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THE EFFECT OF PHYSICAL CONDITIONS OF HOME AND WORK ENVIRONMENT ON THE EVENT OF PULMONARY TUBERCULOSIS IN CONSTRUCTION WORKERS

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Abstract

Tuberculosis (TB) is a directly-infectious disease caused by tuberculosis bacteria (Mycobacterium tuberculosis) that are airborne through droplets or nuclei when a patient coughs and the saliva droplets containing the bacteria are inhaled by another person while breathing. The research investigates the effect of the physical conditions of the house and working environment on the pulmonary TB events among construction workers in the Asahan Regency. It is an analytic epidemiological survey with a case-control design, and involves examining the entire population amounting to 74 people: the first 37 suffered from pulmonary TB and worked as construction workers (case-group), and the other 37 didn't suffer from pulmonary TB and worked as construction workers (control-group). They were analyzed by using univariate analysis, bivariate analysis, and multivariate analysis. The results showed that the types of floor (p=0.040), lighting (p=0.027), wall (p=0.034), working lengths (p=0.102), and masks uses (p=0.000) have affected pulmonary TB events. In this case, the use of masks (p=0.003) was the most dominant variable. This study suggests counseling on healthy houses for families who are prone to pulmonary TB. Good types of lighting, floor, and wall can be useful in every house to reduce the risk of TB developing to last for a long period or leading to death.

Keywords: *pulmonary tuberculosis; physical condition of the house; construction workers*

1. Introduction

Tuberculosis (TB) is one of the ten most fatal diseases in the world. Every year millions of people are infected with TB. In 2017, there were 1.3 million deaths due to TB among the HIV-negative people and there were 300,000 more deaths from TB among the HIV-positive. Globally, there were an estimated 10 million TB events with 6.4 million (64%) of them being new cases in 2017. Of this number, 5.8 million were men, 3.2 million women, and 1.0 million children.

Tuberculosis events affect all countries and age groups, but overall 90% start in the middle of adolescence (aged 15 years old), 64% of them are men, 9% are people with HIV, 72% are in Africa and two-thirds are in eight countries, namely India (27%), China (9%), Indonesia (8%), Philippines (6%), Pakistan (5%), Nigeria (4%), Bangladesh (4%), and South Africa (3%). These countries and 22 others on the WHO's list are the 30 largest TB contributors, i.e. 87% of cases worldwide (WHO, 2018).

In 2017, the highest estimated number of TB cases occurred in Southeast Asia (44%), with an estimate of 4,440,000 or 226 events per 100,000 population. Indonesia is the highest where the event rate is 842,000 or 319 per 100,000 population and the mortality rate for TB sufferers is 40 per 100,000 population (WHO, 2018). According to the World Health

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Organization, there are three indicators of high burden countries (HBC), namely TB, TB/HIV, and MDR-TBC. There are 48 countries categorized as TB HBC. One country can be included in one indicator, both indicators, or even all three indicators. Indonesia and 13 others are included in HBC with all three indicators. This shows that Indonesia is facing serious problems in overcoming TB (Kemenkes RI, 2018). It is indicated in the Indonesian Health Profile data in 2018 that the total number of TB events in Indonesia was 566,623 events, an increase from that in 2017 which amounted to 446,732 events (Kemenkes RI, 2019).

In North Sumatra Province, the ratio of the total TB events being reported receiving treatment to 100,000 residents, known as the Case Notification Rate (CNR), was 238 per 100,000 population in 2018, which is the 10 highest out of 34 provinces in Indonesia. This number has increased compared to 2017 when North Sumatra CNR was 182 per 100,000 population (Kemenkes RI, 2019). According to the 2017 North Sumatra Provincial Health Profile, Asahan Regency ranks the 4th highest CNR among the entire 33 districts or cities in North Sumatra Province, or 1,245 per 100,000 population in 2017. This number comprises males 64.98% and females 35.02%. This was a significant increase from that of 2016 data where it ranked the 5th highest CNR or 910 per 100,000 population with 66.26% were males and 33.74% were female (Dinkes Sumut, 2017).

According to WHO in the World TB Day 2020 Highlights Report, it is estimated that low-income people worldwide spend as much as US$ 12 billion every year due to TB. Several studies conclude that TB causes absenteeism of approximately three to four months, reducing the income by around 20 to 30% per year. Approximately 75% of TB patients are the most economically productive age group (15-50 years). When the head of a household dies from TB, his family members are likely to lose their income for the next 13 to 15 years (WHO, 2020). In addition to getting social stigmatization and ostracization by the surrounding community, families with pulmonary TB usually come from lower socioeconomic levels, making them harder to battle the disease. Socioeconomic factors play a bigger role in the occurrence of pulmonary TB, as the low economic level will make efforts to prevent pulmonary TB smaller (Siregar, 2018; Pamungkas, 2018).

Based on the WHO Regional Office for South-East Asia (2003), TB seriously wrecks workers with prolonged illness, absenteeism, loss of income, possibly even termination of employment, and other discrimination. Their families are at higher risk of being infected with TB for a long duration of contact, not to mention the cut in income affecting their health and well-being (WHO, 2003).

From BPS data in 2019, Asahan Regency has 29 health centers with a population density of around 724,379 people/km2 in an area of 3,732.97 km2. The number of male workers being over 15 years old is 202,252 people, of which 16,208 works as casual workers in non-agricultural businesses (BPS, 2019).

A non-agricultural worker is a person who works for another person/employer/institution non-permanently (more than 1 employer in the last one month) and gets wages or rewards in the form of money or goods through a daily or project payment system basis. Non-agricultural businesses include mining, manufacturing industry, electricity, gas, and water services, construction/building, trade, transportation, warehousing and communication, financial and insurance services, building, land and company rental services, and individual, social, and community services (BPS, 2019).

Budi et al., (2018) in Palembang City, stated that home environmental factors such as lighting, humidity, roof, wall, and floor conditions were significantly related to TB events. In their research, the most influential factor in TB events was occupancy density. In addition, Dwiputra (2019) conducted research on stone crusher workers in Bandar Lampung City. He found that 80.4% of the workers had poor lung function, where 54.1% of them had been working for more than ten years, 75.4% worked more than or equal to eight hours a day, and 80.3% were heavy smokers, and 72.1% not using respiratory protective equipment. His findings show correlations between working period, working hours, smoking habits, the use of respiratory protective equipment the poor lung function.

The susceptibility factors to pulmonary TB generally include age, education, knowledge,

occupation, gender, environmental conditions, immune system, nutrition, interactions with sources of infection, smoking habit, and air pollution from the kitchen or insect repellent (Pangaribuan et al., 2020; Putri, 2016; Siregar, 2018). Familiarity with handling TB can help families reduce the risk of transmission (Siregar, 2021; Wahyuningsih, 2016; Wokas et al., 2015; Yuliastuti, 2016).

One of the prevailing sources of TB transmission is the type of work. Jobs that require workers to be constantly exposed to dust particles, such as stone crushers, carpenters, construction workers, or smoke particles, such as mineral, oil, and gas miners, pose a higher danger to respiratory tract disturbances and elevate transmission and morbidity rates in pulmonary TB events (Muaz, 2014). These workers are prone to decreasing performances and discontinuations (Perdana, Djajakusli, & Syafar, 2010).

Inline, WHO states that workers with dust contamination jobs inhale 10 to 100 times more dust than outsiders, bearing higher risks of abnormalities of lung and respiratory function, which will disrupt work productivity and lead to termination of jobs (WHO, 2020). In many cases, their activities are in enclosed, unprotected environments that allow higher risks of TB transmissions. The presence of silica dust in mining, construction services, stone grinding, and other similar jobs is highly responsible for making them more vulnerable (WHO, 2003). A workplace concentrates people in one time and environment. Therefore, improvement of the working environment and enforcement of the Occupational Health and Safety (OHS) in the workplace matter (Departemen Kesehatan RI, 2008).

The preliminary survey was conducted from February 25, 2019 - to April 2, 2019, in Asahan Regency. There were eleven Public Health Center (PHC) working areas included, namely Gambir Baru, Simpang Empat, Aek Songsongan, Aek Loba, Hessa Air Genting, Binjai Serbangan, Meranti, Bandar Pasir Mandoge, Sei Kepayang, Rawang Pasar IV, Pulau Rakyat and Air Batu. The survey found 223 male patients with pulmonary TB and 37 of them had a history of working as construction workers. These workers became the subjects of our research on the effect of the physical condition of the home and work environment on their pulmonary TB events.

Previously, direct observations in the field indicated 23 houses did not meet the requirements and dwelled by pulmonary TB sufferers, and 11 of them worked as construction workers. Some families still live in relatively narrow houses, lack natural lighting due to lack of ventilation, and the windows of the houses are not regularly opened, resulting in a lack of sunlight entering the house and causing conditions in the house to be damp and dark.

2. Method

The research is an analytic epidemiological survey with a case-control design. It aims to determine the effects of the physical conditions of the home and work environments on the pulmonary TB events in construction workers in Asahan Regency in 2021. The high rate of pulmonary TB events in the Regency with construction workers' backgrounds has become the reason behind this research. The research was conducted from June to December 2021.

Cluster random sampling is applied in our research, by which 15 public health center with TB cases of construction workers are involved as the highest among 29 public health center in Asahan Regency. This takes in an all-male population of 74 construction workers in the 15 public health center area, 37 of which have pulmonary TB (hence, the case group) and the other 37 do not (the control group).

The independent variables in this study are the condition of the house (lighting, humidity, floor, and wall) and the work environment (working lengths, the mask uses). Here, the dependent variable is pulmonary TB events.

Primary data were obtained from interviews with respondents using questionnaires and observation sheets to obtain data on home conditions and working environmental conditions. Secondary data were obtained from the Asahan Regential Health Office and the public health centers (PHCs) on the characteristics of construction workers and pulmonary TB cases using similar tools. The measurement of the home conditions was based on the regulation of the Minister of health No. 1077/Minister of health /Per/V/2011

concerning Guidelines for Air Purification in The Home Room. Criteria are qualified if they meet the requirements of the ministry of health.

In this study, data processing and data analysis were performed using univariate analysis, bivariate analysis, and multivariate analysis to see whether there is an effect of the independent variable on the dependent variable.

3. Result and Discussion

The respondents' distribution based on home and work environment physical conditions can be seen in table 1. Twenty-seven percent of respondents' houses are well-penetrated with sunlight while the other 23.0% do not. The waterproofed floor accounts for 44.6% of the houses while the other 5.4% are still poorly floored. Meanwhile, the houses with stone walls amount to 27.0% while the other 23.0% are with walls made of boards. For the workplace criteria, the respondents working ≤ 8 hours/day are 39.2% and those working > 8 hours/day are 10.8%. Nine point five percent of the respondents use masks while working, while the majority of them do not.

The relationship between the physical conditions of the house and the work environment and the pulmonary TB events for construction workers in Asahan Regency in 2021 can be seen in table 2.

Tabel 1. Distribution of Respondents Based on the Physical Conditions of Home and Work Environment on Pulmonary TB Events among Construction Workers in Asahan Regency in 2021

Variable	Pulmonary TB Events			
	Case		Control	
	N	%	N	%
Lighting				
Qualify	20	27	29	39.2
Not eligible	17	23	8	10.8
Total	37	50	37	50
Floor Type				
Qualify	33	44.6	37	50
Not eligible	4	5.4	0	0
Total	37	50	37	50
Wall Type				
Qualify	20	27	25	33.8
Not eligible	17	23	12	16.2
Total	37	50	37	50
Length of working				
Qualify	29	39.2	34	45.9
Not eligible	8	10.8	3	4.1
Total	37	50	37	50
Use of Masks				
Qualify	7	9.5	23	31.1
Not eligible	30	40.5	14	18.9
Total	37	50	37	50

Lighting

The result indicated that of the 74 respondents, forty-nine have their houses lighted well, of which 20 (40.8%) suffer from pulmonary TB. The other 25 have their houses poorly lighted, of which 17 (68.0%) suffer from pulmonary TB. The results of the bivariate analysis showed a relationship between lighting and pulmonary TB events in construction workers with an OR value of 3.081, which means that poorly-lighted houses make the workers get pulmonary TB approximately three times more likely than the well-lighted houses.

Table 2. Relationship of Physical Conditions of Home and Work Environment and Construction Workers Pulmonary TB Events in Asahan Regency in 2021

Variable	Pulmonary TB Events						*P*	OR CI 95%
	Case		Control		Total			
	n	%	n	%	n	%		
Lighting								
Poorly-lighted	17	68	8	32	25	100	0.027	3.081 (1.116-8.504)
Well-lighted	20	40.8	29	59.2	49	100		
Floor								
Not waterproofed	4	100	0	0	4	100	0.040	2.855 (1.116-6.355)
Waterproofed	33	47.1	37	52.9	70	100		
Wall								
Wooden Board	17	58.6	12	41.4	29	100	0.034	1.771 (0.689-4.553)
Stone	20	44.4	25	55.6	45	100		
Working hours								
>8 working hours	8	72.7	3	27.3	11	100	0.102	3.126 (0.758-12.888
≤8 working hours	29	46	34	54	63	100		
Mask Uses								
Don't use	30	68.2	14	31.8	44	100	0.000	7.041 (2.446-20.271)
Use	7	23.3	23	76.7	30	100		

The results of this study are in line with Budi et al., (2018) which indicated a statistically significant relationship between the house-lighting variable and TB events. Their analysis of the lighting variable showed OR value of 1.6, revealing that subjects living in houses whose lamps were less than 60 Lux had a 1.6 times chance of getting tuberculosis. The observations and interviews with our respondents revealed in the case group how seldom and limited the windows and curtains had been opened by the dwellers of the houses and this had prevented sunlight from entering evenly. Sunlight entered the living room only when the door was opened. Otherwise, they use lamps as a light source. In the case and control groups who did not suffer from pulmonary TB, the houses were equipped with enough ventilation and sunlight, as the windows were fully opened every day. Mycobacterium tuberculosis is resistant to low temperatures so that it can survive for a long time at temperatures between 4℃ to minus 70℃. Germs are very sensitive to heat, ultraviolet, and sunlight. Most germs die within a few minutes of direct exposure to ultraviolet. In phlegm cases, they die at a temperature between 30-37℃ in approximately one week (Kemenkes RI, 2016).

Floors

Our data indicate that only 47.1% of the respondents with waterproof-floored houses (33 out of 70) suffer from pulmonary TB, while 100% of those without do (4 out of 4). The results of the bivariate analysis showed that there was a relationship between the floor condition and the pulmonary TB events. This affirms the results of Harahap et al., (2017) that revealed the relationship between house-floor conditions and the positive smears in pulmonary TB events in Bandarharjo Health Center Semarang City, with a p-value of 0.005. Floors with cleaning-difficulty lead to a buildup of dust, which become a good medium for the proliferation of Mycobacterium tuberculosis bacteria (Budi et al., 2018). Our observations revealed that, for the houses of the respondents with TB, the concrete floorings had been cracked and rough. Cracked flooring opens access to soil moisture from beneath and is difficult to clean from dust.

Walls

Based on the results conducted in the Asahan Regency area, 20 out of 45 (44.4%) respondents whose houses are of stone walls suffered from pulmonary TB. This TB percentage is smaller than those whose walls are made of boards (17 out of 29, or 58.6% of them suffer from pulmonary TB). The bivariate analysis showed an OR value of 1.771, which means wood-planked walls make the dwellers prone to

pulmonary TB 1.7 times more likely than stone walls. This is in agreement with the findings of Budi et al., (2018) which showed a significant association of house walls with TB events. They found that non-standard walls raised the chances for the dwellers of getting TB 2.5 to 4.9 times. This is also in line with Dewi et al., (2018), whose study on pulmonary TB events in Magelang City found a p-value of 0.006 and an OR value of 3.8 for the wall variable. Walls with poor quality to prevent humidity from rain can invite fungus which is dangerous for the lungs. From our observations with respondents, the house walls in the case and control groups are partially made of boards and stones without concrete-reinforcement. Wooden planks accelerate water seeping from rain and develop humidity in the houses. In the summer the walls become dry and retain dust that is harmful to the dwellers. Most of the respondents with pulmonary TB have wooden planks as their walls.

Working Hours

Of the 74 construction workers, 63 worked for less than or equal to 8 hours and 29 (46.0%) of them suffered from pulmonary TB. This percentage is below that of workers with more than 8 working hours (11 people, of which 8 suffered from pulmonary TB). The results of the bivariate analysis showed a relationship with an OR value of 3.126, which means those working more than 8 hours are 3.1 times more likely to get pulmonary TB than those who don't. The interviews with respondents revealed that most of the pulmonary TB sufferers worked as cement mixers. These workers think inhaling a few clouds of cement dust and coughing is common and has been part of the job. In fact, the longer they work, the greater the risk they get of occupational hazards. Theoretically, the effect of dust exposure depends on the concentration, size of the workplace, and time of exposure. Exposure time is defined as the frequency or length of time a person is exposed to dust. The results of this study are in line with research Dwiputra (2019) shows that there is a relationship between the length of work and lung function in stone crusher workers in Bandar Lampung City.

Mask Uses

In our research, the TB percentage difference between the respondents wearing masks when working and those not is quite high. Of the 74 construction workers, 30 wore masks while 44 did not. Of the number wearing masks, 23.3 % (7 out of 30) have TB, while of the number not wearing masks, 68.2% (30 out of 44) have TB. The bivariate analysis gives an OR value of 7.041 which means that construction workers who do not wear masks at work are seven times more likely to get pulmonary TB than workers who do. This is in line with Dwiputra (2019) in his case of stone crushers in Bandar Lampung City. This is also consistent with the research of Martiana et al., (2007) who revealed the correlation of masks wearing habits to pulmonary TB events in Gresik Regency industrial workers. Their statistical analysis offered an OR of 2.006, but it also gave a CI between 0.755 to 5.333. This indicates the habit is a life-saver to prevent pulmonary TB transmission.

The companies' role in providing masks is an inseparable part of this habit. Most of the respondents who wore masks said they developed the habit because the company had been providing masks during work, and vice versa. Based on the results of interviews and observations with respondents, almost all construction workers who suffered from pulmonary TB did not wear masks when working. Regardless of whether it is provided by employers, a mask is a respiratory PPE (Personal Protective Equipment) that must be available in their respective workplaces. In addition to preventing inhaling TB droplets, masks filter from pollutants that either directly harm or accumulatively decrease functions of the respiratory organs.

The results of the bivariate selection of variables whose value ($p<0.25$) will proceed to the multivariate stage. The variables that enter the multivariate stage are lighting, floor, wall, work length, and mask uses. These variables are then entered simultaneously into the model.

Tabel 3. Results of Bivariate Selection with Pulmonary TB events.

Variable	p-value
Lighting	0.027*
Floor	0.040*
Wall	0.034*
Working Length	0.102*
Mask Uses	0.000*

Variables with p-values marked (*) are variables that are included in the multivariate model. All variables entered into the multivariate model were tested simultaneously. Table 4 shows that the variable of wearing a mask is most related to the events of pulmonary TB (p = 0.003) with an Exp value (B) of 5.567. This means that workers who do not use masks have a 5.5 times risk of developing pulmonary TB compared to workers who do.

Tabel 4. Multivariate Analysis of Pulmonary TB events

Variable	B	p-value	Exp(B)	95% CI. For EXP (B)	
				Lower	Upper
Lighting	0.940	0.112	2.559	0.804	8.145
Floor	20.368	0.999	700884247.786	0.000	
Wall	0.852	0.138	2.344	0.760	7.233
Working Length	0.775	0.377	2.171	0.389	12.111
Mask Uses	1.717	0.003	5.567	1.788	17.337
Constant	-22.761	0.999	0.000		

A p-value of 0.003 was obtained based on the results of multivariate analysis using multiple logistic regression. It means that the use of masks is the dominant factor influencing the events of pulmonary TB in construction workers. This research has a strength in that it focuses on construction workers with a case-control design to provide a new perspective to prevent pulmonary TB transmission among those with higher risks. However, it is still limited by the size of the sample, and future similar research with a larger number of samples is still expected.

4. Conclusion and Suggestions

Several results are concluded from the bivariate analysis between lighting, floor, wall, working length, and mask uses among the Asahan's construction workers' houses and their pulmonary TB events. The house with poor lighting, non-waterproofed floors, and damp walls makes them several times more vulnerable to getting pulmonary TB than the ones with good conditions. In addition, construction workers who work more than 8 hours are 3.1 times more likely to get pulmonary TB than workers who work for 8 hours or less, and those who don't develop habits of wearing masks at work are seven times more likely to be infected than workers who do. The use of masks is the most dominant variable affecting the pulmonary TB events in construction workers in Asahan Regency.

It is suggested that workers with TB risks conduct health home counseling and develop mask-wearing habits. It is expected that construction workers be disciplined in their work by using respiratory protective equipment while working.

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