

# The Relationship Between Smoking And The Formation Of Lung Cavity Lesions In Tuberculosis Patients At H Adam Malik General Hospital

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## Abstract.

*The purpose of this study is to ascertain whether smoking has any connection to the development of lung cavity lesions in tuberculosis patients at H Adam Malik General Hospital. This study is an observational, analytical, case-control investigation. In this investigation, 80 samples total 40 individuals who smoked and 40 non-smokers were used. How to choose a sample using the purposive sampling method. Information was gleaned from the medical files of H Adam Malik General Hospital's tuberculosis patients in 2021. The Chi Square test was used to examine the research data. According to the study's findings, 62.5% of the research sample's participants were men and 37.5% were women. The majority 28.7% are in the 46 to 55-year-old age range. According to the Brinkman Index, up to 28.8% of the sample's participants were heavy smokers. Lung cavity lesions are present in 46.25 percent of patients, as may be shown. Up to 30% of patients who smoke have lung cavity lesions. According to the analysis's findings, smoking was associated with the development of lung cavity lesions in tuberculosis patients at Adam Malik General Hospital with a value of  $p = 0.014$  ( $p < 0.05$ ), and those patients who smoked had a risk of developing lung cavity lesions that was 3.115 times higher ( $OR = 3.115$ ). This study's findings suggest that smokers with tuberculosis are three times more likely to develop lung cavity lesions.*

**Keywords:** Lung cavity lesion, tuberculosis, smoking and brinkman index.

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## I. INTRODUCTION

A contagious illness with a high frequency worldwide is tuberculosis. According to World Health Organization (WHO) data, 10.6 million people worldwide have tuberculosis as of 2022. India, Indonesia, and China are the top three nations responsible for the highest incidence of tuberculosis infection, [1] In 2022, the Republic of Indonesia's Ministry of Health (Kemenkes RI) reported that there were approximately 969,000 tuberculosis infections in Indonesia, [2]. The prevalence of tuberculosis infection in North Sumatra Province increased to 0.30 percent in 2018 from 0.2% in 2013 according to Basic Health Research (Riskesmas) data [3], [4]. The number of tuberculosis patients in North Sumatra Province increased by up to 7,361 in 2019, according to the province's health profile data. This increased the number of patients with the disease from 26,418 to 33,779, with Medan City experiencing the highest spike in cases [5]. From 2019 to 2021, the H Adam Malik General Hospital treated 3,259 tuberculosis patients, both as inpatients and outpatients, according to information from the North Sumatra Province's Ministry of Health. According to WHO data, 0.73 million new cases were discovered among individuals who smoked, and men had a 3 times greater prevalence of tuberculosis than women because they were more likely to be exposed to risk factors like smoking, [6], [7]. According to estimates from the WHO, more than 7 million deaths among the world's population occurred as a result of tobacco use or active smoking in 2021, while 1.2 million people died as a result of passive smoking or regular exposure to cigarette smoke, [8]. 64,027,000 Indonesians over the age of 15 who smoke every day, according to statistics from The Tobacco Atlas for 2015, and it is determined that men are more likely than women to smoke.

Based on information from The Tobacco Atlas in 2016, it was discovered that Indonesia has a death rate from smoking of 290,400 per year, with men dying from the disease at a higher rate than women [9]. Smokers over the age of 10 have been more prevalent in Indonesia, rising from 28.8% in 2013 to 29.3% in 2018. The majority of smokers in North Sumatra Province—22.4% of the population—are between the ages of 30-34 and smoke an average of 14 cigarettes per day, according to 2018 Riskesmas data. Kretek cigarettes were the most popular brand, with a usage rate of 77.4%, [4]. Patients with tuberculosis typically have

cavitary lesions because the mycobacterium tuberculosis bacteria can harm the lung parenchyma and result in the formation of a cavity in the lung. Chest X-rays of patients with positive acid-fast bacteria (BTA) results showed a wider picture of lesions compared to patients with negative AFB, and the most frequently found features were uneven infiltrates and lung cavity lesions, according to a study by Jesica Damayanti Situngkir et al. published in 2019 on pulmonary tuberculosis patients in Medan city [10]. Multi-drug resistant tuberculosis (MDR-TB) patients frequently discover cavitary lesions that are thick-walled, large, and many as a result of failed tuberculosis treatment, which further damages the lung parenchyma. 43 MDR-TB patients were discovered to have lung cavities in a 2017 study by Resta Farits Pradana et al. at the MDR-TB polyclinic at Kariadi Hospital in Semarang, and 19 of them had multiple cavitary lesions, [11].

Because the majority of the chemicals in cigarette smoke are carcinogenic, smoking can harm the lung parenchyma, which is why tuberculosis patients who smoke tend to have more severe cavitary lesions. Results from 87 tuberculosis patients who were active smokers and 50 of them had lung cavity lesions were found in the study by Sun-Hyung Kim et al. at Chungbuk National University Hospital in South Korea in 2021 [12]. Neus Altet et al.'s 2017 study, which examined the direct effects of smoking on tuberculosis patients' radiological appearance in multiple Barcelona hospitals, discovered that 71 of the 104 patients had lung cavities [13]. Patients with tuberculosis who smoke more cigarettes had more severe cavity lesions. Yulia Nursyah Putri's 2016 study at RSUDZA Banda Aceh revealed that tuberculosis patients who smoked a lot had severe lung lesions [14]. It was discovered that smokers with moderate-severe degrees had substantial lung cavity lesions in a study on tuberculosis patients at the Friendship Hospital of DKI Jakarta done by Raditya Imam Pratana in 2018 [15]. Studies on the connection between smoking and lung cavity lesions are few and far between. Given this context, the researchers set out to determine if smoking and the development of lung cavity lesions in tuberculosis patients at Adam Malik General Hospital are related.

## II. METHODS

This study is an observational, analytical, case-control investigation. The H Adam Malik General Hospital, Jl. Lau Flower No. 17, Victory of Tani, Medan Tuntungan District, Medan City, North Sumatra, 20136 would be the site of this study. The time frame for this study is August through October 2022. All of Medan City's tuberculosis patients' medical records served as the study's target population. The medical records of tuberculosis patients at H Adam Malik General Hospital served as the reachable population in this investigation. The medical records of tuberculosis patients who smoked, did not smoke, and who met the inclusion criteria but not the exclusion criteria served as the sample for this study. Purposive sampling was used in this study's sample selection process. The researcher employed an unpaired categorical analytic method in this investigation.

$$n1 = n2 = \left( \frac{Z\alpha\sqrt{2PQ} + Z\beta\sqrt{P1Q1 + P2Q2}}{(P1 - P2)} \right)^2$$

$$n1 = n2 = \left( \frac{1,96\sqrt{2 \times 0,5535 \times 0,4465} + 0,84\sqrt{(0,4 \times 0,6) + (0,707 \times 0,293)}}{(0,4 - 0,707)} \right)^2$$

$$n = 39,91$$

The sample size in this study was 40 case groups and 40 control groups. Information :

$Z\alpha$  : standard deviation alpha (1.96)

$Z\beta$  : Standard deviation of beta (0.84)

$P2$  : P value from library = 0.707.15

$Q2$  :  $1 - P2 = 1 - 0.707 = 0.293$

$P1$ : The P value you want to examine = 0.4

$Q1$  :  $1 - P1 = 1 - 0.4 = 0.6$

$P1-P2$  : 0.307

$P$  :  $(P1 + P2) / 2 = (0.4 + 0.707) / 2 = 0.5535$

$Q$  :  $1 - P = 1 - 0.5535 = 0.4465$

**Tabel 1.** Operational definition

Variable	Operational definition	Method measuring	Results	Scale
Smoke	The act of smoking involves burning a cigarette and then inhaling the smoke for a particular reason. Smokers and non-smokers were separated into groups of patients.	Medical record	Smoking / non smoking	Nominal
Cavity Lesion	a lucency on an X-ray of the chest that indicates an air-filled hollow in the lung parenchyma.	Medical record	There is/No	Nominal
Tuberculosis patient	Patients who received a TB diagnosis at H Adam Malik Hospital between 2019 and 2022 and are now receiving hospital care, visiting for treatment, or receiving outpatient care.	Medical record	There is/No	Nominal

SPSS software will be used to examine the study's data. Based on medical record readings, sample data will be collected for this study, including whether or not the sample smokes and whether or not the sample has cavity lesions. In this study, the features of each sample were examined using univariate analysis, and the independent and dependent variables were connected using bivariate analysis utilizing the chi-square approach. The association between smoking and the development of lung cavity lesions in tuberculosis patients will be examined in this study.

### III. RESULT AND DISCUSSION

#### Research result

##### Description of Research Location and Time

In September 2022, this study was carried out at the H. Adam Malik General Hospital's Medical Records Installation. Researchers used computer tools to examine data that they extracted from the medical records of people who had tuberculosis.

##### Description of the Characteristics of Research Subjects

80 medical records of tuberculosis patients who satisfied the inclusion and exclusion criteria and were treated at H Adam Malik General Hospital in 2021 were utilized in this study. Obtained 40 medical records from patients who smoked and 40 from patients who did not smoke in accordance with the study's case-control design. Table 2 lists the gender, age, and occupation-based characteristics of research participants.

**Tabel 2.** Characteristics of Research Subjects

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Man	50	62,5
	Woman	30	37,5
	<b>Total</b>	<b>80</b>	<b>100</b>
Age	17 – 25	9	11,3
	26 – 35	10	12,5
	36 – 45	15	18,8
	46 – 55	23	28,7
	56 – 65	9	11,3
	> 65	14	17,5
	<b>Total</b>	<b>80</b>	<b>100</b>

Work	Enterpriser	25	31,3
	Government employees	5	6,3
	Private employees	6	7,5
	Student	11	13,8
	Teacher	1	1,3
	TNI & POLRI	3	3,8
	Farmer	13	16,3
	IRT	10	12,5
	Driver	3	3,8
	Retired	3	3,8
	<b>Total</b>	<b>80</b>	<b>100</b>

62.5% of the participants in this study were men. 28.7% of the individuals in this study were between the ages of 46 and 55, and 31.3% of them were self-employed.

**Table 3.** Characteristics of Research Subjects Based on Smoking Status

Characteristics	Smoke		Do not smoke	
	n	%	n	%
<b>Gender:</b>				
Man	38	47,5	12	15
Woman	2	2,5	28	35
<b>Age:</b>				
17 – 25	2	2,5	7	8,75
26 – 35	1	1,25	9	11,25
36 – 45	10	12,5	5	6,25
46 – 55	18	22,5	5	6,25
56 – 65	3	3,75	6	7,5
>65	6	7,5	8	10
<b>Work:</b>				
enterpriser	17	21,25	8	10
Government employees	3	3,75	2	2,5
Private employees	1	1,25	5	6,25
Student	2	2,5	9	11,25
Teacher	1	1,25	0	0
TNI & POLRI	2	2,5	1	1,25
Farmer	8	10	5	6,25
Housewives	1	1,25	9	11,25
Driver	3	3,75	0	0
Retired	2	2,5	1	1,25

Men patients made up 47.5% smokers and 15% non-smokers. 2.5% of female patients smoke, compared to 35% who do not. The age group that smoked the most in this study, by a margin of up to 22.5%, was found to be 46 to 55 years old, while the age group that smoked the least, by a margin of up to 1.25%, was 26 to 35 years old. While in the non-smoking group, the highest percentage was discovered in the age range of 26 to 35 years, at up to 11.25%, and the lowest in the age ranges of 36 to 45 and 46 to 55 years, at up to 6.25%. According to occupation, self-employment accounts for 21.25% of tuberculosis patients who smoke, while students and housewives account for 11.25% of the non-smoking group.

#### **Characteristics of Smoking Status in Tuberculosis Patients at H Adam Malik Hospital**

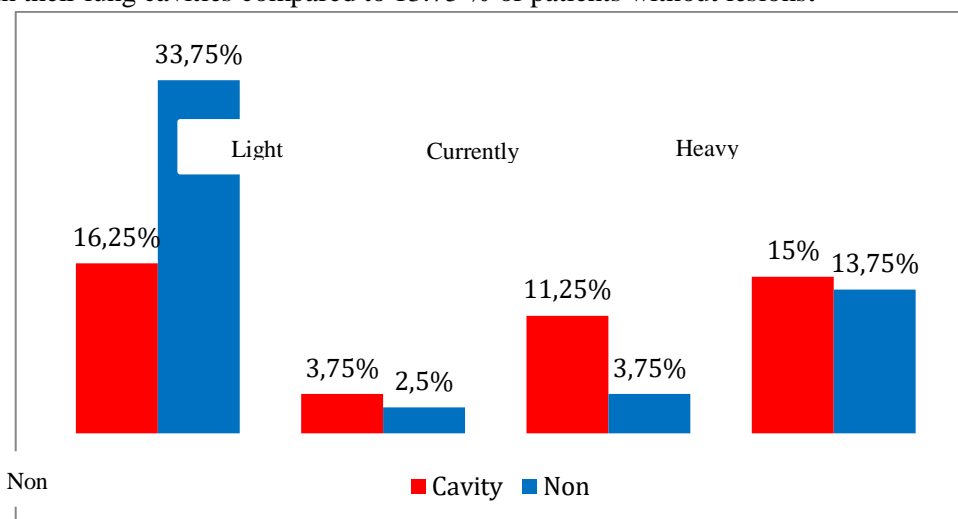
In this investigation, it was discovered that 50% of the patients did not smoke. The biggest percentage of patients, or 26.3%, were those who smoked between 0 and 20 cigarettes per day. 46.3% of patients had smoked for more than ten years, while 3.8% had smoked for one to ten years. Filter cigarettes were the most common type of cigarette ingested by patients (28.7%). According to the Brinkman index, patients who were classified as light smokers made up 6.3% of the population, moderate smokers made up 15%, and heavy smokers made up 28.7%. (Table 3)

**Table 4. Smoking Status of Tuberculosis Patients**

Characteristics	Frequency	
	n	%
<b>Number of Cigarettes (daily)</b>		
Do not smoke	40	50
1 – 20 stems/day	21	26,2
> 20 sticks/day	19	23,8
<b>Smoking Time (years)</b>		
Do not smoke	40	50
1 – 10 Tahun	3	3,8
> 10 Tahun	37	46,3
<b>Cigarette Type</b>		
Do not smoke	40	50
Filter	23	28,7
Non-Filter	17	21,3
<b>Smoking Degree</b>		
Do not smoke	40	50
Mild Degree	5	6,2
Moderate degree	12	15
Degree of Weight	23	28,8

#### Characteristics of Cavity Lesion Based on Degree of Smoking in Tuberculosis Patients at H Adam Malik Hospital

As observed in (Figure 1), the tuberculosis patients in this study were split into those without cavities (in red) and those with cavities (in blue). While 16.25% of patients did not smoke but did have cavitory lesions, there were 33.75% of patients without cavitory lesions. 2.5% of patients did not have lung cavities, while 3.75% of light smokers had lung cavities. 11.25% of patients who were moderate smokers and 3.75% of patients lacked lung cavity lesions had lung lesions. In contrast, among heavy smokers, 15% of patients had lesions in their lung cavities compared to 13.75% of patients without lesions.



**Fig 1. Distribution of Respondents Based on Degree of Smoking and Cavity**

#### Correlation between Smoking and the Formation of Lung Cavity Lesion in Tuberculosis Patients in RSUP H Adam Malik

Based on the findings of the chi square test analysis, it was determined that the value of  $p = 0.014$  ( $p < 0.05$ ) indicated that smoking and the development of lung cavity lesions are related. The obtained OR value was 3.115, indicating that smokers are 3.115 times more likely to have lung cavity lesions.

**Table 5.** The Relationship between Smoking and the Formation of Lung Cavity Lesions

Smoke	Cavity				P	95 % (CI)		OR
	There is		There isn't any			Lower	Upper	
	n	%	n	%				
Yes	24	30	16	20	0,014	1,247	7,781	3,115
No	13	16,25	27	33,75				
No	37	46,25	43	53,75				

### Discussion

In this study, 47.5% of the smoking patients were men. This is consistent with a research on tobacco-using tuberculosis patients in Surakarta by Yulianti Purnamasari, where 75% of the patients were men, [25]. In keeping with research done by Raditya Imam Pratana in 2018, which indicated that the majority of smoking patients were aged 46-55 years at 65%, the age range of the majority smoking patients in this study was 46-55 years at 22.5%, [15]. In this study, it was discovered that the majority of jobs were self-employed to the extent of 21.25%. Yan Hasqi Sebayang discovered the same thing in Medan City in 2018 and discovered that the majority of tuberculosis patients who smoked were self-employed to the extent of 22.2%. [26] The majority of males smoke for a variety of reasons, including the belief that doing so makes them appear cool, mature, and with a large circle of friends. Since many cigarette advertising portray smokers as rugged, successful individuals, many guys have tried smoking since they were young. After reaching adulthood, smokers tend to smoke for reasons of peace, relaxation, and to improve their ability to think clearly. This is based on research done by British American Tobacco, which claims that the effects of nicotine can improve brain function. [27]. The majority of instances in this study, or 46.3%, were people who had smoked for more than ten years, it was discovered. The similar thing was discovered by Francis Tandang et al. in 2015; 56.2% of patients were smokers for more than 15 years [28]. Filter cigarettes (28.7%) and non-filter cigarettes (21.3%) were the two types of cigarettes that the patients in this study smoked most frequently.

Contrary to Yulianti Purnamasari's findings, which examined the link between smoking and the prevalence of tuberculosis and discovered that 64% of cigarettes were non-filter, the majority of cigarettes used now are non-filter, [25]. Yulianti Purnamasari's research findings are further supported by the 2018 Riskesdas statistics, which shows that North Sumatra has the second-highest percentage of kretek smokers in Indonesia, at 77.4%. According to data released by Riskesdas in 2018 that stated that in North Sumatra Province the average daily cigarette consumption was 15 cigarettes/day, [4] it was discovered in this study that the average number of cigarettes smoked by the case group was 1-20 cigarettes/day, which was 26.2%, [4]. The Brinkman index is used in this study to gauge the patient's level of smoking. Geoffrey L. Brinkmann identified three categories of smokers in 1963: light smokers (Brinkman score 0-200), moderate smokers (Brinkman score 201-600), and heavy smokers (Brinkman score > 600). He did this by multiplying the patient's daily cigarette consumption by the number of years the patient had been smoking [29]. In this study, it was discovered that 28.7% of patients were heavy smokers, while 6.3% were light smokers. Yan Hasqi Sebayang discovered something unusual when he examined the association between smoking and the prevalence of pulmonary tuberculosis in Medan City in 2017. In this study, it was discovered that the majority of patients were light smokers, accounting for 13.9% of cases, and the minority were heavy smokers, accounting for 4.2% of cases. [26]. In this study, heavy smokers (15%) and light smokers (3.75%), respectively, exhibited the highest and least cavitory lesions in the case group patients.

This is consistent with research done by Gita Eka Ayuningtyas to determine the relationship between the amount of smoking and the development of lung lesions, which discovered a significant correlation between the two with a value of  $p = 0.013$  ( $p < 0.05$ ) for lesions on chest X-rays, [30]. The same thing was discovered in 2018 by Raditya Imam Pratana for tuberculosis patients at Friendship Hospital to see the relationship between smoking habits and history and the presence of lung cavity lesions. It was discovered that tuberculosis patients who had the most cavitory lesions were moderate-to-severe smokers (69%) with a value of  $p = 0.000289$  ( $p < 0.05$ ), [15]. This study's bivariate analysis utilizing the chi square test yielded the value of  $p = 0.014$  ( $p < 0.05$ ), which was used to calculate the significance level. This suggests that smoking

and the development of lung cavity lesions in tuberculosis patients at H Adam Malik Hospital are related. This is consistent with studies by Raditya Imam Pratana, who examined the association between smoking history and current lung cavity lesions at Friendship Hospital in 2018 and discovered a significant relationship with  $p = 0.000289$ , [15]. In a 2016 study on tuberculosis patients in Spain, Jimenez-Fuentes et al. discovered that 53.7% of smokers had cavitory lesions on their chest X-rays [31]. A research by Kuan-Jen Bai et al. of tuberculosis patients who smoked in three Taiwanese hospitals discovered lung cavity lesions in 59.7% of patients, cavities with a diameter of more than 3 cm in 28% of patients, and numerous cavities in 35.5% of patients [32].

Smoking can directly suppress the growth of interferon gamma (IFN-) in lung tissue, which reduces the generation of T cells and makes the patient's lungs more susceptible to infections from microbes like Mycobacterium TB. The amount of IFN- in the lungs is dose-responsive, which means that the amount will decrease as the patient smokes more cigarettes and for a longer period of time [13]. Cytochrome P450 or CYP 2A6 isoforms are the primary metabolic pathway for breaking down nicotine in humans. Long-term cigarette use can throw off the body's metabolic equilibrium and lead to an overactive CYP 2A6 enzyme, which can lead to the formation of carcinogenic tobacco derivatives. Through receptor mediation, nicotine and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone can activate direct transduction pathways, damaging and killing epithelial cells [33]. Multiple studies have been conducted on experimental animals to determine the direct effects of cigarette smoke on the respiratory tract. It has been discovered that exposure to cigarette smoke fosters the growth of microbes, which worsens lung damage and increases the transmission rate [34], [35]. According to numerous studies that have identified a connection between smoking and the prevalence of pulmonary tuberculosis, [25], [26], and [28], damage to the lung parenchyma caused by exposure to cigarette smoke can raise a person's vulnerability to a disease. Smokers' lungs have a very different defense mechanism than non-smokers, making their lung conditions much more susceptible to infection. Because of this state, the lungs of smokers are an extremely favorable environment for the growth and development of microorganisms like *M. tuberculosis*. To create main nests (ghon foci), the germs will multiply in the cytoplasm of alveolar macrophages in the lungs. A tissue known as a granuloma is formed in primary tuberculosis when an accumulation of macrophages harboring dormant *Mycobacterium tuberculosis* occurs. Granuloma formation can be triggered by immunogenic proteins such early secreted antigenic target-6 (ESAT-6), which is expressed by *Mycobacterium TB*.

The basement membrane will be disrupted as a result of the alveolar tissue degrading and being replaced by fibrotic matrix, which will cause a pathological matrix remodeling process across the granuloma area and lead to the concentration of immune cells. Damaged tissue that is hypoxic is induced to secrete more hypoxia inducible factor (HIF)-1, which in turn increases the release of matrix metalloproteinases (MMPs). Because they may communicate with the immune system and influence vascular permeability, cysteine cathepsin and MMPs serve as the primary mediators of cavity development. This increases the deterioration of alveolar tissue. A typical necrotic tissue will develop in the lung parenchyma as the condition worsens, and when this necrotic tissue (striation) emerges from the lung after coughing, a cavity will develop in the patient's lung [21], [36]. The more cigarettes the patient smokes every day and the longer their history of smoking, the more severe their level of smoking is. Cigarette smoke contains a number of dangerous chemicals that can disrupt the balance of inflammatory mediators in the lungs, causing direct lung parenchymal damage. As a result, *M. tuberculosis* grows rapidly in the parenchyma of the patient's lungs. Smoking-related damage to the lung parenchyma can also worsen oxygenation problems in the lungs, which accelerate the progression of the illness. These different circumstances lead to infarction, necrosis, and cavity formation in the lung tissue, [13], [22], [37].

#### IV. CONCLUSION

Smoking and the development of lung cavity lesions in tuberculosis patients at H Adam Malik General Hospital are related.

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