

Ecological Analysis of the Prevalence of Pulmonary Tuberculosis in Indonesia

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Abstract

Background: Previous studies have found that the potential loss of pulmonary tuberculosis is relatively high. The study aimed at analyzing ecologically the factors related to the prevalence of pulmonary tuberculosis in Indonesia.

Methods: Ecological analysis conducted using secondary data from the Ministry of Health of the Republic of Indonesia report in 2018. All provinces take as samples. Apart from pulmonary tuberculosis, five other variables analyzed as independent variables were smokers' percentage and adequate ventilation. Percentage of proper lighting, the rate of poor people, and the portion of the population completing primary education. Data were analyzed using a scatter plot.

Results: The study results found that the higher the percentage of smokers in a province, the higher the prevalence of pulmonary tuberculosis. The higher the percentage of adequate ventilation in an area, the lower the prevalence of pulmonary tuberculosis. The higher the rate of sufficient lighting in a province, the lower the prevalence of pulmonary tuberculosis. Meanwhile, the higher the percentage of poor people in a region, the higher the prevalence of pulmonary tuberculosis. Finally, the higher the portion of the population completing primary education in a province, the lower the prevalence of pulmonary tuberculosis.

Conclusion: It concluded five independent variables analyzed were related to Indonesia's prevalence of pulmonary tuberculosis.

Keywords: *pulmonary tuberculosis, ecological analysis, sanitation.*

Introduction

Pulmonary tuberculosis is a contagious disease that is caused by *Mycobacterium tuberculosis*. These microorganisms affect not only the lungs but can also be other organs sites (extrapulmonary tuberculosis). According to the World Health Organization (WHO), eight countries accounted for two-thirds of the global total, including Indonesia (8.5%). The other 22 other countries in WHO's 30 high tuberculosis burden

countries accounted for 21% worldwide. Several countries have increased the number of individuals nearly fully diagnosed with tuberculosis in 2013. India and Indonesia, the two countries that rank first and second worldwide in terms of reported incident cases per year, were the most generous contributors to the global rise¹.

Indonesia had reported an incidence of 845,000 in 2018 and estimated mortality of 93,000 cases of tuberculosis. Tuberculosis is the fourth-largest cause of death in Indonesia overall. It is the number one cause of death from infectious disease among Indonesians aged 15 to 49.3 in 2018; only 558,865 (67%) of the 845,000 estimated tuberculosis cases were registered².

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While tuberculosis services are free, recent evidence showed that the costs incurred during the treatment process represent more than three-quarters of the overall treatment cost³. Tuberculosis, widely regarded as a poverty epidemic, challenges domestic and individual economic growth in Indonesia. Tuberculosis is the third leading cause of death and leads to disability-adjusted life years (DALYs) years in Indonesia⁴.

The prevalence of tuberculosis disease is among HIV seropositive patients. It was much more significant (because to weaken the immune system), and is also higher in individuals who smoke, have diabetes, is malnourished, and consume alcohol in excess⁵. The implications of tuberculosis on individuals are very complex and affect physical health and social, economic, and psychological well-being⁶. Since it involves age group economically, active households have been adversely impacted, including social effects (including loss of work, divorce, separation of family members and local communities, and loss of housing)⁷. While the doctor can cure TB patients, due to life-long sequelae, their quality of life decreases significantly⁸.

The burden of tuberculosis varies according to several variables, including age, sex, location, HIV status, and drug resistance status. Furthermore, when examining tuberculosis patterns, these factors need to be taken into consideration. Besides, in many regions, the burden of disease changes from infectious diseases to non-communicable conditions in line with sociodemographic growth⁹⁻¹¹. This study aimed to ecologically examine the factors associated with the prevalence of pulmonary tuberculosis in Indonesia.

Materials and Methods

Study Design

The design of the study used an ecological analysis

approach. Ecological studies focus on a comparison between groups, not individuals. The data analyzed are aggregated data at a specific group or level, at the provincial level in this study. Aggregate measurements, environmental measurements, or global measurements may be variables in ecological analysis. The ecological analysis aim in epidemiology is to make biological inferences about the effects on individual risks or make ecological inferences about the impact on groups^{12,13}.

Data Source

The study conducted using secondary data from the 2018 Indonesia Basic Health Survey report and the 2018 Data and Information of Indonesia Health Profile. Both pieces are officially issued by the Ministry of Health of the Republic of Indonesia. The unit of analysis in this study is the province. The study analyzed all provinces in Indonesia (34 areas).

Data Analysis

The dependent variable in this study was the prevalence of pulmonary tuberculosis. The study only records pulmonary tuberculosis based on the history of the doctor's diagnosis (specialist and general practitioner)¹⁴. There were five independent variables analyzed in this study that describe behavioral factors (percentage of the smoker), sanitation (percentage of adequate ventilation and rate of proper lighting), and demography (percentage of poor people and grade of the population completing primary education).

The data were analyzed by univariate and bivariate. Bivariate analysis performed using a scatter plot. The research used a linear fit line to determine the relationship between pulmonary tuberculosis prevalence and the independent variable. The entire analysis process uses SPSS 21 software.

Table 1. The data source of the ecological analysis of the prevalence of pulmonary tuberculosis in Indonesia

Source	Variables	Note
The 2018 Indonesia Basic Health Survey	Prevalence of pulmonary tuberculosis	
	Percentage of smoker	Smoker every day and sometimes
	Percentage of adequate ventilation	Main room sanitation
	Percentage of adequate lighting	Main room sanitation
The 2018 Data and Information of Indonesia Health Profile	Percentage of poor people	Recorded in September 2018
	Percentage of the population completing primary education	Graduated from Junior High School

Ethical Approval

The study conducted using secondary data from published reports. Ethical clearance is therefore not required in the conduct of this study.

Results**Table 2. Statistics descriptive of variables of the ecological analysis of the prevalence of pulmonary tuberculosis in Indonesia**

Statistics Descriptive	Prevalence of pulmonary tuberculosis	Percentage of smoker	Percentage of adequate ventilation	Percentage of adequate lighting	Percentage of poor people	Percentage of the population completing primary education
N	34	34	34	34	34	34
Mean	0.381	28.074	53.397	75.4412	10.608	76.747
Median	0.360	28.100	54.100	76.850	8.905	77.555
Mode	0.39	25.30a	38.10a	65.80a	3.55a	57.09a
Std. Deviation	0.151	2.425	7.731	6.465	5.703	6.173
Variance	0.023	5.881	59.774	41.792	32.529	38.104
Range	0.68	8.50	27.90	30.20	23.88	29.29
Minimum	0.09	23.50	38.10	55.90	3.55	57.09
Maximum	0.77	32.00	66.00	86.10	27.43	86.38

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

Table 2 provides descriptive statistics of the prevalence of pulmonary tuberculosis and other variables analyzed in this study. The information presented in Table 2 shows a very high variation between provinces. The lowest prevalence of pulmonary tuberculosis reached 0.09% (Bangka Belitung Province). Meanwhile,

the highest prevalence of 0.77% was in Papua Province.

Figure 1 shows a map of the prevalence of pulmonary tuberculosis by the province in Indonesia. Based on this spatial information, the majority of pulmonary tuberculosis tends to be higher in eastern Indonesia.

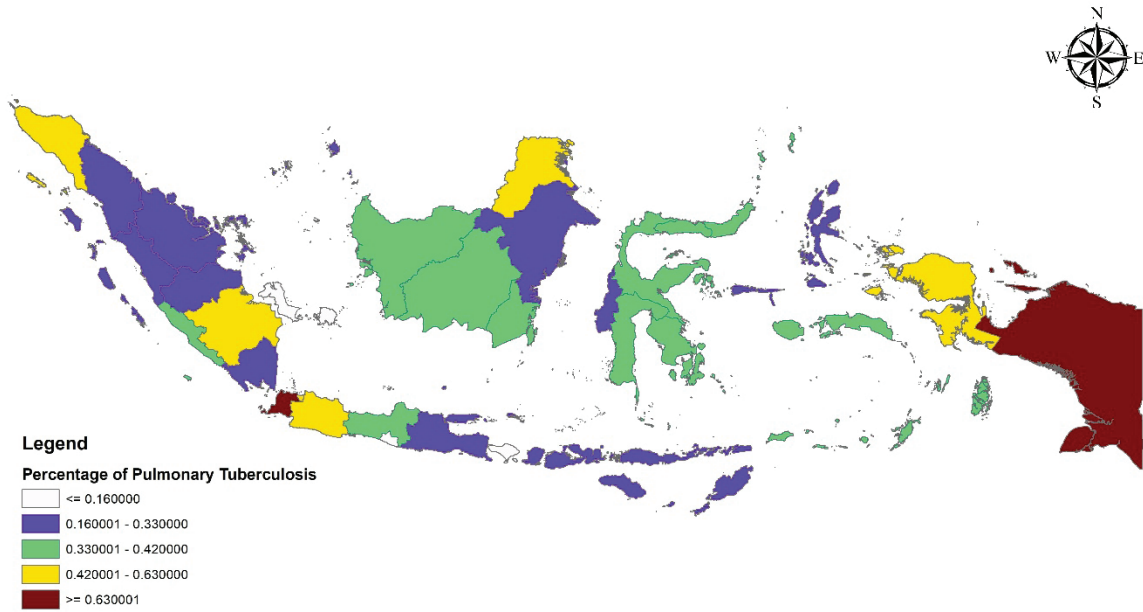


Figure 1. Map of the Prevalence of Pulmonary Tuberculosis by Province in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey

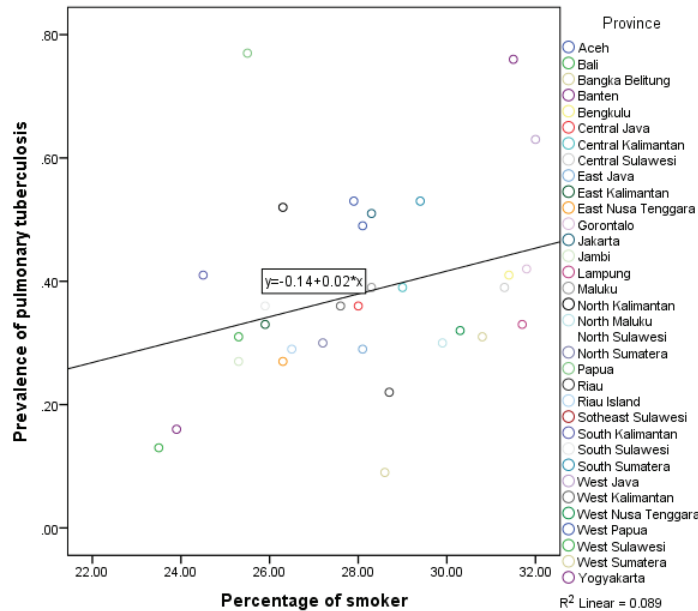


Figure 2. Scatter Plot of the Prevalence of Pulmonary Tuberculosis and the Percentage of Smoker in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

Figure 2 is a scatter plot between the prevalence of pulmonary tuberculosis and the percentage of smokers in Indonesia. The figure shows the relationship between the two variables shows a positive trend. The situation means that the higher the percentage of smokers in a province, the higher the prevalence of pulmonary tuberculosis.

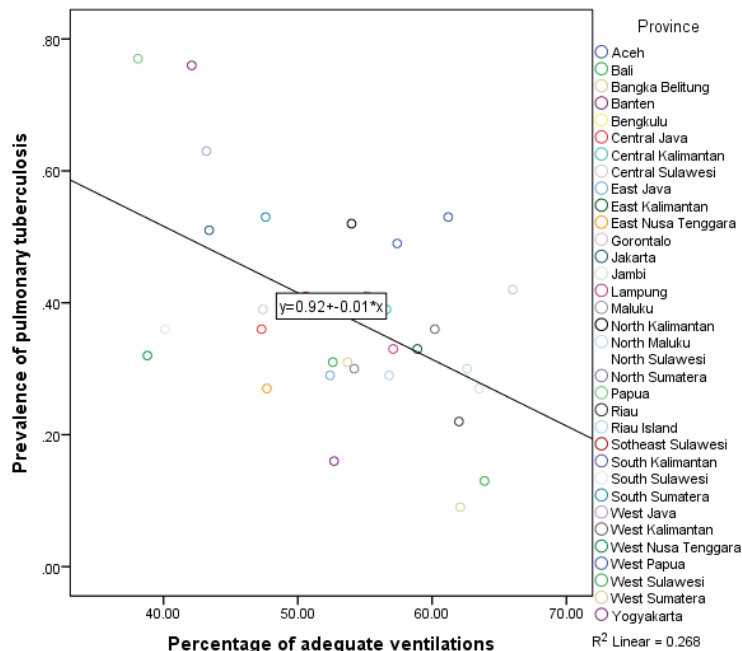


Figure 3. Scatter Plot of the Prevalence of Pulmonary Tuberculosis and the Percentage of Adequate Ventilation in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

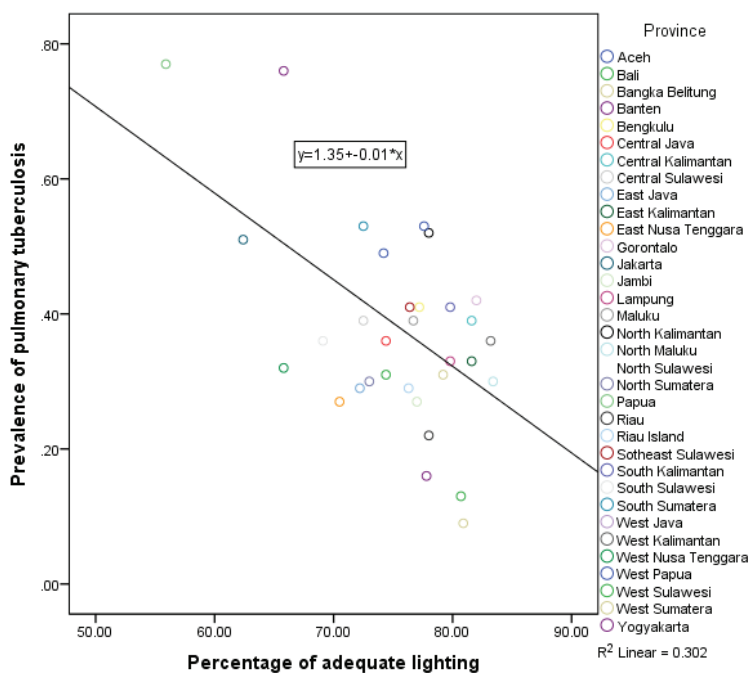


Figure 4. Scatter Plot of the Prevalence of Pulmonary Tuberculosis and the Percentage of Adequate Lighting in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

Figure 3 shows the scatter plot results between pulmonary tuberculosis prevalence and the percentage of adequate ventilation in Indonesia. The figure shows the relationship between the two variables indicates a negative trend. It means that the higher the rate of sufficient ventilations in a province, the lower the prevalence of pulmonary tuberculosis.

Figure 4 is a scatter plot between the prevalence of pulmonary tuberculosis and the percentage of adequate lighting in Indonesia. The relationship between the two variables shows a positive trend. The higher the rate of proper lighting in a province, the lower the prevalence of pulmonary tuberculosis.

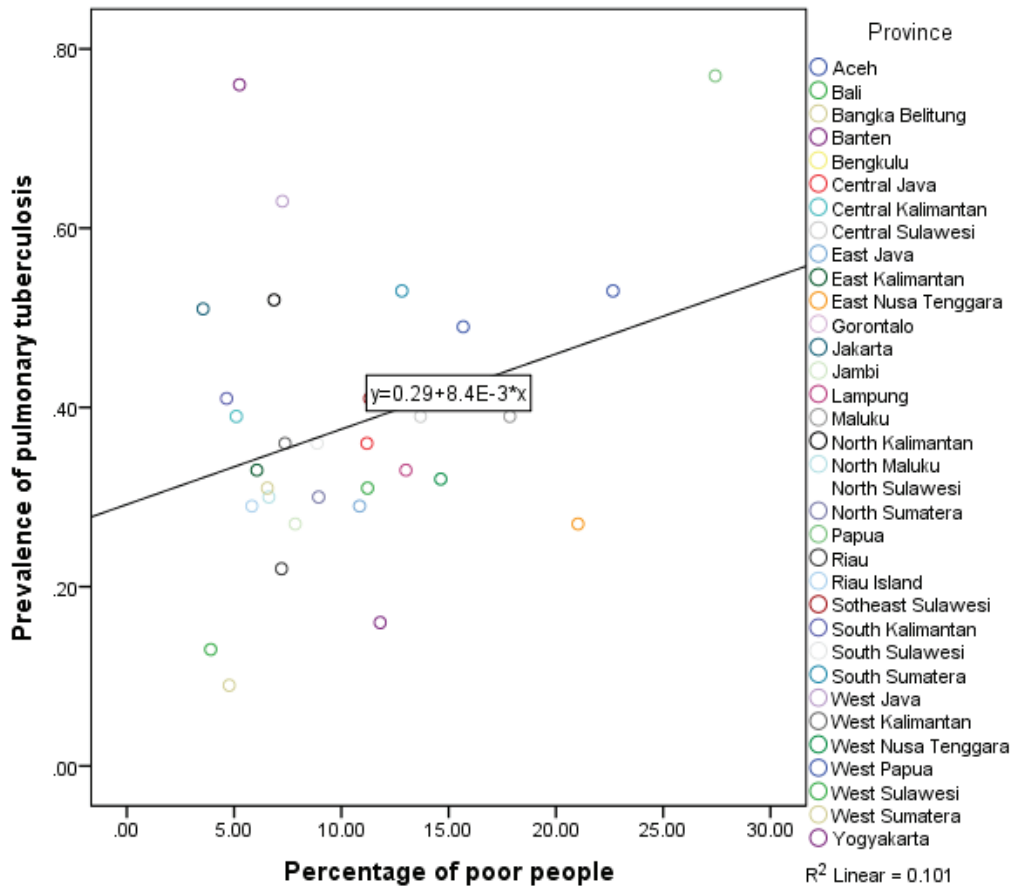


Figure 5. Scatter Plot of the Prevalence of Pulmonary Tuberculosis and the Percentage of Poor People in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

Figure 5 shows a scatter plot between the prevalence of pulmonary tuberculosis and the percentage of poor people in Indonesia. It shows the relationship between the two variables shows a positive trend. It means that the higher the rate of poor people in a province, the higher the prevalence of pulmonary tuberculosis.

Figure 6 shows a scatter plot between pulmonary tuberculosis prevalence and the population's percentage completing primary education in Indonesia. The figure shows the relationship between the two variables shows a positive trend. It means that the higher the portion of the population completing primary education in a province, the lower the prevalence of pulmonary tuberculosis.

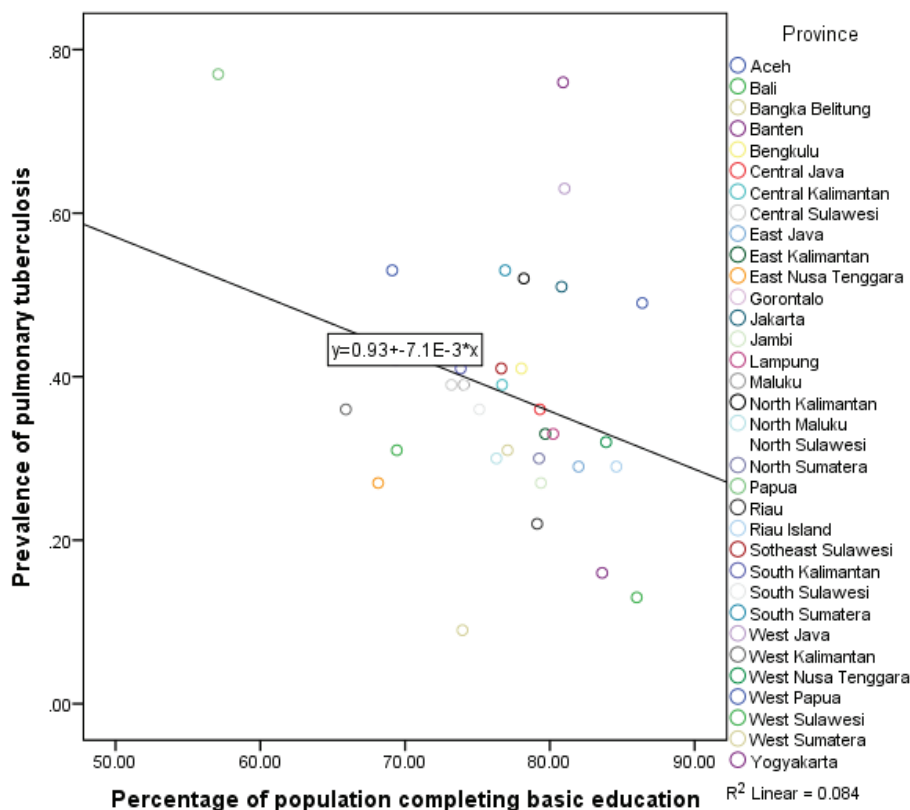


Figure 6. Scatter Plot of the Prevalence of Pulmonary Tuberculosis and the Percentage of Population Completing Basic Education in Indonesia, 2018

Source: The 2018 Indonesia Basic Health Survey and The 2018 Data and Information of Indonesia Health Profile

Discussion

The results showed that spatially the prevalence of pulmonary tuberculosis tended to be higher in eastern Indonesia. The information displayed in this spatial analysis is consistent with the development trends in Indonesia in general. Health development in Eastern Indonesia tends to lag behind other regions in Indonesia^{15,16}. The ongoing inequality was allegedly a result of insufficient resource input¹⁷.

Analysis using a scatter plot informed a positive relationship between smokers’ percentage in a province and pulmonary tuberculosis prevalence. The higher the percentage of smokers in a region, the higher the prevalence of pulmonary tuberculosis in that province. The results of this study indicate that smoking is a risk factor for pulmonary tuberculosis. Consistent

with Malaysia’s research results, as many as 83.1% were associated with pulmonary tuberculosis among smokers¹⁸. Similarly, a study in South Tangerang City showed a significant relationship between smoking and the incidence of pulmonary tuberculosis, with 3.44 times greater risk in cases than in controls¹⁹. Smoking is a risk factor for tuberculosis infection and tuberculosis disease growth and is estimated to cause an additional 18 million tuberculosis cases by 2050^{20–22}.

The different analysis results found that the higher the percentage of adequate ventilation in a province, the lower the prevalence of pulmonary tuberculosis. These results indicate a relationship between ventilation and the incidence of pulmonary tuberculosis. The ventilation that meets the requirements is >10% of the floor area, the lower the chance of pulmonary tuberculosis²³. Tuberculosis is an airborne disease transmitted by an induced infectious aerosol from patients during coughing²⁴. In an indoor space, except for the indoor air that is continuously replaced by fresh outside air with

ventilation, aerosol transmission can accumulate and put everyone in the room at risk. Lousy ventilation is related to an increased risk of skin testing for tuberculin (TST) conversion²⁵.

Meanwhile, the higher the percentage of adequate lighting in a province, the lower the prevalence of pulmonary tuberculosis. The better the quality of lighting in the house, the less likely the incidence of pulmonary tuberculosis. These results align with Eastern Ethiopia research; places' lighting status associate with pulmonary tuberculosis²⁶. Persistent with Aceh Besar District's findings, there was a significant correlation between the lighting condition and pulmonary tuberculosis incidence. Respondents who had poor lighting conditions were more likely at risk of 1,056 times infected pulmonary tuberculosis than respondents with good lighting²⁷. House environment is a risk factor for pulmonary tuberculosis incidence, including room ventilation, humidity, temperature, lighting, floor type, and occupancy density^{28,29}.

On the other hand, information from the research results found that the higher the percentage of poor people in a province, the higher the prevalence of pulmonary tuberculosis. This study results in line with a lesson in sub-Saharan Africa. Low education, unemployment, poor salaries, poverty, smoking, and alcohol use positively correlated with pulmonary tuberculosis³⁰. The previous study in Bandar Lampung, which aimed to predict tuberculosis transmission based on socioeconomic position determinants, also revealed that socioeconomic status impacted housing determinants and determinants of housing on tuberculosis transmission³¹. Low socioeconomic status leads to an increased risk of tuberculosis and adverse tuberculosis treatment outcomes³².

Finally, the analysis results inform that the higher the percentage of the population completing primary education in a province, the lower the prevalence of pulmonary tuberculosis. The respondents' education level affects the incidence of pulmonary tuberculosis, the higher the level of education, the lower the incidence of pulmonary tuberculosis. Similar to the result in Semarang revealed most of the tuberculosis patients' education level was relatively low. Many people only

finished elementary school, where adequate tuberculosis education has been challenging³³. Other study results in European countries also showed that people with higher education levels had lower mortality rates. The study found significant disparities in rural and urban areas according to education level³⁴. The socioeconomic status, an individual's relative position in society, is defined by the degree of education obtained (usually completed in early adulthood) by work carried out during adult life, with income received and wealth accrued in a person's lifetime³⁵.

Several studies found better education to be a positive determinant of performance output in the field of health³⁶⁻³⁸. This situation is associated with a better understanding of health risks. On the other hand, poor education is a barrier to higher-quality performance output in the health sector³⁹⁻⁴¹.

The research conducted using an ecological analysis approach has limitations in its use as a policy basis because the data used are aggregated data at the provincial level. Further study at the individual level is needed to obtain more accurate information on intervention policy choice.

Conclusion

The study results concluded the five independent variables analyzed ecologically are related to the prevalence of pulmonary tuberculosis in Indonesia. The five variables are the smoker percentage, percentage of adequate ventilation, percentage of proper lighting, rate of poor people, and percentage of the population completing primary education.

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Source of Funding: Self-funding

Ethical Clearance: The study conducted using secondary data from published reports. Ethical clearance is therefore not required in the conduct of this study.

Conflicting Interests: Nil

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