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Risk factors for tuberculosis patients with diabetes mellitus in Indonesia: a case control study

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Abstract

Tuberculosis (TB) is a chronic infectious disease caused by Mycobacterium Tuberculosis (Mtb), and its burden is exacerbated by the increasing prevalence of Non-Insulin-Dependent Diabetes Mellitus (NIDDM). This case-control study aimed to identify risk factors associated with TB among patients with NIDDM in Banjar Regency, Indonesia. A total of 93 respondents with TB or TB with NIDDM were included using a purposive sampling technique. Data were collected via questionnaires and medical records, analyzing demographic characteristics, history of TB exposure, and health parameters. The results showed that gender, education level, smoking history, hospitalization history, and a family history of TB were significantly associated with TB among NIDDM patients. These findings highlight the need for targeted interventions to reduce TB risk among individuals with NIDDM, including enhanced screening, public health education, and lifestyle modifications.

Introduction

Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis.[1] Globally, TB is one of the 10 causes of death and ranks first among single infectious agents.[2] Indonesia is ranked second out of eight countries with 8.5% TB.[3] According to the World Health Organization (WHO), Indonesia ranks second after India in terms of the global Tuberculosis (TB) burden.[4] Globally, there were an estimated 10.6 million new TB cases in 2022, with more than half of them concentrated in eight high-burden countries, including Indonesia.[5] The burden is unequally distributed across provinces, with the highest numbers recorded in West Jawa.[6] These figures highlight Indonesia's critical role in the global TB epidemic and the urgent need for regionally targeted interventions. It's important to note that underreporting and underdiagnosis of TB have been significant challenges in Indonesia. The WHO estimated

that 15.6% of detected TB cases were underreported, with variations among different types of health facilities.[7] In summary, while the WHO provides comprehensive national data on TB in Indonesia for 2018, detailed statistics for specific provinces and cities, including South Kalimantan.[8]

Although the number of TB cases has decreased, the burden of TB disease is getting heavier due to the increasing cases of Non-Insulin-Dependent Diabetes Mellitus (NIDDM). NIDDM cases can increase the risk of TB infection by 1.5 fold.[9] TB patients with diabetes are more likely to experience treatment failure and relapse compared to those without diabetes, increasing their risk of developing multidrug-resistant.[10]

Cellular immune response is impaired in patients with NIDDM, despite its crucial role in controlling TB infection. There is a decrease in lymphocyte count in TB patients with NIDDM compared to those without diabetes. Additionally, levels of TNF-α and IFN-γ are elevated in patients with both TB and NIDDM. This indicates a weakened cellular immune response, which requires stronger stimulation for optimal activation.[11, 12]

Data from Indonesia health basic research indicated that men are more vulnerable to TB than women, partly due to smoking habits, which are nearly twice as common among men.[13] Smoking exacerbates tuberculosis by impairing alveolar macrophage function, suppressing T-cell mediated immunity, damaging pulmonary mucosal defenses, and contributing to poor treatment outcomes.[14] The highest incidence of TB occurs in 45–54 age group (17.3%), followed by the 25–34 age group (16.8%) and the 15–24 age group (16.7%).[15] TB is more prevalent among individuals aged below 60 years with a Body mass index > 25.[16] TB screening for NIDDM clients, especially sociodemographic was limit.[17,18] Therefore, this study is needed to explore the factors contributing to TB in NIDDM patients.

Materials and Methods

All of procedure of this study was granted by ethical clerance from Faculty of Medicine and Health Science, Universitas Lambung Mangkurat, number 407/KEPK-FK ULM/EC/XI/2023. This study was a the case-control study approach and conducted from February to November 2023 in the Health Care Center of Banjar Regency, South Kalimantan, Indonesia. The sample size was determined using the formula for testing the difference between two proportions.[19] The calculation was based on a significance level of 5% ($\alpha = 0.05$; $Z\alpha = 1.96$), study power of 80% ($\beta = 0.20$; $Z\beta = 0.84$), an expected odds ratio (OR) of 3.3, and an assumed proportion of exposure among controls (P2) of 0.50. Using these parameters, the estimated proportion of exposure among cases (P1) was calculated as 0.50, with the average proportion (P) of 0.40.

Substituting into the formula yielded a minimum required sample size of 48 subjects**.** Total sample in this study were 93 respondents with pulmonary TB or pulmonary TB with NIDDM. We used consecutive sampling technique. Inclusion criteria were pulmonary TB patients diagnosed at the Banjar Regency Health Center who agreed to participate in the study. Cases were defined as pulmonary TB patients with NIDDM, while controls were pulmonary TB patients without NIDDM. Exclusion criteria were patients with extrapulmonary TB, TB-HIV co-infection, or incomplete medical records. Data collection was carried out using primary and secondary data. This study used questionnaire and data from medical records. The data will be analyzed with a SPSS. Descriptive statistics are used to measure the frequency and percentage random blood glucose, acid-fast bacilli sputum smear and sociodemographic of respondents. We used chi-square test determine if there is a significant association betweencharacteristic/sociodemographic and NIDDM Statistical significance ($p < 0.05$) was used as a criterion to include or exclude the hypothesis. Variables with a p-value < 0.05 in the bivariate analysis were then included in a multivariate logistic regression model to control for potential confounders and to determine independent risk factors.

Results

Table 1 showed the characteristic of respondents of TB. All of respondents had positive acid bacilli sputum smear. In term of age, respondents in risk age was 46.3% and not risk age was 53.7%. Most of respondents were female (86.1%) and had high school degree (59.1%). In term of job, more than a half of respondents had risk job (51.7%) and normal body mass index (52.6%), however there were 45.1% of respondents had underweight body mass index. 100% repondents had history of smoking, and more than half had history of family with TB (51.7%). 81.7% of respondents never hospitalized and 71 % of respondents was TB patients with NIDDM. Patients TB with NIDDM was become case study.

Table 2 showed risk factors of TB among TB patients NIDDM. It listes that gender (*p* value: 0.000), education (*p* value: 0.005), history of smooking (*p* value: 0.000), history of hospitalized (*p* value: 0.000), and family with TB history (*p* value: 0.000) were factors that related to TB with NIDDM.

The multivariate logistic regression analysis showed that the model had a Cox & Snell R Square value of 0.150 and a Nagelkerke R Square value of 0.231. This indicates that the independent variables included in the model were able to explain approximately 21.3% of the

variability in the dependent variable. The remaining 78.7% of the variability was influenced by other factors outside the model.

Discussion

The objective of this study was to identify the risk factors for t TB with NIDDM. The results showed that gender, education, history of smooking, history of hospitalized, and family with TB history were factors that related to TB with NIDDM.

This study found no relationship between age and TB with NIDDM. This finding contrasts with previous research in Indonesia that mentioned a correlation between young age and the incidence of TB with NIDDM.[20] The majority of TB cases occur in individuals aged 15–55 years, which is considered the productive age group. During this period, people often prioritize work, leading to reduced rest and a weakened immune system.[15] However, there was study mentioned that most TB with NIDDM were men aged 47 years or older, attributing the higher prevalence of NIDDM in older individuals to decreased immunity and age-related frailty, which increase vulnerability to TB. Based on these studies, it showed that the relationship between age and the prevalence of TB in individuals with NIDDM may vary across different populations and settings.[21]

The statistical test analysis revealed there was significant relationship between gender and TB in individuals with NIDDM. This finding aligns with previous studies indicating a relationship between gender and TB.[21] TB is generally more prevalent in men than in women. Study among individuals with TB and NIDDM showed that from 1,243 smear-positive TB cases found that 63.2% were male. Interestingly, the prevalence of NIDDM among these TB patients was higher in women (22.9%) compared to men (9.2%), suggesting that while TB is generally more prevalent in men, women with TB are more likely to have concurrent NIDDM.[22,23] This may be attributed to men often having unhealthy habits such as smoking[24, 25] and alcohol consumption.[26]

These study conclude that there is a relationship between education and TB with NIDDM. This is in line with previous study that there is a relationship between the level of knowledge and the TB cases with NIDDM.[27] These results show that the higher or better a person's knowledge was related with adherence in medication.[28] Level of education greatly influences health literacy. If TB patients do not understand the benefits of taking medication regularly and regular check-ups, the patient will discontinue treatment, resulting in resistance.[29]

The analysis results showed no significant relationship between job and the incidence of TB with NIDDM. However, previous study mentioned that work environment factors can

influence a person's risk of exposure to disease.[30] Poor working conditions contribute to a higher risk of TB infection, particularly among individuals in occupations such as drivers, laborers, and pedicab drivers, compared to those working in office settings. Factors such as exposure to respirable silica dust, lack of personal protective equipment, and poor living conditions, including overcrowding and inadequate ventilation, contributed to this increased risk.[31] Additionally, occupational factors are also closely linked to income levels.[32] Families with little or no income have lower purchasing power, making it difficult to meet adequate nutritional needs. This often leads to malnutrition, which weakens the immune system and increases vulnerability to various diseases, especially TB.[32]

This study revealed no significant association between body mass index (BMI) and tuberculosis with diabetes mellitus. Theoretically, BMI is related to TB;[33] however, weight gain may occur until BMI returns to normal in TB patients who have completed the initial intensive phase of treatment (2–8 weeks). In addition to completing the standard 6 month treatment regimen, maintaining adequate nutrition is also essential. We assumed that the risk of tuberculosis increases regardless of BMI, as diabetes mellitus serves as a dominant factor that may overshadow the effect of BMI.

Therefore, it is recommended that respondents maintain normal nutritional status by consuming nutritious food, routinely measuring weight and height so that their bmi is known periodically, in addition to increasing the coverage of bcg immunization in infants in order to prevent TB because it can increase the body's immune system.

The history of hospital admissions showed a statistically significant association with TB patients who also have NIDDM The coexistence of these conditions can result in more severe disease manifestations and complications, often requiring hospitalization for comprehensive management. Previous study mentioned that people with NIDDM have a 1.5-fold increased risk of developing TB. The risk is even higher among individuals using insulin for NIDDM management. This increased susceptibility underscores the importance of comprehensive management strategies, including potential hospital admissions, to address the complications arising from the coexistence of TB and NIDDM.[34]

The analysis showed that all TB patients in the study were smokers, either active or passive, and there was a link between smoking, TB and NIDDM. Smoking may worsen TB by affecting the body's defense system.[35] It can impair the lungs' ability to clear mucus, weaken immune cells like macrophages and Natural Killer (NK) cells, and disrupt other immune responses. Research also suggests that smoking is related to the severity of lung damage in TB and the speed of recovery. The longer a person smokes, the greater the risk, as harmful

toxins from cigarettes build up in the body. Smoking and TB together create a dangerous combination, as smoking increases the spread of infection, turns latent TB into an active disease, and makes the illness more severe.[36]

Family history of TB was related to TB patient with NIDDM. A family history of TB suggests prolonged exposure to Mtb, increasing the likelihood of latent TB infection and some genetic factors may make individuals in the same family more susceptible to TB.[37] And the respondents close contact with a TB -infected family member increases the risk of acquiring the infection, especially in crowded living conditions.[38] Further, the logistic regression model explained 21.3% of the variability in TB among patients with NIDDM, indicating that gender, education level, smoking history, hospitalization history, and family history of TB are important but not exclusive predictors. The remaining unexplained variability suggests that other biological, behavioral, and environmental factors also contribute significantly to the risk of TB in this population.

This study has several limitations that should be considered when interpreting the findings. first, the relatively small sample size may limit the generalizability of the results to broader populations. a larger, more diverse sample would provide a more comprehensive understanding of the relationship between TB with NIDDM. second, as a case-control study, this research identifies associations but does not establish causation between the examined risk factors and TB among NIDDM patients. additionally, some data, such as smoking history and past TB exposure, were self-reported, which may introduce recall bias.

Conclusions

This study identified key risk factors for TB among individuals with NIDDM, including gender, education level, smoking history, hospitalization history, and a family history of TB. The findings of this study have significant implications for TB prevention and management among individuals. Public health interventions should focus on targeted strategies to reduce TB risk in NIDDM patients, including early screening. Health education programs are essential to raise awareness about risk factors such as smoking and non-adherence to treatment, encouraging patients to adopt healthier lifestyles. Additionally, regular TB screening for individuals with NIDDM, particularly those with a family history of TB or other identified risk factors, should be prioritized to facilitate early detection and treatment.

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Table 1. Sociodemographic and clinical characteristic of respondents.

Characteristic	**Frequency**	**Percentage**
	N = 93	**%**

Characteristic	Frequency	Percentage
	N = 93	%
Age		
Not risk (>55 years old)	50	53.7
Risk (15-55 years old)	43	46.3
Gender		
Female	13	13.9
Male	80	86.1
Education		
Elementary School	33	35.4
High School	55	59.1
University	5	0.5
Job		
Not Risk	45	48.3
Risk	48	51.7
Body mass index		
Underweight	42	45.1
Normal	49	52.6
Obesity	2	2.3
History of smoking		
Passive or active	93	100
Family history of TB		
Yes	45	48.3
No	48	51.7
History of hospitalized		
Yes	17	18.2
No	76	81.8
Random Blood Glucose		
Yes	27	29
No	66	71
Acid-fast bacilli sputum smear		
Yes	93	100

Characteristic	Frequency	Percentage
	N = 93	%
No	0	0

Table 2. Bivariate analysis of factors that related with TB among TB patients with NIDDM.

Variable	Tuberculosis		*p-value*
	Case (%)	Control (%)	
Age			
Not risk (>55 years old)	11 (40.7)	39 (59.1)	0.778
Risk (15-55 years old)	16 (59.3)	27 (40.9)	
Gender			
Female	13 (48.1)	0 (0)	0.000
Male	14 (51.9)	66 (100)	
Education			
Elementary school	16 (59.2)	17 (25.8)	0.005
High school	8 (29.6)	47 (71.2)	
University	3 (11.2)	2 (3.0)	
Job			
Risk	16 (59.3)	29 (43.9)	0.171
Not risk	11 (40.7)	37 (56.1)	
BMI			
Underweight	9 (33.3)	34 (50)	0.873
Normal	18 (66.7)	32 (47)	
Obesity	0 (0)	2 (3)	
History of Smooking			
Yes	14 (51.9)	66 (100)	0.000
No	13 (48.1)	0 (0)	
History of hospitalized			
Yes	7 (25.9)	10 (15.2)	0.000
No	20 (74.1)	56 (84.8)	
Family history of TB			

Yes	16 (59.3)	29 (43.9)	0.000
No	11 (40.7)	37 (56.1)	

Table 3. Logistic regression.

Model Fit Measure	**Value**
Cox & Snell R Square	0.150
Nagelkerke R Square	0.231
R^2 (Interpretation)	0.213