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Risk factors for tuberculosis and diabetes mellitus comorbidity in West Sumatra, Indonesia: A matched case-control study

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ABSTRACT

The comorbidity between tuberculosis (TB) and diabetes mellitus (DM) (TB-DM) is a growing public health issue globally. In Indonesia, where both TB and DM remain highly prevalent, evidence on factors contributing to TB-DM comorbidity is still limited, particularly in West Sumatra. Patients with TB-DM tend to experience more severe disease, including an increased risk of death, treatment failure, and pulmonary complications. This study aims to analyse the sociodemographic, clinical, and environmental risk factors that influence the prevalence of TB-DM comorbidity in West Sumatra Province. This study used a retrospective matched case–control design using secondary data from the West Sumatra TB Information System. Cases were TB patients with documented DM comorbidity, and controls were TB patients without DM, with all subjects registered in 2024. A purposive sampling approach was applied using secondary SI-TB registry data. Eligible TB–DM patients with complete key variables were included as cases (n = 830) and matched 1:1 with TB patients without DM as controls (n = 830). Statistical tests used the McNemar test and Conditional Logistic Regression. Significant risk factors for tuberculosis and diabetes mellitus (TB-DM) comorbidity are age (OR = 11.500; 95% CI: 8.39–15.76, p = 0.0001), occupation (OR = 1.559; 95% CI: 1.201–2.022, p = 0.0001), pulmonary tuberculosis (OR = 6.615; 95% CI: 3.692–11.853, p = 0.0001), and history of TB treatment, with patients who had a history of relapse being at higher risk (OR = 2.857; 95% CI: 1.857–4.393, p = 0.0001). Meanwhile, residential area and referral status did not show significant differences, with ORs of 1.218 (95% CI: 0.852–1.740, p = 0.277) and 1.246 (95% CI: 0.899–1.727, p = 0.185), respectively. In the final model, age (OR = 11.031; 95% CI: 8.014–15.185) and pulmonary tuberculosis (OR = 4.895; 95% CI: 2.327–10.296) remained significant as risk factors for TB-DM comorbidity. Age, occupation, pulmonary tuberculosis, and history of TB treatment are significantly associated with tuberculosis and diabetes mellitus (TB-DM) comorbidity. It is important to conduct early screening for diabetes in TB patients and to manage both diseases simultaneously to improve treatment outcomes and reduce morbidity and mortality.

Keywords:
tuberculosis; diabetes mellitus; comorbidity; risk factors; socioeconomic factors

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INTRODUCTION

The comorbidity between tuberculosis (TB) and diabetes mellitus (DM) (TB-DM) is a serious and growing public health problem worldwide. Patients with TB-DM tend to show greater severity of their disease, such as more frequent pulmonary cavities, pulmonary TB with positive smears, and a higher risk of death.[1] Furthermore, TB-DM has been demonstrated to heighten the probability of treatment failure and to exacerbate the patient's overall condition. Diabetes mellitus, a chronic metabolic disease that affects multiple organs, has been demonstrated to exacerbate the course of infectious diseases such as tuberculosis (TB), increase susceptibility to infection, and prolong the recovery process.[2] Data show that approximately 10.6 million people live with active TB and 536.6 million people live with diabetes mellitus worldwide, adding urgency to addressing this comorbidity.[3]

According to data from the International Diabetes Federation (IDF), the global prevalence of DM is 10.5%, with an estimated increase to 12.2% by 2045.[4] TB-DM comorbidity is a major concern due to its high prevalence, especially in countries with a high TB burden, such as in Asia (17%) and Africa (7%).[5] In Indonesia, particularly in West Sumatra Province, the number of tuberculosis and diabetes mellitus cases continues to rise, with a significant prevalence of tuberculosis-diabetes mellitus. Data from the West Sumatra Provincial Health Department in 2022 recorded 48,206 cases of diabetes, and the increasing number of tuberculosis cases indicates a significant association between the two diseases that warrants attention.[6,7]

Recent research shows that various risk factors, including sociodemographic, clinical, and environmental factors, influence the incidence of TB-DM. Age over 40 years has consistently been identified as a significant risk factor for this comorbidity, with older individuals having a higher risk of developing TB-DM.[8,9] In addition, gender plays a role, with men being more frequently affected by TB-DM than women,[10] as well as low socioeconomic status, including low education and low income, are associated with higher prevalence.[8] Occupational factors, particularly among blue-collar workers, indicate a higher incidence of TB-DM compared to other occupational groups.[11] From a clinical perspective, poor glycemic control in diabetic patients is a primary factor increasing the risk of tuberculosis, with elevated HbA1c levels directly associated with an increased incidence of tuberculosis in diabetic patients.[12] A higher body mass index (BMI) also serves as a primary risk factor in the development of TB-DM, with obesity or overweight conditions increasing the risk of contracting both diseases.[13]

In addition, several other medical conditions such as chronic kidney disease, hypertension, and anemia are often found in patients with TB-DM comorbidity.[14] Environmental factors also play an important role, where poor living conditions, such as inadequate ventilation and high population density, as well as geographical location, especially urban areas with high poverty rates, can exacerbate the risk of TB-DM.[15,16] Migrant populations are at higher risk due to poor environmental factors and limited access to healthcare services.[17] Research shows that tuberculosis patients with diabetes mellitus are at greater risk of more severe disease, poor treatment outcomes, and higher mortality rates than tuberculosis patients without diabetes mellitus. The presence of diabetes mellitus complicates tuberculosis treatment, causing delayed microbiological response, relapse, and higher drug resistance, which ultimately increases the risk of death.[18]

Despite the existence of numerous studies addressing the issue of TB-DM comorbidity, there remains a dearth of

research specifically addressing the risk factors for TB-DM comorbidity in West Sumatra Province. The majority of extant studies are global or national in scope, and few have examined sociodemographic, clinical and environmental factors in greater depth at the regional level, particularly those focused on West Sumatra Province. A number of studies conducted in Asia and Europe on TB-DM have indicated a pressing necessity for further research at the regional level, given the observed variations in risk factors across different geographical areas.[19,20] In addition, factors such as occupation, residential area, and referral status in relation to TB-DM cases have not been studied in depth,[21,22] even though these factors play an important role in the prevalence and severity of comorbidity in areas with a high TB burden, such as West Sumatra.

The present study examines the sociodemographic, clinical, and environmental risk factors for TB-DM comorbidity, with a particular focus on West Sumatra Province, which has a high prevalence of TB and diabetes. A novel approach that merits further exploration in future studies at the regional level involves the examination of variables such as age, the specific type of tuberculosis, the subject's occupation, their residential area, and their referral status within this region. The objective of this study is to analyze the risk factors contributing to the prevalence of tuberculosis (TB) and diabetes mellitus (DM) comorbidity in West Sumatra Province, with the aim of providing deeper insights into the influence of local factors on TB-DM incidence and offering recommendations for more effective management and prevention in areas with similar characteristics. In this registry-based matched case–control study, the source population consisted of tuberculosis patients. Cases were TB patients with documented diabetes mellitus comorbidity at the time of TB registration, while controls were TB patients without DM. Therefore, the study focuses on identifying factors associated with TB–DM comorbidity among TB patients.

METHODS

Study Design and Research Location

This quantitative study employed a retrospective matched case–control design to identify risk factors associated with TB–DM comorbidity in West Sumatra, Indonesia. Cases were TB patients with documented DM comorbidity, while controls were TB patients without DM. Cases and controls were matched 1:1 on age, occupation, residential area (urban/rural), referral status, type of tuberculosis (pulmonary/extrapulmonary), and history of TB treatment to ensure comparability between groups and to control for potential confounding at the design stage.

Data were extracted from the 2024 SI-TB 03 surveillance database of the West Sumatra Provincial Health Office between March and May 2025. The research covered all 12 districts and 7 cities in West Sumatra Province, selected due to their high TB burden and the availability of complete TB surveillance data.

Population and Sample

The source population comprised all TB patients with documented DM comorbidity recorded in the SI-TB 03 database for West Sumatra Province in 2024 (n = 1,157). After applying the inclusion and exclusion criteria and checking data completeness for the matching and analysis variables, 830 TB–DM patients were eligible and included as cases. The remaining records were excluded due to incomplete or inconsistent information in one or more key variables required for matching and regression

analysis. Each case was matched 1:1 with a TB patient without DM from the same database, resulting in a total of 830 controls.

Sample Technique

A purposive sampling approach was applied using secondary registry data. All TB patients with documented DM comorbidity in the SI-TB 03 database for 2024 who met the inclusion criteria and had complete information on key variables were included as cases (n = 830). Controls were selected from TB patients without DM in the same database and matched 1:1 to cases on age, occupation, residential area (urban/rural), referral status, type of tuberculosis (pulmonary/extrapulmonary), and history of TB treatment, resulting in 830 matched controls.

No a priori sample size calculation was performed because this study used a registry-based design and included all eligible TB–DM cases recorded in 2024 with complete data for key variables. Consequently, the final sample size was determined by data availability, and each case was matched 1:1 with an eligible TB patient without DM as a control. This approach is commonly applied in secondary surveillance studies to maximise statistical power within the available dataset.

Sample Criteria

Case Criteria: Inclusion Criteria; TB-DM patients based on data from the TB Information System (SiTB) programme at the West Sumatra Provincial Health Office in 2024, and TB-DM patients with complete data in accordance with the variables studied and in accordance with the operational definition of the study. Exclusion Criteria: Not diagnosed with positive diabetes mellitus results in Si-TB 03 West Sumatra Province in 2024, incomplete data for the variables under study, residing outside the West Sumatra Province and TB-DM patients with HIV.

Control Criteria: Inclusion Criteria; TB patients free of DM based on examination results using data from the TB Information System (SiTB) at the West Sumatra Provincial Health Office in 2024. TB patients free of DM have complete data according to the variables studied and in accordance with the operational definition of the study. Exclusion Criteria: incomplete data on key variables, residing outside West Sumatra Province, and TB patients with HIV infection. TB patients with HIV were excluded because HIV is a strong independent risk factor for TB and may modify or confound the association between DM and TB outcomes; moreover, HIV-related clinical variables (e.g., CD4 count and ART status) were not available in the registry for adequate adjustment.

Procedure of Data Collection

Data collection was conducted using secondary data obtained from SI-TB 03 of the West Sumatra Provincial Health Office and the West Sumatra Provincial Statistics Agency. The data obtained consisted of information on patients' health status, including medical history, TB diagnosis, and information related to diabetes mellitus. The data collection procedure was carried out through structured data access and verified by the West Sumatra Provincial Health Office.

Data Analysis

The collected data were analysed using Epi-Info 7 software. Data analysis was performed using the following steps: Univariate: To describe the characteristics of the variables studied. Bivariate: Using the McNemar test to test the relationship between risk factors and the incidence of TB-DM comorbidity. Multivariate: Using Conditional Logistic Regression to analyse the factors that significantly contribute to the incidence of TB-DM comorbidity.

RESULTS

Table 1. Characteristics of Comorbidity Respondent TB-DM and TB in West Sumatera

Sample Characteristics		Cases (TB-DM)		Control (TB)	
		f	%	f	%
Gender	Male	495	59.64%	495	59.64%
	Female	335	40.46%	335	40.46%
District/City	Agam Regency	32	3.86%	32	3.86%
	Dhamasraya Regency	77	9.28%	77	9.28%
	Lima Puluh Kota Regency	31	3.73%	31	3.73%
	Padang Pariaman Regency	82	9.88%	82	9.88%
	Pasaman Regency	38	4.58%	38	4.58%
	West Pasaman Regency	120	14.46%	120	14.46%
	Pesisir Selatan Regency	79	9.52%	79	9.52%
	Sijunjung Regency	42	5.06%	42	5.06%
	Solok Regency	22	2.65%	22	2.65%
	South Solok Regency	5	0.60%	5	0.60%
	Tanah Datar Regency	54	6.51%	54	6.51%
	Mentawai Islands Regency	1	0.12%	1	0.12%
	Bukittinggi City	9	1.08%	9	1.08%
	Padang City	194	23.37%	194	23.37%
	Padang Panjang City	3	0.36%	3	0.36%
	Pariaman City	24	2.89%	24	2.89%
	Payakumbuh City	3	0.36%	3	0.36%
	Sawahlunto City	4	0.48%	4	0.48%
	Solok City	10	1.20%	10	1.20%

The characteristics of respondents with tuberculosis (TB)-diabetes mellitus (DM) comorbidity and TB in West Sumatra Province are presented in **Table 1**. This table presents the characteristics of respondents based on gender and district/city in a sample divided into two groups, namely the case group (TB-DM comorbidity) and the control group (TB). Regarding gender, the distribution of respondents shows that in both the case and control groups, the majority of respondents were male (59.64%), while the remainder were female (40.46%). In terms of district/city distribution, Padang City had the highest number of respondents in both groups (23.37%), followed by Pasaman Barat District (14.46%) and Padang Pariaman District (9.88%). Other districts and cities had smaller distributions, with some areas having only one respondent, such as Mentawai Islands District.

Table 2. Frequency Distribution of Risk Factors for TB-DM Comorbidity

Variable	Cases (TB-DM)		Control (TB)	
	f	%	f	%
Age				
≥ 45 Years old	676	81.45	235	28.31
< 45 Years old	154	18.55	595	71.69
Occupation				
Employed	519	62.53	467	56.27
Unemployed	311	37.47	363	43.73
Residential Area				
Urban	396	47.21	384	46.27
Rural	434	52.29	446	53.73
Referral Status				
Health facility referral	106	12.77	90	10.84
Come alone	724	87.23	740	89.16
Types of Tuberculosis				
Pulmonary Tuberculosis	815	98.19	742	89.40
Extrapulmonary Tuberculosis	15	1.81	88	10.60
TB Treatment History				
Relapse	89	10.72	37	4.46
New	741	89.28	793	95.54
Total	**830**	**100%**	**830**	**100**

Table 2 shows the distribution of risk factors for tuberculosis and diabetes mellitus (TB-DM) comorbidity based on age, occupation, residential area, referral status, type of tuberculosis, and history of TB treatment. The majority of respondents in the TB-DM case group were aged 45 years or over (81.45%), while the control group had a higher proportion aged under 45 years (71.69%). With regard to occupational status, the majority of respondents in both groups were employed, although the proportion of unemployed individuals was higher in the control group. The distribution of residential areas was almost equal between urban and rural regions, and the majority of respondents sought treatment independently. The majority of cases were found to be pulmonary tuberculosis, with a prevalence of 98.19% in the case group and 89.40% in the control group. Furthermore, the majority of respondents in both groups had a history of new TB treatment.

Table 3. Chi Square Test of Risk Factors for TB-DM Comorbidity

Cases	Control				Total		Matched OR (95% CI)	*p-value*
	Risk factors (+)		Risk factors (-)					
	n	%	n	%	n	%		
≥ 45 Years old	112	72.7	483	71.5	595	71.7	11.500 (8.39-15.76)	0,0001
< 45 Years old	42	27.3	193	28.5	235	28.3		
Total	**154**	**100**	**676**	**100**	**830**	**100**		

Cases	Control				Total		Matched OR (95% CI)	*p-value*
	Risk factors (+)		Risk factors (-)					
	n	**%**	**n**	**%**	**n**	**%**		
Employed	218	70.1	145	27.9	363	43.7	1.559 (1.201-2.022)	<0.001
Unemployed	93	29.9	374	72.1	467	56.3		
Total	**311**	**100**	**519**	**100**	**830**	**100**		
Urban	379	87.3	67	16.9	446	53.7	1.218 (0.852-1.740)	0,277
Rural	55	12.7	329	83.1	384	46.3		
Total	**434**	**100**	**676**	**100**	**830**	**100**		
Health facilities referral	659	91.0	81	76.4	740	89.2	1.246 (0.899-1.727)	0,185
Come alone	65	9.0	25	23.6	90	10.8		
Total	**724**	**100**	**106**	**100**	**830**	**100**		
Pulmonary TB	2	13.3	86	10.5	88	10.6	6.615 (3.692-11.853)	<0.001
Extrapulmonary TB	13	86.7	729	89.5	742	89.4		
Total	**15**	**100**	**815**	**100**	**830**	**100**		
Relapse	713	96.2	80	89.9	793	95.5	2.857 (1.857-4.393)	<0.001
New	28	3.8	9	10.1	37	4.5		
Total	**741**	**100**	**676**	**100**	**830**	**100**		

Table 3 shows that the risk factors for tuberculosis and diabetes mellitus (TB-DM) comorbidity are age (OR = 11.500; 95% CI: 8.39–15.76, p = <0.001), occupation, which also shows a significant difference (OR = 1.559; 95% CI: 1.201–2.022, p = <0.001), pulmonary tuberculosis, which has a higher risk (OR = 6.615; 95% CI: 3.692–11.853, p = <0.001), and a history of TB treatment, which indicated that patients with a history of relapse were at higher risk (OR = 2.857; 95% CI: 1.857–4.393, p = <0.001). Meanwhile, the variables of residential area and referral status did not show significant results (OR = 1.218; 95% CI: 0.852–1.740, p = 0.277) and (OR = 1.246; 95% CI: 0.899–1.727, p = 0.185).

Table 4. Multivariate Analysis of Risk Factors for TB-DM Comorbidity in West Sumatra Province

Variabel	Full Model		First Model		Second Model		Third Model		Fourth Model	
	p-value	Matched OR	*p-value*	Matched OR	*p-value*	Matched OR	*p-value*	Matched OR	*p-value*	Matched OR
Age	<0.001	10.758	<0.001	10.773	<0.001	10.760	<0.001	10.801	<0.001	11.031
Occupation	0.0690	1.418	0.0677	1.421	0.0647	1.426	-	-	-	-
Residential Area	0.4172	1.211	0.4214	1.209	-	-	-	-	-	-
Referral Status	0.7573	1.075	-	-	-	-	-	-	-	-
Types of TB	<0.001	4.682	<0.001	2.234	<0.001	4.769	<0.001	4.742	<0.001	4.895
History treatment of TB	0.0055	2.172	0.005	2.177	0.0057	2.163	0.0058	2.153	-	-

Table 4 shows the results of multivariate analysis for risk factors for tuberculosis and diabetes mellitus (TB-DM) comorbidity in West Sumatra Province. The initial model tested the influence of sociodemographic, clinical, and environmental variables, and variables with a p-value < 0.05 were considered significant. Variables with a p-value > 0.05 were gradually excluded, starting with the variable with the largest p-value. In the first model, referral status was excluded (p = 0.7573), followed by residential area in the second model (p = 0.4172), occupation in the third model (p = 0.0690), and TB history in the fourth model (p = 0.0055). The age variable remained significant across all models with p-values < 0.001 (OR = 10.758–11.031), and the type of tuberculosis was also significant with p-values < 0.001 (OR = 2.234–4.895). The final multivariate analysis model is presented in **Table 5.**

Table 5. Final Multivariate Analysis Model

Variable	β	*p-value*	Matched OR	95% Cl	
				Lower	Upper
Age	2.400	<0.001	11.031	8.014	15.185
Types of TB	1.588	<0.001	4.895	2.327	10.296

In the final model (**Table 5**), age and type of tuberculosis remained significant as risk factors for comorbidity. The age variable showed that each increase in age was associated with an increase in the risk of TB-DM (OR = 11.031; 95% CI: 8.014–15.185). The type of tuberculosis is also significant, indicating that patients with tuberculosis have a higher risk of developing TB-DM comorbidity (OR = 4.895; 95% CI: 2.327–10.296).

DISCUSSION

The results of this study indicate that age is a significant risk factor for

tuberculosis and diabetes mellitus (TB-DM) comorbidity. These findings are consistent with those of previous studies, such as one conducted in Kazakhstan, which found a high prevalence of TB-DM in the 45-64 age group,[23] and another in Ethiopia, where TB patients aged 40-50 and over 50 had a higher risk of developing diabetes mellitus.[24] In China, age over 47 years was also found to be a risk factor for comorbidity,[25] and in patients with pulmonary TB, those aged 40–59 years and over 60 years had a higher chance of developing DM.[11] These findings underscore that the decline in bodily functions and immune system function with age increases the risk of TB-DM, which is also consistent with other research highlighting advanced age as a risk factor for mortality in TB-DM patients.[26]

Occupation also showed a significant association with TB–DM comorbidity in several studies. However, in our study, occupation was used as a matching variable, which reduced between-group variation and may explain why it did not remain a significant predictor in the final model. In addition, occupation in the SI-TB registry is recorded in broad categories, which may lead to non differential misclassification and attenuate the observed association. A study in China involving pulmonary TB patients undergoing retreatment found that occupation was a significant risk factor for developing TB-DM comorbidity, with certain types of occupations showing higher prevalence.[11] A further study in India has indicated that sedentary work, such as office-based employment, is associated with an increased risk of diabetes mellitus (DM) in tuberculosis (TB) patients. This suggests that a lack of physical activity contributes to the development of DM and worsens TB conditions.[27] A body of research, including a study undertaken in Kenya, has identified a correlation between socioeconomic factors related to employment status and the risk of TB-DM. The aforementioned Kenyan study demonstrated that employment status is associated with DM in TB patients and that lifestyle factors, including alcohol consumption and smoking, influence the risk of DM in such patients.[21]

Although some studies have shown a link between residential area and TB–DM comorbidity, this study found no significant association. This may be because the residential area (urban/rural) was included as a matching variable, reducing between-group variation and limiting its ability to emerge as an independent predictor. In addition, the urban–rural classification in the registry is broad and may involve misclassification, which could attenuate the observed association. However, a study in northwestern Ethiopia showed that TB patients from rural areas had a higher risk of developing diabetes mellitus, with an adjusted odds ratio (aOR) of 3.13.[19] In Jiangsu, China, the cumulative incidence of TB among diabetic patients is higher in rural areas than in urban areas.[28] Conversely, in India, the higher prevalence of diabetes in urban areas is associated with a higher incidence of smear-positive TB than in rural areas.[20] Although rural areas may have a greater TB-DM burden, the results of this study indicate that other factors such as age, BMI, family history of diabetes, and HIV/TB co-infection have a greater influence on the occurrence of this comorbidity. Therefore, integrated screening and management strategies are needed in both urban and rural areas.

This study also found that referral status had no significant association with TB–DM comorbidity. This may be because referral status was included as a matching variable, which reduced differences between cases and controls and limited its ability to emerge as an independent

predictor. In addition, referral status in the SI-TB registry reflects the pathway of entry into care rather than underlying clinical risk, so its effect on TB–DM comorbidity may be indirect. Although referral status is important in disease management, the success of TB–DM management depends more on the readiness of the health facility itself. In Bangladesh, only 36% of TB facilities were highly prepared to treat diabetes,[29] while in Tanzania, although many TB facilities reported providing diabetes management, overall readiness remained low.[22] This finding suggests that the effectiveness of TB-DM comorbidity management is contingent not only on referral status, but also on the facility's capacity to undertake early screening and effective diabetes management. Early screening of TB patients has been demonstrated to facilitate faster diagnosis and better blood sugar control, which in turn can improve treatment outcomes.[30,31] Therefore, more effective referral systems and integrated health services are essential, especially in resource-constrained settings, such as the use of telemedicine in South Africa to connect high-risk patients with hospital care.[32]

Patients with pulmonary tuberculosis (PTB) are found to be at higher risk of developing diabetes mellitus (DM) comorbidity compared to patients with extrapulmonary tuberculosis (EPTB). This finding is consistent with studies showing that PTB patients with DM are more likely to exhibit more severe disease manifestations, such as fever, haemoptysis, and cavitary lesions on chest radiography.[33,34] A study also reported a higher incidence ratio for pulmonary tuberculosis patients developing DM compared to EPTB patients, with an incidence ratio of 5.74 for PTB and 4.66 for EPTB (Extrapulmonary tuberculosis).[35] Hyperglycaemia in DM patients can alter the immune response, increase their susceptibility to TB, and worsen the course of the disease, including changes in cytokine levels and immune cell function that are important in the pathogenesis of TB-DM comorbidity.[36,37] Therefore, it is important to screen pulmonary tuberculosis patients for diabetes and manage both conditions simultaneously to reduce morbidity and mortality and improve patient prognosis.

A history of TB treatment is also significantly associated with the incidence of DM comorbidity. Patients who experience recurrence or who undergo retreatment are at greater risk of developing diabetes. This is due to chronic inflammation caused by TB, which can disrupt the body's metabolism and worsen blood sugar control. Several studies have shown that diabetes can increase susceptibility to TB, with a threefold increase in the risk of developing TB in diabetic patients.[37–39] Conversely, TB infection has been observed to exacerbate blood sugar control, resulting in hyperglycaemia and glucose intolerance, which can ultimately lead to the development of diabetes. Ineffective or interrupted TB treatment can worsen inflammation and increase the likelihood of developing diabetes, which further increases the risk of treatment failure and disease recurrence.[40,41] Therefore, it is important to complete TB treatment and ensure proper management of patients who relapse in order to prevent or reduce the risk of TB-DM comorbidity.

This study has several strengths and limitations that should be acknowledged. In terms of strengths, it used a large province-wide sample with a 1:1 matched case–control design, which enhanced comparability between groups and provided adequate statistical power, and it relied on official SI-TB surveillance data covering all districts and cities in West Sumatra, ensuring high real-world and programmatic relevance; moreover, conditional logistic regression was appropriately applied to the matched design. However, several limitations must

also be considered: first, the analysis was based on secondary surveillance data, which may be affected by under-recording or misclassification of diagnoses and treatment histories; second, the study was conducted only in West Sumatra Province, which may limit generalisability to other Indonesian settings; and third, important behavioural and metabolic variables such as dietary patterns, physical activity, smoking habits, glycaemic control (e.g., HbA1c), and body mass index were not available in the registry, leaving potential residual confounding. Future research should therefore confirm these findings using prospective or cohort designs, with particular attention to clarifying the mechanisms linking older age and pulmonary TB to DM comorbidity, incorporate key clinical and behavioural factors not captured in SI-TB (e.g., HbA1c, BMI/obesity, smoking, diet, and physical activity), explore barriers in TB–DM screening and referral through qualitative or mixed-methods approaches, and extend analyses to other provinces to assess geographic variation and inform more targeted regional interventions.

CONCLUSION

This study shows that age, occupation, type of tuberculosis, and history of TB treatment are significantly associated with tuberculosis and diabetes mellitus (TB-DM) comorbidity. Patients over 45 years of age, those with pulmonary tuberculosis, and patients with a history of TB recurrence have a higher risk of developing this comorbidity. Additionally, occupations involving low physical activity also increase the risk of diabetes in TB patients. Meanwhile, residential area and referral status did not show significant associations in this study. Based on multivariate analysis, age and type of tuberculosis remain the primary risk factors. Therefore, it is important to conduct early screening for diabetes in TB patients and manage both conditions simultaneously to improve treatment outcomes and reduce morbidity and mortality.

AUTHOR CONTRIBUTIONS

IA: Conceptualization, Methodology, Supervision, Writing – review & editing. AS: Data curation, Formal analysis, Validation, Writing – original draft. WDM: Data curation, Formal analysis, Writing – review & editing. HS: Investigation, Project administration, Resources, Writing – review & editing. MY: Funding acquisition, Resources, Writing – original draft. EDN: Investigation, Visualization, Writing – original draft, Writing – review & editing.

ETHICAL CONSIDERATION

This study was approved by the Health Research Ethics Committee of Bhakti Kencana University (Approval No. 098/09.KEPK/UBK/VII/2024; approved on September 9, 2024). Written informed consent was obtained from all participants before participation.

CONFLICTS OF INTERESTS

The authors declare no conflict of interest.

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