

ORIGINAL ARTICLE

Correlation between smoking intensity and pulmonary function at the faculty medicine, universitas jenderal achmad yani

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ABSTRACT

Smoking is a major factor contributing to impaired lung function. This study aimed to analyze the correlation between the Brinkman Index score and lung function parameters, including Forced Expiratory Volume in 1 second (FEV₁), Forced Vital Capacity (FVC), Total Lung Capacity (TLC), and the FEV₁/FVC ratio, among the academic community of the Faculty of Medicine, Universitas Jenderal Achmad Yani (FK UNJANI). This analytic cross-sectional study employed consecutive sampling and included 42 respondents. The Brinkman Index was used to assess smoking intensity, while lung function was evaluated using spirometry. Spearman's correlation test demonstrated weak negative but non-significant correlation between the Brinkman Index and FEV₁ ($r = -0.302$; $p = 0.052$), TLC ($r = -0.254$; $p = 0.105$), and the FEV₁/FVC ratio ($r = -0.182$; $p = 0.249$). However, a weak but statistically significant negative correlation was observed with FVC ($r = -0.341$; $p = 0.027$). Approximately, 11.90% of respondents were classified as having obstructive impairment, whereas 1.41% had restrictive impairment, indicating the impact of smoking on airflow limitation. The majority of respondents were light smokers, which may explain the weak correlations observed. These findings emphasize the importance of awareness regarding smoking's impact on lung function and highlight the need for further research on its long-term effects.

Keyword: Brinkman index, FEV₁, FVC, TLC, FEV₁/FVC ratio.

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INTRODUCTION

Cigarette smoking is one of the most commonly consumed tobacco products in Indonesia, with its prevalence remaining high. Data from the 2021 Global Adult Tobacco Survey (GATS) indicate that the number of adult smokers increased to 69.1 million, compared with 60.3 million in 2011.¹ Smoking among young adults, including university students, has been associated with an increased risk of developing pulmonary diseases and related complications later in life, such as chronic obstructive pulmonary disease (COPD), emphysema, and bronchitis.²⁻²⁰

The degree of smoking exposure can be assessed using the Brinkman Index, which categorizes smokers as light, moderate, or heavy based on both the quantity and duration of smoking.²⁻³ The impact of smoking on pulmonary function is commonly evaluated using spirometry, which measures parameters such as Forced Expiratory Volume in one second (FEV₁), Forced Vital Capacity (FVC), the FEV₁/FVC ratio, and Total Lung Capacity (TLC).⁴⁻⁵ Previous studies have demonstrated that smoking is associated with an increased risk of pulmonary function impairment.^{5,6,17}

This study aimed to address gaps in the existing literature by utilizing available spirometry facilities to further investigate the relationship between smoking intensity, as assessed by the Brinkman Index, and pulmonary function among the academic community at the Faculty of Medicine, Universitas Jenderal Achmad Yani (UNJANI). The findings are expected to provide novel insights into the effects of smoking on pulmonary function, particularly through the analysis of multiple spirometric parameters across a broader age range of participants.

METHODS AND SUBJECT

This study employed a quantitative descriptive-correlational design with a cross-sectional approach to analyze the relationship between smoking intensity

and pulmonary function among the academic community of the Faculty of Medicine, Universitas Jenderal Achmad Yani (UNJANI). The study was conducted at the Faculty of Medicine, Universitas Jenderal Achmad Yani, Cimahi, in February 2024. The target population included all members of the Faculty of Medicine, UNJANI, comprising both students and academic staff. Consecutive sampling was employed, resulting in a total of 42 respondents who met the inclusion and exclusion criteria.

The inclusion criteria comprised active students or faculty members who were willing to participate and complete the questionnaire. The exclusion criteria included respondents with a history of chronic pulmonary diseases (asthma, COPD, or chronic bronchitis), acute respiratory infections, structural abnormalities, or a history of respiratory tract surgery.

The study instruments included spirometry measurements (FEV₁, FVC, FEV₁/FVC ratio, and TLC) and the Brinkman Index questionnaire. Data collection began with recording respondents' demographic characteristics, including age and sex. Participants then completed the Brinkman Index questionnaire to assess smoking intensity, followed by spirometry to evaluate pulmonary function. The spirometer was calibrated regularly, and respondents were instructed to perform respiratory maneuvers to obtain FEV₁, FVC, FEV₁/FVC ratio, and TLC measurements. Each parameter was measured at least three times to ensure reproducibility, and the highest acceptable value was used for analysis.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Normality was assessed with the Shapiro-Wilk test because the sample size was fewer than 50 participants. Since the data were not normally distributed, the correlation between smoking intensity, as assessed by the Brinkman Index, and

pulmonary function parameters (FEV₁, FVC, FEV₁/FVC ratio, and TLC) was analyzed using Spearman's rank correlation test. Statistical significance was defined as $p < 0.05$. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Jenderal Achmad Yani (Approval No. 035/UM1.09/2024). A copy of the ethical approval letter is provided in the appendix of this journal.

RESULTS AND DISCUSSION

The correlations between the Brinkman Index and FEV₁, TLC, and FEV₁/FVC ratio were negative but not statistically significant. Therefore, the hypothesis that smoking intensity is associated with impaired pulmonary function was not fully supported. This finding may be explained by the uneven

distribution of smoking distribution within the study population, as approximately 88% of respondents were classified as light smokers, whereas only a small proportion were moderate and heavy smokers. Such conditions reduced the variability of smoking exposure and limited the statistical power to detect significant associations. In addition, the relatively small sample size and the influence of other factors affecting pulmonary function, such as age, environmental exposure, physical activity, and smoking duration, may also have contributed to the non-significant findings. Nevertheless, FVC demonstrated a statistically significant negative correlation with the Brinkman Index ($p = 0.027$), indicating that smoking may begin to affect certain pulmonary parameters even among predominantly light smokers.

Table 1. General Characteristics of the Respondents

Variable	n=42	Percentage
Group		
Students	32	76%
Academic Staff	10	24%
Smoking Intensity		
Light	37	88%
Moderate	2	5%
Heavy	3	7%

Table 1 presents an overview of the general characteristics of the study participants, consisting of the academic community at the Faculty of Medicine, Universitas Jenderal Achmad Yani (UNJANI). Among the 42 respondents, the majority were students, totaling 32 individuals (76% of the sample), while the remaining 10 respondents (24%) were academic staff.

The table also illustrates the distribution of smoking intensity based on the Brinkman Index. Most participants (37 respondents, 88%) were classified as light smokers, whereas only a small proportion were moderate smokers (2 respondents, 5%) or heavy smokers (3 respondents, 7%). This distribution indicates that light smokers constituted the majority of the study population.

Table 2. Shapiro-Wilk Normality Test Results

Variable	P-value	Normality
Smoking intensity	0.000	Not normal
FEV ₁	0.234	Normal
FVC	0.022	Not normal
TLC	0.054	Normal
FEV ₁ /FVC	0.001	Not normal

The results of the Shapiro-Wilk normality test presented in Table 2 indicate that not all variables were normally distributed. Specifically, FEV₁ and TLC met the assumption of normality, whereas smoking intensity, FVC, and FEV₁/FVC did not. As not all variables were normally

distributed, a non-parametric correlation test was considered appropriate. Therefore, Spearman's rank correlation test was employed to evaluate the relationship between smoking intensity and pulmonary function parameters. The results of this analysis are presented in Table 3.

Table 3. Correlation between smoking intensity (Brinkman Index) and Total Lung Capacity (TLC)

Smoking Intensity	TLC					Correlation Coefficient (r)	P-Value
	Normal		Reduced		n	Total	
	n	%	n	%			
Light	31	(83,8%)	6	(16,2%)	37	100%	
Moderate	2	(100%)	0	(0%)	2	100%	
Heavy	3	(100%)	0	(0%)	3	100%	
Total	36	(85,7%)	6	(14,3%)	42	100%	

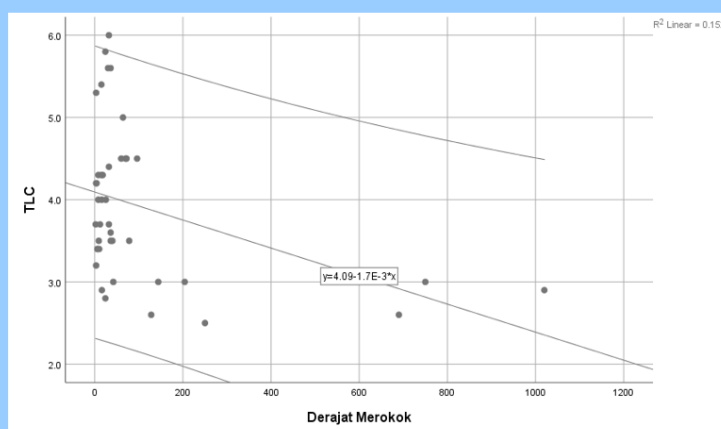


Figure 1. Scatterplot illustrating the correlation between smoking intensity (Brinkman Index) and Total Lung Capacity (TLC). The scatterplot visually represents the relationship between the degree of smoking and TLC values among the respondents. Source: Processed research data, 2024.

The analysis of the relationship between the Brinkman Index and Total Lung Capacity (TLC) among the academic community of the Faculty of Medicine, Universitas Jenderal Achmad Yani (UNJANI), revealed a weak and statistically non-significant correlation ($r = -0.254$, $p = 0.105$). Among the 42 smoking respondents, 85.7% exhibited normal TLC, whereas 14.3% had reduced TLC. Linear regression analysis indicated that each one-unit increase in the Brinkman Index was associated with a decrease of 0.0017 liters in TLC, with an R^2 value of 0.152, suggesting that approximately 84.8% of the variability in TLC is influenced by other factors.^{42,47,56}

Physiologically, cigarette smoke induces chronic inflammation and

interstitial fibrosis, which reduce pulmonary elasticity and consequently lower TLC. In some smokers, Combined Pulmonary Fibrosis and Emphysema (CPFE) may also occur, in which the predominance of fibrosis decreases TLC despite the presence of emphysematous components.⁷⁻¹⁶⁻¹⁸

These findings differ from those reported by George R. et al., who, with a larger sample size ($n = 2,508$), found a significant association between smoking and TLC ($p < 0.05$). This discrepancy may be attributed to differences in assessment methods, as George R. et al. utilized computed tomography (CT) with Airway Inspector software for pulmonary analysis, which provides more precise measurements compared to conventional spirometry.⁸⁻⁹⁻¹⁵

Table 4. Correlation between Smoking Intensity (Brinkman Index) and FEV₁

Smoking Intensity	FEV ₁				Total		Correleation Coefficient (r)	P-
	Normal to Mild impairment.		Mild to Severe Impairment		n	%		
	n	%	n	%				
Light	33	89,2%	4	10,8%	37	100%	-.302	.052
Moderate	2	100%	0	0%	2	100%		
Heavy	0	0%	3	100%	3	100%		
Total	35	83,3%	7	16,7%	42	100%		

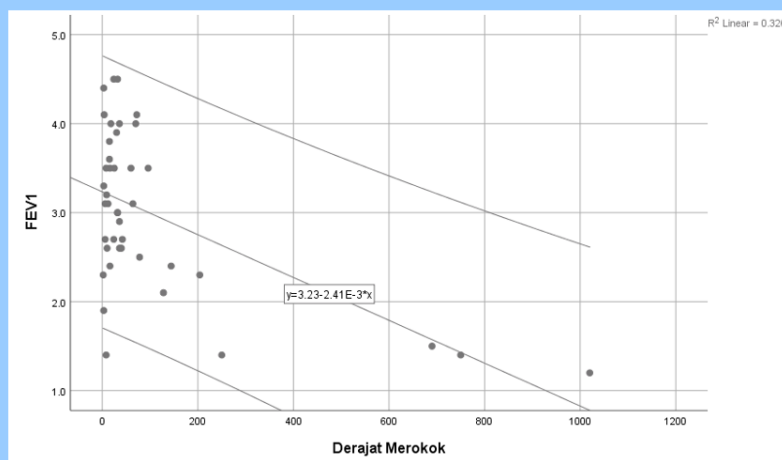


Figure 2. Scatterplot showing the correlation between Smoking intensity (Brinkman index) and FEV₁.

The relationship between the Brinkman Index and FEV₁ among the academic community of the Faculty of Medicine, UNJANI, demonstrated a weak to moderate negative correlation ($r = -0.302$, $p = 0.052$). Among 37 respondents classified as light smokers, 89.2% exhibited normal FEV₁ capacity, whereas all respondents categorized as heavy smokers experienced reduced FEV₁ capacity. Linear regression analysis ($y = 3.32 - 0.00241 \times x$) indicated that each one-unit increase in the Brinkman Index was associated with a decrease in FEV₁ of 0.00241 liters, with $R^2 = 0.326$, suggesting that 67.4% of the FEV₁ variability was influenced by other factors.

Although this correlation did not reach statistical significance, a trend indicating that increased smoking habits are associated with reduced FEV₁ was observed. The discrepancy between these findings and those of Jayalakshmi M.K., who reported a significant relationship between smoking duration and FEV₁ reduction ($p < 0.001$), may be attributed to differences in sample size or measurement methodology. Nevertheless, the present findings support the theory that exposure to cigarette smoke induces chronic inflammation, oxidative stress, and disruption of the protease–antiprotease balance, contributing to airway remodeling and reduced pulmonary elasticity.¹⁰⁻¹¹⁻¹⁹

Table 5. Correlation between Brinkman Index and FVC

Smoking Intensity	Normal FVC	Reduced FVC	Total	r	P-value
Light	35 (94.6%)	2 (5.4%)	37		
Moderate	2 (100%)	0 (0%)	2		
Heavy	0 (0%)	3 (100%)	3		
Total	37 (88.1%)	5 (11.9%)	42	-0.341*	0.027

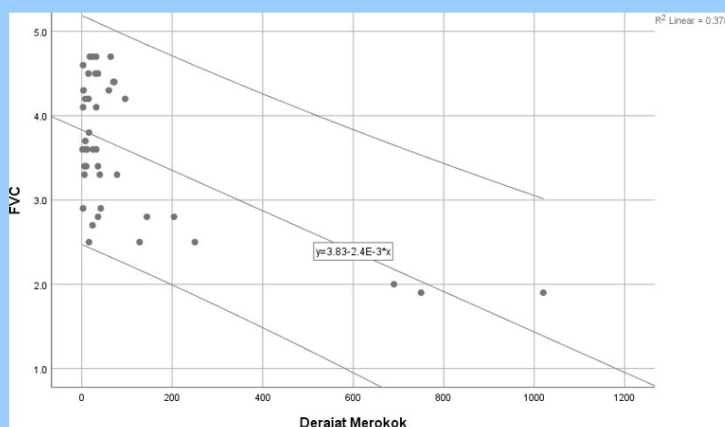


Figure 3. Scatterplot illustrating the Correlation between Smoking intensity (Brinkman Index) and FVC.

The correlation between the Brinkman Index and FVC among the academic community of the Faculty of Medicine, UNJANI, showed a weak-to-moderate negative relationship ($r = -0.341$, $p = 0.027$). Among 37 respondents classified as light smokers, 94.6% exhibited normal FVC values, whereas all respondents categorized as heavy smokers experienced reduced FVC. Linear regression analysis ($y = 3.83 - 0.0024 \times x$) indicated that each one-unit increase in the Brinkman Index was associated with a decrease in FVC of 0.0024 liters, with $R^2 = 0.378$, suggesting that 62.2% of FVC variation was influenced by other factors.¹²⁻¹³

Although the correlation was not particularly strong, the p-value (<0.05) indicates statistical significance. This finding aligns with Jayalakshmi M.K.'s study, which reported a significant relationship between smoking duration and reduced FVC ($p < 0.001$). High intensity and prolonged smoking negatively impact FVC due to exposure to toxic substances that induce chronic inflammation, oxidative stress, airway remodeling, and decreased pulmonary elasticity. In contrast, Verrena Natalie reported a higher proportion of pulmonary function impairment among smokers (68.3%). These differences may be related to variations in sample size or measurement methods.¹²⁻¹³

Table 6. Correlation between Brinkman Index and FEV₁/FVC Ratio

Smoking Intensity	Normal (n, %)	Reduced (n, %)	Total (n, %)	r	P-Value
Light	26	70,3%	11	(29,7%)	
Moderate	1	50,0%	1	(50,0%)	
Heavy	0	0%	3	(100%)	
Total	27	64,3%	15	(35,7%)	

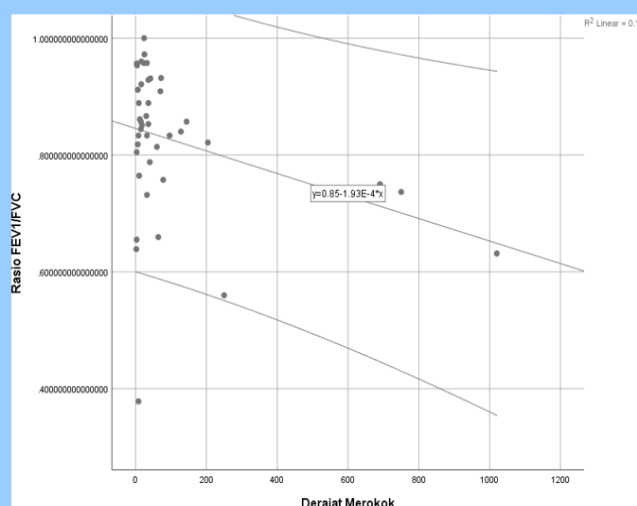


Figure 4. Scatterplot illustrating the correlation between Brinkman Index and FEV₁/FVC Ratio.

The correlation between the Brinkman Index and the FEV₁/FVC ratio among the academic community of the Faculty of Medicine, UNJANI, was weak and not statistically significant ($r = -0.182$, $p = 0.249$). Among the 37 respondents categorized as light smokers, 70.3% maintained a normal FEV₁/FVC ratio, whereas all respondents classified as heavy smokers exhibited a reduced ratio. Linear regression analysis ($y = 0.80 - 1.93 \times 10^{-4} \times x$) indicated that each one-unit increase in the Brinkman Index was associated with a slight decrease in the FEV₁/FVC ratio; however, with an R^2 value of 0.107, 89.3% of the variation in the FEV₁/FVC ratio is attributable to other factors.¹⁴

Although no significant relationship was observed, the findings suggest that light and moderate smokers generally maintained a near-normal FEV₁/FVC ratio. This aligns with previous studies reporting that individuals smoking 3–12 cigarettes per day over 10–35 years may retain near-normal pulmonary function. In contrast, Dugral et al. (2019) identified a significant association between smoking habits and pulmonary function, particularly the FEV₁/FVC ratio. Variations in cigarette consumption and smoking duration may account for the discrepancies between the present study and prior research.

CONCLUSION

This study demonstrated that smoking intensity, as measured by the Brinkman Index, had weak negative correlations with FEV₁, TLC, and the FEV₁/FVC ratio, although these were not statistically significant. A statically significant negative correlation was observed between the Brinkman Index and FVC, indicating that smoking may begin to affect certain pulmonary function parameters even among predominantly light smokers. Future studies with larger and more balanced samples, particularly

involving moderate and heavy smokers, are recommended to better evaluate the impact of smoking on pulmonary function.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this manuscript. This work has not been published elsewhere and is not under consideration by any other journal. All authors have approved the publication of this manuscript.

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