Determinants of Pulmonary Tuberculosis Among Inmates in Class IIA Penitentiary in Jambi City

Anggi Syahdia Damanik[1]*, Adelina Fitri[1], Fajrina Hidayati[1], Helmi Suryani Nasution[1]
Evy Wisudariani[1], Edo Riyandani[2]

[1]Department of Public Health, Faculty of Medicine and Health Science, Jambi University, Jambi 36361, Indonesia
[2]Department of Infectious Disease, Faculty of Medicine, Tottori University, Tottori 680-8550, Japan

*Correspondence: anggidamanik0109@gmail.com

ABSTRACT: Pulmonary tuberculosis (pulmonary TB) is a contagious infectious disease caused by *Mycobacterium tuberculosis*. Pulmonary TB can be fatal for those affected. This study aimed to determine the relationship between comorbidities, contact history, nutritional status, smoking habits, and prison time with pulmonary tuberculosis among inmates. A case-control research design was used, with purposive sampling of 82 inmates from the Class IIA penitentiary in Jambi City in 2024. Data collection took place from January to July 2024. The research variables included age, comorbidities, contact history, nutritional status, smoking habits, and prison time, assessed through interviews, BMI measurement, and tuberculosis diagnosis. The data were analyzed using the Chi-Square test. The results showed that 94.1% of participants were aged 15–64, 91.8% had no comorbidities, 56.5% had a history of contact, 55.3% had a normal BMI (<18.5), 70.5% were smokers, and 83.5% had been incarcerated for more than three months. There was no significant association between pulmonary TB and comorbidities (OR 3.16, 95% CI 0.32–31.7). However, significant relationships were found with contact history (OR 39.27, 95% CI 9.93–155.25), nutritional status (OR 45.04, 95% CI 11.23–180.58), and smoking habits (OR 7.24, 95% CI 2.18–24.08). No significant relationship was observed between pulmonary TB and prison time (OR 3.07, 95% CI 0.75–12.53).

KEYWORDS: Comorbid; panitentiary; inmates; pulmonary tuberculosis; smoking habit

1. Introduction

Environmentally based diseases are illnesses caused by unhealthy environmental conditions that disrupt human health and may even lead to fatal outcomes [1]. These diseases remain a significant concern today. One type of environmentally based disease caused by bacteria is pulmonary tuberculosis (pulmonary TB) [2]. Pulmonary tuberculosis is an infectious disease caused by *Mycobacterium* bacteria. Transmission occurs when an individual inhales saliva droplets expelled by a TB patient through sneezing or coughing. Pulmonary tuberculosis has severe consequences, including death [3]. According to Gordon's theory, the epidemiological triangle consists of host, agent, and environmental factors, all of which contribute to disease risk. These three aspects influence an individual's overall health. Risk factors for pulmonary

tuberculosis (TB) include comorbidities (such as HIV or diabetes mellitus), contact history, nutritional status (BMI), smoking habits, and prison time [4]. The bacteria that cause pulmonary tuberculosis thrive in damp, dark, cold environments with poor ventilation. Tuberculosis is more prevalent in populations experiencing malnutrition, overcrowding, and inadequate ventilation [5]. Environmental factors play a crucial role in the incidence of pulmonary tuberculosis, both physically and biologically [6].

Pulmonary tuberculosis (TB) is a major global health concern. It ranks as the ninth leading cause of death worldwide and is the most fatal infectious disease, surpassing HIV. Globally, TB affects an estimated 10 million people annually [7]. According to the National TB Report, pulmonary tuberculosis cases in Indonesia increased from 824,000 in 2020 to 969,000 in 2021 [8]. In 2022, the number of cases further rose to 1,060,000, with a case notification rate (CNR) of 68%, leaving 32% of cases undiagnosed, undetected, or unreported [9]. Based on the Jambi Provincial Health Service Report in 2021, 3,682 tuberculosis cases were identified out of an estimated 13,681 cases, with a CDR (Case Detection Rate) of 26.91%—still far from the national target of 85%. The CNR for Jambi City in 2021 was 21.5%, with 740 cases reported out of an estimated 3,000 cases requiring treatment. Tuberculosis cases decreased compared to the previous year, which recorded 766 cases [10]. However, in 2022, the number of pulmonary tuberculosis cases in Jambi Province increased to 5,308. The highest number of cases was reported in Jambi City, which accounted for 24.38% of the province's total TB cases [10].

The Minister of Law and Human Rights highlighted overcrowding as the primary issue in prisons. Most prisons and detention centers in Indonesia face this problem. According to data from the Directorate General of Corrections (Ditjenpas), Indonesian prisons and detention centers have a capacity of 135,561 inmates, yet currently house 266,828 inmates. In Jambi City Prison, approximately 80% of inmates were convicted in narcotics cases [11]. Based on Integrated Biological-Behavioral Surveillance (IBBS) data, injecting drug users (IDUs) are at high risk for HIV/AIDS, which is a major risk factor for pulmonary TB. HIV/AIDS weakens the immune system, increasing susceptibility to pulmonary TB [12]. Data from the Class IIA penitentiary in Jambi City showed that the prison housed 1,514 inmates across 10 blocks. Interviews with officers and doctors at the Class IIA Prison Polyclinic in Jambi City in 2023 revealed a sharp increase in pulmonary TB cases. The prevalence rate of TB in prisons was found to be eight times higher than the previous year. Inmates had a 7.5 times higher risk of contracting TB compared to the general population [13]. TB detection activities, known as Active Case Finding (ACF), were initiated by the Directorate of Care, Health, and Rehabilitation of the Directorate General of Corrections, in collaboration with the TB Work Team of the Directorate of Disease Prevention and Control, Ministry of Health. These efforts targeted 206,330 inmates and juveniles across 374 prisons and detention centers in 33 Regional Offices of the Ministry of Law and Human Rights. Symptom screenings conducted since August 2023 at the Class IIA penitentiary in Jambi City revealed a rapid increase in pulmonary TB cases, from 4 cases in 2022 to 75 cases in 2023 [13].

According to Hamid (2022), ventilation was a significant risk factor for TB, while residential density and contact history were not. Proper ventilation played a protective role against TB incidence [4]. Maqfirah (2018) found that residential density and ventilation area were risk factors, whereas nutritional and smoking status were not [5]. Habibah (2019)

reported a significant relationship between residential density, ventilation, and pulmonary TB incidence [14]. Evrilda et al. (2018) identified lighting levels and coughing behavior as factors influencing TB incidence, while the length of detention had no impact [15]. The Regulation of the Minister of Law and Human Rights of the Republic of Indonesia No. 11 of 2017, concerning the Grand Design for Handling Overcrowding in Detention Centers and Penitentiaries, states that overcapacity negatively affects the health conditions of inmates [16]. Overcrowding reduces the quality of sanitation and the environment, worsening the living conditions of inmates and increasing the potential for TB transmission [17]. Based on the data and observations, this study aims to determine the relationship between comorbidities, contact history, nutritional status, smoking habits, and prison time with pulmonary tuberculosis in inmates.

2. Materials and Methods

This study was a quantitative research study using a case-control design, where researchers compared the degree of exposure between individuals who suffered from pulmonary tuberculosis (cases) and those who did not (controls). This research was conducted in July 2024 with a sample size of 82. Based on the minimum sample size calculation, at least 37 participants were required. To account for potential dropouts, the sample size was increased by 10 percent (4 participants), resulting in a total of 41 cases. Thus, 41 respondents formed the case group, and 41 respondents formed the control group. The case sampling technique used was purposive sampling. Ethical clearance was obtained before conducting the research. The first step was to secure permission from the Class IIA penitentiary institution in Jambi by submitting a research permission letter from the university. The research was then conducted following the institution's regulations, including the requirement to censor inmates' faces and ensure that they felt comfortable and honest during interviews. The independent variables in this study were comorbidities, contact history, and prison time. Data collection was carried out through interviews and BMI measurements using height and weight measuring instruments to determine whether respondents were underweight. The collected data were analyzed using the Chi-Square statistical test.

3. Results and Discussion

3.1. Corellation between comorbidities with the incidence of pulmonary tuberculosis.

Based on Table 1, a bivariate analysis using the Chi-Square test was performed to determine the relationship between comorbidities and the incidence of tuberculosis. The results showed that there was no significant relationship between comorbidities and the incidence of tuberculosis among WBP in the Class IIA penitentiary in Jambi City. Comorbid diseases were not found to be a contributing factor to pulmonary TB.

This finding contradicts research by Purwati (2020), which stated that comorbidities are a risk factor for pulmonary TB, with an odds ratio (OR) of 1.778. This means that patients with comorbidities such as HIV, diabetes, and asthma were 1.778 times more likely to develop pulmonary TB compared to those without such conditions [18]. Similarly, this research also contradicts findings by Anisah et al. (2021), which suggested that comorbid diabetes mellitus (DM) is a significant risk factor for tuberculosis, with an OR of 9.185. This

indicates that individuals with comorbid DM had a 9.185 times higher risk of developing tuberculosis than those without DM [19].

Comorbidity refers to the presence of two or more health conditions simultaneously. Comorbid diseases are chronic health issues that arise from a combination of multiple medical conditions, including physical illnesses, mental health disorders, or both. These comorbidities can accelerate and facilitate the onset of TB. HIV, for instance, is a known comorbidity that increases susceptibility to TB, while diabetes mellitus is another condition associated with a higher risk of TB [19].

This study indicated that HIV testing was conducted regularly, once a month. However, very few pulmonary TB sufferers in the penitentiary were found to have comorbid HIV. DM examinations were typically performed only when symptoms were present and were often diagnosed before inmates entered the penitentiary. Interviews with respondents and a review of medical records revealed that out of the 82 samples, only 4 respondents (4.89%) had comorbidities (HIV/DM). This suggests that pulmonary TB sufferers in this penitentiary rarely had comorbidities, which may explain the lack of a relationship between comorbidities and the incidence of tuberculosis among inmates in the Class IIA penitentiary in Jambi City.

The discrepancies between this study and previous research may be attributed to several factors, including the number of respondents, the research location, and the characteristics of the study populations. Previous studies reported a higher prevalence of comorbidities among pulmonary TB sufferers, whereas the inmates at the Class IIA penitentiary in Jambi City had very few pulmonary TB cases with comorbid conditions.

Table 1. Corellation between comorbidities with the incidence of pulmonary tuberculosis.

Comorbid	Status				OR	95%CI	P-*Value*
	Case		Control				
	N	%	N	%			
Yes	3	7,3	1	2.4			
No	38	92.7	40	97.6	3.16	0.32-31.7	0.305
Total	41	100	41	100			

3.2.Corellation between contact history with the incidence of pulmonary tuberculosis.

The The results shown in Table 2 indicate a significant relationship between contact history and the incidence of tuberculosis, with a risk value suggesting that individuals with a history of close contact with pulmonary TB sufferers were 39 times more likely to develop the disease compared to those without such a history. This finding is supported by Fitrianti's (2022) research, which demonstrated a relationship between contact history and the incidence of pulmonary tuberculosis, with a risk value of 2.4 times (p-value < 0.05, OR = 2.419) [20]. Husna (2020) also reported a significant relationship between a history of close contact and tuberculosis incidence, with a risk value of 13 times (p-value 0.000 < 0.05, OR = 13.000) [21]. Furthermore, Rita (2020) identified a significant association between close contact history and tuberculosis incidence, with a p-value of 0.029 < 0.05 and OR = 1.34, indicating a 1.3 times greater risk [22].

The term "contact history" refers to individuals who have been in close proximity to a TB sufferer, which may occur at home, in the workplace, or in public spaces. Transmission can happen through conversations or being near TB sufferers without wearing masks,

allowing TB germs to be inhaled from droplets released through sneezing or coughing. However, not everyone with a contact history contracts TB; susceptibility depends on an individual's immune system, which influences the onset of tuberculosis symptoms. The presence of BTA+ sufferers poses a significant infection risk to those in their surroundings. The closer and more prolonged the contact, the greater the risk; therefore, household exposure to infected family members, neighbors, or others significantly increases the likelihood of transmission [23].

This was further supported by interviews conducted with respondents regarding their contact history with pulmonary TB sufferers. The findings suggest that a lack of knowledge about TB may have contributed to a higher incidence of contact history and, subsequently, pulmonary TB. Understanding TB transmission is crucial, as it influences preventive behaviors such as cough etiquette, avoiding spitting in public places, wearing masks, and seeking early treatment to prevent the spread of the disease. This is reflected in the frequency distribution, where 58.55% of respondents reported a history of close contact with pulmonary TB sufferers. Many respondents interacted with individuals exhibiting symptoms such as persistent coughing, coughing up phlegm or blood, or experiencing chest pain, yet they were unaware that these were symptoms of pulmonary TB. Interviews revealed that this lack of awareness stemmed from insufficient concern and knowledge about TB transmission and its dangers. Individuals who frequently interacted with pulmonary tuberculosis sufferers were more likely to have a history of close contact. Education regarding pulmonary tuberculosis risk factors should be enhanced to ensure that WBP receive clear guidelines on maintaining a safe distance from individuals displaying symptoms of the disease.

Table 2. Corellation between contact history with the incidence of pulmonary tuberculosis.

Contact history	Status				OR	95%CI	P-*Value*
	Case		Control				
	N	%	N	%			
Ever		38		92.7			
Never		3		7.3	39.267	9.93-155.25	0.0001
Total	41	100	41	100			

3.3. Corellation between detention period with the incidence of pulmonary tuberculosis.

A bivariate analysis using the Chi-Square test to determine the relationship between detention time and the incidence of tuberculosis is presented in Table 3. The p-value of 0.305 (greater than 0.05) indicates that there was no significant relationship between detention time and the incidence of tuberculosis among WBP at the Class IIA penitentiary in Jambi City. This finding aligns with Andani's (2018) research, which showed that the length of stay in detention was not related to the incidence of pulmonary TB, with an odds ratio (OR) of 1.894, a confidence interval (CI) of 95% (0.761–4.716), and a p-value of 0.251. The duration of detention was not associated with pulmonary TB incidence if respondents had no history of contact with infected individuals or exposure to *Mycobacterium tuberculosis* [15].

Although tuberculosis is contagious, it is not easily transmitted. TB germs can remain airborne for 1–2 hours, though some may die when exposed to sunlight. Pulmonary TB bacteria can survive for hours or even months in damp, dark environments. In cases where there is a history of contact, the transmission rate of *Mycobacterium tuberculosis* is higher [15]. The history of detention was associated with an OR of 4.103 (95% CI: 1.815–9.275, p-

value = 0.032), further indicating that there was no significant relationship between prison time and pulmonary tuberculosis [24].

Prison detention refers to the period during which a prisoner is held in custody. Detainees include suspects or defendants placed in a prison or detention center (remand center). WBP is a high-risk group for TB. The prevalence of TB in prisons is estimated to be significant, as prison conditions facilitate the spread of pulmonary tuberculosis due to prolonged and repeated exposure to *Mycobacterium tuberculosis.* This is exacerbated by delayed case detection, a lack of isolation rooms for suspected TB patients, inaccuracies in the treatment of infectious pulmonary tuberculosis cases, and high inmate turnover due to transfers between facilities [5].

This was further supported by interviews conducted with respondents, which revealed that the majority of detainees had been in the Class IIA penitentiary in Jambi City for more than three months. However, no relationship was found between the length of detention and the incidence of pulmonary tuberculosis. The duration of detention was irrelevant if there was no history of contact, such as talking, sleeping in the same room, or being in close proximity to infected individuals or those exhibiting symptoms.

Table 3. Corellation between detention period with the incidence of pulmonary tuberculosis

Detention period	Status				OR	95%CI	P-*Value*
	Case		Control				
	N	%	N	%			
>3 month	38	92.7	33	80.5			
<3 month	3	7.3	8	19.5	39.267	9.93-155.25	0.0001
Total	41	100	41	100			

4. Conclusions

The study conducted at the Class IIA penitentiary in Jambi City identified key determinants of pulmonary tuberculosis (TB) among inmates. A history of contact with TB sufferers (58.55% of cases) was significantly associated with TB incidence, likely due to low health awareness. Undernutrition (41.4%) was also a contributing factor, influenced by economic and lifestyle conditions, while smoking habits (73.17%) were linked to poor adherence to health warnings. However, comorbidities (4.89% prevalence) and sentence duration (86.59% >3 months) showed no significant association with TB occurrence. This may be attributed to the institution's robust health programs, which include monthly HIV screenings, effective TB treatment protocols, and routine health assessments for inmates. The findings underscore the need for targeted interventions to enhance health education, improve nutritional support, and implement smoking cessation programs. Additionally, they highlight the success of existing TB control measures in mitigating risks associated with comorbidities and inmate turnover.

Acknowledgments

Author Contribution

Conceptualization: Fajrina Hidayati; Methodology: Adelina Fitri; Data Collection: Anggi Syahdia Damanik; Data Analysis: Helmi Suryani Nasution; Writing: Evy Wisudariani; Supervision: Fajrina Hidayati, Edo Riyandani

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

References

[1] Darmawansyah, D.; Wulandari, W. (2021). The relationship between knowledge levels and the incidence of pulmonary tuberculosis in the work area of Padang Serai Health Center, Bengkulu City. *Journal of Nursing and Public Health*, *9*, 18–22. https://doi.org/10.37676/jnph.v9i2.1790.

[2] Lindsey, M.; Chen, S.-R.; Ben, R.; Manoogian, M.; Spradlin, J. (2021). Defining Environmental Health Literacy. *International Journal of Environmental Research and Public Health*, *18*, 11626. https://doi.org/10.3390/ijerph182111626.

[3] Nasution, R.A.; Rengganis Wardani, D.W.S.; Pramesona, B.A.; Saputra, O. (2024). The Relationship between House Conditions and the Household Contacts with the Incidence of Children's Pulmonary Tuberculosis. *Jurnal Kesehatan, 15,* 106–111.

[4] Yaghi, A.R.; Shaheed, H.S.; Harun, S.N.; Hyder Ali, I.A.; Khan, A.H. (2022). Survival Trend of Tuberculosis Patients and Risk Factors Associated with Mortality and Developing Drug-Resistant Tuberculosis in Hospital Pulau Pinang, Malaysia: A Retrospective Study. *Advances in Respiratory Medicine*, *90*, 467-482. https://doi.org/10.3390/arm90060054.

[5] Ibrahim, M.N.; Nik Husain, N.R.; Daud, A.; Chinnayah, T. (2022). Epidemiology and Risk Factors of Delayed Sputum Smear Conversion in Malaysian Aborigines with Smear-Positive Pulmonary Tuberculosis. *International Journal of Environmental Research and Public Health*, *19*, 2365. https://doi.org/10.3390/ijerph19042365.

[6] Chanpho, P.; Chaiear, N.; Kamsa-ard, S. (2020). Factors Associated with Latent Tuberculosis Infection among the Hospital Employees in a Tertiary Hospital of Northeastern Thailand. *International Journal of Environmental Research and Public Health*, *17*, 6876. https://doi.org/10.3390/ijerph17186876.

[7] Global tuberculosis report 2022. (accessed on 1 August 2024) Available online: https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2022.

[8] The second national TB inventory study in Indonesia (accessed on 1 August 2024) Available online: https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2024/featured-topics/the-second-national-tb-inventory-study-in-indonesia.

[9] Peraturan Menteri Kesehatan Republik Indonesia (accessed on 1 August 2024) Available online: http://hukor.kemkes.go.id/uploads/produk_hukum/PMK%20No.%201077%20ttg%20Pedoman%20Penyehatan%20Udara%20Dalam%20Ruang%20Rumah.pdf.

[10] Health and Housing Statistics Analysis of Jambi Province 2023 (accessed on 1 August 2024) Available online: https://jambi.bps.go.id/en/publication/2024/08/05/20f9580cc1ea04bf9f656e62/health-and-housing-statistics-analysis-of-jambi-province-2023.html.

[11] Ramadhani, S.; Situmorang, R.K.; Public Health, F.; Study, P.S.; Community, K., et al. (2022). Environmental quality and personal hygiene related to tuberculosis incidence in inmates at Rantauprapat penitentiary. *Journal of Health and Physiotherapy*, *0*, 176–182.

[12] Handayani, R.; Adnan, N.P. (2019). Risk factors for pulmonary tuberculosis in prisoners at the Jakarta Narcotics Penitentiary. *Journal of Public Health Science*, *11*, 194–198.

[13] Rinawati, S.A.W.; Hidayat, N. (2020). Socialization of active case finding implementation for tuberculosis officers in Sleman Regency. *Journal of Public Health and Community Service*, *1*, 72.

[14] Sangphoo, T.; Chaiear, N.; Chanpho, P. (2020). Work-Related Tuberculosis among Health Workers Employed in a Tertiary Hospital in Northeastern Thailand: A Report of Nine Cases. *International Journal of Environmental Research and Public Health*, *17*, 5156. https://doi.org/10.3390/ijerph17145156.

[15] Andani, P.E.; Martini, D.S.L. (2018). Risk factors for pulmonary tuberculosis in inmates at Class I Semarang Penitentiary. *Journal of Public Health*, *6*, 245–52.

[16] Uqbah Iqbal, (2024). Infectious Disease Epidemiology: History, Transmission and Prevention. *Clinical Case Reports and Trails. 3*(1). https://doi.org/10.58489/2836-2217/019.

[17] Guo J, Feng YP, Liu ZD, Luo SR, Wu QY. Analysis of factors influencing patient delay by patients with pulmonary tuberculosis in Lishui City, Zhejiang Province. *BMC Pulmonary Medicine, 23*, 264. https://doi.org/10.1186/s12890-023-02554-w.

[18] Maja, T.F.; Maposa, D. (2022). An Investigation of Risk Factors Associated with Tuberculosis Transmission in South Africa Using Logistic Regression Model. *Infectious Disease Reports*, *14*, 609–620. https://doi.org/10.3390/idr14040066.

[19] Anisah, A.; Sumekar, D.W.; Budiarti, E. (2023). The relationship between demographics and comorbidities with the incidence of drug-resistant tuberculosis (TB RO). *Health Tadulako Journal*, *9*, 331–9.

[20] Fitrianti, T. (2022). Analysis of determinants of pulmonary tuberculosis incidence. Palgrave Handbook of Urban Development and Planning in Africa, 75–103. https://doi.org/10.1007/978-3-031-06089-2_4.

[21] Masanga, P.; Paul, S.; Mbelele, P.; Daud, P.; Liyoyo, A.; Munuo, L.; Lyimo, S.; Lyimo, B.; Srinivasan, S.; Cattadori, I.; et al. (2023). Perception and Risk Factors Associated with Tuberculosis in the Manyara Region, Tanzania. *Zoonotic Diseases*, *3*, 266-278. https://doi.org/10.3390/zoonoticdis3040022.

[22] Musuenge, B.B.; Poda, G.G.; Chen, P.-C. (2020). Nutritional Status of Patients with Tuberculosis and Associated Factors in the Health Centre Region of Burkina Faso. *Nutrients*, *12*, 2540. https://doi.org/10.3390/nu12092540.

[23] Domínguez, Á.; Soldevila, N.; Toledo, D.; Parrón, I.; Millet, J.-P.; Barrabeig, I.; Godoy, P.; on behalf of Transmission of Tuberculosis in Catalonia (Spain) Working Group. (2023). Factors Associated with Treatment Prescription to Pulmonary Tuberculosis Contacts in Catalonia (2019–2021): A Population-Based Epidemiological Study. *Vaccines*, *11*, 1800. https://doi.org/10.3390/vaccines11121800.

[24] Marín, D.; Keynan, Y.; Bangdiwala, S.I.; López, L.; Rueda, Z.V. Tuberculosis in Prisons: Importance of Considering the Clustering in the Analysis of Cross-Sectional Studies. *International Journal of Environmental Research and Public Health*, *20*, 5423. https://doi.org/10.3390/ijerph20075423.