Original Article

THE INDONESIAN
JOURNAL OF INFECTIOUS DISEASES

p-ISSN: 2354-6077), e-ISSN: 2599-1698

Analysis of Risk Factors for Pulmonary Tuberculosis in Cirascas District, East Jakarta, 2022

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ARTICLE INFO

Received: 12 August 2024
Reviewed: 7 November 2024
Accepted: 19 March 2025

Keywords:
Tuberculosis, Contact, Transmission, Risk Factor

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ABSTRACT

Background: *Tuberculosis (TB) is a global public health problem, with Indonesia ranked second in the world in 2022. In East Jakarta, TB cases continue to increase, including in the Ciracas sub-district. This study aims to identify risk factors for pulmonary TB cases in the Ciracas sub-district in 2022.*
Methods: *The method of this study was quantitative with a case-control design, involving 115 samples (23 cases and 92 controls) selected by purposive sampling technique.*
Results: *The results showed that there was a relationship between contact history and TB patients (p=0.004; OR=6.27; 95% CI=1.86 – 21.11) and occupancy density (p=0.000; OR=29.52; 95%CI: 8.99 – 96.89) with Pulmonary TB infection. However, there was no significant relationship between gender, age, education, occupation, marital status, family income, and knowledge of patients with Pulmonary TB infection.*
Conclusion: *In conclusion, contact with TB patients and housing density increases the risk of pulmonary TB infection. Therefore, it is recommended that isolation of TB patients to a place from the surrounding environment needs to be done to prevent transmission and airborne contamination.*

INTRODUCTION

Tuberculosis is a lung infection caused by the bacterium *Mycobacterium tuberculosis*, which is transmitted through droplets from coughing or sneezing [1]. Tuberculosis (TB) remains a global public health issue despite various efforts to improve case detection and treatment adherence. To this day, TB is still one of the leading infectious diseases and is included in the priority disease control programs. According to data from the World Health Organization (WHO) in 2022, approximately 10.6 million people suffered from TB worldwide, including 5.8 million men, 3.5 million women, and 1.3 million children. TB exists in all countries and affects all age groups [2].

More than 80% of TB cases and deaths occur in low- and middle-income countries. However, almost every country continues to report TB cases. In 2022, the largest number of new TB cases was reported in the Southeast Asia region (46%), followed by the African region (23%) and the Western Pacific region (18%). Around 87% of new TB cases occurred in 30 high-burden countries, with more than two-thirds of global cases found in Bangladesh, China, the Democratic Republic of the Congo, India, Indonesia, Nigeria, Pakistan, and the Philippines [3]. Two countries that contributed significantly to the increase in global TB cases in 2022 were India and Indonesia, which together accounted for 56% of the total cases [4].

In high-burden TB countries, the WHO-recommended TB control strategy, Directly Observed Therapy Short-course (DOTS), has not yet succeeded in curbing the rising number of cases [5]. TB does not only affect adults, but people of all age groups. Individuals at higher risk of developing TB after being infected with *Mycobacterium tuberculosis* include those with malnutrition and those with weakened immune systems, such as people living with HIV, individuals with diabetes, alcohol users, leukemia patients, and those undergoing immunosuppressive therapy [6].

Due to the slow decline in TB incidence, there is increasing attention on innovative efforts. Current efforts include the development of new TB vaccines, extending the use of existing TB drugs, and formulating shorter TB treatment regimens. However, understanding the risk factors that lead to TB infection can help redirect and refine innovative TB control strategies. Risk factors for TB include male gender, HIV coinfection, comorbidities such as Diabetes Mellitus (DM), family history of TB, absence of a Bacillus Calmette-Guérin (BCG) scar, smoking, alcohol consumption, being single/divorced, overcrowded living conditions, and low socioeconomic status [7–10]. In addition, age, educational status, marital status, household income, occupation, knowledge, residential density, humidity, air ventilation, sunlight exposure, contact history, and comorbid illnesses have all been associated with TB infection [11,12].

To control TB effectively, it is necessary to re-evaluate patient characteristics and risk factors contributing to the rising incidence of TB, particularly in developing countries. National tuberculosis programs have helped prevent transmission and increase public awareness of TB symptoms, transmission methods, treatment access, drug resistance, and rumors that TB is difficult to cure. Based on this background, the researchers aim to further investigate and validate these concerns by identifying the risk factors that contribute to pulmonary TB infection. This includes focusing on residential and population density factors, which may result in poor air quality—such as high humidity, lack of sunlight exposure, and inadequate ventilation—in densely populated areas. These conditions also facilitate close and direct contact with TB patients, thereby increasing the risk of disease transmission. Understanding these factors is essential to improving TB prevention and control strategies.

METHODS

This quantitative study employed a case-control design using primary data sources. The data collection instrument used was a questionnaire that had undergone validity and reliability testing. The study population consisted of patients aged ≥17 years who were registered and diagnosed by the attending physician (DPJP) at Ciracas Primary Health Center (Puskesmas Ciracas). The inclusion criteria for cases were patients with bacteriologically confirmed pulmonary tuberculosis (TB), while controls were patients diagnosed with diseases other than pulmonary TB by the attending physician and who sought treatment at Puskesmas Ciracas. The exclusion criteria were patients who were unwilling to participate as respondents and those who were unable to communicate, read, or write.

The sample size for this study was calculated using the formula for comparing two proportions [13] with a study power of 90%, a confidence level of 95%, P1 (the proportion of dense housing as a risk factor among TB patients) at 45%, and P2 (the proportion of dense housing as a risk factor among non-TB patients) at 35%. With a case-to-control ratio of 1:4, the total sample size was determined to be 115 respondents, consisting of 23 cases and 92 controls. This ratio can enhance statistical power compared to a more balanced ratio like 1:1, especially when the number of cases is limited. Including more controls per case helps to better detect differences in proportions between groups, which is beneficial for increasing sensitivity in identifying risk factors.

The research variables consisted of characteristics (sex, age, education, occupation, marital status, and income) and risk factor variables (knowledge, housing density, and contact history). The study was conducted from April to August 2022. Secondary data were obtained from the electronic medical records of patients at Ciracas Primary Health Center, while primary data were collected through a mobile questionnaire/Google Form for the variables of knowledge (17 questions), housing density (2 questions), and contact history (1 question). The questionnaire had previously undergone validity and reliability testing.

Data collection was carried out by including all newly registered TB patients until the required sample size was reached. The data analysis used in this study included univariate analysis using frequency (n) and proportion (%), and bivariate analysis using the Chi-square test to calculate the level of significance (p-value) with $\alpha < 0.05$, along with the measure of association in the form of crude Odds Ratio (cOR).

The matching technique in this study was designed to control for variables that potentially have a significant influence on TB risk. Independent variables such as age, sex, contact history with TB patients, and housing density were selected as matching variables to control for major risk factors due to their strong association with TB risk. Frequency matching was used to

maintain proportional balance between case and control groups within the selected variable categories, while individual matching was applied to specific variables such as contact history.

RESULTS

The descriptive analysis of respondent characteristics in Table 1 below shows several differences in the distribution of characteristics such as gender, education, occupation, and income between the case and control groups. The male-to-female ratio in the case group was more balanced compared to the control group. Additionally, the proportion of respondents with higher education and income levels tended to be greater in the control group. These differences in characteristics may be important considerations in further analysis to explore the relationship between demographic factors and the risk of tuberculosis (Table 1).

Table 1. Frequency Distribution of Respondent Characteristics

Variable	Category	Case (n=23)		Control (n=92)	
		n	%	n	%
Sex	Male	12	52,2	37	40,2
	Female	11	47,8	55	59,8
Age	Productive Age	23	100	91	98,9
	Non-productive age	0	0	1	1,1
Education	High	19	82,6	87	94,6
	Low	4	17,4	5	5,4
Employment	Employed	12	52,2	53	57,6
	Unemployed	11	47,8	39	42,4
Marital Status	Married	14	60,9	48	52,2
	Single/Divorced	9	39,1	44	47,8
Income	< Minimun Wage	7	30,4	12	13,0
	≥ Minimun Wage	16	69,6	80	87,0

The analysis results showed that risk factors such as high housing density and a history of contact with TB patients were more common in the case group compared to controls. This suggests that housing density and contact history likely play an important role as risk factors for pulmonary tuberculosis (Table 2).

Table 2. Frequency Distribution of Pulmonary TB Risk Factors

Risk Factor	Category	Case (n=23)		Control (n=92)	
		n	%	n	%
Knowledge	Poor	0	0	7	7,6
	Good	23	100	85	92,4
Housing Density	Crowded	18	78,3	10	10,9
	Not Crowded	5	21,7	82	89,1
Contact History	Yes	7	30,4	6	6,5
	No	16	69,6	86	93,5

The bivariate analysis shown in the table below, it was found that the risk factors of housing density and contact history with pulmonary TB patients were associated with the occurrence of pulmonary TB (p value ≤ 0.05). Meanwhile, sociodemographic factors and TB-related knowledge showed no association with pulmonary TB incidence (p value > 0.05) (Table 3).

Table 3. Bivariate Analysis of Variables

Variable	Category	Case (n=23)		Control (n=92)		p-value	cOR (95% CI)
		n	%	n	%		
Sex	Male	12	52,2	37	40,2	0,423	1,62 (1,64-4,06)
	Female	11	47,8	55	59,8		
Age	Productive	23	100	91	98,9	1,000	1,01 (0,99-1,03)
	Non-productive age	0	0	1	1,1		
Education	High	19	82,6	87	94,6	0,077	0,27 (0,06-1,11)
	Low	4	17,4	5	5,4		
Employment	Employed	12	52,2	53	57,6	0,814	0,80 (0,32-2,00)
	Unemployed	11	47,8	39	42,4		
Marital Status	Married	14	60,9	48	52,2	0,607	1,41 (0,56-3,62)
	Single	9	39,1	44	47,8		
Income	< Minimum Wage	7	30,4	12	13,0	0,060	2,91 (0,99-8,55)
	≥ Minimum Wage	16	69,6	80	87,0		
Knowledge	Poor	0	0	7	7,6	0,342	1,08 (1,02-1,14)
	Good	23	100	85	92,4		
Housing	Crowded	18	78,3	10	10,9	0,000	29,52 (8,99-96,89)
Density	Not Crowded	5	21,7	82	89,1		
Contact	Yes	7	30,4	6	6,5	0,004	6,27 (1,86-21,11)
History	No	16	69,6	86	93,5		

DISCUSSION

Most respondents in the case group (78.3%) lived in overcrowded housing, whereas in the control group (89.1%) did not live in overcrowded houses. Bivariate analysis showed a significant association between housing density and pulmonary tuberculosis (TB) occurrence (p value <0.05). Housing conditions were worse for cases compared to controls, as a higher percentage of cases (53.8%) lived in one-room houses compared to controls (38.1%), while more controls (35.8%) than cases (22.7%) lived in two-room houses. The disproportionate size of the house relative to the number of occupants results in no physical distance during communication and frequent sharing of the same room. This increases the risk of transmission.

Housing density is closely related to socioeconomic factors, as low income can limit the ability to live decently according to required health standards. Public housing standards usually include providing good housing in terms of design, location, building size, and other facilities to

meet the criteria of healthy and comfortable homes. The presence of ventilation and windows for sunlight is important to maintain healthy indoor air.

Almost one-third (30.4%) of cases and nearly one-tenth (6.7%) of controls had household members suffering from TB. Other studies have shown that 17.5% of TB patients reported having family members with TB [14]. Close contact is a very strong risk factor for TB [15–17]. Close contact is significantly associated with increased risk of TB transmission in Ethiopia [18]. In a systematic review by Fox GJ et al., the prevalence of active TB and latent TB infection among TB contacts was 3.1% and 51.5%, respectively [19].

Further analysis confirmed a significant association between history of contact with a family member and the occurrence of pulmonary TB (p value <0.05). The effect of previous TB experience within households has been consistently observed in other studies, and this effect increases with the number of people who had TB in the past [8]. Additionally, some evidence shows this effect is stronger when former TB patients have a close familial relationship with the index TB case, compared to household members without family ties. As reported in other studies, within TB households, the risk of TB infection increases with social proximity to the case, and this effect is consistently higher for first-degree relatives than more distant relatives [9].

The sociodemographic characteristics of respondents in this study showed that 52.2% of cases were male. Similar findings were reported in other studies, with 60.5% [20], and 57.5% male TB patients respectively [21]. However, some studies reported a lower percentage of male patients (43.3%) [22], while most studies reported very high percentages of males: 70.0% [20], 70.7% [23], and 71,1% [24]. Males are more vulnerable to TB because they have more opportunities for contact with carriers of the disease due to their social activities outdoors.

The sociodemographic characteristics also showed that 100% of cases and 98.9% of controls were in the productive age group, which is economically active and productive. This aligns with other studies among TB patients in Northern Ethiopia (Gondar and Borumeda), which showed 54.9% of cases were aged 26-45 years [21]. Another study in St. Peter Hospital, Addis Ababa, showed 29.9% in the 26-45 age group [25]. Generally, these findings are consistent with other studies reporting rapid increases in TB morbidity and mortality among young adult populations, mostly aged 15-44 years [26]. The high risk of infection in this age group relates to higher social contacts in the community during young adulthood [27].

Both case (82.6%) and control groups (94.6%) had the majority of respondents with higher education. In this study, higher education was defined as senior high school or above. In contrast, other studies grouped education into two categories: low education (no school, elementary, and junior high school) and high education (senior high school and academy/university) [28]. Education level strongly influences knowledge about housing conditions or healthy house

criteria, knowledge about TB disease, prevention, and treatment. This condition motivates individuals to develop awareness in implementing Clean and Healthy Living Behavior [29].

Most respondents in the case group (52.2%) and control group (57.6%) were employed. This aligns with a study at Karya Jaya Palembang Public Health Center in 2019 where most pulmonary TB and non-TB patients were employed [28]. However, a 2015 study showed that most pulmonary TB and non-TB patients were unemployed [30]. Employment involves activities performed to meet individual needs. Individuals with low-income jobs may consume inadequate nutrition for their families, which can cause poor nutritional status and increase the risk of infectious diseases such as pulmonary TB [28].

This study also showed that most respondents in the case group (60.9%) and control group (52.2%) were married. Family income for both groups was above the regional minimum wage (UMR). This differs from a 2022 study which found that most pulmonary TB and non-TB patients had low income levels [30]. Economically, working individuals have purchasing power, which improves welfare. However, in reality, financial variables alone do not determine disease frequency. Pulmonary TB is a multi-complex problem where not only economic variables but also other factors play roles [31].

Regarding patient knowledge about pulmonary TB, 100% of the case group and 92.4% of controls had good knowledge. This differs from a 2016 study reporting that most pulmonary TB patients had low knowledge (54.5%), whereas non-TB patients had high knowledge (54.5%). 29

Knowledge about TB and its treatment should increase with higher education levels. The respondents' education level is a determining factor in overall health education. Although the number of respondents who answered correctly was not significantly different from those who answered incorrectly on questions about causes, symptoms, and TB prevention, this may be due to a lack of respondent knowledge on the topic.

Particularly, a lack of knowledge about pulmonary TB prevention can cause new cases to emerge because awareness of disease prevention makes people more cautious and concerned about TB risk. Therefore, TB prevention and control programs (P2TB) should provide clear information to the community about pulmonary TB and the importance of a healthy living environment. One way to achieve this is by disseminating information through leaflets, brochures, or posters, so respondents can understand the disease and preventive measures. Thus, efforts to control transmission and new pulmonary TB cases can be realized.

Other research showed seven factors/variables as independent predictors for TB occurrence after controlling for confounders. Subjects living in houses without windows or with only one window were 1.8 times more likely to be infected with TB compared to those with houses having many windows (aOR = 1.81; 95% CI: 1.06-3.07). Poor ventilation and population density have been reported in several other studies in various locations [29,30]. People living in

houses without windows or with only one window are at high risk of TB because poor ventilation increases the airborne transmission risk. Additionally, they may belong to low-income groups, and larger family sizes cause crowding and malnutrition, further increasing risk. This increases vulnerability to infectious diseases and creates an environment that supports TB transmission.

We acknowledge limitations due to other variables not studied in this research. Some patients refused to participate despite efforts to contact and visit them. Those with high household income tend to live in decent houses of proportional size. Large-scale research with adequate sample size and representation, involving other variables contributing to pulmonary TB occurrence, is recommended.

CONCLUSION

This case-control study explored various socio-demographic factors and identified several contributors to the occurrence of tuberculosis (TB). The findings revealed that TB was more common among individuals in the productive age group, males, those with higher education, employed individuals, those who were married, and those with income levels at or above the regional minimum wage. In addition, all TB patients had good knowledge about the disease, a higher proportion of TB patients lived in overcrowded housing, and there was a notable absence of prior contact history in some cases. Further analysis identified two key risk factors significantly associated with tuberculosis in this region: housing density and history of contact with TB patients.

Therefore, TB control efforts require targeted strategies to address issues related to residential overcrowding and contact history with infected individuals. These two factors are closely linked—when a person infected with TB lives in a home that is not proportionate in size to the number of occupants, the risk of transmission increases. Infection control efforts must go beyond healthcare facilities and extend to households, where frequent and close interactions among residents can facilitate the spread of TB.

DECLARATIONS

Ethics approval

This study was approved by the Ethics Committee of Universitas Respati Indonesia, Reference Number: 382/SK.KEPK/UNR/VII/2022.

Conflict of interest.

The authors declare no conflict of interest.

Funding

This research did not receive any specific grants from funding agencies in the public, commercial, or not for profit sectors.

Acknowledgments

The authors would like to express their gratitude to all study participants for their cooperation and willingness to take part in this research. We also extend our sincere thanks to Ciracas Public Health Center for their outstanding support throughout the research process.

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