The Relationship between House Conditions and the Household Contacts with the Incidence of Children's Pulmonary Tuberculosis

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ABSTRACT

Tuberculosis (TB) is a high risk in vulnerable groups with low immunity, such as children. Environmental factors and household contacts influence the high incidence of tuberculosis. This study aimed to analyze the relationship between housing conditions and the presence of household contacts with the incidence of pulmonary tuberculosis in children. This study used a case-control design. This study used a case-control design at the Puskesmas Kedaton Bandar Lampung from December 2023 to January 2024. The total sample was 58 children (29 cases and 29 controls), selected using Simple Random Sampling. The variables of this study were residential density, humidity, lighting, floor type, ventilation area, and the presence of household contacts. This study used univariate analysis, bivariate analysis with chi-square, and multivariate with multiple logistic regression. This study shows that there is a relationship between lighting (p=0,008), ventilation area (p=0,032), and the presence of household contacts (p<0,001) with the incidence of pulmonary TB in children. The factor most associated with the incidence of pulmonary TB in children was lighting (OR=6.061; 95% CI=1.768-20.777), which means children with home lighting that does not meet the requirements have a 6.061 times higher risk of experiencing childhood pulmonary TB than those who meet the lighting requirements. There is a relationship between lighting, ventilation area, and the presence of household contacts with the incidence of pediatric pulmonary tuberculosis in the Puskesmas Kedaton, Bandar Lampung working area.

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INTRODUCTION

Tuberculosis is a chronic disease caused by the bacterium Mycobacterium tuberculosis, which is in the form of a bacillus (rod) known as Acid-Fast Bacillus. Most of these bacteria generally attack the lung organs, which is called extrapulmonary TB. Tuberculosis carries a risk of infecting vulnerable groups who have low immune systems, such as children aged 0-14 years (Ministry of Health RI, 2020).

Based on data from the Ministry of Health RI (2022) it was found that on Lampung Province is included among the 20 provinces with the highest number of childhood TB cases in Indonesia (2653 cases). Of the total cases, Bandar Lampung City contributed 790 cases of childhood TB. This is the highest TB case in Lampung Province (Lampung Provincial Health Office, 2022). In 2022 pediatric TB case detection coverage will be 59.4%, higher than in 2021, namely 35.1% (Bandar Lampung Health Office, 2022). Tuberculosis is a health problem because

this disease can cause children to experience failure, disability, and even death. A child who has TB can experience respiratory problems and decreased lung function (Martinez et al., 2023).

The high incidence of TB disease is influenced by various interrelated factors, namely the host, the agent, and the environment. Home physical environmental factors that influence the incidence of pulmonary TB are residential density, humidity, ventilation, lighting, floors, and walls (Sari, 2022). The presence of household contacts can also influence risk factors for TB transmission. Contact with pulmonary TB sufferers causes bacteria to quickly enter the child's body because the child's immune system is still weak (Singh et al., 2013).

The high number of cases of TB in children causes a significant impact on a child, so it is essential to know the risk factors that can influence this incident. Researchers conducted research in the working area of Puskesmas Kedaton, Bandar Lampung because it has the highest number of pediatric TB cases in Bandar

Lampung. This is a reason for researchers to research the relationship between housing conditions and the presence of household contacts with the incidence of pulmonary tuberculosis in children at the Puskesmas Kedaton, Bandar Lampung working area.

METHOD

This case-control study was conducted in the working area of Puskesmas Kedaton, Bandar Lampung, Indonesia, which has the highest number of pediatric TB cases in Bandar Lampung City from December 2023 to January 2024. The total of population cases was 45 people, and the number of respondents recruited using simple random sampling was 58, consisting of 29 people in each case and a control group based on address data from the Puskesmas Kedaton, Bandar Lampung. This sample was selected through the categorical unpaired hypothesis test sample formula, with Z1-α/2: standard deviation of alpha, with the α value set at two-way Zα 1.96 and Z1-β: standard deviation is different, with the β value set at 90% (Adiputra et al., 2021). The inclusion criteria for the case group are pediatric pulmonary TB patients aged 0-14 years, have a complete address or reside in the work area of the Kedaton Public Health Center, Bandar Lampung, Indonesia, and are recorded as having received treatment within January to September 2023, while the inclusion criteria for the group controls, namely respondents were children aged 0-14 years, respondents had an examination at the Kedaton Public Health Center, had a complete address or lived in the working area of the Kedaton Public Health Center, Bandar Lampung, respondents were not diagnosed with pulmonary TB. Meanwhile, the exclusion criteria in this study were patients who had moved house, and the house had been physically renovated within the previous 12 months, respondents who had died, been diagnosed with HIV, had comorbidities, and were not willing to be respondents for this study.

The variables in this study are age, gender, residential density, humidity, lighting, floor type, ventilation area, and presence of household contacts. The measurements of each respondent were carried out only once. Children's age consists of three categories, namely toddlers (12 months-59 months), preschool children (60 months-72 months), and school-age children (>6 years-17 years) (Ministry of Health RI, 2014). Residential density is a comparison between the area of the house and the occupants of the house in the qualifying category, namely if it is ≥8 m²/person.

In contrast, it does not meet the requirements if it is <8 m²/person. Humidity is the average water content in the house room as measured by a thermohygrometer with a qualifying category if ≥40% and ≤60, while not qualifying if <40% and >60%. Lighting is the condition of natural light during the day as measured by a TASI TA8133 lux meter with a qualifying category if ≥60 lux, while not qualifying if <60 lux (Ministry of Health RI, 2014). The type of floor that meets the requirements is a floor that is watertight (ceramic, cement, plaster), whereas it does not meet the requirements if the floor is not watertight (soil, bamboo, wooden planks, lontar) (Pradita *et al.*, 2018). The ventilation area is the ratio between the ventilation holes and the floor area multiplied by 100%, with the category meeting the requirements if ≥10% while not meeting the requirements if <10% (Ministry of Health RI, 2011).

This research uses univariate analysis, bivariate analysis using chi-square, and multivariate analysis using logistic regression analysis. This research has received ethical permission from the Health Research Ethics Committee, Faculty of Medicine, Universitas Lampung 3974/UN26.18/PP.05.02.00/2023.

RESULTS

Table 1. Distribution of variables

Variables	Case		Control	
	n	%	n	%
Age				
Toddler	13	44.8	19	65.5
Preschool age	10	34.5	5	17.2
School-age	6	20.7	5	17.3
Gender				
Male	17	58.6	14	48.3
Female	12	41.4	15	51.7
Residential density				
Not Qualify	11	37.9	8	27.6
Qualify	18	62.1	21	72.4
Humidity (Mean±SD = 69.90±7.752)				
Not Qualify	24	82.8	19	65.5
Qualify	5	17.2	10	34.5
Lighting (Mean±SD=55.10± 29.627)				
Not Qualify	21	72.4	10	34.5
Qualify	8	27.6	19	65.5
Floor-type				
Not Qualify	0	0.0	0	0.0
Qualify	29	100.0	29	100.0
Ventilation				
Not Qualify	22	75,9	13	44,8
Qualify	7	24,1	16	55,2
The existence of household contacts				
Yes	12	41,4	0	0,0
No	17	58,6	29	100,0

Based on Table 1, it was found that the majority of cases were male (58.6%) and were in the toddler age group (44.8%). Residential density in the majority of cases was qualified 62.1%), house humidity in the majority of cases was not qualified (82.8%), lighting in the majority of cases was not qualified (72.4%), floor types for each group all qualified (100%), ventilation in the majority of cases were not qualified (75.9%). The majority of cases do not have household contacts (58.6%).

Table 2. The relationship between residential density, humidity, lighting, ventilation area, and the existence of household contacts with the incidence of pulmonary TB in children

| Variables | The incidence of pulmonary TB in children | | | | Total | | p-value | OR (95%CI) |
| | Yes | | No | | | | | |
	n	%	n	%	n	%		
Residential density								
Not Qualify	11	57.9	8	42.1	19	100	0.576	-
Qualify	18	46.2	21	53.8	39	100		
Humidity								-
Not Qualify	24	55.8	19	44.2	43	100	0.230	
Qualify	5	33.3	10	66.7	15	100		
Lighting								4.988
Not Qualify	21	67.7	10	32.3	31	100	0.008	(1.631-15.252)
Qualify	8	29.6	19	70.4	27	100		
Ventilation								3.868
Not Qualify	22	62.9	13	37.1	35	100	0.032	(1.260-11.880)
Qualify	7	30.4	16	69.6	23	100		
The existence of household contacts								
Yes	12	100	0	0	12	100	<0.001	-
No	17	37	29	63	46	100		

Based on Table 2, it is known that chi-square analysis shows that there is a relationship between lighting (p=0.008), ventilation area (p=0.032), and the presence of household contacts (p<0.001) with the incidence of childhood pulmonary tuberculosis. There is no relationship between residential density (p=0.576) and humidity (p=0.230) with the incidence of pediatric pulmonary tuberculosis in the working area of Kedaton Public Health Center, Bandar Lampung.

Table 3. Multivariate analysis

Variables	B	p-value	OR (95%CI)
Lighting	1.802	0.004	6.061 (1.768-20.777)
Ventilation area	1.581	0.014	4.860 (1.373-17.209)
Constant	-1.932	0.003	0.145

Based on Table 3, it was found that the final modeling showed that the variable most related to the incidence of pulmonary TB in children was lighting, with a p-value of 0.004 (p<0.05) which means there was a relationship between lighting and the incidence of TB in children with an OR value of 6.061 (95%CI=1.768-20.777) which means that children with home lighting that do not meet the requirements have a 6.061 times higher risk of experiencing childhood pulmonary TB than those who meet the lighting requirements.

DISCUSSION

Bivariate analysis showed no relationship between residential density and the incidence of pulmonary TB in children. These results are in line with research by Azzahrain et al. (2023) found that there is no relationship between residential density and the incidence of pulmonary TB in children, with a p-value of 0.238 (p>0.05). Residential density is a risk factor for pulmonary TB. In this study, residential density in the respondents' houses was unrelated to the incidence of pulmonary TB. The respondent's house having an area proportional to the number of occupants will make the house less densely occupied. The presence of residential density that meets the requirements in the respondent's house means that the incidence of pulmonary TB in children is most likely to be caused by other factors, such as the environment around the residence, which is quite dense and close together and TB transmission which is acquired from outside the home. Population density also influences a child's risk of developing TB because dense populations cause more intense interactions

and influence the spread of Mycobacterium tuberculosis bacteria (Pratiwi, 2021).

Based on Table 3, it shows that there is no relationship between humidity and the incidence of pulmonary TB in children. This finding aligns with Putri's (2019) research that there is no relationship between humidity and the incidence of pulmonary TB in the working area of the Karya Jaya Palembang Public Health Center, which has a p-value of 0.107. Air humidity is one of the factors that influences the incidence of pulmonary TB. Humidity is the amount of water vapor in the air, expressed as a percentage of the amount required for saturation at the same temperature. Humidity in a house that meets the requirements is a minimum of 40–60% (Ministry of Health RI, 2011). The humidity level in the house is measured using a thermohygrometer from 10.00 a.m. to 02.00 p.m. at a temperature of 26–36ºC and sunny weather conditions (Romanda, 2019). However, in this study, some measurements were not carried out at the recommended times, allowing differences to occur and influencing the results of humidity measurements. Based on Table 4.1, the humidity variable shows that the average humidity is 66.71%. Another thing that might influence it is changes in weather and humidity conditions; respondents experienced erratic results that caused the air in the house to change (Dhiu et al., 2022). This research also shows a relationship between lighting and the incidence of pulmonary TB in children (p-value=0.008), with OR (95%CI) being 4.988 (1.631-15.252). This is in line with previous research, which showed a relationship between lighting and the incidence of pulmonary TB (Mardianti et al., 2020). A house with lighting conditions that meet the lighting level requirements of≥60 lux (Ministry of Health RI, 2011). House lighting levels were measured using a lux meter at 10.00 a.m.-02.00 p.m., with a temperature between 26ºC-36ºC and sunny weather. Table 1 shows that the majority of lighting that does not meet the requirements is in the case group at 72.4%. Most houses have minimal ventilation, so little sunlight comes in. The presence of sunlight inhibits TB bacteria. High lighting levels (≥60 lux) can kill *Mycobacterium tuberculosis* bacteria, thereby reducing the risk of pulmonary TB (Mardianti et al., 2020). Reducing TB transmission can be done by making home lighting conditions meet health standards because it can make it difficult for bacteria to grow (Muhyi et al., 2018).

Table 2 shows a relationship between the ventilation area and the incidence of pulmonary TB in children (p-value=0.032), with OR (95%CI) being 3.868 (1.260-11.880). This finding is in line with previous research, which showed a relationship between the extent of ventilation and the incidence of pulmonary TB in children. The ventilation area is an environmental indicator that plays a vital role in the occurrence of TB cases (Hasan et al., 2023). Based on Table 1, most houses with ventilation areas that do not meet the requirements are in the case group at 75.9% because most respondents in the case group have minimal ventilation. The lack of air exchange in the house due to ventilation areas not meeting health standards can increase the risk of transmitting bacteria that cause pulmonary TB. Inadequate ventilation can have a significant impact on the incidence of pulmonary TB (Hasan et al., 2023). Ventilation also affects the humidity level and air temperature in the room. Inadequate ventilation can cause an increase in air humidity in the room, thereby creating conditions that support the growth of pathogenic bacteria (Muslimah, 2019).

The study results show a relationship between the presence of household contacts and the incidence of pulmonary TB in children. Alin's research found a relationship between household contacts and the incidence of TB in children (Wardani et al., 2020; Stevany et al., 2021). Close contact with sufferers who have TB will be the primary source of trigger for transmission of TB bacteria because these bacteria can spread in the air when TB sufferers cough or sneeze; the droplets released can be inhaled by people in the house and facilitate the transmission of the bacteria (Stevany et al., 2021). Children have a higher risk of TB infection because their immune systems are still low and have not yet developed optimally, so bacteria can quickly enter their bodies (Yani et al., 2018). Having household contacts will increase the child's risk of being exposed to droplets of TB bacteria, so the child will be vulnerable to being exposed to TB disease (Wardani et al., 2020).

The results of the logistic regression test showed that the variable most related to the incidence of pulmonary TB in children was the lighting factor (p-value=0.004) with OR (95%CI) is 6.061 (1.768-20.777). This finding aligns with previous research stating that lighting was the factor most associated with the incidence of pulmonary TB. Home lighting that does not meet the requirements has a 3.423 times greater risk of contracting TB than home lighting that meets the requirements (Halim & Budi, 2016). Other research also found that lighting was the dominant factor related to the incidence of pulmonary TB (Hamidah et al., 2015). The function of house ventilation is to allow sunlight to enter the house and as a place for air to be exchanged between

inside and outside the house. The rapid spread of bacteria is supported by house ventilation conditions that do not meet standards, making a person vulnerable to TB (Putri, 2019). Natural lighting in the house can be obtained by having ventilation holes, windows, or doors that are frequently opened. Mycobacterium tuberculosis bacteria can die due to the influence of ultraviolet rays from sunlight entering the room (Hamidah et al., 2015). This finding contrasts with other research, which shows that the factor most associated with the incidence of pulmonary TB is the presence of household contacts. Having household contact will accelerate TB transmission because the source of contact is in the house. TB adults who frequently come into contact with children will increase the risk of TB infection in children (Abimulyani et al., 2023). However, in this study, based on Table 1, it was found that the majority of children who had pulmonary TB did not have household contacts, so it could be interpreted that the source of infection was mostly not from contacts within the household but from other factors, such as factors from outside the home or other factors not studied.

CONCLUSION

There is a relationship between lighting, ventilation area, and the presence of household contacts with the incidence of pediatric pulmonary tuberculosis in the Puskesmas Kedaton, Bandar Lampung working area. Lighting is the factor most related to the incidence of pediatric pulmonary tuberculosis in the Kedaton Bandar Lampung Community Health Center working area. Advice for the public, especially parents, to pay more attention to environmental aspects and history of household TB contacts to reduce the risk of contracting pulmonary TB in children.

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