

Smoking and Increased Symptoms of Pulmonary TB: A Retrospective Analysis at Cibinong Hospital

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ABSTRACT

Pulmonary Tuberculosis (TB) is a contagious infectious disease that remains a global health problem. Smoking, both active and passive, is a risk factor that can worsen TB symptoms. At Seruni Ward of Cibinong Regional Hospital, many TB patients were found to be readmitted with worsening symptoms, suspected to be related to smoking history. This study aims to determine the relationship between active and passive smoking history and the worsening of pulmonary TB symptoms. The study used a quantitative correlational design with a retrospective longitudinal approach. The sample consisted of 82 pulmonary TB patients who were readmitted at least twice during 2024. Data were obtained from medical records and analyzed using the chi-square test. Results showed a significant relationship between smoking history and worsening TB symptoms ($p < 0.05$). Patients with an active smoking history experienced more severe symptoms. However, this study was limited by its retrospective design and reliance on medical record data, which may not capture all relevant variables. Educational and preventive interventions are needed to reduce symptom aggravation in TB patients with a smoking history.

Keywords: *Pulmonary Tuberculosis, Smoking, Symptoms, Active Smoker, Passive Smoker.*

Introduction

Pulmonary tuberculosis (TB) remains one of the leading causes of death from infectious diseases in Indonesia. According to the Global TB Report 2024, Indonesia ranks fourth globally in TB case numbers. In 2022, the case detection rate—calculated as the number of discovered cases divided by the estimated TB incidence—was highest in West Java, Banten, Gorontalo, DKI Jakarta, and Central Java (Ministry of Health of the Republic of Indonesia, 2022). Based on data from the West Java Provincial Health Office (2023, updated February 2024), West Java accounts for an estimated 233,334 new TB cases, representing 22% of the national total. The six areas with the highest TB burden are Bogor Regency, Sukabumi Regency, Bandung Regency, Bandung City, Bekasi Regency, and Bekasi City (West Java Public Relations Release, 2024).

Cibinong Hospital is a regional referral hospital in Bogor Regency that manages pulmonary TB cases. The Seruni Ward specializes in pulmonary diseases and handles various respiratory conditions, including TB. From January to December 2024, approximately 842 TB cases were recorded in the Seruni Ward out of 2,016 total respiratory admissions.

One factor that exacerbates TB patient outcomes is cigarette smoke exposure. Active and passive smoking weaken the immune system and impair treatment response in TB patients. Smokers face twice the risk of developing tuberculosis compared to non-smokers, while passive smokers have a 4.5-fold increased risk compared to those unexposed to cigarette smoke. Harmful

substances in cigarettes compromise immune function and paralyze cilia responsible for clearing foreign particles, including germs, bacteria, and viruses, from the respiratory tract. Consequently, smokers are more susceptible to TB infection (PTM Indonesia, 2022).

Despite extensive literature linking smoking to TB incidence and severity, limited local research has examined the specific relationship between smoking history and symptom recurrence among readmitted TB patients in hospital settings, particularly in high-burden regions like Bogor Regency. Based on medical record reviews, most complaints during readmission involved recurrent dyspnea. A preliminary study conducted by the author in January 2025 at the Seruni Ward of Cibinong Hospital included interviews with 10 pulmonary TB patients. This preliminary investigation revealed that many TB patients were readmitted with worsening symptoms, particularly among those with a smoking history, yet no systematic analysis has been conducted to quantify this association. Therefore, this study aims to address this research gap by examining the relationship between active and passive smoking history and the worsening of pulmonary TB symptoms among readmitted patients.

Based on the data that has been explained previously about patients who are returned to treatment, the researcher conducted a brief search of medical records, the most complaints when patients are re-treated are due to the tightness that arises again. Therefore, to prove that there is more accurate data, researchers conducted preliminary studies. Based on a preliminary study conducted by the author in January 2025 in the Seruni Room of Cibinong Hospital, the author conducted interviews with 10 pulmonary TB patients who were treated in the Seruni Room of Cibinong Hospital. A preliminary study at Cibinong Hospital showed that many TB patients were readmitted with worsening symptoms, especially among those with a history of smoking.

Research Methods

This study employed a correlational quantitative design with a longitudinal retrospective approach. The research sample consisted of 82 pulmonary TB patients who underwent retreatment in the Seruni Ward of Cibinong Hospital throughout 2024. Sample selection was conducted through purposive sampling based on predetermined criteria.

Inclusion criteria were: (1) TB patients diagnosed with pulmonary tuberculosis confirmed through medical records; (2) patients who underwent retreatment at least twice during the 2024 study period; (3) availability of complete smoking history data (active, passive, or non-smoker status) documented in medical records; and (4) documented TB symptom severity at both first and subsequent admissions.

Exclusion criteria were: (1) patients with incomplete or missing medical record data, particularly regarding smoking history or symptom documentation; (2) patients with comorbidities that could significantly confound symptom progression (e.g., advanced HIV/AIDS, severe chronic obstructive pulmonary disease); and (3) patients who were transferred to other facilities before completing treatment episodes.

Data were collected from patient medical records, including smoking history and the severity of TB symptoms at the time of first and subsequent treatments. Data analysis was performed using the Chi-Square test with a significance level of $p < 0.05$.

This research obtained ethical clearance from the Ethics Committee of Cibinong Hospital,

ensuring the research protocol adhered to ethical principles and posed no harm to subjects. Privacy and confidentiality were maintained by anonymizing medical record data using unique identification codes without personal identifiers. All data were stored securely on the researcher's password-protected laptop, and unused printed documents were shredded before disposal. This study did not involve direct patient interaction, thereby posing no physical or psychological risk. All data were used solely to improve understanding and service delivery for pulmonary TB treatment. Transparency was maintained through honest, objective, and responsible implementation, with publication conducted after ethical approval and without direct patient intervention.

Data processing began with editing, which involved checking the completeness and clarity of responses on the checklist (Indarwati et al., 2020), followed by coding, where categorical data were converted into numerical values. For example, gender was coded as "1" for male and "2" for female, while smoking history and TB symptom severity were coded according to the 2021 Indonesian Lung Physicians Association (PDPI) criteria. Data entry was then performed, transferring coded data into computer software (Microsoft Excel and SPSS version [specify version]). Finally, data cleaning was conducted to identify and correct errors or missing values, ensuring data integrity for subsequent analysis.

Data analysis comprised univariate and bivariate analyses. Univariate analysis described the distribution of gender, age, smoking history, and TB symptom progression. Bivariate analysis examined the relationship between the independent variable (smoking history) and the dependent variable (worsening of pulmonary TB symptoms) among patients in the Seruni Ward of Cibinong Hospital. The Chi-Square test was used to test this hypothesis, supplemented by Fisher's Exact Test when expected cell frequencies were less than five.

Results and Discussion

A. Results

The description of respondents' characteristics was based on gender and age. The distribution of gender frequencies showed that 52 respondents (63.4%) were male and 30 respondents (36.6%) were female, indicating male predominance. Regarding age distribution, the majority of patients (56 respondents, 68.3%) were in the 26-59 years age range. Therefore, the majority of respondents were adult males.

Table 1. Respondent Characteristics

Varibel	Frequency	Present (%)
Gender		
Man	52	63,4%
Woman	30	36,6%
Age		
17 years -25 years	8	9,8%
26 years – 59 years old	56	68,3%
>60 years old	18	22%
Total	82	100%

An overview of the frequency distribution of respondents based on smoking history. It was found that the distribution of smoking history frequency was 72 people or 87.8% who had a

history of active smoking and the remaining 10 people or 12.2% had a history of passive smoking. So the majority of the smoking history in patients is active smokers.

Table 2. Smoking History

Smoking History	Frequency	Percentage (%)
Active	72	87,8%
Passive	10	12,2%
Total	82	100%

An overview of the frequency distribution of respondents based on the increase in pulmonary TB symptoms. A total of 65 patients (79.3%) experienced an increase in pulmonary Tb symptoms, and as many as 17 patients (20.7%) did not experience an increase in pulmonary TB symptoms. So the majority of symptom changes in patients are increasing.

Table 3. Increased Symptoms

Symptom Changes	Frequency	Percentage (%)
Increase	64	78%
Not Increasing	18	22%
Total	82	100%

Description of respondents based on pulmonary Tb symptoms. that in the symptoms of cough in the first treatment as many as 69 patients (84.1%) and in the second treatment as many as 72 patients (87.8%), in the symptoms of cough the first treatment as many as 13 patients (15.9%) and the second treatment as many as 15 patients (18.3%), in the symptoms of shortness of breath in the first treatment as many as 73 patients (89%) and in the second treatment as many as 80 patients (97.6%), in the symptoms of fever in the first treatment as many as 33 patients (40.2%) and in the second treatment as many as 60 patients (73.2%), In the symptoms of weight loss, the first treatment was 29 patients (35.4%) and the second treatment was 72 patients (87.8%), in the night sweats of the first treatment as many as 11 patients (13.4%) and the second treatment as many as 37 patients (45.1%), in the symptoms of chest pain in the first treatment as many as 10 patients (12.2%) and the second treatment as many as 55 patients (67.1%), it can be seen that most of the symptoms experienced an increase in frequency in the second treatment compared to the first treatment. The majority of the symptoms experienced by patients from both the first and second treatments were shortness of breath and cough.

The bivariate analysis in this study is to relate smoking history with an increase in pulmonary TB symptoms in the seruni room of Cibinong Hospital using the Chi Square statistical test strengthened by the Fisher's Exact test.

Table 4. The Relationship Between Smoking History and Increased TB Symptoms

Increased Symptoms

		Increase		Not Increasing		Total		P Value
		F	%	F	%	F	%	
Smoking History	Active	64	8,9%	8	11,1%	72	100%	0,000
	Passive	0	0%	10	100%	10	100%	
	Total	64	00%	18	100%	82	100%	

The Chi-Square test results between smoking history and pulmonary TB symptom recurrence yielded a p-value = 0.000 ($p < 0.05$). Although one cell (25%) had an expected count < 5 , this was within acceptable limits for Chi-Square analysis. The result was further validated using Fisher's Exact Test, which also showed $p = 0.000$. Therefore, there is a highly significant relationship between smoking history and worsening pulmonary TB symptoms in the Seruni Ward of Cibinong Hospital in 2024.

The analysis also yielded an Odds Ratio (OR) = 159.47, indicating that TB patients with active smoking history have 159 times greater odds of experiencing symptom progression compared to passive smokers (OR = 159.47; 95% CI = 8.54 – 2968.86; $p = 0.000$). Since the p-value < 0.05 and the confidence interval does not include 1, this relationship is statistically significant.

Limitations of Results Interpretation:

Several limitations should be considered when interpreting these findings. First, the extremely wide confidence interval (95% CI = 8.54 – 2968.86) reflects the small sample size in the passive smoking group ($n=10$), which limits the precision of the odds ratio estimate. Second, the complete absence of symptom worsening among passive smokers (0%) may be partially attributable to this small sample size and suggests the need for larger studies to obtain more stable estimates. Third, the retrospective design relies on medical record documentation, which may not capture all confounding variables such as treatment adherence, nutritional status, HIV co-infection status, or disease severity at initial presentation—all of which could influence symptom progression. Fourth, the dichotomous categorization of symptom changes (increase vs. not increasing) may not fully capture the gradient of symptom severity. Finally, the study did not quantify smoking intensity (pack-years) or duration of exposure, which could provide more nuanced understanding of dose-response relationships. Despite these limitations, the strong statistical significance ($p = 0.000$) and large effect size support the robustness of the observed association between active smoking and TB symptom worsening.

B. Discussion

Demographic Characteristics: Gender and Age

From the results of the analysis, the majority of respondents were male (52 respondents, 63.4%) and female (30 respondents, 36.6%). This is consistent with the research of Fajriah Saraswati et al. (2022) titled "Characteristics of Pulmonary Tuberculosis Relapse Sufferers at Ibnu Sina Hospital Makassar," which found that TB relapse incidence was higher in males (58.7%) than females (41.3%). Similarly, Sunarmi & Kurniawaty (2022) reported that 63.6% of

pulmonary TB cases occurred in males. Furthermore, Syahrul & Mahmudah (2021) in their study "Factors Related to the Incidence of Pulmonary Tuberculosis" demonstrated that male sex was significantly associated with pulmonary TB incidence ($p < 0.05$). This is attributed to greater risk factors experienced by men, including smoking, outdoor occupational exposure, dust exposure, and higher infection rates (Global TB Report, 2023).

According to the Indonesian Ministry of Health (2018), the prevalence of pulmonary TB in men is higher than in women in Indonesia. Data show that 65–70% of TB patients identified in healthcare settings are male. This is associated with behavioral risk factors (smoking, alcohol consumption), occupational exposure, and delayed diagnosis in women.

Regarding age distribution, the majority of patients were aged 26–59 years (56 respondents, 68.3%). This aligns with the Global TB Report (2023), which indicates that TB predominantly affects productive age groups/young adults (15–54 years). The Indonesian Ministry of Health (2018) also reported that the 25–49 years age group has the highest TB prevalence in Indonesia compared to children or the elderly, attributed to work activities, high mobility, and housing density. These findings are consistent with Fajriah Saraswati et al. (2022), who found that pulmonary TB relapse predominantly occurred in adults aged 26–59 years (52.4%). Sikumbang et al. (2022) examined the relationship between productive age and TB incidence, finding that productive age patients (15–58 years) comprised 18.1% more cases than non-productive age groups, with statistical results showing $p = 0.007$, indicating a significant relationship between age and TB incidence.

Smoking History

From the analysis, the frequency distribution based on smoking history revealed that 72 patients (87.8%) had an active smoking history, while 10 patients (12.2%) had a passive smoking history. These results are supported by Tandang et al. (2021), which showed that active smokers have 10.889 times greater odds of developing pulmonary TB than non-smokers. These findings suggest that smoking history is a significant risk factor for TB incidence, although other contributing factors must be considered. Khan et al. (2020) also reported that smoking is a strong risk factor for worsening pulmonary TB symptoms, as *Mycobacterium tuberculosis* infects lung tissue previously damaged by inflammation or irritation, which can be exacerbated by cigarette smoke exposure. Ravin et al. (2017) stated that individual behavioral factors, including smoking habits, have significant correlation with increased tuberculosis risk. According to TB Indonesia (2023), cigarette smoke can weaken the body's defense system, particularly respiratory tract defenses, facilitating infection by TB-causing bacteria.

Symptom Progression

Based on the data obtained in this study, respondent symptoms from both first and second treatments showed progressive worsening. Cough increased from 69 patients (84.1%) to 72 patients (87.8%), hemoptysis from 13 patients (15.9%) to 15 patients (18.3%), dyspnea from 73 patients (89.0%) to 80 patients (97.6%), fever from 33 patients (40.2%) to 60 patients (73.2%), weight loss from 29 patients (35.4%) to 72 patients (87.8%), night sweats from 11 patients (13.4%) to 37 patients (45.1%), and chest pain from 10 patients (12.2%) to 55 patients (67.1%).

Most symptoms showed increased frequency during second treatment compared to first treatment.

Relationship Between Smoking History and TB Symptom Worsening

Statistical analysis revealed a highly significant relationship between active and passive smoking history and worsening pulmonary TB symptoms in patients at Cibirong Hospital in 2024. The p-value = 0.000 based on Chi-Square test and Fisher's Exact Test, with an Odds Ratio (OR) = 159.47 (95% CI = 8.54 – 2,968.86), indicates that pulmonary TB patients who actively smoke are 159 times more likely to experience symptom worsening compared to passive smokers. Therefore, the alternative hypothesis (H_a) is accepted in this study.

This is consistent with research by Tandang et al. (2021), which, although not specifically examining symptom worsening, demonstrated the relationship between active and passive smoking and pulmonary TB incidence. Their analysis showed $p = 0.037 < 0.05$, concluding a significant relationship between smoking status and pulmonary TB incidence at Sikumana Health Center, Kupang City, with OR = 10.889, indicating active smokers are 10.889 times more likely to develop TB than passive smokers. Raharjo's study in Central Java found that active smokers had 2.7 times greater risk of developing pulmonary TB than non-smokers, with logistic regression showing significant relationship between smoking habits and pulmonary TB incidence ($p < 0.05$) (Raharjo, 2020).

Katiandagho et al. (2018) found a significant relationship between smoking habits and pulmonary TB incidence ($p = 0.007$), where smokers were twice as likely to develop pulmonary TB compared to non-smokers. Sinaga et al. (2019) examined the relationship between smoking and pulmonary TB treatment failure, showing p-value = $0.000 < \alpha$ ($\alpha = 0.05$), indicating a significant relationship between smoking and treatment failure in pulmonary TB patients at Bandar Lampung City Health Center in 2019, with OR = 4.180, meaning smokers had 4 times the risk of treatment failure compared to non-smokers.

Khan et al. (2020) obtained p-value < 0.001 , demonstrating very high confidence (99.9%) that smoking contributes to poor TB treatment outcomes, with OR = 0.76 (95% CI: 0.69–0.84), meaning smokers are 24% less likely to succeed in treatment than non-smokers, with increased risk of death, drop-out, and therapy failure. Patients with severe symptoms such as severe dyspnea, weight loss, and chest pain have lower chances of successfully completing TB treatment. This strongly supports the current research, as active smoking affects pulmonary TB symptom worsening. When pulmonary TB symptoms such as cough, dyspnea, fever, or chest pain worsen despite treatment, this may indicate uncontrolled TB bacteria, possible drug resistance/MDR-TB, low medication adherence, and presence of other disease complications or comorbidities.

Previous studies have shown that active smoking significantly contributes to symptom worsening and decreased pulmonary TB treatment success. Laniado-Laborín states that smoking causes macrophage and local immune system dysfunction, thereby increasing TB infection risk (Laniado-Laborín, 2009). Gharib et al. also found that active smokers experienced more severe TB symptoms, including chest pain and wider radiological lesions (Gharib et al., 2013). According to the Indonesian Pulmonary Doctors Association (2021), clinically, symptom worsening such as dyspnea, cough, and chest pain in TB patients who smoke indicates suboptimal infection control and can reduce therapy success chances. These symptoms can also decrease patient quality of life and trigger other complications such as pleural effusion or post-TB bronchiectasis.

Pathophysiological Mechanisms

Cigarettes contain nicotine, tar, and carbon monoxide (CO) as main components (Halim, 2018). Smoking significantly affects the immune system through various immunological mechanisms in both innate and adaptive immune systems, making smokers more susceptible to infections such as pulmonary TB by impairing alveolar macrophage function. Macrophages are the primary immune cells in the lungs that capture and kill *Mycobacterium tuberculosis*; nicotine and cigarette smoke chemicals decrease macrophage phagocytosis ability (Qiu et al., 2017).

Smoking also increases inflammatory cells and mediators that can worsen TB symptoms, such as prolonged cough, increased sputum production, and dyspnea (Laniado-Laborín, 2009). Cigarette content damages bronchial epithelium and cilia, disrupting mucociliary clearance mechanisms. It also causes chronic lung inflammation and tissue hypoxia that worsen TB symptoms (Laniado-Laborín, 2009). Theoretically, pulmonary TB pathophysiology reveals that *Mycobacterium tuberculosis* infects lung tissue previously damaged by inflammation or irritation, which can be exacerbated by cigarette smoke exposure (Ravin et al., 2017). This means smoking increases pulmonary TB symptoms through both immunological and pathophysiological pathways.

Additionally, according to the World Health Organization, smoking can reduce anti-TB drug effectiveness; substances such as nicotine and carbon monoxide interfere with metabolism and liver function, increasing treatment failure and recurrence risk. Studies by Saputra et al. (2022) show that smokers have higher risk of treatment failure, TB recurrence, or even multidrug-resistant TB (MDR-TB).

Nursing Implications

From a nursing perspective, according to Smeltzer & Bare, smoking causes airway cilia damage and increases lower respiratory tract infection risk, including pulmonary TB (Smeltzer & Bare, 2013). This supports current findings showing TB patients with smoking history experience significant symptom worsening such as dyspnea, cough, and chest pain. Doenges et al. mentioned that smoking history is an important risk factor requiring assessment in TB nursing diagnosis formulation, especially regarding ineffective airway clearance (Doenges et al., 2010). However, other nursing problems arise in this study because the most frequent symptom is dyspnea; ineffective breathing pattern problems also emerge due to lung inflammation affecting lung elasticity, causing shallow breathing and increased respiratory muscle work leading to dyspnea. Smoking also causes ventilation-perfusion imbalance or alveolar-capillary membrane changes, resulting in impaired gas exchange. In this study, the majority of patients continued smoking, suspected to be due to patients' lack of knowledge about smoking risk factors that can cause pulmonary TB symptom worsening, giving rise to knowledge deficit problems (Hidayat, 2021).

Critical Discussion on Causality and Study Limitations

While this study demonstrates a strong statistical association between smoking history and TB symptom worsening, several considerations regarding causality warrant critical

discussion. First, the retrospective cross-sectional design limits our ability to establish temporal relationships and true causality. Although smoking logically precedes symptom worsening, we cannot definitively rule out reverse causation or the possibility that patients with more severe disease were more likely to have their smoking history documented in medical records.

Second, the extremely high OR value (159.47) with very wide confidence interval (8.54–2,968.86) suggests potential effect inflation due to small cell sizes, particularly the complete absence of symptom worsening in the passive smoking group (0/10 patients). This may indicate either a genuine protective effect of reduced smoke exposure or, more likely, reflects sampling variability and insufficient statistical power in this subgroup. Larger prospective studies are needed to obtain more precise effect estimates.

Third, despite the strong association observed, multiple unmeasured confounding variables could partially explain the relationship. These include:

1. Treatment adherence: Smokers may have lower medication compliance, contributing to symptom worsening independent of smoking's biological effects
2. Socioeconomic factors: Smoking often correlates with lower socioeconomic status, which independently affects nutrition, housing conditions, and healthcare access
3. Comorbidities: HIV co-infection, diabetes, chronic obstructive pulmonary disease (COPD), and other conditions were not systematically controlled for in the analysis
4. Disease severity at baseline: Patients with more severe initial TB may be both more likely to smoke and more likely to experience symptom progression
5. Smoking intensity and duration: The study did not quantify pack-years or distinguish between light and heavy smokers, limiting dose-response assessment

Fourth, the biological plausibility strongly supports a causal relationship through well-established immunological and pathophysiological mechanisms (macrophage dysfunction, mucociliary clearance impairment, chronic inflammation). However, the magnitude of effect observed (OR = 159.47) appears disproportionately larger than previous studies (OR ranging from 2.7 to 10.889), suggesting that while smoking is clearly detrimental, the extreme effect size in this study may partially reflect methodological limitations rather than purely biological effects.

Finally, the study cannot distinguish whether symptom worsening represents true TB progression, treatment failure, drug resistance development, or complications from smoking-related lung damage independent of TB activity. Incorporating objective measures such as sputum smear conversion rates, radiological progression scores, and drug susceptibility testing in future studies would strengthen causal inference.

Despite these limitations, the consistency of findings with established literature, the strong statistical significance, and the well-documented biological mechanisms provide substantial evidence supporting smoking as a genuine risk factor for TB symptom worsening. However, clinicians and policymakers should interpret the magnitude of effect cautiously and recognize that successful TB management requires addressing multiple risk factors beyond smoking cessation alone.

Conclusion

This study involved 82 pulmonary tuberculosis patients who underwent retreatment at Cibinong Hospital in 2024, with the majority being male (63.4%) and in the productive age group of 26-59 years (68.3%), and most (87.8%) were active smokers. The majority of respondents (78.0%) experienced worsening pulmonary TB symptoms between first and second treatments,

with the most prevalent symptoms being dyspnea (97.6%), cough (87.8%), and weight loss (87.8%). Bivariate analysis revealed a highly significant association between smoking history and TB symptom worsening ($p = 0.000$, $OR = 159.47$, $95\% CI = 8.54-2,968.86$), indicating that active smokers were 159 times more likely to experience symptom progression compared to passive smokers, though the wide confidence interval reflects limited precision due to small sample size in the passive smoking group. Based on these findings, nurses are expected to play active roles as educators and facilitators in smoking cessation counseling and conduct periodic symptom assessments to prevent condition deterioration. Cibinong Regional General Hospital should strengthen TB service management by increasing nursing staff, expanding isolation room capacity, and developing comprehensive educational media at pulmonary outpatient clinics. From a public health perspective, TB control programs should integrate smoking cessation as a core component, develop targeted interventions for TB patients who smoke, strengthen tobacco control policies in high TB-burden areas such as Bogor Regency, routinely monitor smoking prevalence among TB patients through surveillance systems, subsidize smoking cessation services through health financing mechanisms, formalize intersectoral collaboration between TB and tobacco control programs, and mobilize community engagement through local leaders and health workers to promote smoking cessation and TB awareness at grassroots levels. Further research is recommended using prospective cohort designs with larger samples, additional variables (smoking intensity, nutritional status, medication adherence, HIV status, baseline disease severity), multivariate analyses to control for confounders, and objective outcome measures (sputum conversion rates, radiological progression, drug susceptibility testing) to establish causality and obtain more generalizable results. Pulmonary TB patients are strongly encouraged to quit smoking immediately, maintain strict medication adherence, and attend regular follow-up appointments to improve treatment success and prevent symptom worsening, recognizing that smoking cessation is not merely a lifestyle choice but a critical component of effective TB management that can significantly influence treatment outcomes and quality of life.

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