagerstrom Test for Nicotine Dependence (FTND) has been validated for use in the Indonesian population by Suryo et al. (2022), showing good internal consistency (Cronbach's $\alpha = 0.847$) and test-retest reliability ($r = 0.891$) in a study of 284 Indonesian smokers. The Indonesian version demonstrated similar psychometric properties to the original

English version, with cultural adaptations made for items related to smoking patterns and social contexts.

The Brinkman Index, being a mathematical calculation (cigarettes per day × years of smoking), does not require cultural validation but was calculated using standardized procedures. Research assistants were trained to accurately collect smoking history data, with particular attention to distinguishing between different tobacco products commonly used in Indonesia (kretek cigarettes, white cigarettes, traditional tobacco) and converting consumption to standardized cigarette equivalents.

Spirometry was performed by trained personnel and interpreted according to American Thoracic Society guidelines. Spirometry testing was conducted using a calibrated MasterScreen PFT spirometer (CareFusion, Germany) according to the 2019 American Thoracic Society/European Respiratory Society guidelines. All tests were performed by certified pulmonary function technicians who completed standardized training. Quality control measures included daily calibration checks, and only tests meeting acceptability and repeatability criteria were included in the analysis. Predicted values were calculated using the Global Lung Function Initiative (GLI) reference equations appropriate for the Asian population.

Descriptive statistics were used to summarize the data. The Kruskal-Wallis test was employed to assess associations between FTND, Brinkman Index, and spirometric patterns (obstructive or restrictive). A p-value of <0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 28.0 (IBM Corporation, Armonk, NY, USA). Normality of data distribution was assessed using the Shapiro-Wilk test and histogram visualization. For non-normally distributed data, non-parametric tests were used. Pearson correlation analysis was performed for continuous variables with normal distribution, while Spearman's rank correlation was used for non-parametric data. Multiple linear regression analysis was conducted to identify independent predictors of spirometric parameters, with adjustment for potential confounding variables including age, gender, education level, and lung cancer stage.

RESULTS AND DISCUSSION

Study Population Characteristics

A total of 68 lung cancer patients with a history of smoking participated in the study. The results are presented in several subsections, including demographic characteristics, Fagerstrom scores, Brinkman Index, spirometry outcomes, and statistical correlation analyses between the variables. The population consisted 55 males (80.9%) and 13 females (19.1%), suggesting a predominance of smoking and lung cancer cases in men, which is consistent with global epidemiological trends. The most common age group was 61–70 years (44.1%), indicating that lung cancer is more prevalent among older individuals who likely have longer cumulative exposure to smoking.

In terms of educational background, the majority had completed senior high school (52.9%) or held an undergraduate degree (44.1%). A wide range of occupations was reported, with entrepreneurs (26.5%) and farmers (20.6%) being the most represented. These

sociodemographic factors may reflect lifestyle behaviors and environmental exposure related to tobacco consumption.

Table 1. Demographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	55	80.9
	Female	13	19.1
Age Group	40–50 years	9	13.2
	51–60 years	19	27.9
	61–70 years	30	44.1
	>70 years	10	14.7
Education	Junior High	1	1.5
	Senior High	36	52.9
	Undergraduate	30	44.1
	Postgraduate	1	1.5
Occupation	Entrepreneur	18	26.5
	Housewife	7	10.3
	Retired	7	10.3
	Teacher	1	1.5
	Farmer	14	20.6
	Civil Servant	6	8.8
	State Employee	2	2.9
	Private Worker	5	7.4
	Laborer	8	11.8

The nicotine dependence levels, measured using the Fagerstrom Test, showed that nearly half of the patients (44.1%) had a moderate level of dependence. Meanwhile, 29.4% had low dependence, and a quarter (25%) had high dependence. Only 1.5% showed very low dependence. This distribution illustrates that most lung cancer patients in this cohort had a significant degree of nicotine addiction, which likely contributed to long-term pulmonary damage.

Table 2. Fagerstrom Test

FTND Score Category	Frequency (n)	Percentage (%)
Very Low (0–2)	1	1.5
Low (3–4)	20	29.4
Moderate (5)	30	44.1
High (6–7)	17	25.0

The Brinkman Index, used to assess cumulative smoking exposure, revealed that the majority (52.9%) of patients fell into the moderate category, while 38.2% were classified as heavy smokers. Only 8.8% were considered light smokers. This finding aligns with previous literature that associates higher Brinkman Index scores with an increased risk of lung cancer and impaired lung function.

Table 3. Brinkman Index

Brinkman Category	Frequency (n)	Percentage (%)
Light (<200)	6	8.8

Moderate (200–599)	36	52.9
Heavy (≥600)	26	38.2

The result of correlation between Fagerstrom Test for Nicotine Dependence and Brinkman Index using Pearson's correlation test showed a statistically significant positive correlation between the two variables ($r = 0.690$, $p < 0.001$, $N = 68$). This indicates that individuals who have a higher cumulative exposure to cigarette smoke (as measured by the Brinkman Index) also tend to have a higher level of nicotine dependence (as assessed by the Fagerstrom Test).

Table 4. Pearson Correlation between Brinkman Index and Fagerstrom Test Score

Variable	Brinkman Index	Fagerstrom Score	p-value	N
Brinkman Index	1.000	0.690**	<0.001	68
Fagerstrom Score	0.690**	1.000	<0.001	68

Spirometry results were diverse, revealing various degrees of respiratory impairment. More than half (55.9%) showed no obstructive defects, while 17.6% had severe obstruction, and 16.2% exhibited very severe obstruction. Mild and moderate obstructions were observed in 4.4% and 5.9% of patients, respectively. On the restrictive spectrum, 32.4% had mild restriction, 30.9% moderate, and 19.1% severe, while 17.6% had normal findings.

Table 5. Spirometry Results

Spirometry Type	Severity	Frequency (n)	Percentage (%)
Obstruction	None	38	55.9
	Mild	3	4.4
	Moderate	4	5.9
	Severe	12	17.6
	Very Severe	11	16.2
Restriction	None	12	17.6
	Mild	22	32.4
	Moderate	21	30.9
	Severe	13	19.1

Discussion

Demographic Profile and Regional Context

The findings of this study clearly indicate a significant relationship between the degree of nicotine dependence, smoking intensity, and impaired lung function in lung cancer patients. The majority of participants were male (80.9%), in line with global trends indicating that men are more likely to smoke and therefore are more susceptible to developing lung cancer. This finding is particularly relevant in the Indonesian context where cultural and social factors strongly influence smoking patterns. According to the 2023 Indonesian Global Adult Tobacco Survey, the male smoking prevalence in North Sumatra (69.2%) exceeds the national average, which may explain the pronounced gender disparity observed in our lung cancer patient population.

Most patients fell within the 61–70 age group, which is consistent with the age at which lung cancer is typically diagnosed. Smoking history accumulates over time, which explains the appearance of symptoms and diagnosis in later life (Keputusan Menteri Kesehatan Republik Indonesia, 2023; Tim Editor, 2016). The mean age of 62.4 ± 8.7 years in our study aligns closely with national Indonesian lung cancer registry data showing peak incidence at 60-65 years. This age distribution reflects the cumulative effect of smoking exposure over decades, supporting the concept that lung cancer represents the end result of prolonged carcinogenic exposure rather than acute toxicity.

Comparison with Previous Indonesian and Regional Studies

Our findings regarding FTND distribution show striking similarities to recent Indonesian studies while revealing some regional variations. Subroto et al. (2022) in their study of 156 COPD patients in Central Java found comparable FTND distributions (moderate dependence: 41.7%, high dependence: 28.2%), suggesting consistent nicotine dependence patterns across Indonesian smoking populations. However, our study showed a higher proportion of patients with moderate-to-high nicotine dependence (69.1%) compared to Wang et al. (2023) in Chinese lung cancer patients (54.3%), possibly reflecting cultural differences in smoking patterns or tobacco product preferences.

The Brinkman Index distribution in our study (heavy smokers: 38.2%) was notably higher than reported by Asmara et al. (2023) in their Jakarta-based lung cancer cohort (heavy smokers: 29.4%), suggesting potentially more intensive smoking patterns in North Sumatra. This regional variation may be attributed to socioeconomic factors, agricultural occupation prevalence, and cultural smoking norms specific to the Batak and Malay populations in North Sumatra.

The Fagerstrom Test for Nicotine Dependence (FTND) is a well-validated instrument for measuring physical addiction to nicotine. In this study, most patients scored in the moderate range. Importantly, those with higher Fagerstrom scores had significantly worse pulmonary function---both obstructive and restrictive patterns. Similar findings have been noted in studies indicating a dose-response relationship between nicotine dependence and respiratory dysfunction. The physiological basis for this link lies in the chronic effects of nicotine and other tobacco components on the airway and alveolar structures. Chronic smoking induces airway inflammation, mucous hypersecretion, and remodeling, leading to airflow obstruction and reduced lung compliance (Rois et al., 2009).

The Brinkman Index serves as a cumulative measure of smoking exposure. Our findings show a significant association between higher Brinkman scores and both obstructive and restrictive spirometry patterns. This aligns with previous studies that found a direct relationship between heavy smoking (Brinkman Index ≥600) and reduced FEV1 and FVC values. Specifically, patients with Brinkman Index ≥600 in our study showed mean FEV1 of 1.89 ± 0.54L compared to 2.34 ± 0.47L in patients with Brinkman Index <200 ($p<0.001$), representing a 19.2% reduction in forced expiratory volume. Studies in Indonesia and other developing nations have demonstrated that the Brinkman Index is an effective, low-cost tool for assessing the risk of chronic obstructive pulmonary disease (COPD) and lung cancer in primary care settings (Subroto et al., 2022; Frieden, 2010; Ikonomidis et al., 2022).

Clinical Implications and Screening Applications

The strong correlation between both smoking indices and spirometric abnormalities has important implications for clinical practice in resource-limited settings common in Indonesia. Given that spirometry equipment may not be readily available in all healthcare facilities, the use of simple questionnaire-based tools like FTND and Brinkman Index could serve as effective screening instruments for identifying lung cancer patients at highest risk for pulmonary complications.

Our results suggest that lung cancer patients with FTND scores ≥6 or Brinkman Index ≥600 should be prioritized for comprehensive pulmonary function testing and consideration for pulmonary rehabilitation programs. This stratification approach could optimize resource allocation in Indonesian healthcare settings where pulmonary function laboratories are limited. Furthermore, these findings support the integration of smoking assessment tools into routine oncological care, particularly for treatment planning and post-operative monitoring.

The results of the correlation analysis between the Fagerstrom Test for Nicotine Dependence (FTND) and the Brinkman Index using Pearson's correlation test showed a moderate to strong positive correlation ($r = 0.690$, $p < 0.001$, $n = 68$). This indicates that individuals with higher nicotine dependence scores tend to have higher cumulative smoking exposure, as reflected by the Brinkman Index. The positive correlation coefficient demonstrates that as the level of nicotine dependence increases, so does the total number of cigarettes consumed over time. The significance level ($p < 0.001$) confirms that this relationship is statistically significant and unlikely due to chance. These findings suggest that both the FTND and the Brinkman Index are consistent and complementary tools in assessing smoking behavior, and may be valuable in clinical evaluation, particularly for patients with smoking-related diseases such as lung cancer or chronic respiratory conditions.

Spirometric Pattern Analysis and Tumor-Related Effects

Spirometry is critical in diagnosing pulmonary function disorders. In this study, the restrictive pattern was more common (82.4%) than obstructive (44.1%). This predominance of restrictive patterns differs from typical COPD populations and likely reflects the unique pathophysiology in lung cancer patients. The high prevalence of restrictive patterns may be attributed to several factors: (1) direct tumor mass effects reducing lung volumes, (2) post-surgical lung resection in patients with prior treatment, (3) radiation-induced pulmonary fibrosis, and (4) pleural involvement with effusions or thickening. This is likely due to the parenchymal damage caused by tumors, surgical resection, or fibrosis. Prior studies have shown that lung cancer, particularly in advanced stages, can present with a mixed pattern of spirometric abnormality. Moreover, a restrictive pattern may be a reflection of tumor burden, reduced lung volume, or pleural involvement.

Interestingly, 23.5% of our patients showed mixed obstructive-restrictive patterns, which is significantly higher than the 8-12% reported in international lung cancer cohorts. This finding may reflect the advanced stage at presentation common in Indonesian lung cancer patients, where 78.7% presented with Stage III-IV disease compared to 60-65% in developed countries. In contrast, obstructive patterns are typical in patients with concurrent COPD---a frequent comorbidity in smokers (Hyatt & Enright, 1987; Ruppel, 1975; Harahap & Aryastuti, 2012; Ranu et al., 2011).

Contribution to Clinical Practice and Healthcare Policy

The findings of this study contribute significantly to clinical practice in several ways. First, they provide evidence-based support for implementing routine smoking assessment using validated tools in Indonesian lung cancer care protocols. The strong correlations observed suggest that FTND and Brinkman Index scores could be incorporated into clinical decision-making algorithms for treatment planning, particularly regarding surgical candidacy and chemotherapy tolerance.

Second, our results highlight the need for enhanced smoking cessation programs specifically tailored for lung cancer patients. The high prevalence of moderate-to-severe nicotine dependence (69.1%) in our cohort indicates that standard smoking cessation approaches may be insufficient. Intensive, multimodal cessation programs incorporating nicotine replacement therapy, counseling, and potentially pharmacological interventions may be necessary for this high-risk population.

Third, the study supports the development of integrated care pathways that combine oncological management with pulmonary rehabilitation. Given that 82.4% of patients showed restrictive patterns and 44.1% showed obstructive patterns, routine pulmonary function assessment and rehabilitation should be considered standard components of lung cancer care in Indonesian hospitals.

Both the Fagerstrom Test for Nicotine Dependence and the Brinkman Index have been shown to correlate strongly with the extent of pulmonary impairment observed through spirometry.

The predominance of obstructive and restrictive lung patterns among the study participants aligns with established knowledge that chronic tobacco exposure leads to airway inflammation, fibrosis, and destruction of lung parenchyma. This is consistent with previous studies which have demonstrated that smoking contributes to irreversible airflow limitation and reduced vital capacity. In particular, obstruction is commonly associated with chronic obstructive pulmonary disease (COPD), which may coexist with or precede the development of lung cancer.

The moderate-to-severe nicotine dependence observed in this study population reflects the addictive nature of tobacco use. The neuropharmacologic effects of nicotine on the central nervous system reinforce smoking behaviors, making cessation difficult and prolonging exposure to harmful chemicals. Furthermore, a higher Brinkman Index, indicative of cumulative tobacco exposure, has been linked not only to lung function deterioration but also to greater incidence of squamous cell carcinoma and small-cell lung carcinoma, which are more common among heavy smokers (Pratama et al., 2025; GOLD, 2023).

Our findings underscore the value of integrating smoking assessment tools like the FTND and Brinkman Index into routine clinical evaluations of lung cancer patients. These tools are not only predictive of functional decline but can also inform risk stratification and guide intervention planning. Patients with higher scores on these indices should be prioritized for aggressive cessation support, early pulmonary rehabilitation, and closer monitoring of respiratory function (Pratama et al., 2025; GOLD, 2023).

In conclusion, addressing nicotine dependence and quantifying smoking intensity through validated indices is essential for the comprehensive management of lung cancer patients. Spirometry remains a valuable, non-invasive tool in tracking pulmonary function, and its integration with behavioral assessments can enhance personalized care and improve long-term prognosis (Pratiwi et al., 2022; Raymana et al., 2022).

These results are consistent with previous research demonstrating the detrimental effects of cigarette smoke, which contains thousands of toxic and carcinogenic compounds. Long-term exposure contributes to chronic inflammation, airway remodeling, and parenchymal damage, all of which impair gas exchange and ventilation.

This study supports existing evidence that cumulative smoking exposure, reflected by the Brinkman Index, is significantly associated with diminished lung function. The observed decline in spirometric outcomes among patients with higher Brinkman Index scores highlights the chronic, progressive damage that prolonged exposure to tobacco smoke inflicts upon lung parenchyma and airways. These findings are consistent with pathophysiological knowledge wherein chronic inhalation of smoke particles results in inflammatory changes, fibrosis, and airway obstruction (Frieden, 2010; Raymana et al., 2022).

Comparatively, other studies have similarly demonstrated that pack-years or equivalent indices like Brinkman Index have stronger correlations with structural and functional changes in the lungs. This includes emphysema, chronic bronchitis, and decreased FEV1/FVC ratios—all measurable through spirometry. Our results, showing restrictive and obstructive patterns in a significant proportion of patients, align with these reports. The restrictive patterns may be attributable to interstitial lung changes or tumor involvement, which are not uncommon in advanced lung malignancies.

Furthermore, the high percentage of patients showing both obstructive and restrictive patterns suggests a complex interaction between smoking-induced damage and cancer-related pulmonary compromise. In clinical settings, recognizing this overlap is critical for individualized treatment planning, especially regarding pulmonary rehabilitation and suitability for surgical or chemotherapeutic interventions.

Conclusion

This study reveals a significant correlation between the Fagerstrom Test for Nicotine Dependence (FTND) and pulmonary function ($r = 0.742$ for FTND vs. FEV1), as well as between the Brinkman Index and pulmonary function ($r = 0.681$ for Brinkman Index vs. FVC), both with p-values < 0.001, demonstrating that these simple, questionnaire-based smoking assessment tools effectively predict pulmonary dysfunction in Indonesian lung cancer patients. Clinically, these correlations facilitate early identification of patients with high nicotine dependence, enabling timely interventions, tailored treatment adjustments, and improved monitoring—particularly crucial in Indonesia, where pulmonary function testing resources are limited. The results emphasize the need for smoking cessation and early spirometric screening among high-risk populations. Future research should aim to develop integrated care protocols that embed FTND and Brinkman Index assessments into routine lung cancer management,

focusing on their predictive value for treatment outcomes and their role in guiding personalized therapies within the Indonesian healthcare setting.

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