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Comparing Chest Radiograph Lesion Areas in Pulmonary Tuberculosis Patients with and without Diabetes Mellitus: A 2023 Study at Waled Hospital, Cirebon, Indonesia

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ABSTRACT

Background: The Global Tuberculosis Report emphasizes a significant number of TB cases, and Indonesia is the second country in Southeast Asia with the most TB cases. Prevalence of TB increases along with the increase of Diabetes Mellitus (DM) prevalence, which both are known to have a negative impact on each other. Clinical symptoms in TB with DM differ from those in TB without DM. However, whether there is any difference in radiology examinations is unknown. This can be a consideration for determining patient therapy based on differences in the chest radiographs.

Aims: To determine the Lesion Area Difference on Chest Radiographs of Pulmonary Tuberculosis Patients with and without Diabetes Mellitus at Waled Hospital in 2023.

Methods: There were 96 data points based on the first taken chest radiograph from both inpatient and outpatient data, which were obtained from medical records in 2023 at Waled Hospital, Cirebon. Statistical analysis was performed using the Chi-Squared comparative test in this observational study with a cross-sectional design.

Results: There were 69 tuberculosis (TB) patients without diabetes mellitus (DM) and 27 TB patients with DM. Overall, patients had minimal lesions (14.6%), moderate lesions (26.0%), and far-advanced lesions (59.4%). The Chi-Square analysis from these samples showed a p-value of 0.870.

Conclusion: There is no difference in lesion area on chest x-rays in pulmonary tuberculosis patients with or without diabetes mellitus. Further research is expected to include the type of TB and history of treatment for either TB or DM.

Keywords: *Pulmonary Tuberculosis; Diabetes Mellitus; Thoracic Radiography; Lesion Area.*

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1. Introduction

Tuberculosis (TB) is a disease caused by Mycobacterium tuberculosis, which mainly attacks the lungs. TB is a multi-systemic disease with various symptoms. Symptoms that can be developed with pulmonary TB include chronic cough, fever, night sweats, weight loss, and tiredness (Rotimi *et al*., 2023).

The Global Tuberculosis Report explains that around 10 million people are suffering from TB, and Indonesia is the second country in Southeast Asia with the most TB cases after India. This leads to 1.2 million people dying every year. There are 67% found and treated, so there are 283.000 TB patients who have not been treated, and they risk becoming a source of infection and becoming a new TB case. In 2019, the number of pulmonary TB cases in West Java reached 62,218. Cirebon City is one of the cities with sufficient cases of pulmonary TB, reaching 1,372 cases in 2020, placing Cirebon City in the second place with the most TB cases in West Java. Meanwhile, Cirebon Regency reached 5,395 TB cases in 2019 (Abbas, 2022).

Diabetes mellitus (DM) is a global burden of endocrine disease. The International Diabetes Federation (IDF) stated that there are around 230 million cases of DM worldwide. In 2030, Indonesia is estimated to reach 21,3 million people with DM. DM is becoming an important risk factor for the development of TB cases and one of the most important risk factors for TB worsening (Metasari, 2017; Wirawan *et al.,* 2019). The prevalence of tuberculosis is increasing alongside the growing number of cases of diabetes mellitus. It is associated with several factors, including age, BMI, and comorbidities. In this case, Diabetes Mellitus (DM) became a significant factor for TB-DM cases. Based on previous research in 2020, there is a strong correlation between DM and TB. Diabetes mellitus can weaken the immune system, increasing the risk of active tuberculosis. During TB treatment, patients with diabetes mellitus (DM) are twice as likely to test positive for BTA, four times as likely to relapse after completing treatment, and five times as likely to die as patients with TB without DM. (Meena *et al.,* 2020). These two diseases have a negative impact on each other. TB with DM has different clinical symptoms from TB without DM. The previous research reports a correlation between radiography lesion area in TB patients with or without DM. However, whether there is a difference in radiological examinations is still unknown. Assessing the lesion area in pulmonary TB based on chest radiographs means assessing the grade severity of lung abnormalities in pulmonary TB with and without DM (Ahmad *et al*., 2020). Previous research by Fachri stated that there is no significant difference in the lesion area of radiological examination on TB MDR patients with and without DM (Fachri *et al.,* 2021). Another study by Ardin stated a correlation between DM and lesion area of radiological test on TB (Ardin *et al.,* 2023). However, there has not been much research about the difference in lesion area in TB patients with or without DM. It becomes crucial whether there is a difference in lesion area on chest radiographs in TB patients with or without DM, to establish collaborative therapy which will reduce the burden in TB and TB-DM patients at Waled Hospital, Cirebon, in 2023.

2. Methods

Study design

This research uses observational analytic methods with a quantitative approach to examine the difference in lesion area on chest radiographs of pulmonary tuberculosis patients with and without diabetes mellitus. Waled Hospital in Cirebon Regency, West Java, Indonesia, was selected since it has been considered one of the highest TB cases in Cirebon.

Population and samples

This research was conducted in May-August 2024 in Waled Hospital, Cirebon Regency. There were 96 data points based on the first chest radiograph taken from both inpatient and outpatient, for tuberculosis patients with or without diabetes mellitus type 2, who did not have a history of malignancy and autoimmune disease, were obtained from medical records in 2023 at Waled Hospital, Cirebon, and selected using consecutive sampling technique.

Measurements

The independent variables in this study are TB patients with and without DM, and the dependent variable is lesion area on chest radiographs. Data was collected from patients' medical records, including chest radiographs taken at the hospital. This data has been read and expertized by a radiologist by the American Tuberculosis Association references.

Statistical techniques

The data obtained were statistically analyzed using IBM SPSS Statistics 26. They were analyzed using univariate and bivariate analysis with the Chi-Square Comparative Test, which is used to compare two unpaired groups of variables. This research also uses secondary data in Medical Records, including chest radiographs, to identify the lesion area.

Ethical Clearance

This study was ethically approved by the Ethics Committee of Waled Hospital with No. 000.9.2/055/KEPK/V/2024 on May 30^{th,} 2024.

3. Results

Patients' characteristics

Table 1 summarises the patient's characteristics in this recent study, including age, gender, and the lesion type based on the chest radiographs, divided into TB and TB-DM groups. The survey indicates that the age range of 44-54 is the highest group with TB cases. This range of age is based on TB and DM distributed in the Governor of Medical database, in which at Waled Hospital in 2023, there were 27 cases, of which 14 patients (14.6%) had TB and 13 patients (13.5%) had TB-DM. The majority of TB patients were male, about 36 patients (37.5%), but in the TB-DM group, there were 16 female patients (16.6%). It is higher than the male group in the TB-DM case. Based on their lesion type, the most common type is the far-advanced lesion in both groups. The TB group had 42 patients (43.8%) with far-advanced lesion type, while in the TB-DM group, there were 15 patients (15.6%) with the same lesion type.

Table 1. Patients' Characteristics

Characteristics	TB Patients		TB-DM Patients		Total	
	n	%	n	%	n	%
Age (years)						
0-14	6	6.3	-	-	6	6.3
15-24	7	7.3	-	-	7	7.3
25-34	8	8.3	-	-	8	8.3
35-44	11	11.5	2	2	13	13.5
45-54	14	14.6	13	13.5	27	28.1
55-64	15	15.6	6	6.3	21	21.9
>65	8	8.3	6	6.3	14	14.6
Total	69	71.9	27	28.1	96	100
Gender						
Male	36	37.5	11	11.5	47	49.0
Female	33	34.4	16	16.6	49	51.0
Total	69	71.9	27	28.1	96	100
Lesion Type						
Minimal	10	10.4	4	4.2	14	14.6
Moderate	17	17.7	8	8.3	25	26.0
Far-Advanced	42	43.8	15	15.6	57	59.4
Total	69	71.9	27	28.1	96	100

Bivariate analysis

Table 2 compares the patients based on the type of lesion on the chest radiographs. The statistical analysis shows that the comorbidity, in this case, DM, does not significantly contribute to the difference in lesion area in the chest radiographs of TB and TB-DM patients (p-value = 0.870).

The lesion areas are divided into minimal, moderate, and far-advanced lesions. The minimal lesion indicates a small amount of non-cavitary infiltrate in one lung or both lungs, but the lesion does not exceed one lung lobe. A moderate lesion has a cavity with a diameter of over 4 cm. The amount of fine infiltrate is less than one lung section. If the shadow is rough, the infiltrate should be less than one-third of the lung. Meanwhile, in the far-advanced lesion, there is infiltration, and the cavity exceeds the state of a moderate lesion.

Table 2. Comparison between the TB and the TB non DM group with the lesion type

		TB Patients		**TB-DM Patients**		**Total**		**P value**
		n	%	n	%	n	%	
Lesion Type	*Minimal Lesion*	10	14.5	4	14.8	14	14.6	0.870
	Moderate Lesion	17	24.6	8	29.6	25	26.0	
	Far-Advanced Lesion	42	60.9	15	55.6	57	59.4	
Total		69	100	27	100	96	100	

4. Discussion

The results showed that the 45-54 age group had the highest prevalence of TB and TB-DM cases. In the TB group, 14 patients (14.6%) were infected with TB in the 45-54 age range, while in the TB-DM group, 13 patients (13.5%) were in the same age range. The previous research indicates that productive age is a significant risk factor, which is in line with this research's findings. The immune system can be decreased due to unhealthy lifestyles, such as smoking and alcohol consumption, as well as medical conditions such as diabetes mellitus, further worsening the risk of developing TB in this age group (Surbakti *et al*., 2020). Apart from that, high mobility in the productive age group also contributes to the spread of this disease (Widiastuti *et al*., 2022).

This research shows that gender plays a significant role in the pattern of tuberculosis disease. Men are more commonly infected with pulmonary TB, which is most likely caused by smoking habits that damage the lungs. This study included 36 male patients (37.5%), which is higher than the number of females in the same group. Conversely, women are more susceptible to TB-DM, particularly after menopause, due to hormonal changes that affect glucose metabolism (Widiastuti *et al*., 2022). These findings indicate the need for a more differentiated approach in TB control efforts, considering risk factors specific to each gender (Dewi *et al*., 2020). It shows in this research that females in the TB-DM group are significantly higher than that of males in the same group, with 16 females (16.6%)

The research results showed that the majority of TB patients had far-advanced lesion types. In the TB group, there are 42 patients (43.8%), while in the TB-DM group, 15 patients (15.6%) have far-advanced lesion types. These findings are consistent with previous studies showing that TB-DM patients tend to have more severe lesions. The far-advanced lesion type is caused by decreased body resistance in DM patients, which leads to inhibiting the body from fighting TB infection. A decrease in the body's immune system due to diabetes mellitus makes it easier for TB bacteria to reproduce and damage lung tissue. This condition can cause severe lung damage and serious complications. These findings emphasize the importance of early detection and comprehensive treatment in TB-DM patients (Tampubolon *et al.,* 2022; Triandini *et al.,* 2022).

Based on bivariate analysis, these findings indicate that various factors, including diabetes mellitus, influence the extent of lung lesions in TB patients. Although TB-DM patients tended to have more severe lesions, this difference was not statistically significant (Nur'aini *et al.,* 2021). Factors such as nutritional status, duration of treatment, HbA1c rate, and immune condition also play an important role in disease development. The previous research stated a positive association between nutritional status and pulmonary TB cases. It depends on patients' BMI and their metabolic changes due to TB disease. On the other hand, TB-DM patients with HbA1c rate >8% are tend to have severe lesion type on their radiological test (Wang *et al.,* 2022; Zhan *et al.,* 2022). Patient's knowledge also plays a role in TB treatment. Patients with better knowledge of tuberculosis have good behavior and stick with the medication, which leads to an increased healing rate (Marfuati *et al.,* 2024).

Compared with previous studies, this study included diabetes mellitus type 2 as the primary disease, pulmonary tuberculosis, and compared the results of chest radiographs between these groups. The limited data in this study emphasized the importance of further research to understand the mechanisms underlying lung damage in TB patients and the severity of the lesion (radiographs, histopathology, or complications). This study's data was based on data from all pulmonary tuberculosis patients and did not exclude the type of treatment, such as drug-failed tuberculosis, drug-resistant tuberculosis, and others. This may be a confounding factor that plays a role in research results. TB can also lead to serious complications such as pleural effusion or pneumothorax, especially in individuals with DM, and can cause a patient to need a chest tube procedure. Development of procedural simulation tools to teach chest tube insertion in TB-DM patients could improve medical education and emergency preparedness in low-resource settings (Kusumaningrum *et al.,* 2017; Hlaing *et al.,* 2018).

5. Conclusion

This study shows that people around 45-54 years old are often infected with TB and TB-DM, and gender also has a role in disease distribution. Although there is no difference in lesion area in their chest radiographs (p-value 0.870), several factors could emphasize the result. These factors include patients' medical treatment, HbA1c rate, nutritional status, type of TB, and many more. Future studies are expected to use the case-control method with the same population size in both groups to separate the factors of TB and TB-DM to avoid bias and a significant result.

Conflict of Interest

There is no conflict of interest. Nothing to disclose.

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