The Relationship between the Quality of the Physical Environment of the House and the Incidence of Pulmonary Tuberculosis in Tangerang City in 2022

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Abstract

Tuberculosis is an infectious disease that is a major health problem and one of the leading causes of death in the world. This study aimed to determine whether there is a relationship between the physical condition of the house and the incidence of pulmonary tuberculosis in Tangerang City, Banten Province. This research is a quantitative research with a case control design. This study was conducted in Tangerang City conducted from June to September 2022. The sample for this study was 400 people, consisting of 200 case samples and 200 control samples. The sampling technique used in this research is proportional sampling technique. Data analysis in this study was analysis using the Chi square test and the Odds Ratio value. The research results show that there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with (p value = 0.001; OR= 4,397; 95% CI=2,454-7,879), there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with a value of (p value=0,001; OR=2,970; 95% CI=1,968-4,482), there is no relationship between occupancy density and the incidence of pulmonary tuberculosis with a (p value=0.679; OR=0,858; 95% CI=0,499–1,476), there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with a (p value =0.001; OR=6,791; 95% CI=4,382–10,523), there is no relationship between occupancy density and the incidence of pulmonary tuberculosis with a (p value=0.764; OR=0,874; 95% CI =0,485–1,574); there is no relationship between occupancy density and the incidence of pulmonary TB with a (p value=0.471; OR=1,225; 95% CI=0,764–1,964).in the Tangerang City area. The advice that can be given is that patients pay more attention to the house physical condition so that no proliferation of mycobacterium tuberculosis can be transmitted to other people and people in the house.

Keyword: Environmental Factors, Physical Environment, Tuberculosis

INTRODUCTION

Tuberculosis is an infectious disease that is a major health problem and one of the leading causes of death in the world. About a quarter of the world's population is infected with *mycobacterium tuberculosis*. Based on data from the World Health Organization the number of TB cases in 2021 globally is 10.6 million cases, an increase of around 600.000 cases from only 10 million cases in 2020. Indonesia itself is in the second position with the highest number of TB sufferers in the world after India. TB cases in Indonesia are estimated at 969.000 TB cases (one person every 33 seconds). This figure is up 17% from 2020, namely 824.000 cases. The incidence of TB cases in Indonesia is 354 per 100.000 population, which means that for every 100.000 people in Indonesia there are 354 of them suffering from TB. The death rate due to TB in Indonesia has reached 150.000 cases (one person every 4 minutes), up 60% from 2020

where there were 93.000 deaths due to TB. With a death rate of 55 per 100.000 population (WHO, 2022).

Banten Province is one of the areas with the highest prevalence of Pulmonary Tuberculosis in Indonesia at 0.76% (Kemenkes RI, 2018). There are several districts in Banten province that have a high number of TB cases. TB cases in Tangerang City are still very high, data from the Tangerang City Health Office shows that in 2019 there were 5.014 TB cases; in 2020 there were 3998 with 56 Drug Resistant Tuberculosis (DR-TB) cases; in 2021 there were 4.137 with 85 TB cases. The number of TB death cases in 2020 was 80 people, and in 2021 was 83 people. The TB Case Fatality Rate (CFR) in 2020 was 4.18% per 100.000 population. CFR TB in the year has increased with a CFR 2021 value of 4.34% per 100.000 population. This shows that Tuberculosis (TB) is still a problem in the health sector (Dinkes Kabupaten Tangerang, 2021).

TB disease is one of the environment-based diseases caused by bacteria and transmitted through the air (airborne diseases) and can survive in the air (Kenedyanti et al., 2017). Bacteria in dried sputum that adhere to dust can survive for 8-10 days longer (Mahawati et al., 2021). The environment-based disease is a pathological condition in the form of abnormalities in the function or morphology of an organ of the body caused by human interaction with everything around that has the potential to cause disease (Fitriani, 2020). Some environmental risk factors for TB disease are house occupancy density, humidity, temperature, ventilation/Air Change Per Hour (ACH), and daylighting (Meo et al., 2022).

The increase in pulmonary tuberculosis cases can be influenced by several factors, including the physical condition of the home environment. The quality of the physical environment of an unhealthy home plays an essential role in the transmission and proliferation of Mycobacterium tuberculosis. Lack of light entering the house and little ventilation create a humid and dark atmosphere (Fitriani, 2020). This condition causes germs to survive for days to months in the house. Risk factors for the physical environment of the house that play a role in determining the interaction between the host and the agent in the process of the incidence of pulmonary tuberculosis disease are occupant density, humidity, ventilation area, lighting, floor, and walls of the house (Juliati et al., 2020).

Tuberculosis is an infectious disease, in the epidemiological approach to infectious diseases, John Gordon's theory states that the onset or absence of disease in humans is influenced by three main factors, namely the host, agent, and environment. A Tuberculosis

disease will occur if these three factors are not in balance (KEPMENKES RI No.829/Menkes/SK/VII/1999 About Housing Health Requirements, 1999).

The distribution of Tuberculosis cases in Tangerang City is highest in the productive age range of 17-55 years old. This makes Tuberculosis disease able to reduce the productivity of human resources, even the quality of the nation's generation. This also impacts the government's burden because Tuberculosis treatment requires a large amount of money. Ultimately, TB will significantly affect social and economic development.

In order to achieve the National Tuberculosis Control Program, more synergistic and comprehensive efforts are needed to overcome the challenges that exist in Tangerang City, including the lack of a strategic plan for Tangerang City related to Tuberculosis handling and the absence of adequate data related to the analysis of environmental risk factors in Tuberculosis problems.

Prevention of airborne environment-based diseases can be done by knowing the environmental risk factors that affect it so that these risk factors can be controlled to reduce the potential for transmission and spread of disease and improve the degree of health. Based on the description above, researchers will examine environmental risk factors that can affect the transmission and spread of TB cases that occur.

METHODS

The method used in this study was analytic observational with a case control approach. This study was conducted in Tangerang City conducted from June to September 2022. Sample population in this study used data from Tuberculosis Information System (SITB) Tangerang City with 1046 cases. Then it was filtered using the inclusion criteria to get a total of 398 cases and afterward calculated using the Slovin formula so that 200 cases would be taken using proportional sampling. This study uses 200 controls to balance the comparison of cases and controls. Cases were patients with TB pulmonary tuberculosis in Tangerang City who were diagnosed clinically and laboratory BTA (+) and entered in the Tangerang City Tuberculosis Information System application in June-September 2022, while controls were neighbors of cases who had balanced characteristics who were not diagnosed with pulmonary TB. The sample for this study was 400 people, consisting of 200 case samples and 200 control samples.

This study used inclusion and exclusion criteria from both cases and controls, while the criteria are described as follows:

A. Inclusion Criteria

1. Cases
   a) Residing in Tangerang City
   b) Registered in Tuberculosis Information System application with tuberculosis and still undergoing treatment until September 2022.
   c) Above 15 years old

2. Control
   a) Residing in Tangerang City
   b) Not registred in SITB application and not suffering from tuberculosis
   c) Above 15 years old

B. Exclusion Criteria

1. Case
   a) People who have suffered from tuberculosis and declared cured
   b) Not living in Tangerang City
   c) Less than 15 years old

2. Control
   a) Not living in Tangerang City
   b) Less than 15 years old

The sampling technique used in the study was the proportional sampling technique, which is a sampling technique that pays attention to sub-samples according to the comparison. Data collection in this study used a questionnaire by interviewing case respondents and control respondents.

This study analysis consists of two phases: univariate analysis and bivariate analysis using the SPSS-23 program to conduct analytical studies. Univariate analysis was conducted to characterize the distributions and frequencies studied. The factors studied were occupancy density, humidity, temperature, lighting, Air Change Per Hour, and ventilation area. In the bivariate analysis using the Chi-Square test to see the relationship between independent variables and respiratory symptoms, $p = 0.05$ is statistically significant. If the p-value is less than 0.05, it can be concluded that there is a significant relationship between the independent variable and the dependent variable, while if the p-value is more than 0.05, it can be concluded that there is no significant relationship between the variables (at the 95% confidence interval

level). And statistical analysis of Odds Ratio (OR) to determine the dominant risk factors for the incidence of Pulmonary Tuberculosis.

RESULTS

Based on the results of interviews with 200 case respondents and 200 control respondents, the results are described in the following table:

Table 1. Respondent Characteristics

Characteristics	Cases		Control	
	f	%	f	%
Ages				
≥ 40	123	61,6	154	77,0
< 40	77	38,4	46	23,0
Gender				
Male	114	57	47	23,6
Female	86	43	153	76,4

From the table 1 above, the distribution of respondents based on age > 40 years in the case group was 123 respondents (61.6%), and in the control group as many as 154 respondents (77.0%). While respondents aged <40 years in the case group were 77 (38.4%) and in the control group were 46 respondents (23.0%). Most of the respondents were male. In the case group 114 male respondents (57%) were more than the control group 47 respondents (23.6%). At the same time, 86 respondents (43%) of women in the case were fewer than the control group of 153 respondents (76.4%)

Table 2. Relationship between Residential Density and the Incidence of Pulmonary Tuberculosis

Residental Density	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	58	29,0	17	26,4			
Qualified	142	71,0	183	91,6	0,001	4,397	(2,454 - 7,879)
Total	**200**	**100**	**200**	**100**			

The results from table 2 show that the proportion of residential density that does not qualified is more in the case of 58 respondents (29,0%) than in the control of 17 respondents (26,4%). Based on the results of statistical tests shows that there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with a p value = 0,001. Based on the statistical test, the Odds Ratio (OR) value = 4,397 which indicates that respondents who have a residential density that does not meet the requirements are 4,397 times more likely to suffer from pulmonary tuberculosis than those who have a residential density that meets the requirements (95% CI=2,454 - 7,879).

Table 3. Relationship between Humidity and the Incidence of Pulmonary Tuberculosis

Humidity	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	112	56,0	60	30,0			
Qualified	88	44,0	140	70,0	0,001	2,970	(1,968 - 4,482)
Total	**200**	**100**	**200**	**100**			

The results obtained in Table 3 show that the proportion of unqualified humidity is more in the case of 112 respondents (56,0%) than in the control of 60 respondents (30,0%). Based on the results of statistical tests shows that there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with a value of p=0,001. Based on the statistical test, the Odds Ratio (OR) value =2,970 which indicated that respondents who had humidity that did not meet the requirements had a 2,970 times greater risk of suffering from pulmonary tuberculosis compared to those who had humidity that met the requirements (95% CI=1,968 - 4,482).

Table 4. Relationship between Temperature and the Incidence of Pulmonary Tuberculosis

Temperature	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	167	83,6	171	85,6			
Qualified	33	16,4	29	14,4	0,679	0,858	(0,499 – 1,476)
Total	**200**	**100**	**200**	**100**			

The results obtained in Table 4 show that the proportion of unqualified temperature is less in the case of 167 respondents (83.6%) than in control 171 respondents (85.6%). Based on the results of statistical tests shows that there is no relationship between occupancy density and the incidence of pulmonary tuberculosis with a p value = 0.679.

Table 5. Relationship between Natural Lighting and the Incidence of Pulmonary Tuberculosis

Natural Lighting	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	142	71,0	53	26,4			
Qualified	58	29,0	147	73,6	0,001	6.791	(4,382 – 10,523)
Total	**200**	**100**	**200**	**100**			

The results obtained in Table 5 show that the proportion of natural lighting that does not qualified is more in the case of 142 respondents (71.0%) than in control 53 respondents (26.4%). Based on the results of statistical tests shows that there is a relationship between occupancy density and the incidence of pulmonary tuberculosis with a p value = 0.001. Based on the statistical test, the Odds Ratio (OR) value = 6.791 which indicates that respondents who have natural lighting that does not meet the requirements have a 6.791 times greater risk of suffering from pulmonary tuberculosis compared to those who have natural lighting that meets the requirements (95% CI=4,382 – 10,523).

Table 6. Relationship between Ventilation Area and the Incidence of Pulmonary Tuberculosis

Ventilation Area	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	173	86,4	176	88,0			
Qualified	27	13,6	24	12,0	0,764	0,874	(0,485 – 1,574)
Total	**200**	**100**	**200**	**100**			

The results in Table 6 show that the proportion of ventilation area that does not qualified is less in the case of 173 respondents (86.4%) compared to control respondents (88.0%). Based on the results of statistical tests shows that there is no relationship between occupancy density and the incidence of pulmonary tuberculosis with a p value = 0.764.

Table 7. Relationship between Air Change Per Hour (ACH) and the Incidence of Pulmonary Tuberculosis

Air Change Per Hour (ACH)	Pulmonary Tuberculosis				p	OR	CI 95%
	Case		Control				
	f	%	f	%			
Unqualified	159	79,6	152	76,0			
Qualified	41	20,4	48	24,0	0,471	1.225	(0,764 – 1,964)
Total	**200**	**100**	**200**	**100**			

The results obtained in Table 7 show that the proportion of Air Change Per Hour (ACH) that does not qualified is more in the case of 159 respondents (86.4%) than in control 152 respondents (76.0%). Based on the results of statistical tests shows that there is no relationship between occupancy density and the incidence of pulmonary TB with a p value = 0.471.

DISCUSSION

Relationship between Residential Density and the Incidence of Pulmonary Tuberculosis

Residential density is the floor area in the house divided by the number of family members of the occupants. The density of occupants in one house will affect the occupants. Excessive residential density creates unhealthy conditions. Besides that, it can cause a lack of oxygen consumption, and if one of the family members is infected with pulmonary TB, then the residential density will be a risk factor for transmission (Fitriani, 2020). Occupancy density is categorized as eligible if per 8 m² is occupied by no more than two people except children under five years (Meo et al., 2022).

Housing density can be a risk factor for TB transmission because it is related to the quality of air exchange in the house. In addition, the denser the number of occupants in one room will cause higher humidity caused by human sweat, and when breathing humans release water vapor (Kenedyanti et al., 2017). In a closed room with many occupants, the humidity will be higher than outdoors or in a less crowded room. Humidity plays a role in the growth of microorganisms including tuberculosis (TB) bacteria. The dense number of occupants also

allows more frequent contact between people with pulmonary tuberculosis and family members, thus accelerating disease transmission (Lolan et al., 2022). To reduce the risk factor of residential density, it can be done by maximizing air circulation in the house, such as windows and doors that are often opened, or by regulating the density of occupants in existing rooms (Monintja, 2020).

Researchers assume that residential density has an influence because the denser the house, the air circulation will not run properly, besides that if the house is in a dense condition, it will trigger an increase in humidity values and a stuffy feeling. Statistical results show a relationship between residential density and the incidence of pulmonary tuberculosis with a p value = 0.001. Based on the housing density category results, that does not meet the requirements more in cases 58 respondents (29.0%) than in control 17 respondents (26.4%). Based on the statistical test, the Odds Ratio (OR) value = 4,397 which indicates that respondents who have a residential density that does not meet the requirements are 4,397 times more likely to suffer from pulmonary tuberculosis than those who have a residential density that meets the requirements (95% CI=2,454 - 7,879).

This research is in line with research Konde et al., (2020) which states that there is a relationship between occupancy density and Pulmonary Tuberculosis. Because people who live in houses with an occupancy density of $<8m^2$ do not meet the requirements have a higher risk of suffering from pulmonary tuberculosis compared to respondents who live with a residential density that meets the requirements of $8m^2$. Having a house area that is not proportional to the number of occupants in the house will cause it to be overcrowded, this is unhealthy because it can cause a lack of oxygen consumption in the room. If one family member has an infectious disease, it will easily spread to other family members.

In addition, this study's results align with the findings of Kusrianti et al., (2019) that occupancy density has a relationship with pulmonary tuberculosis. Odds Ratio test results = 2.455 > 1, where the value is Lower Limit (0.730) and Upper Limit (8.249), this means that occupancy density is a risk factor for the occurrence of smear TB+.

Relationship between Residential Humidity and the Incidence of Pulmonary Tuberculosis

Humidity is the total content of water vapor in the air which can be measured with a thermohygrometer with units (%). Indoor air humidity that is ideal and meets the requirements ranges from 40-60%, humidity is a factor in the growth of bacteria and viruses (Kusrianti & Said, 2019).

High humidity can create an aggregation of airborne particles, and larger particles are believed to cause infection compared to small particles. High humidity conditions can cause dry mucosa and reduce the ability to fight microorganisms entering the respiratory tract (Nuraini et al., 2022). Air humidity that is too high or too low can be a place for the growth of microorganisms, including mycobacterium tuberculosis (Amaliah et al., 2022). The cause of high humidity in homes/residential areas can be caused by several factors, including the construction of the house's leaky roof, the house's floor and the house's walls which are not waterproof so that water can seep through the pores of the construction (Zulaikhah et al., 2019).

Suppose the air humidity is less than 40%. In that case, efforts can include using a humidifier that can increase humidity, opening house windows, expanding house windows, and modifying the physical building (increasing lighting and air circulation). If the air humidity exceeds 60%, efforts can include installing glass roof tiles and using tools to reduce humidity, such as dehumidifiers (Sriratih et al., 2021).

The researcher assumed that the level of humidity in the house has an influence to trigger the occurrence of pulmonary tuberculosis because at the time of the interview, it was found that many houses rarely opened doors and windows so that there was no air exchange from outside to inside or from inside to outside and caused an increase in the level of humidity in the house which could trigger the growth of Mycobacterium tuberculosis bacteria. The statistical test results showed an association between occupancy density and the incidence of pulmonary tuberculosis with a value of p=0.001. It shows that the proportion of unqualified humidity is more in the case of 112 respondents (56.0%) than in the control of 60 respondents (30.0%). Based on the statistical test, the Odds Ratio (OR) value =2,970 which indicated that respondents who had humidity that did not meet the requirements had a 2,970 times greater risk of suffering from pulmonary tuberculosis compared to those who had humidity that met the requirements (95% CI=1,968 - 4,482).

In this study, houses with unqualified humidity (<40% and >60%) had a 2.9 times risk of disease compared to those that met the humidity requirements (40% - 60%). If the humidity condition in the room is >70%, it will facilitate the breeding of microorganisms, one of which is mycobacterium tuberculosis (Zulaikhah et al., 2019). This study is in line with Nuraini (2022), who states that there is a relationship between humidity and pulmonary tuberculosis disease (p = 0.0001; OR = 14.875; 95% CI = 3.865-57.251) which means that humidity has a risk level 14.875 is greater to trigger the emergence of pulmonary tuberculosis if it does unqualified (Nuraini et al., 2022).

Relationship between Residential Temperature and the Incidence of Pulmonary Tuberculosis

Temperature is the amount of heat of an object, while the air temperature is a measure of the heat-coldness of the earth's surface and atmosphere. Air temperature is expressed in Celsius, Fahrenheit, Reamur, or Kelvin units measured using a temperature measuring device called a Thermometer. Temperature is invisible but can be felt high and low. Temperature is one of the factors for the proliferation of TB bacteria in the air. People with pulmonary TB cough or sneeze can produce about 3000 sputum splashes. Sputum containing tuberculosis bacteria germs can survive in the air at room temperature for several hours (Lestari Muslimah, 2019). The temperature range favored by Mycobacterium tuberculosis bacteria is 25ºC - 40ºC, and the bacteria will grow optimally at 31ºC - 47ºC (Aditama et al., 2019). The house air temperature is considered qualified if it is 18 ºC - 31ºC (Wahyudi et al., 2019).

At the time of the interview with the respondents, the temperature of the home environment in urban areas does tend to be hot plus the home environment tends to be stuffy because there is no air circulation from outside to inside or vice versa. The results of the statistical test showed that there was no relationship between occupancy temperature and the incidence of pulmonary tuberculosis with a value of p = 0.679, indicating that the proportion of unqualified temperature was less in the case of 167 respondents (83.6%) than the control 171 respondents (85.6%).

The results of this study are in line with research Rahmawati et al., (2021) which states that there is no relationship between house temperature and the incidence of tuberculosis (p value = 0,353). Research Widiati et al., (2022) states that there is no relationship between temperature and pulmonary tuberculosis (p value = 0,775). Temperature conditions play a role in the growth of Mycobacterium tuberculosis bacteria, the growth rate of these bacteria is determined based on the temperature of the air around them. A room suitable for health is not only influenced by temperature factors but various other factors such as humidity and air circulation occurs in the room. One of the efforts to maintain the temperature of the house is with sufficient ventilation area, which is 10% of the floor area of the house (Monintja, 2020).

Relationship between Natural Lighting and the Incidence of Pulmonary Tuberculosis

Lighting is something that provides light (rays) or illuminates, lighting includes natural lighting and artificial lighting. Natural lighting is a source of lighting that comes from sunlight while artificial lighting is lighting produced by light other than sunlight (Satwikasari, 2018). The ideal lighting value (lux) in the house is at least 60 lux (Meo et al., 2022). Lighting that is

too high can increase room temperature while lighting that is too low can increase eye accommodation. Lighting in the living space should fulfill the need to see the surroundings. Natural and artificial lighting will be a risk factor for TB disease when lighting is insufficient because it can increase room humidity, which can favor the growth of tuberculosis bacterial microorganisms (Septidwina et al., 2022).

The lack of sunlight entering the house tends to cause the air to become more humid and the room to become darker so that bacteria can survive for days or even months (KEPMENKES RI No.829/Menkes/SK/VII/1999 About Housing Health Requirements). Insufficient lighting can be caused by several factors, including lack of ventilation, not opening existing windows, and sunlight blocked by the walls of neighboring houses due to dense settlements (Lolan et al., 2022).

The researcher assumed that there was a relationship between the level of natural lighting and the incidence of tuberculosis because all the light measured was in rooms that were usually used for daily activities. For example, if respondents did a lot of their work in the living room, the lighting level measured was done in the living room without the use of lamps and relied on the light coming in from the windows and doors that were opened. The statistical test results show a relationship between occupancy density and the incidence of pulmonary TB with a value of $p = 0.001$. Indicating that the proportion of natural lighting that does not meet the requirements is more in the case of 142 respondents (71.0%) than in control 53 respondents (26.4%). Based on the statistical test, the Odds Ratio (OR) value = 6.791 which indicates that respondents who have natural lighting that does not meet the requirements have a 6.791 times greater risk of suffering from pulmonary tuberculosis compared to those who have natural lighting that meets the requirements (95% CI=4,382 – 10,523).

This study is in line with research conducted by Septidwina et al., (2022) which states that there is a relationship between lighting and the incidence of pulmonary tuberculosis ($p = 0.004$). Research Zulaikhah et al., (2019) states that there is a significant relationship between lighting and the incidence of Pulmonary Tuberculosis transmission (p value=0,001), where respondents who live in homes with inadequate lighting have a risk of 4.89 times greater risk of developing pulmonary tuberculosis, compared to respondents who live in homes with adequate lighting.

Light has properties that can kill bacteria. In addition, ultraviolet light from sunlight is often used to treat rachitis. Adequate lighting to illuminate the space in the house is one of the human health needs (Tamrin, 2022). This lighting can be obtained by setting artificial light

from lamps and natural light from sunlight. Natural lighting is obtained from sunlight that enters through vents or windows on the walls of the house or from glass tiles (Fika & Aryanti, 2021). Adequate sunlight is essential to human health because sunlight can kill bacteria that are not good for the human body in the house, including mycobacterium tuberculosis bacteria (Sriratih et al., 2021). Sunlight can also kill pathogenic bacteria that cause various other diseases, the ultraviolet rays in sunlight can kill mites. Lack of sunlight entering the house tends to cause the air to become humid, and the room becomes dark so that bacteria can last for days to months in the house (Kenedyanti et al., 2017).

Relationship between Ventilation Area and the Incidence of Pulmonary Tuberculosis

Ventilation is a place for the exit and entry of air and also as an outside lighting hole, it functions to keep the airflow fresh (Nurany et al., 2022). entilation of houses that meet the requirements according to the regulations is the area of permanent ventilation ≥ 10% of the floor area (Rojali et al., 2020). Unqualified ventilation (<10% of the floor area) can result in reduced oxygen concentrations and increased carbon dioxide concentrations that are toxic to the occupants, in addition to unqualified ventilation can cause an increase in room humidity caused by the obstruction of the air exchange process and sunlight entering the house (Monintja, 2020). As a result, the mycobacterium tuberculosis bacteria released by TB patients when coughing and sneezing can survive in the room and be inhaled through the respiratory process (Mindiharto, 2020). The assessment of house ventilation was done by comparing the ventilation area with the floor area of the house using a meter. The type of ventilation measured is natural ventilation that comes from sunlight that can enter through windows, doors, vents, and holes in the walls (Kusrianti at al., 2019).

The results found in the field are that most people do not utilize ventilation properly because the air from outside tends to be hot and makes the occupants of the house feel uncomfortable, making the occupants of the house close all the vents to reduce the heat felt by the occupants. The statistical test results show no relationship between occupancy density and the incidence of Pulmonary TB with a p value = 0.764. The proportion of ventilation area that does not meet the requirements are less in the case of 173 respondents (86.4%) compared to control respondents (88.0%).

The results of this study are in line with research Mariana et al., (2017) states that there is no relationship between home ventilation and the incidence of pulmonary tuberculosis (p value=0,461). Research Imaduddin et al., (2019) stated that there was no relationship between the ventilation area of the house and the incidence of pulmonary TB p-value=0,786. This study

is not in line with the research of Septidwina et al., (2022) which shows a significant relationship between the ventilation area of the house and the incidence of pulmonary TB which shows a value of p = 0.001. Other research results Dewi et al., (2019) that there is a relationship between ventilation area and the incidence of pulmonary tuberculosis (p = 0,014).

This study is not in line with research conducted by Kusrianti et al., (2019) which shows that the ventilation area has no relationship with the incidence of pulmonary tuberculosis (p = 0.168). Ventilation affects the air dilution process and also dilutes the concentration of TB germs and other germs, where the germs will be carried out and die exposed to ultraviolet light (Sriratih et al., 2021). The journey of pulmonary TB germs, after being released by the patient through coughing will be inhaled by people around him and reach the lungs. Good ventilation will ensure air exchange so that the concentration of droplets can be reduced to reduce the possibility that someone will be infected with pulmonary TB germs (Nuraini et al., 2022).

Relationship between Air Change Per Hour and the Incidence of Pulmonary Tuberculosis

Air Change Per Hour (ACH) is the amount of air volume in a room that changes every hours (Imaduddin et al., 2019). ACH is the ratio of the volume of air flowing through a room in a specific time interval divided by the volume of the room, this ratio is expressed as the number of air changes per hour. ACH is the ratio of the overall volume of air that enters and leaves the room at a specific time divided by the area of the room. ACH plays a role in infection transmission and disease control (Setiyowati, 2020).

Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017 concerning Guidelines for Infection Prevention and Control in Health Service Facilities states that, Air Change Per Hour (ACH) is essential to strive for air exchanges 12 times per hour as an effort to prevent transmission of tuberculosis (Kementerian Kesehatan RI, 2017). High air changes can also accelerate circulating pathogens and reduce the risk of airborne infections (Zulaikhah et al., 2019).

The air in the room will circulate due to ventilation. The maximum and minimum amount of air exchange per hour is 1-60 (Rojali et al., 2020). If the ACH is less than 1 per hour, it will not affect the ventilation system or in other words, there will be no air exchange, whereas if the air exchange is more than 60 times per hour, it will cause discomfort (Setiyowati, 2020).

The results found in the field are that each house has many vents but they are not opened so there is no air exchange. Coupled with the density of houses between residents which causes a reduction in the amount of wind entering the house because it is blocked by other houses.

ACH is highly dependent on air exchange from outside to inside and vice versa. The statistical test results showed no relationship between occupancy density and the incidence of pulmonary tuberculosis with a value of p = 0.471. This indicated that the proportion of ACH (Air change per hour) that did not meet the requirements were higher in the cases of 159 respondents (86.4%) than 152 controls respondents (76.0%).

In this study, it was found that those fulfilling the ACH room requirements ≥ 12 had a risk of developing pulmonary TB disease compared to those who did not meet the ACH room requirements < 12 (Rojali at al., 2020).

CONCLUSIONS

The conclusion obtained in this study is that there are several factors of the quality of the physical environment of the house that affect the incidence of pulmonary TB in Tangerang City. The study found a relationship between the variables of occupancy density, humidity and natural lighting. The variables of ventilation area, temperature and ACH had no relationship to the incidence of pulmonary tuberculosis in Tangerang City. Based on these findings, it is expected that the community will pay more attention to the quality of the physical environment of the house that meets the requirements so that efforts can be made to prevent the occurrence of pulmonary tuberculosis disease.

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