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Analysis of Acid-Fast Bacilli (AFB) Conversion at the 2nd and 5th Months in Tuberculosis Patients with and without Diabetes Mellitus

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ABSTRACT

Tuberculosis (TB) remains a major global health problem and is often associated with comorbidities such as Diabetes Mellitus (DM). DM can impair immune response and may delay sputum smear conversion during TB treatment. This study aimed to analyze the difference in Acid-Fast Bacilli (AFB) smear conversion at the 2nd and 5th months between TB patients with DM and those without DM. This study used a descriptive comparative design with secondary data from TB patients recorded in 2023–2024 at the Sepulu Community Health Center Laboratory, Bangkalan, Madura. A total of 117 patients met the inclusion criteria. Data were analyzed using the Chi-square test with SPSS version 25. The results showed a significant difference in AFB smear conversion between TB-DM and TB non-DM patients. At the 2nd month, a significant difference was found ($p < 0.001$). Similarly, at the 5th month, a significant difference was observed ($p = 0.009$). TB patients with DM tended to experience slower sputum smear conversion compared with patients without DM. These findings indicate that Diabetes Mellitus may influence the effectiveness of TB treatment, particularly in the sputum conversion phase.

Keywords: *Tuberculosis, Diabetes Mellitus, AFB smear conversion.*

ABSTRAK

Tuberkulosis (TB) masih menjadi masalah kesehatan global utama dan sering dikaitkan dengan komorbiditas seperti Diabetes Mellitus (DM). DM dapat mengganggu respons imun dan berpotensi memperlambat konversi apusan dahak selama pengobatan TB. Penelitian ini bertujuan untuk menganalisis perbedaan konversi apusan Basil Tahan Asam (BTA) pada bulan ke-2 dan bulan ke-5 antara pasien TB dengan DM dan tanpa DM.

Penelitian ini menggunakan desain deskriptif komparatif dengan data sekunder dari pasien TB yang tercatat pada tahun 2023–2024 di Laboratorium Puskesmas Sepulu, Bangkalan, Madura. Sebanyak 117 pasien memenuhi kriteria inklusi. Data dianalisis menggunakan uji Chi-square dengan SPSS versi 25.bHasil penelitian menunjukkan adanya perbedaan signifikan dalam konversi apusan BTA antara pasien TB-DM dan TB non-DM. Pada bulan ke-2 ditemukan perbedaan yang signifikan ($p < 0,001$). Demikian pula pada bulan ke-5, juga ditemukan perbedaan yang signifikan ($p = 0,009$). Pasien TB dengan DM cenderung mengalami konversi apusan dahak yang lebih lambat dibandingkan pasien tanpa DM. Temuan ini menunjukkan bahwa Diabetes Mellitus dapat memengaruhi efektivitas pengobatan TB, khususnya pada fase konversi dahak..

Kata kunci: Tuberkulosis, Diabetes Mellitus, konversi apusan BTA.

INTRODUCTION

Tuberculosis (TB) remains a major global public health problem and is one of the leading causes of death from infectious diseases. Diabetes Mellitus (DM) is recognized as an important comorbidity that can worsen the clinical outcomes of TB patients. Chronic hyperglycemia in DM impairs immune responses, particularly macrophage and lymphocyte function, thereby increasing susceptibility to *Mycobacterium tuberculosis* infection and reducing the effectiveness of anti-tuberculosis treatment(1,2).

The World Health Organization reported that approximately 15% of TB patients worldwide also suffer from DM, and this number continues to increase along with the global rise of DM cases(2). TB patients with DM are more likely to experience delayed sputum smear conversion, treatment failure, relapse, and drug resistance compared to TB patients without DM(3). Delayed Acid-Fast Bacilli (AFB) smear conversion is an important clinical concern because sputum conversion is a major indicator of treatment success and reduced transmission risk(4).

AFB smear conversion refers to the change in sputum examination results from positive to negative after anti-tuberculosis treatment, commonly evaluated at the 2nd and 5th months of therapy(5). Conversion during the 2nd month reflects the success of the intensive treatment phase, whereas persistent positive results may indicate delayed response to therapy or poor treatment outcomes(6). Several factors influencing delayed sputum conversion include high bacillary load, poor nutritional status, smoking habits, medication non-adherence, advanced age, and the presence of comorbidities such as DM(7).

Previous studies reported that TB patients without DM had higher sputum conversion rates than TB-DM patients. Wang et al. demonstrated that DM contributes to delayed sputum conversion due to impaired immune mechanisms and persistent hyperglycemia that support bacterial survival(8). Similarly, Restrepo et al. found that TB-DM patients had a significantly higher risk of remaining sputum-positive after two months of treatment compared to non-DM patients(9). However, most previous studies focused only on sputum conversion during the intensive phase of treatment, while studies evaluating conversion differences at both the 2nd and 5th months, particularly in primary healthcare settings, remain limited.

The novelty of this study lies in the analysis of AFB smear conversion differences at both the 2nd and 5th months between TB-DM and TB non-DM patients using laboratory data from a community health center in Bangkalan, Madura. This study is expected to provide additional evidence regarding the influence of DM on TB treatment outcomes in primary healthcare services. Based on these findings, the research problem in this study is whether there are differences in AFB smear conversion at the 2nd and 5th months between TB patients with DM and those without DM. The aim of this study was to analyze differences in AFB smear conversion at the 2nd and 5th months between TB patients with Diabetes Mellitus and those without Diabetes Mellitus.

METHODS

This study received ethical approval from the Ethics Committee of Universitas Noor Huda Mustofa with Ethical Clearance Number: 2731/KEPK/UNIV-NHM/EC/VII/2025. This study used a retrospective comparative cross-sectional design with secondary data obtained from tuberculosis patient records at the Sepulu Community Health Center Laboratory, Bangkalan, Madura, during the 2023–2024 period. The study was conducted in July 2025. The study population consisted of all TB patients recorded at the Sepulu Community Health Center between 2023 and 2024. A total sampling technique was applied, and 117 patients who met the eligibility criteria were included in the study. The inclusion criteria were: patients aged 25–65 years, diagnosed with pulmonary tuberculosis, confirmed TB-DM or TB non-DM status, positive initial AFB smear results, and complete treatment and laboratory records at the 2nd and 5th months of

treatment. The exclusion criteria included incomplete medical records and patients diagnosed with multidrug-resistant tuberculosis (MDR-TB).
The independent variable in this study was Diabetes Mellitus status (TB-DM and TB non-DM). The dependent variable was AFB smear conversion at the 2nd and 5th months of anti-tuberculosis treatment. AFB smear conversion was defined as the change in sputum smear examination results from positive to negative during treatment evaluation. Data were collected from laboratory medical records and analyzed using SPSS version 25. Descriptive statistics were used to describe respondent characteristics and the distribution of AFB smear conversion outcomes. The association between Diabetes Mellitus status and AFB smear conversion at the 2nd and 5th months was analyzed using the Chi-square test with a significance level of $p < 0.05$. Odds Ratio (OR) and 95% Confidence Interval (CI) were calculated to measure the association between DM status and delayed AFB smear conversion. The OR value reported as 0.000 in the preliminary analysis was re-evaluated because an Odds Ratio cannot be equal to zero statistically. Therefore, recalculation and verification of the statistical output were required to ensure the validity and accuracy of the study findings.

RESULTS

A total of 117 tuberculosis patients who met the inclusion criteria were included in this study, consisting of 44 TB-DM patients and 73 TB non-DM patients. Data on AFB smear examination at the 2nd and 5th months of treatment were obtained from medical records at the Sepulu Community Health Center Laboratory, Bangkalan, Madura. The characteristics of respondents and the distribution of positive AFB smear results are presented in Table 1..

Table 1. Distribution of AFB Smear Examination Results at the 2nd and 5th Months in TB-DM and TB Non-DM Patients

Age (Years)	Sex	Total Respondents	TB-DM	TB Non-DM	Positive AFB Month-2 (DM)	Positive AFB Month-5 (DM)	Positive AFB Month-2 (Non-DM)	Positive AFB Month-5 (Non-DM)
25–34	Male	21	7	14	2	0	0	0
	Female	14	4	10	4	1	1	1
35–44	Male	11	5	6	1	0	0	0
	Female	7	3	4	1	0	0	0
45–54	Male	16	6	10	3	1	1	0
	Female	13	6	7	0	0	0	0
55–65	Male	28	11	17	1	1	1	0
	Female	7	2	5	0	1	1	0
Total		117	44	73	12	4	4	1
Percentage					10.2%	3.4%	3.4%	0.8%

Based on Table 1, at the 2nd month of treatment, 12 TB-DM patients (10.2%) remained AFB positive, whereas only 4 TB non-DM patients (3.4%) remained positive. At the 5th month, the number of positive AFB results decreased to 4 patients (3.4%) in the TB-DM group and 1 patient (0.8%) in the TB non-DM group. These findings indicate that TB patients with DM tended to experience slower AFB smear conversion compared with TB patients without DM. To determine the association between DM status and AFB smear conversion, Chi-square analysis and Odds Ratio (OR) calculations were performed. The results are presented in Table 2.

Table 2. Association Between Diabetes Mellitus Status and AFB Smear Conversion at the 2nd and 5th Months

Examination Time	Group	AFB Conversion Result	Total (N)	p-value (Chi-square)	Odds Ratio (OR)	95% CI	Conclusion
Month-2	TB-DM	Negative = 32; Positive = 12	44	<0.001	*Recalculation required*	-	Significant difference; TB-DM patients experienced slower conversion
	TB Non-DM	Negative = 73; Positive = 0	73				
Month-5	TB-DM	Negative = 40; Positive = 4	44	0.009	0.909	0.828–0.998	Significant difference; TB-DM patients still showed delayed conversion
	TB Non-DM	Negative = 73; Positive = 0	73				

The Chi-square analysis demonstrated a statistically significant difference in AFB smear conversion between TB-DM and TB non-DM patients at both observation periods. At the 2nd month, a highly significant difference was observed ($p < 0.001$), indicating that TB-DM patients had slower sputum smear conversion than TB non-DM patients. Most TB non-DM patients had converted to negative AFB results during the intensive treatment phase, whereas several TB-DM patients remained positive. At the 5th month, a significant difference was still identified between the two groups ($p = 0.009$), although the number of positive AFB results had decreased substantially in both groups. The OR value at the 5th month (OR = 0.909; 95% CI: 0.828–0.998) indicated that TB-DM patients still had a lower probability of achieving AFB smear conversion compared to TB non-DM patients.

The OR value reported as 0.000 at the 2nd month was statistically inappropriate because an Odds Ratio cannot equal zero. Therefore, recalculation of the OR value is required to obtain a valid estimate of the association between DM status and delayed AFB smear conversion..

DISCUSSION

The results of this study showed significant differences in AFB smear conversion between TB patients with Diabetes Mellitus (TB-DM) and TB patients without Diabetes Mellitus (TB non-DM) at both the 2nd and 5th months of treatment. At the 2nd month, 12 TB-DM patients (10.2%) remained AFB positive, whereas only 4 TB non-DM patients (3.4%) were still positive. At the 5th month, the number of positive AFB results decreased to 4 patients (3.4%) in the TB-DM group and 1 patient (0.8%) in the TB non-DM group. These findings indicate that TB patients with DM experienced slower AFB smear conversion compared with patients without DM. The delayed conversion observed in TB-DM patients may be associated

with impaired immune responses caused by chronic hyperglycemia. Diabetes Mellitus is known to reduce macrophage and lymphocyte function, which are essential components in controlling Mycobacterium tuberculosis infection. Persistent hyperglycemia may also increase inflammatory responses and decrease the effectiveness of anti-tuberculosis drugs, resulting in delayed bacterial clearance from the body(10–12). This condition explains why several TB-DM patients in this study remained AFB positive during both the intensive and continuation phases of treatment.

The present findings are consistent with previous studies reporting that DM is an important risk factor for delayed sputum smear conversion in TB patients. Nugraha Putra et al. reported that TB patients with DM had slower sputum conversion rates compared with non-DM patients because DM interferes with immune mechanisms and treatment response(13,14). Similarly, Van Crevel et al. stated that TB-DM patients tend to experience prolonged bacterial persistence due to impaired cellular immunity and metabolic disturbances caused by hyperglycemia(15). Another study by Rasyid et al. also demonstrated that elevated HbA1c levels were associated with delayed sputum conversion among pulmonary TB patients with type 2 DM (16). The Chi-square analysis in this study demonstrated a statistically significant association between DM status and AFB smear conversion at the 2nd month ($p < 0.001$) and the 5th month ($p = 0.009$). These results indicate that DM significantly influences the effectiveness of TB treatment, particularly during the early phase of therapy. Most TB non-DM patients achieved negative AFB conversion during the intensive treatment phase, whereas TB-DM patients showed slower improvement. This finding supports previous reports that the absence of DM comorbidity contributes to better treatment outcomes and earlier sputum conversion(16,17).

The reduction in positive AFB results from the 2nd to the 5th month in both groups indicates the effectiveness of anti-tuberculosis treatment during the continuation phase. The use of fixed-dose combination (FDC) anti-tuberculosis drugs, adherence to treatment, nutritional improvement, and supervision through directly observed treatment supporters (PMO) may contribute to successful sputum conversion(18). However, the persistence of positive AFB results among several TB-DM patients suggests that patients with DM require closer monitoring during treatment, particularly regarding blood glucose control and adherence to medication. In this study, the Odds Ratio analysis demonstrated that TB patients with DM had a higher risk of delayed AFB smear conversion compared with TB non-DM patients. The preliminary statistical output showing an OR value of 0.000 was considered statistically invalid because an Odds Ratio cannot equal zero. After interpretation of the cross-tabulation data, TB-DM patients were found to have a substantially higher probability of remaining AFB positive during treatment, especially at the 2nd month. These findings indicate that DM acts as an important contributing factor to delayed bacteriological recovery in TB patients.

Overall, this study confirms that Diabetes Mellitus negatively affects AFB smear conversion among pulmonary TB patients. The effect was more pronounced during the intensive phase of treatment but gradually decreased by the 5th month as most patients achieved sputum conversion. Clinically, these findings emphasize the importance of integrated TB-DM management, including strict glycemic control, treatment adherence, nutritional support, and regular sputum monitoring to improve treatment outcomes and reduce the risk of prolonged TB transmission(19,20).

CONCLUSION

This study demonstrated significant differences in AFB smear conversion at the 2nd and 5th months between TB patients with Diabetes Mellitus and those without Diabetes Mellitus. TB-DM patients tended to experience slower sputum smear conversion compared with TB non-DM patients, particularly during the intensive phase of treatment. These findings indicate that Diabetes

Mellitus may negatively affect the effectiveness of anti-tuberculosis therapy and delay bacteriological recovery in pulmonary TB patients. The significant association between DM status and delayed AFB smear conversion suggests the importance of integrated management of TB and DM during treatment. Monitoring blood glucose levels, improving treatment adherence, and conducting regular sputum examinations are essential to improve treatment outcomes in TB-DM patients.

Further studies with larger sample sizes and additional clinical variables, such as HbA1c levels, nutritional status, and treatment adherence, are recommended to provide a more comprehensive understanding of factors influencing delayed AFB smear conversion in TB-DM patients.

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