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Association Between BMI, Immunocompromised Status, and Pulmonary TB History with Severity of TB Spondylitis

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Abstract

Background: Tuberculous spondylitis is the most common form of skeletal TB that can cause joint damage and disability if left untreated. Several studies have discussed risk factors associated with the severity of TB spondylitis. However, there are differences in findings among these studies, especially regarding age, sex, body mass index, immunocompromised conditions, and pulmonary TB history. Early detection through risk factor screening and adequate treatment can be useful to prevent disease severity. **Objective:** This research aims to find out the association between risk factors and the severity of TB spondylitis using GATA classification. **Methods:** Observational analytical methods with a retrospective hospital-based cross-sectional study design were used. Using consecutive sampling technique. The total research sample was 50 patients diagnosed with TB spondylitis between January 1, 2022-December 31, 2024 at Gatot Soebroto Army Hospital Jakarta. **Result:** Most TB spondylitis patients in this study were adults (68%), male (54%), with normal BMI (42%), immunocompromised conditions (52%), and a history of pulmonary TB (58%); 42% presented with severe disease. Notably, bivariate analysis identified BMI (p=0.033) and immunocompromised conditions (p=0.047) as significant predictors of TB spondylitis severity, while age, sex, and prior pulmonary TB were not significantly associated. **Conclusion:** BMI and immunocompromised conditions were significantly associated with TB spondylitis severity, whereas a history of pulmonary TB showed no significant association. These findings underscore the importance of incorporating nutritional status and immune function assessment into the initial evaluation of patients with suspected TB spondylitis.

Keywords: Risk factors, Severit, Tuberculous spondylitis

Original Research Article

INTRODUCTION

Indonesia ranks second in the world for the highest number of tuberculosis cases (Kemenkes RI, 2020). Around 15% of cases are extrapulmonary tuberculosis, with 10–35% involving bones and joints (Brotoarianto *et al*., 2024). Of this group, tuberculous spondylitis accounts for almost 50% of cases (Sadewo *et al*., 2023). This condition is often recognized late because most patients present with

atypical symptoms. Therefore, screening for risk factors is important as an early detection effort to prevent worsening of the disease (Johan *et al*., 2021).

Several studies have identified various factors that play a role in the incidence and severity of TB spondylitis. Sadewo *et al*. (2023) reported that age and sex are the main risk factors, where there is a significant relationship between sex and disease severity. The majority of patients were female, which may be related to decreased estrogen levels and its impact on bone metabolism. In the pediatric population, factors such as early age, female sex, poor nutritional status, and HIV co-infection contribute to the worsening of clinical conditions (Sekarsari *et al*., 2024). Patients with immunocompromised conditions such as HIV, vitamin D deficiency, and immunosuppressant use are at risk of increased disease severity due to an impaired immune response (Glassman *et al*., 2023). Study by Jung *et al*. (2022) found a history of pulmonary TB as a risk factor for TB spondylitis.

Although several studies have discussed the risk factors for TB spondylitis severity, there are inconsistent findings between these studies, especially regarding the distribution of age, sex, body mass index (BMI), immunocompromised conditions, and history of pulmonary TB. Athiyyah et al. (2024) reported a predominance of 17–25 years of age, which was thought to be related to the large amount of vascularization in the intervertebral disc at a young age. In contrast, Haiga (2021) found that the average age of patients ranged from 45–60 years, possibly influenced by decreased immune function in the elderly group.

Sadewo et al. (2023) found that 70% of TB spondylitis patients were female, which was associated with impaired bone metabolism due to decreased estrogen. However, Kennedy et al. (2024) reported that the majority of patients were male, indicating the possibility of population variation or differences in sample characteristics. Differences were also seen in the age distribution. Regarding nutritional status, Mijaya et al. (2020) stated that patients with a low BMI had a higher risk of mortality and morbidity. However, Kennedy et al. (2024) found that most patients had a normal BMI. These inconsistencies suggest that further research is needed to definitively identify the risk factors for TB spondylitis that play a role in disease severity, especially in the context of local populations.

The severity of TB spondylitis can be minimized with early diagnosis through assessment of existing risk factors (Sadewo et al., 2023). Establishing a diagnosis and assessing the severity of TB spondylitis requires a multidisciplinary approach, one of which is through radiological imaging (Swari et al., 2023). The GATA (Gülhane Askeri Tıp Akademisi) classification can be used to evaluate the severity of TB spondylitis based on seven radiological and clinical criteria to help determine appropriate treatment options. This classification divides TB spondylitis into types IA/B, II, and III.

There is still a lack of study that assess individual factors such as age, sex, BMI, immunocompromised conditions, and history of pulmonary TB influencing the disease severity. This study aims to address the limited evidence on determinants of TB spondylitis severity by employing a quantitative approach using the GATA classification system. Specifically, it evaluates the contribution of demographic, clinical, and host-related factors to disease severity. We hypothesize that host-related factors, particularly nutritional status (BMI) and immunocompromised conditions, are significantly associated with TB spondylitis severity, whereas demographic characteristics and a history of pulmonary TB are not. The results of this study are expected to provide a basis for the development of a more targeted early screening and management system.

MATERIALS AND METHODS

This study is a retrospective hospital-based cohort study from January 1, 2022 to December 31, 2024, using secondary data in the form of medical records of TB spondylitis patients at Gatot Soebroto Army Hospital Jakarta. The sampling technique employed in this study was consecutive sampling, in which medical record data from patients meeting the inclusion and exclusion criteria were collected sequentially over a defined study period. Inclusion criteria included TB spondylitis patients with complete medical records, including age, sex, body mass index (BMI), immunocompromised conditions, and a history of pulmonary TB. The exclusion criteria included patients with incomplete

medical records, spinal infections caused by bacterial infections other than *Mycobacterium tuberculosis*, and patients with a history of spinal tumors, spinal surgery, or spinal fractures other than those caused by TB spondylitis. The data used included age, sex, BMI, immunocompromised conditions, history of pulmonary TB, and the management given. The patient's immuno-compromised condition is determined by the presence or absence of conditions such as HIV/AIDS, DM, or steroid use.

Univariate and bivariate analysis was performed to analyze the data using IBM SPSS Statistics for Windows Version 25.0 from the Faculty of Medicine UPN Veteran Jakarta Computer Lab. Chi-square test was used to determine the relationship between risk factors and the severity of TB spondylitis. There is a simplification of cells in the age and IMT variables because the Chi-Square test requirements are not met. Cell simplification consists of high-risk age (*children and elderly*) and low-risk age (*adult*) referring to research by Jain *et al*. (2020) and Olmo-Fontánez & Turner (2022), high-risk BMI categories (*underweight*, *overweight*, and *obese*) and low-risk BMI categories (*normal*) referring to research by Kennedy *et al*. (2024) and Tanaviriyachai *et al*. (2023). Research by Jain *et al*. (2020) suggests that spinal deformities in children can progress more severely and rapidly because the spine is largely cartilage. Research by Olmo-Fontánez & Turner (2022) suggests that elderly patients are more susceptible to TB infection and experience worsening disease due to comorbidities and a weakened immune system. Research by Kennedy *et al*. (2024) states that patients with a BMI <18.5 kg/m^2 and inadequate weight gain play a role in disease progression. Research by Tanaviriyachai *et al*. (2023) states that patients with a BMI >25 kg/m^2 are at higher risk of experiencing neurological deficits because excess body weight can lead to mechanical instability in the vertebrae. This study has passed the ethical review of the Health Research Ethics Commission (KEPK) Gatot Soebroto Army Hospital Jakarta with the ethical review number 209/V/KEPK/2025.

RESULTS

In 2022-2024, there were 1.503 TB patients recorded at RSPAD Gatot Soebroto Jakarta, with 1.198 patients being pulmonary TB patients and 305 patients being extrapulmonary TB patients. Out of 305 extrapulmonary TB patients, only 242 medical records were available, with 57 of them diagnosed with TB spondylitis (Figure 1). There were 50 patients who met the inclusion and exclusion criteria. Based on data obtained from 50 research subjects (Table 1), TB spondylitis patients were dominated by adult (68%), male (54%), normal BMI (42%), had immunocompromised conditions (52%), and had history of pulmonary TB (58%). The lesion mostly located at the lumbar region (42%). In the data on the severity of TB spondylitis, most patients experienced severe TB spondylitis (Type III) (42%), followed by moderate category (Type II) (32%), and mild category (Type IA and IB) (26%). Based on the management given, most TB spondylitis patients received operative treatment (84%).

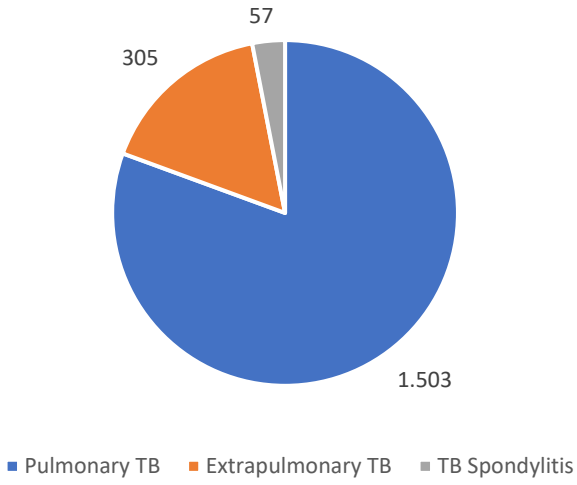

Figure 1. Distribution of Tuberculosis Patients

Table 1. Characteristics of TB Spondylitis Patients

Characteristics	Frequency (n)	Percentage (%)
Age (year)		
< 18	16	32
18–59	31	62
≥ 60	3	6
Sex		
Male	27	54
Female	23	46
Body Mass Index (BMI)		
Underweight (< 18,5 kg/m^2)	13	26
Normal (18,5-24,9 kg/m^2)	21	42
Overweight (25-29,9 kg/m^2)	11	22
Obese (≥ 30 kg/m^2)	5	10
Immunocompromised condition		
Yes	26	52
No	24	48
History of pulmonary tuberculosis		
Yes	29	58
No	21	42
Lesion location		
Cervical	2	4
Thoracal	17	34
Lumbar	21	42
Sacral	0	0
Multiple	10	20
Tuberculous spondylitis severity		
Mild (Type IA & IB)	13	26
Moderate (Type II)	16	32
Severe (Type III)	21	42
Management		
Conservative	8	16
Operative	42	84

Chi-Square test was used in bivariate analysis. Based on the results of cross-tabulation with the Chi-Square test in the Table 2, there is a significant association between BMI (*p*=0.033) and immunocompromised conditions (*p*=0.047) with the severity of TB spondylitis. In addition, the Table 2 showed there is no significant association between age (*p*=0.482), sex (*p*=0.356), and history of pulmonary TB (*p*=0.469) with the severity of TB spondylitis.

Table 2. Analysis of TB Spondylitis Patients

Variable		Tuberculous Spondylitis Severity						Total		*p-value*
		Mild (Type IA & IB)		Moderate (Type II)		Severe (Type III)				
		n	%	N	%	n	%	n	%	
Age	High risk (*children, elderly*)	4	21.1	8	42.1	7	36.8	19	100	0.482
	Low risk (*adult*)	9	29	8	25.8	14	45.2	31	100	
Sex	Male	6	22.2	11	40.7	10	37	27	100	0.356
	Female	7	30.4	5	21.7	11	47.8	23	100	
BMI	High risk	4	13.8	9	31	16	55.2	29	100	0.033*

Variable		Tuberculous Spondylitis Severity						Total		*p-value*
		Mild (Type IA & IB)		Moderate (Type II)		Severe (Type III)				
		n	%	N	%	n	%	n	%	
	(*underweight, overweight,* and *obese*)									
	Low risk (*normal*)	9	42.9	7	33.3	5	23.8	21	100	
Immunocompromised condition	Yes	6	23.1	5	19.2	15	57.7	26	100	0.047*
	No	7	29.2	11	45.8	6	25	24	100	
History of pulmonary TB	Yes	6	20.7	11	37.9	12	41.4	29	100	0.469
	No	7	33.3	5	23.8	9	42.9	21	100	

DISCUSSION

This study found that adult patients (18–59 years) had a higher prevalence of TB spondylitis, consistent with findings by Zeng *et al*. (2021) and Sadewo *et al*. (2023). The productive age group may be more susceptible due to cumulative spinal strain from long-term physical workload, which facilitates *Mycobacterium tuberculosis* infection in the spine. However, no significant association was observed between age and disease severity, in line with Sadewo *et al*. (2023). Adults generally possess more effective immune responses, which may protect against severe progression (Quiros-Roldan *et al*., 2024). By contrast, TB spondylitis in children often manifests more severely, as immature vertebral structures and high spinal vascularization accelerate disease spread and predispose to spinal collapse. Furthermore, because cartilage predominates in the pediatric spine, spinal deformities progress more rapidly and severely, with greater vertebral angulation during growth compared to adults (Jain *et al*., 2020; Handryastuti *et al*., 2024).

In this study there is a higher prevalence of TB spondylitis in male patients, consistent with previous research by Garg *et al*. (2022) and Kennedy *et al*. (2024). The Y chromosome, which contains genes linked to autoimmune disorders and immunological responses to infection, is linked to the occurrence of TB spondylitis. Variations in Y chromosome-encoded genes can impact an individual's vulnerability to specific illnesses. The X chromosome, which is crucial for both innate and adaptive immunity, is linked to women's lower vulnerability to TB spondylitis (Gupta *et al*., 2022). Behavioral factors like smoking, alcohol use, and outdoor exposure also contribute to higher risk in men (Athiyyah *et al*., 2024). Consistent with research by Khan *et al*. (2021), the findings of this study show no significant association between sex and the severity of TB spondylitis. There are many factors that make a person susceptible to infection, including both external factors like the availability and quality of public health services and individual factors like hygiene, immune status, nutritional status, smoking and drinking habits, history of chronic diseases, and low individual awareness of one's health. As a result, it is challenging to determine the severity of TB spondylitis based on a person's sex. However, contrary to this study, Sadewo *et al*. (2023) reported a significant association between sex and TB spondylitis severity, with higher severity in females. This may be explained by estrogen-related disruptions in bone metabolism, which can exacerbate spinal damage.

This study found that patients with normal BMI had a higher prevalence of TB spondylitis, in line with Kennedy *et al*. (2024) and Mijaya *et al*. (2020). However, Katkar *et al*. (2024) had different findings with most of TB spondylitis patients had low BMI (<18.5 kg/m^2). Low BMI may impair immune responses due to protein-calorie deficiency, increasing susceptibility and severity of TB spondylitis secondary immunodeficiency (Cho *et al*., 2022). Individuals with low BMI have the potential to experience higher mortality and morbidity (Mijaya *et al*., 2020). This study confirmed a significant association between BMI and disease severity, supporting findings by Vulpe *et al*. (2025). According to research by Kennedy *et al*. (2024), patients with a BMI below 18.5 kg/ m^2 and inadequate weight gain

play a role in disease progression. Tanaviriyachai *et al*. (2023) stated that patients with BMI> 25 kg/m^2 are at higher risk of experiencing neurological deficits since being overweight can cause the vertebrae to become mechanically unstable. A study by Zheng *et al*. (2022) found that obese patients may experience a worsening of TB spondylitis. The adaptive immune response to TB spondylitis infection may be weakened due to abnormal hormone and adipokine regulation that disrupts T cell function.

Immunocompromised patients have a higher risk of severe TB spondylitis, consistent with Katkar *et al*. (2024), Tidja *et al*. (2020), and Vulpe *et al*. (2025). Several conditions contribute to this vulnerability, including diabetes, malnutrition, malignancy, HIV infection, and the use of immunosuppressive therapies (Leowattana *et al*., 2023). HIV impairs host defense through CD4+ T-cell depletion and cytokine dysregulation (Zheng *et al*., 2022), while diabetes alters both humoral and cellular responses through complement deficiencies and cytokine imbalances such as TNF, IL-1β, IL-2, and IL-6 (Tidja *et al*., 2020). Immunosuppressive agents, including anti-TNF therapies, methotrexate, and chemotherapy, further compromise T-cell, macrophage, and cytokine function, predisposing to TB reactivation (Ciang *et al*., 2020). Mechanistically, immunocompromised individuals may experience impaired macrophage responses (Glassman *et al*., 2023), dysfunctional adaptive immunity, and reduced tissue repair capacity (Zeng *et al*., 2021), all of which exacerbate disease severity. In diabetes, elevated resistin disrupts neutrophil phagocytosis and chemotaxis, while hyperglycemia interferes with antigen-presenting cell function, further weakening T-cell–mediated responses (Zheng *et al*., 2022). Collectively, these mechanisms explain why immunocompromised status emerged as a strong predictor of severe TB spondylitis in this study.

TB spondylitis was more common in patients with pulmonary TB history, in line with Ciang *et al*. (2020). This is most likely caused by TB reactivation due to decreased immune system capabilities or hematogenous and lymphogenous spread of *Mycobacterium tuberculosis* to the spine resulting in TB spondylitis (Zheng *et al*., 2022). However, this study found no significant association between pulmonary TB history and disease severity, consistent with Zeng *et al*. (2021). Despite a history of pulmonary TB, the diagnosis of extrapulmonary TB is often delayed, resulting in many patients presenting with worsening disease. One-third to two-thirds of cases of severe tuberculous spondylitis present without a history of active pulmonary TB (Arifin *et al*., 2024). Age, systemic inflammation, time of diagnosis, comorbidities, and the patient's nutritional and immune status have a greater influence on the prognosis of the disease.

The implications of these findings highlight the need for a multidimensional approach to TB spondylitis management, focusing not only on therapy but also considering nutritional interventions and immune system strengthening. This highlights the importance of screening for immune factors and nutritional status as part of the initial evaluation of patients with suspected TB spondylitis. Hospitals need to include these factors as part of the initial assessment of patients with TB spondylitis, considering that these factors play an important role in determining the severity of the disease. From a research perspective, future studies should employ multicenter, longitudinal designs with larger sample sizes to validate these associations and elucidate the underlying biological mechanisms.

CONCLUSION

This study shows that BMI and immunocompromised conditions are significantly associated with TB spondylitis severity, emphasizing the importance of nutritional and immune assessments in clinical evaluation. Interestingly, a history of pulmonary TB did not contribute significantly to disease severity, suggesting that host-related factors may outweigh prior infection history in influencing outcomes. These findings provide new empirical evidence that can support more tailored risk stratification and treatment planning in TB spondylitis. Nevertheless, several limitations of this study should be considered, including the use of secondary data, which may lead to incomplete and inconsistency in the data obtained. The cross-sectional study design only demonstrates associative relationships between variables, not providing conclusions about the strength of causal relationships. Furthermore, the relatively limited sample size, collected from a single hospital, may not be generalizable to the

population. Future studies should conduct longitudinal research on a broader population to obtain better generalizability. This study did not include other variables such as socioeconomic factors, medication adherence, and environmental conditions that may play a role in disease severity. Therefore, research with a broader scope and more comprehensive variables is recommended.

CONFLICT OF INTEREST

There is no conflict of interest in this article.

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