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Prediction of pulmonary tuberculosis incidence based on epidemiological triad as a preventive measure

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ABSTRACT

The decline in the incidence of tuberculosis to date still looks very slow, although some efforts have been made to improve case identification and treatment adherence. This study aimed to assess the factors associated with the incidence of pulmonary tuberculosis. The research design for this study was observational analytical with a cross-sectional design. A total of 830 people suspected of tuberculosis, aged over 15 years, and not drug-resistant were selected by simple random sampling. Overall, 59.9% of people are infected with pulmonary tuberculosis. There was a significant association between age (p=0.002) (OR=1.69; 95% CI: 1.22, 2.35), smoking behavior (p=0.000) (OR=2.3; 95% CI: 1.67, 3.30), temperature (p=0.000) (OR=4.2; 95% CI: 2.84, 6.47), humidity (p=0.000) (OR=6.7; 95% CI: 4.69, 9.77), lighting (p=0.000) (OR=4.174; 95% CI: 2.94, 5.92) and incidence of pulmonary tuberculosis. The study showed that tuberculosis was more common among productive age and smokers living in homes with unqualified temperature, humidity, and lighting. Room humidity is the most associated factor with the incidence of pulmonary tuberculosis. Therefore, education on the importance of paying attention to the physical environment of the house to avoid pulmonary tuberculosis is highly recommended.

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1. INTRODUCTION

Tuberculosis remains a major public health problem in the world, despite efforts made to improve case identification and treatment adherence. It is the single highest contagious killer that can be cured in the world today. It is the leading cause of health disorders among millions of people every year in the world and ranks second in the cause of death from infectious diseases, after the human immunodeficiency virus (HIV). Based on the latest estimates of the World Health Organization (WHO), there were 10 million people recorded as having tuberculosis in 2019, and 1.2 million increased due to the disease [1].

Tuberculosis is a disease that attacks the lungs and is transmitted from person to person through droplets. More than 90% of people infected with tubercle bacillus will not develop into tuberculosis (TB) disease. Those at risk of developing the disease after infection with tubercle bacillus include malnourished

individuals and those with poor immune defenses, such as HIV-infected people, people with diabetes, alcoholics, leukemia patients, and patients receiving immunosuppressive therapy [2].

Indonesia ranked the second highest in tuberculosis cases globally [1]. The confirmed tuberculosis cases in 2019 totaled 543,874 cases, a decrease compared to the number of confirmed cases in 2018 of, 566,623 cases [3]. West Java Province contributed 109,463 TB cases in 2019, with a success rate in all instances of 79,943 patients (85.8%). Bandung was West Java's second-largest contributor to pulmonary tuberculosis. With a case notification rate (CNR) of 477 per 100,000 people, Bandung City has 11,959 cases of pulmonary tuberculosis. The rise of crowded and slum areas, low-health living patterns, and a reduction in environmental health quality were all risk factors for high cases of pulmonary tuberculosis in urban places like Bandung City. At the Bandung City Health Office, a preliminary study was undertaken. Tuberculosis officials indicated that the high case of tuberculosis was likely attributable to a densely populated environment, where a substantial number of households did not match healthy housing standards. Furthermore, studies of the community's home environment revealed densely packed settlements, residential dwellings stacked against each other, and even the terraced roofs of each house touching each other, obstructing sunlight from reaching the streets. Researchers observed that the air inside three residences of pulmonary tuberculosis patients felt stuffy, that the house lights had to be turned on when talking in the living room, and that the house windows did not open.

The decline in tuberculosis incidence to date still looks very slow, so there is new interest in finding new strategies for tuberculosis control. The management focus is strategies such as supplementing existing tuberculosis drugs, finding tuberculosis vaccines, and designing shorter specific treatment protocols (regimens). Because of the emphasis on control, the focus on prevention needs to be improved. However, some studies have helped refocus the search for tuberculosis prevention strategies in the new public health. Reported tuberculosis risk factors include sociodemographic and environmental factors, such as disease history, heredity, education, age, gender, psychic state, and endurance, HIV infection, comorbidities such as diabetes, tuberculosis contact history, absence of Bacillus Calmette Guerin (BCG) scars, smoking, alcohol use, single-marriage status, overcrowding, and poor socioeconomics [2], [4]–[7]. The environment is the next consideration, and climate and air quality are potential regulators of TB events [8]. Another study looking at environmental factors and cases of pulmonary tuberculosis found that temperature, humidity, and lighting were important factors in tuberculosis transmission [9].

With the increasing trend of TB, especially affecting developing countries, there is a need to re-examine the characteristics of patients and understand the contributing factors, to adjust and adapt TB control policies. Indonesia's National TB program has supported ongoing public education campaigns through the media about TB symptoms, ways of transmission, the importance of seeking treatment, the risk of multidrug resistant tuberculosis (MDR-TB), and the fact that TB can be cured. To further enhance the struggle, the government has also made many efforts to ensure the availability of adequate medicines and adequately trained staff in all government hospitals and selected missions. However, current efforts to find, treat, and cure everyone sick with the disease are not enough. Therefore, this study aimed to establish the main risk factors and risk factors that contribute to the increase in the incidence of TB. The findings in this study will help the government in an effort to improve the policy and planning for TB prevention and control in Indonesia.

2. METHOD

Observational analytical and cross-sectional designs were the research methods used. By concurrently making observations and at the same time, cross-sectional was used to analyze a relationship between the cause of illness risk and the cause of health problems. This study took place in Bandung City, especially in the three districts with the highest deaths, namely Kiaracondong (20 deaths), Batununggal (15 deaths), and Andir (13 deaths) from January to Mei 2022. Ethical clearance was issued by the Health Research Ethics Committee, Emmanuel School of Health Sciences Bandung, with ethical approval number 132/KEPK/STIKI/VII/2022. All respondents already signed informed consent for the study.

The dependent variable was the pulmonary tuberculosis case categorized into acid-resistant bacterial pulmonary tuberculosis (BTA+/positive for acid fast bacteria) and (BTA-/negative for acid fast bacteria), where data was retrieved from the patient's medical record data. The host factor: are age, gender, and education. There were two types of smoking behavior: smoking and non-smoking. When the respondent stayed in the same house as a tuberculosis patient, the history of household contact was classified as contacted; meanwhile, if the respondent did not live in the same place as a tuberculosis patient. Environmental considerations: temperature, humidity, lighting.

The population in this study was all male and female tuberculosis suspects. The sample size is calculated using the sample size formula for a one-sample test of proportion (level of significance 5%, power 90%). Inclusion criteria include age over 15, patients suspected of tuberculosis, drug-sensitive tuberculosis,

and cooperation and willingness to participate in the study by signing informed consent. Exclusion criteria include drug-resistant tuberculosis. This study included persons with probable tuberculosis who had laboratory tests and were reported in the Public health Center's tuberculosis report. The research sample consisted of 830 people who were chosen at random from a pool of 830 people who were on regular therapy. Questionnaires, thermal hygrometer observation sheets, and lux meters were among the tools employed.

Univariate analysis was performed to obtain an idea of the frequency distribution of each research variable, and bivariate analysis used the Chi-square test and Fisher's exact probability test to assess the relationship between research variables. Multivariate analysis used multiple logistic regression to evaluate relationships (age, gender, education, smoking behavior, household contact history, temperature, humidity, and lighting) and incidence of pulmonary tuberculosis. Multiple logistic regression tests were used to assess the variables most associated with the incidence of pulmonary tuberculosis-statistical analysis using the established significance level $p<0.05$).

3. RESULTS AND DISCUSSION

Less than half of the respondents in the study were in the at-risk group (47.2%), and the majority were female (55.9%), well-educated (63.3%), and had a household contact history (57.1%). More than half of the respondents were smokers (54.3%). The results of room temperature measurements are mostly qualified (70.1%), the results of air humidity measurements are mostly unqualified (64.7%), and the effects of room lighting measurements are declared unqualified by more than half (66.6%). Dietary factors and environmental factors related to the development of pulmonary tuberculosis are age (p=0.004), smoking behavior (p=0.000), temperature (p=0.000), humidity (p=0.000), and lighting (p=0.000) are statistically significantly related to pulmonary tuberculosis in the bivariate analysis as presented in Table 1. For multivariate analysis, all variables were substantially considered to play an important role in the transmission of pulmonary tuberculosis, so all study variables were included in multivariate logistic regression.

Table 1. Relationships between host's factors, environmental factors, and pulmonary tuberculosis incident

Risk factors	Pulmonary tuberculosis's case				p-value	POR (95% CI)
	BTA+		BTA-			
	n	%	n	%		
Age						
Risky	235	59.9	157	40.1	0.004	1.1511 (1.147-1990)
No risk	218	49.8	220	50.2		
Gender						
Male	189	51.6	177	48.4	0.150	0.809 (0.614-1.065)
Female	264	56.9	200	43.1		
Education						
Low	173	56.7	132	43.3	0.383	1.147 (0.863-1.524)
High	280	53.3	245	46.7		
Smoking behaviour						
Smoking	293	65.0	158	35.0	0.000	2.538 (1.916-3.362)
No smoking	160	42.2	219	57.8		
Household contact history						
Contact	265	55.9	209	44.1	0.414	1.133 (0.860-1.493)
No contact	188	52.8	168	47.2		
Temperature						
>70%	178	71.8	70	28.3	0.000	2.839 (2.060-3.913)
40-70%	275	47.3	307	52.7		
Humidity						
Ineligible	362	67.4	175	32.6	0.000	4.592 (3.380-6.237)
Eligible	91	31.1	202	68.9		
Lighting						
Ineligible	351	63.5	202	36.5	0.000	2.981 (2.210-4.021)
Eligible	102	36.8	175	63.2		

Humidity is most closely related to the incidence of pulmonary tuberculosis, with an Exp(B) of 6,774, as shown in Table 2. Humidity is 6.6 times more likely to affect the incidence of pulmonary tuberculosis. The resulting model satisfies the meaning of the model; This can be seen from the P value of the omnibus test ($p<0.05$). In a study conducted in Bangladesh, the risk of increased incidence of the highest tuberculous occurred at an average temperature of 72.2% (RR=1.26) [10]. Study in Chinese found that relative humidity (69%) can increase the risk of tuberculosis [11]. Another study in Indonesia found that the dominant factor in the incidence of tuberculosis is humidity. Houses that have ineligible humidity are at risk of developing tuberculosis by 3.1 times compared to houses that have sufficient humidity [12]. Another study in Semarang found that people living in homes with ineligible humidity are more at risk of contracting

pulmonary tuberculosis than those living in homes with qualified temperatures (OR=5.17) [13]. Research in Vietnam found that high relative humidity for at least six months later increased tuberculosis incidence [14].

Table 2. Results of multivariate logistic regression

Variabel		p-value	Exp(B)	95% C.I. for EXP (B)		Omnibus tests
				Lower	Upper	
Age	Risky No risk	0.002	1.696	1.221	2.356	0.000
Smoking	Smoking No smoking	0.000	2.354	1.678	3.301	
Temperature	Ineligible Eligible	0.000	4.291	2.845	6.471	
Humidity	Ineligible Eligible	0.000	6.774	4.697	9.770	
Lighting	Ineligible Eligible	0.000	4.174	2.940	5.928	
Constant		0.000				

In our study, those who stayed at home with unqualified humidity had a higher risk of lung tuberculosis. According to Hong Kong research, there was a higher chance of tuberculosis notification when the relative humidity was 60.0-63.6% [15]. In a study conducted in Southwest China, minimum relative humidity was shown to be inversely associated with the frequency of tuberculosis cases [16]. One theory was that in dry conditions, the body's mucus secretion and clearance of external pathogens were diminished, making humans more susceptible to Mycobacterium tuberculosis infection [15].

This research showed a link between age and the occurrence of pulmonary tuberculosis. This finding is consistent with prior research conducted in India, which found a those in the age group of 55 years and above had a very high prevalence of smear-positive pulmonary tuberculosis estimated [17]. Another study in Cambodia proved that prevalence tuberculosis prevalence rates were more than twice as high as case notification rates among adults older than 45 years [18]. Meanwhile, other research suggests that as a person reaches a productive age, they are more likely to contract pulmonary tuberculosis [19]. A study in Zambia found that most tuberculosis cases occurred in the age group of 2-44 years, with a peak in the age group of 35-44 years [20].

The pulmonary tuberculosis case was not significantly related to gender. This finding supports research in Iran, which found no relationship between gender and the case of pulmonary tuberculosis [21]. Another study in the Indonesian population aged 15 and above found that men were two times more likely than women to get pulmonary tuberculosis [22]. Contrary to Indian studies, it found that the incidence of pulmonary tuberculosis can be affected by gender, where women are less likely [23]. The pulmonary tuberculosis case was not significantly linked to education. This finding is different with study in Brazil that showed TB prevalence associated with low educational level, time incarcerated, productive cough, previous TB [24]. Contrary to studies in Peru that found MDR-TB patients with lower levels of education had a greater risk of death during certain treatments. Education is also recognized as a marker of economic status; In this case, low education can be associated with a lack of resources, overcrowding, and unsanitary conditions [11].

The prevalence of pulmonary tuberculosis was strongly associated with smoking habits. Previous studies have suggested that smoking was a risk factor for pulmonary TB development [25]. Furthermore, smoking could result in treatment resistance for pulmonary tuberculosis. Patients with tuberculosis with a history of smoking exposure (whether present or former smokers) were 1.57 times more likely than nonsmokers to develop treatment resistance [26]. Research in the US found an estimated relative risk for the association between smoking and tuberculosis. The relative risk of tuberculosis in smokers was higher than that of non-smokers (RR=2.3 (CI): 2.0, 2.8), and the relative risk of tuberculosis death compared smokers to non-smokers (RR=2.1, 95% CI: 1.4, 3.4) [27].

Previous household contact had no significant effect on the pulmonary tuberculosis case. This study's findings contrasted those of Ethiopian research that revealed some evidence that having household contact enhanced the risk of developing pulmonary tuberculosis. This effect was higher when past pulmonary tuberculosis cases had a close family relationship with index pulmonary tuberculosis cases compared to unrelated household members [2]. In households with pulmonary tuberculosis cases, the risk of infection increased with social proximity to the case, according to another study, and the effect was persistently larger in first-degree relatives than in more distant relatives [28].

Temperature is significantly related to the incidence of pulmonary tuberculosis. Research in India found a correlation between minimum temperature and the number of positive BTA tuberculosis cases found to be ($r=0.64$, p-value<0.001). These findings suggest a strong and significant association between minimum

temperatures and the number of positive BTA tuberculosis cases [29]. Another study in the United States found that the mean daily minimum temperature (which has a favorable influence) was a significant climatic element. This could be related to the negative effects of lsow air temperatures on the patient's respiratory system and the lifestyle of people who lived close together in cold weather, which raised the chance of tuberculosis infection [30]. Other research has shown similar findings. Onozuka and Hagihara discovered a substantial positive link between extreme cold and tuberculosis cases in a time series analysis study in Fukuoka (Japan) [31]. Our findings were also in line with what has been discovered in China [32]. A residence should have a humidity level of 40-60%. If the humidity level was higher than 60%, actions such as installing glass tiles or using a humidifier were required to achieve the desired humidity level [13].

Lighting is significantly related to the incidence of pulmonary tuberculosis. Other studies have found a link between lighting and the occurrence of pulmonary tuberculosis, as well as a 3.5-fold increase in the risk of acquiring pulmonary tuberculosis in homes with lighting that did not match the standards [33]. Research in Bengkulu City states that a person who lives in a house with lighting that does not meet the requirements has a 2.7 times greater risk of suffering from tuberculosis than a person who lives in a house with qualified lighting [34]. Meanwhile, systematic studies found that 45% of journals stated that lighting was also a factor that had a relationship with the incidence of pulmonary tuberculosis [35].

4. CONCLUSION

This study concluded that humidity is the most influencing factor in the incidence of pulmonary tuberculosis. In addition, age, smoking behavior, temperature, and lighting also play a role in the incidence of pulmonary tuberculosis. The variables of gender, education, and household contact history showed no significant relationship. Education related to the importance of paying attention to the home's physical environment to avoid pulmonary tuberculosis is highly recommended.

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REFERENCES

[1] WHO, "Global tuberculosis report 2020," *World Health Organization*, 2020. https://www.who.int/publications/i/item/9789240013131 (accessed May 01, 2022).

[2] E. Shimeles *et al.*, "Risk factors for tuberculosis: A case-control study in Addis Ababa, Ethiopia," *Plos One*, vol. 14, no. 4, Apr. 2019, doi: 10.1371/journal.pone.0214235.

[3] Indonesian Ministry of Health "Indonesia health profile 2019 (in Indonesia: *Profil kesehatan indonesia 2019*)," *Jakarta: Kementerian Kesehatan RI*, 2020. https://www.kemkes.go.id/folder/view/01/structure-publikasi-pusdatin-profil-kesehatan.html (accessed Apr. 14, 2022).

[4] T. R. Luba, S. Tang, Q. Liu, S. A. Gebremedhin, M. D. Kisasi, and Z. Feng, "Knowledge, attitude and associated factors towards tuberculosis in Lesotho: a population based study," *BMC Infectious Diseases*, vol. 19, no. 1, p. 96, Dec. 2019, doi: 10.1186/s12879-019-3688-x.

[5] I. Nur, N. N. Noor, A. U. Salmah, A. Mallongi, and H. Amqam, "Risk factors analysis and mapping of pulmonary tuberculosis in community health centre Tamalatea of Jeneponto District," *Open Access Macedonian Journal of Medical Sciences*, vol. 8, no. T2, pp. 59–62, Jul. 2020, doi: 10.3889/oamjms.2020.5186.

[6] H. Rohman, "Spatial patterns of pulmonary tuberculosis analysing rainfall patterns in visual formation," *International Journal of Public Health Science (IJPHS)*, vol. 7, no. 1, pp. 13–21, Mar. 2018, doi: 10.11591/ijphs.v7i1.11376.

[7] N. Mohidem, M. Osman, F. Muharam, S. Elias, R. Shaharudin, and Z. Hashim, "Prediction of tuberculosis cases based on sociodemographic and environmental factors in gombak, Selangor, Malaysia: A comparative assessment of multiple linear regression and artificial neural network models," *International Journal of Mycobacteriology*, vol. 10, no. 4, 2021, doi: 10.4103/ijmy.ijmy_182_21.

[8] C. Y. Zhang and A. Zhang, "Climate and air pollution alter incidence of tuberculosis in Beijing, China," *Annals of Epidemiology*, vol. 37, pp. 71–76, Sep. 2019, doi: 10.1016/j.annepidem.2019.07.003.

[9] A. Khaliq, S. A. Batool, and M. N. Chaudhry, "Seasonality and trend analysis of tuberculosis in Lahore, Pakistan from 2006 to 2013," *Journal of Epidemiology and Global Health*, vol. 5, no. 4, 2015, doi: 10.1016/j.jegh.2015.07.007.

[10] M. A. Kuddus, E. S. McBryde, and O. A. Adegboye, "Delay effect and burden of weather-related tuberculosis cases in Rajshahi province, Bangladesh, 2007-2012," *Scientific Reports*, vol. 9, no. 1, Sep. 2019, doi: 10.1038/s41598-019-49135-8.

[11] H. Wang, C. Tian, W. Wang, and X. Luo, "Temporal cross-correlations between ambient air pollutants and seasonality of tuberculosis: a time-series analysis," *International Journal of Environmental Research and Public Health*, vol. 16, no. 9, May 2019, doi: 10.3390/ijerph16091585.

[12] R. Tanjung, E. L. Mahyuni, N. Tanjung, O. S. Simarmata, J. Sinaga, and H. R. Nolia, "The spatial distribution of pulmonary tuberculosis in Kabanjahe District, Karo Regency, Indonesia," *Open Access Macedonian Journal of Medical Sciences*, vol. 9, no. E, pp. 817–822, Sep. 2021, doi: 10.3889/oamjms.2021.6808.

[13] S. T. Zulaikhah, R. Ratnawati, N. Sulastri, E. Nurkhikmah, and N. D. Lestari, "The relationship between knowledge, behavior and home environment with the incidence of pulmonary tuberculosis transmission in the work area of the Bandarharjo Health Center Semarang (in Indonesia: *Hubungan pengetahuan, perilaku dan lingkungan rumah dengan kejadian transmisi tuberkulosis paru di wilayah kerja Puskesmas Bandarharjo Semarang)*," *Jurnal Kesehatan Lingkungan Indonesia*, vol. 18, no. 2, Oct. 2019, doi: 10.14710/jkli.18.2.81-88.

[14] A. Bonell *et al.*, "Does sunlight drive seasonality of TB in Vietnam? A retrospective environmental ecological study of tuberculosis seasonality in Vietnam from 2010 to 2015," *BMC Infectious Diseases*, vol. 20, no. 1, Dec. 2020, doi: 10.1186/s12879-020-4908-0.
[15] M. Xu *et al.*, "Temperature and humidity associated with increases in tuberculosis notifications: a time-series study in Hong Kong," *Epidemiology and Infection*, vol. 149, Dec. 2021, doi: 10.1017/S0950268820003040.
[16] Y. Xiao *et al.*, "The influence of meteorological factors on tuberculosis incidence in Southwest China from 2006 to 2015," *Scientific Reports*, vol. 8, no. 1, Jul. 2018, doi: 10.1038/s41598-018-28426-6.
[17] B. Dhanaraj *et al.*, "Prevalence and risk factors for adult pulmonary tuberculosis in a metropolitan city of South India," *Plos One*, vol. 10, no. 4, Apr. 2015, doi: 10.1371/journal.pone.0124260.
[18] J. Negin, S. Abimbola, and B. J. Marais, "Tuberculosis among older adults-time to take notice," *International Journal of Infectious Diseases*, vol. 32, pp. 135–137, Mar. 2015, doi: 10.1016/j.ijid.2014.11.018.
[19] J. Kehbila, C. J. Ekabe, L. N. Aminde, J. J. N. Noubiap, P. N. Fon, and G. L. Monekosso, "Prevalence and correlates of depressive symptoms in adult patients with pulmonary tuberculosis in the Southwest Region of Cameroon," *Infectious Diseases of Poverty*, vol. 5, no. 1, Dec. 2016, doi: 10.1186/s40249-016-0145-6.
[20] N. Kapata *et al.*, "The prevalence of tuberculosis in Zambia: results from the first national TB prevalence survey, 2013-2014," *Plos One*, vol. 11, no. 1, Jan. 2016, doi: 10.1371/journal.pone.0146392.
[21] M. Moosazadeh, A. Bahrampour, M. Nasehi, and N. Khanjani, "The incidence of recurrence of tuberculosis and its related factors in smear-positive pulmonary tuberculosis patients in Iran: A retrospective cohort study," *Lung India*, vol. 32, no. 6, 2015, doi: 10.4103/0970-2113.168113.
[22] A. L. Cremers, M. M. de Laat, N. Kapata, R. Gerrets, K. Klipstein-Grobusch, and M. P. Grobusch, "Assessing the consequences of stigma for tuberculosis patients in Urban Zambia," *Plos One*, vol. 10, no. 3, Mar. 2015, doi: 10.1371/journal.pone.0119861.
[23] S. K. Singh, G. C. Kashyap, and P. Puri, "Potential effect of household environment on prevalence of tuberculosis in India: evidence from the recent round of a cross-sectional survey," *BMC Pulmonary Medicine*, vol. 18, no. 1, Dec. 2018, doi: 10.1186/s12890-018-0627-3.
[24] M. S. Valença, J. L. R. Scaini, F. S. Abileira, C. V Gonçalves, A. von Groll, and P. E. A. Silva, "Prevalence of tuberculosis in prisons: risk factors and molecular epidemiology," *The International Journal of Tuberculosis and Lung Disease*, vol. 19, no. 10, pp. 1182–1187, Oct. 2015, doi: 10.5588/ijtld.15.0126.
[25] B. E. Thomas *et al.*, "Smoking, alcohol use disorder and tuberculosis treatment outcomes: A dual co-morbidity burden that cannot be ignored," *Plos One*, vol. 14, no. 7, Jul. 2019, doi: 10.1371/journal.pone.0220507.
[26] M.-G. Wang *et al.*, "Association between tobacco smoking and drug-resistant tuberculosis," *Infection and Drug Resistance*, vol. 11, pp. 873–887, Jun. 2018, doi: 10.2147/IDR.S164596.
[27] G. A. Amere, P. Nayak, A. D. Salindri, K. M. V Narayan, and M. J. Magee, "Contribution of smoking to tuberculosis incidence and mortality in high-tuberculosis-Burden Countries," *American Journal of Epidemiology*, vol. 187, no. 9, pp. 1846–1855, Sep. 2018, doi: 10.1093/aje/kwy081.
[28] R. Basu Roy, E. Whittaker, J. A. Seddon, and B. Kampmann, "Tuberculosis susceptibility and protection in children," *The Lancet Infectious Diseases*, vol. 19, no. 3, pp. 96–108, Mar. 2019, doi: 10.1016/S1473-3099(18)30157-9.
[29] P. Narula, P. Sihota, S. Azad, and P. Lio, "Analyzing seasonality of tuberculosis across Indian states and union territories," *Journal of Epidemiology and Global Health*, vol. 5, no. 4, 2015, doi: 10.1016/j.jegh.2015.02.004.
[30] A. Mollalo, L. Mao, P. Rashidi, and G. E. Glass, "A GIS-based artificial neural network model for spatial distribution of tuberculosis across the Continental United States," *International Journal of Environmental Research and Public Health*, vol. 16, no. 1, Jan. 2019, doi: 10.3390/ijerph16010157.
[31] D. Onozuka and A. Hagihara, "The association of extreme temperatures and the incidence of tuberculosis in Japan," *International Journal of Biometeorology*, vol. 59, no. 8, pp. 1107–1114, Aug. 2015, doi: 10.1007/s00484-014-0924-3.
[32] K. Cao *et al.*, "Spatial-temporal epidemiology of tuberculosis in Mainland China: an analysis based on bayesian theory," *International Journal of Environmental Research and Public Health*, vol. 13, no. 5, May 2016, doi: 10.3390/ijerph13050469.
[33] S. Izzati, M. Basyar, and J. Nazar, "Risk factors associated with the incidence of pulmonary tuberculosis in the working area of the Andalas Health Center in 2013 (in Indonesia: *Faktor risiko yang berhubungan dengan kejadian tuberkulosis paru di wilayah kerja Puskesmas Andalas tahun 2013*)," *Jurnal Kesehatan Andalas*, vol. 4, no. 1, Jan. 2015, doi: 10.25077/jka.v4i1.232.
[34] A. Zuraidah and H. Ali, "The relationship between home environmental factors and the incidence of smear-positive pulmonary TB in the Nusa Indah Health Center, Bengkulu City (in Indonesia: *Hubungan faktor lingkungan rumah terhadap kejadian TB paru BTA positif di wilayah puskesmas Nusa Indah Kota Bengkulu*)," *Journal of Nursing and Public Health*, vol. 8, no. 1, pp. 1–10, May 2020, doi: 10.37676/jnph.v8i1.1004.
[35] E. A. Sriratih, S. Suhartono, and N. Nurjazuli, " Analysis of indoor physical environmental factors related to the incidence of pulmonary tuberculosis in developing countries (in Indonesia: *Analisis faktor lingkungan fisik dalam ruang yang berhubungan dengan kejadian tuberkulosis paru di negara berkembang*)," *Jurnal Kesehatan Masyarakat (Undip)*, vol. 9, no. 4, pp. 473–482, Aug. 2021, doi: 10.14710/jkm.v9i4.29741.

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