

Active tuberculosis identification based on workers environmental sanitation during the COVID-19 pandemic

Tri Hari Irfani^{1*}, Agita Diora Fitri¹, Eddy Roflin¹, Reynold Siburian², and Tungki Pratama Umar²

¹Department of Public Health and Community Medicine, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

²Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

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Corresponding author:

dr.Tri Hari Irfani, MPH

Sriwijaya University Faculty of Medicine

Department of Public Health and Community Medicine

Dr. Mohammad Ali Street, RSMH Complex, Km 3.5

Palembang, Indonesia, 30126

Email: trihariirfani@fk.unsri.ac.id

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Abstract

Background: Coronavirus Disease 2019 (COVID-19) is a pandemic that may complicate the active detection of Tuberculosis (TB) and increase the mortality rate. This pushes for more effective and efficient case finding to mitigate the possible growing number of TB mortality.

Objective: The purpose of this research was to identify TB among workers and to analyze the correlation between human, environmental, behavioral, and economic factors with TB findings among workers during the COVID-19 period.

Methods: This research employed a case-control method conducted from January to December 2020. In total, 120 employees were included in this research. The employees were divided into two groups, sixty workers were involved in the TB case group, and another sixty workers were in the control group. We reported TB patients from several Public Health Center (Puskesmas) in each regency of South Sumatera, Indonesia. Sputum testing was performed by the rapid molecular tests (GeneXpert) and Ziehl-Neelsen to confirm the diagnosis of TB infection. We performed a Chi-square analysis to analyze factors that can influence TB cases.

Results: In comparison to the control group, we found the association of age, body mass index, occupation, and sun exposure to the incidence of active TB cases ($p < 0.05$).

Conclusion: Since statistically significant differences between the two groups have been identified, the incidence of TB in workers might be affected by age, occupation, BMI, and exposure to sunlight. Associated significant variables can be integrated into the TB control program for better case-finding practice to recognize concealed burdens of TB that are overlooked due to COVID-19.

Keywords: COVID-19; environmental health; infectious diseases; tuberculosis

Introduction

Tuberculosis (TB) is one of the most infectious occupational diseases for the worker globally (Ehrlich, Spiegel, Adu, & Yassi, 2020) and affecting many organs, especially the lungs (Loddenkemper, Lipman, & Zumla, 2016). Due to the nature of this disease, TB infection can transform into potentially life-threatening and even lead to death if left untreated (Tiemersma, van der Werf, Borgdorff, Williams, & Nagelkerke, 2011). According to the World Health Organization (WHO) Global Tuberculosis Report, our country, Indonesia, is ranked third in the highest TB cases. The majority of cases are working productive age or ≥ 15 years of age (World Health Organization, 2015). However, despite the high number of cases, there is still a low level of effective case reporting globally, especially in Indonesia, that causes late diagnosis and leads to high disease mortality (Bakhtiari et al., 2019; Li et al., 2019; Surya et al., 2017; Zhou, Pender, Jiang, Mao, & Tang, 2019).

One of the most important diagnostic tools for confirming a suspected TB diagnosis is the Ziehl-Neelsen stain, also known as an acid-fast stain (AFS). However, this method is not very sensitive (70%) as positive results can only result if there are more than 10^3 organisms/ml sputum (Abdelaziz, Bakr, Hussien, & Amine, 2016). Culture also has an important role in diagnosing TB because it has better sensitivity and specificity than AFS (American Thoracic Society, 2000; van Zyl-Smit et al., 2011). Lowenstein-Jensen culture (LJ) is the gold standard for confirming *Mycobacterium tuberculosis*, with respective sensitivity and specificity is 99% and 100% (Muzaffar, Batool, Aziz, Naqvi, & Rizvi, 2002). However, the time taken to achieve the culture result is quite long (two to eight weeks), which creates a substantial delay in diagnosis and initiation of therapy (American Thoracic Society, 2000). Indonesia has now carried out a Molecular Rapid Test (GeneXpert[®]) to identify Sensitive and Drug-Resistant TB, but the distribution of the equipment was still limited to some hospitals. TB detection and screening models need to be more efficient and effective so that TB can be detected more easily and reliably (Faraid, Handayani, & Esa, 2020).

COVID-19 is a pandemic that may complicate the active finding of tuberculosis (Gunawan, 2020; Tosepu, Effendy, & Ahmad, 2020; Tosepu, Effendy,

Lestari, et al., 2020). According to one study model, if the COVID-19 pandemic triggers a 3-month decrease in the TB detection rate, a rational prediction given a reduction in TB detection will result in an increase of 13 percent in TB deaths, leading to a TB mortality rate like five years ago (Glaziou, 2020). This pushes for more effective and efficient case finding to mitigate the possible growing number due to TB mortality. Our research goal was to identify high TB risk groups in workers. Pulmonary TB in workers was identified by several risk factor variables such as individual factors, environmental factors, behavioral factors, and economic factors.

Methods

Study Design and Setting

A case-control study was conducted to determine the association between individual, environmental, behavioral, and economic factors in TB cases, with a total sample of 120, which 60 were assigned in a control group and a case group. The setting of this study was at the District Public Health Centre (Puskesmas) of South Sumatra, Indonesia.

Sample

Population and sample are employees who work in their respective businesses, each according to the location of the test. We use purposive sampling to identify active cases of TB. The inclusion criteria were active TB cases and willingness to participate in the study, proved by informed consent. The exclusion criteria were workers with lung diseases (pneumonia, pneumothorax, and lung cancer), extrapulmonary tuberculosis, post tuberculosis lung damage, and tuberculosis without acid-fast stain or molecular rapid test result.

Instrument

Primary data were collected from the questionnaire and the medical check-up (MCU), including the acid-fast stain (AFS) smear from the research participants at the respective workplace. Secondary data were obtained from medical records at the workplace clinic, such as X-ray examinations. We then confirmed the diagnosis of TB Molecular Rapid Test using the GeneXpert[®] machine.

Data Analysis

Statistical tests have been performed by using IBM[®] SPSS[®] Statistics version 24. We conducted a univariate and bivariate analysis and presented the

findings on the table. Univariate analysis was performed by showing the proportions of the respondent's characteristics. Bivariate analysis was conducted using a Chi-square analysis to analyze the associations of each factor between TB and non-TB employees and to present the results in proportions, p-values, and odds ratios. $P < 0.05$ was deemed statistically important.

Ethical Consideration

This research was approved by the Institutional Ethical Committee of the Sriwijaya University Faculty of Medicine and the District Public Health Centre.

Results

One hundred twenty-two patients were enrolled in the study. We divided the participants into two groups. Group 1 consisted of 60 workers with active TB, and group 2 consisted of 60 workers with non-TB infection. We identify sociodemographic characteristics of participants such as age, gender, occupation, income, body mass index, smoking history, and a number of cigarettes (each day).

Table 1 Sociodemographic characteristics of respondents

Characteristics	Number	Percent (%)
Age (year)		
15-50	106	88.3
> 50	14	11.7
Sex		
Male	77	64.2
Female	43	35.8
Occupation		
Farmer	10	8.3
Laborer	27	22.5
Entrepreneurs	31	25.8
Employee	36	30.0
Civil Servant	16	13.3
Income		
<=56 million/year	98	81.7
>56 million/year	22	18.3
Body Mass Index		
Under Weight	45	37.5
Over Weight	14	11.7
Normal	61	50.8
Smoking Status		
Yes	71	59.2
No	49	40.8
Number of Cigarette/day		
10-15	9	7.5
5-10	39	32.5
1-5	23	19.2
Don't smoke	49	40.8
Occupancy Density		
Not Eligible	27	22.5
Eligible	93	77.5
Spacious Room		
Not Eligible	65	54.2
Eligible	55	45.8
Ventilation		
Not Eligible	72	60.0
Eligible	48	40.0
Sun Exposure		
Not Eligible	34	28.3
Eligible	86	71.7

As can be seen in Table 1, most of the workers are 15-50 years old ($n=106$), 77 people were male (64.2%), mostly self-employed (30 %), predominantly receiving <56 million rupiahs(US\$ 3,980) annually (87.7%). Majority of worker has normal body mass index (50.8%), and as many as 71 people (59.2 %) are smoking, mostly consuming 5-10 cigarettes per day.

On environmental sanitation, occupancy density and sun exposure in workers environment has met the standard requirement (77.5% and 71.7%, respectively). However, for room space and ventilation, the majority of workers environment did not meet the requirements (54.2% and 60%, respectively).

Table 2 Association of potential risk factors and cases of active TB in workers

	Tuberculosis		Total <i>n</i> (%)	<i>p</i> -value	OR (95% CI)
	Case <i>n</i> (%)	Control <i>n</i> (%)			
Age (year)					
15-50	57 (95.0)	49 (81.7)	106 (88.3)	0.047	4.265 (1.125-16.167)
>50	3 (5.0)	11 (18.3)	14 (11.7)		
Sex					
Male	36 (60%)	41 (68.3)	77 (64.2)	0.446	0.695 (0.326 -1.472)
Female	24 (40%)	19 (31.7)	43 (35.8)		
Body mass index					
Underweight	30 (50.0)	15 (25.0)	45 (37.5)	0.013	-
Overweight	7 (11.7)	7 (11.7)	14 (11.7)		
Normal	23 (38.3)	38 (63.3)	61 (50.8)		
Occupation					
Farmer	1 (1.7)	9 (15.0)	10 (8.3)	0.011	-
Laborer	9 (15.0)	18 (30.0)	27 (22.5)		
Trader	19 (31.7)	12 (20.0)	31 (25.8)		
Employee	22(36.7)	14 (23.3)	36 (30.0)		
Civil Servant	9 (15.0)	7 (11.7)	16 (13.3)		
Income					
<56	53 (88.3)	45 (75.0)	98 (81.7)	0.099	-
>56	7 (11.7)	15 (25.0)	22 (18.3)		
Smoking status					
Yes	36 (60.0)	35 (58.3)	71 (59.2)	1.000	1.071 (0.517-2.219)
No	24 (40.0)	25 (41.7)	49 (40.8)		
Number of cigarette/day					
10-15	7 (11.7)	2 (3.3)	9 (7.5)	0.271	
5-10	18 (30.0)	21 (35.0)	39 (32.5)		
1-5	13 (21.7)	10 (16.7)	23 (19.2)		
0	22 (36.7)	27 (45.0)	49 (40.8)		
Occupancy density					
Not Eligible	17 (28.3)	10 (16.7)	27 (22.5)	0.190	1.977 (0.819-4.771)
Eligible	43 (71.7)	50 (83.3)	93 (77.5)		
Spacious room					
Not Eligible	35 (58.3)	30 (50.0)	65 (54.2)	0.464	1.400 (0.681-2.878)
Eligible	25 (41.7)	30 (50.0)	55 (45.8)		
Ventilation					
Not Eligible	37 (61.7)	35 (58.3)	72 (60.0)	0.852	1.149 (0.553-2.387)
Eligible	23 (38.3)	25 (41.7)	48 (40.0)		
Sun exposure					
Eligible	24 (40.0)	10 (16.7)	34 (28.3)	0.008	3.333 (1.420-7.823)
Not Eligible	36 (60.0)	50 (83.5)	86 (71.7)		
Total	60 (100.0)	60 (100.0)	120 (100.0)		

Table 2 summarize associated risk factors with cases of active TB in workers. We conducted a Chi-square analysis to examine the association between specific risk factors and the development of active TB cases. Upon further analysis, age ($p=0.047$, $OR=4.265$), body mass index ($p=0.013$), occupation ($p=0.011$), and sun exposure ($p=0.008$) are significantly associated with cases of active TB infection.

Discussion

In this study, we found a significant association between age and the cases of active TB in workers with 15-50 years old group has a higher risk of contracting active TB. According to the Indonesian Ministry of Health, following WHO, this age group the productive age for work (15-64 years) (Wisnumurti, Darma, & Suasih, 2018; World Health Organization, 2015). If an individual suffers from pulmonary tuberculosis, this will result in a significant income loss (16–94%), with total costs of \$55 to \$8198 (Tanimura, Jaramillo, Weil, Raviglione, & Lönnroth, 2014).

We did not find an association between sex and active TB cases in this study. This finding is supported by research conducted by Widjanarko, Gompelman, Dijkers, and van der Werf (2009), which is showing no substantial correlation between sex and TB cases ($p=0.696$). Sex is not a risk factor for the occurrence of pulmonary TB since both men and women have equal opportunities for outdoor activities such as work, community engagements, and religious activities lead to an equal risk of developing the disease (Sahiratmadja & Nagelkerke, 2011).

There is a significant association found between BMI and cases of TB. This is supported by a previous study that found a significant difference between BMI of tuberculosis patients with positive acid-fast stain and negative acid-fast stain. This difference indicates that the BMI of tuberculosis patients with negative acid-fast stains is higher than that of tuberculosis patients with positive acid-fast stains (Lazulfa, Wirjatmadi, & Adriani, 2016). Another potential explanation to clarify our results is how nutritional status influences the immune system. Healthy nutritional status can improve the strength of

the immune system and vice versa (Effendy, Prangthip, Soonthornworasiri, Winichagoon, & Kwanbunjan, 2020; Venter, Eyerich, Sarin, & Klatt, 2020). Tuberculosis is an infectious disease that weakens the immune system as a consequence (Kumar, 2016).

A significant association has been established between the occupation and the incidence of active TB in workers. In support of this result, a previous study has found a strong correlation between the type of work performed and TB incidence in Central Java. Male respondents who work as entrepreneurs have a 2.84-fold risk of TB compared to freelancers, and female respondents who work as employees have a 5.99-fold risk of TB compared to freelancers (Suharjo & Girsang, 2015).

There is no significant association between smoking history and cases of active TB. This result is in line with the previous research that found no significant relationship between smoking habits and the incidence of pulmonary tuberculosis (Ernawati, 2017; Padrão, Oliveira, Felgueiras, Gaio, & Duarte, 2018). However, contrary to our finding, a previous study found a significant association between smoking and the incidence of pulmonary TB relapse (Jaya & Mediarti, 2017).

Smoking plays an important role in the occurrence of pulmonary TB, as viewed from a variety of existing hypotheses. Cigarette particles and the chemicals they produce play a role in inflaming the airways that activate the tumor necrosis factor-alpha (TNF- α), interleukin-6 (IL-6), cytokines IL-8, activation of the nuclear factor (NF- $\Delta\beta$), and lipid peroxidation. These compounds have a pro-inflammatory ability, which causes oxidative damage to the lungs (ÇALIŞ, 2014). The process of pulmonary TB infection by *M.tuberculosis* usually occurs by inhalation, so that transmission takes place through inhalation of bacilli containing droplet nuclei containing acid-resistant bacteria (BTA) (Nardell, 2016). Possible mechanisms for the effects of TB infection in response to smoking are mucociliary clearance dysfunction, decreased alveolar macrophage activity, immunosuppression in pulmonary lymphocytes, NK (Natural Killer) cell inactivation, and pulmonary dendritic cell dysfunction (Chuang et al., 2015).

We also did not find an association between the number of cigarettes per day and active TB cases in workers. The particles contained in cigarette smoke can affect the mucociliary system. These cigarette smoke particles will also settle on the mucus layer of the respiratory system, which increases irritation to the bronchus epithelium and can easily develop diseases, especially tuberculosis. The different results found in this study could be attributed to the fact that the respondents studied had smoked but quit when exposed to pulmonary TB and did not smoke again (Widyasari, 2012).

We did not find a significant association between occupancy density and cases of active TB. The result is in accordance with a previous study in Hong Kong by (Chan-Yeung et al., 2005) and Ethiopia by (Shaweno, Shaweno, Trauer, Denholm, & McBryde, 2017). The density determined by the Indonesian Ministry of Health in 2000 is the ratio of the floor area of all rooms divided by the number of occupants at least 10m² / person. The minimum bedroom area is 8m² and it is not recommended to have more than two people sleeping in the bedroom, except for children under five years. High occupancy density will greatly influence the risk of TB disease transmission (Beggs, Shepherd, & Kerr, 2010)

We did not find a significant association between ventilation and cases of active TB. In the previous study conducted in Surabaya, ventilation was also not correlated with the TB cases (Lestari, Sustini, Endaryanto, & Asih, 2011). Lack of ventilation is associated with an increase in indoor air humidity due to the trapping of steam-water resulting from the evaporation of liquids from the skin or moisture absorption from outside the home. Humid home environments can be a good medium for the growth of pathogens, including TB bacteria, which have the ability to survive in dark and humid spaces (Madhona, Ikhwan, & Aminin, 2016).

We found a significant association between sunlight exposure to cases of active TB. This result is in line with a study stating that after 28 years time course, increased sunshine is correlated with lower notification of TB cases (Koh, Hawthorne, Turner, Kunst, & Dedicoat, 2013). Meanwhile, an ecological study in 154 countries has shown that countries with higher UV-B exposure levels had significantly lower TB cases (Boere, Visser, Van Furth, Lips, & Cobelens, 2017). Therefore, a house with bad

lighting standards greatly affects the incidence of tuberculosis. Tuberculosis germs can survive in a cool, humid, and dark place without sunlight for years and die when exposed to sunlight (Madhona et al., 2016).

Our study has some limitations. Due to the nature of case-control studies, it is impossible to make causal inferences and only correlation based on our aforementioned data. Our data is also subject to recall bias due to collecting data with the questionnaire. We also recognize the possibility of unidentified confounding factors that may complicate our finding.

Conclusion

In conclusion, there is a significant association between age, occupation, BMI, and active tuberculosis. Environmental sanitation factors that serve as risk factors include sunlight exposure. Case-finding approaches need to be improved in endemic regions and can be accomplished by identifying the associated risk factor. The TB control program should also highlight associated variables for the reduction of TB incidents, particularly in poor living conditions. Future studies can consider assessing the long-term effects, cost-effectiveness, and feasibility of incorporating associated variables as a national scale approach. Current research has provided data on which variables are required for early detection and prompt treatment, especially during the COVID-19 pandemic, which has a massive impact on the Tuberculosis Settlement Program.

Declaration of Conflicting Interest

The authors declare no conflict of interest in this study.

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Authors' Contribution

Tri Hari Irfani, Agita, Diora Fitri, Eddy Roflin, and Reynold Sibirian contributed to study conception and design, data acquisition, analysis and interpretation of data, drafted manuscript, and critical revision. Tungki Pratama Umar contributed to study conception and design, analysis and interpretation of data, drafted

manuscript, and critical revision. All authors agreed with the final version of the article.

Authors Biographies

dr. Tri Hari Irfani, MPH, Agita Diara Fitri, and Eddy Roflin are Lecturers at the Public Health Department, Faculty of Public Health, Sriwijaya University, Indonesia.

Reynold Siburian and Tungki Pratama Umar are Medical Profession Students at the Faculty of Medicine, Universitas Sriwijaya, Indonesia.

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