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Relationship between Nutritional Status and Living Conditions with the Risk of Tuberculosis in Children

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Abstract

Children are very susceptible to TB infection. One of the causes of TB in children is nutritional status. Poor one causes a weak immune system, making contracting tuberculosis easier. In addition, living conditions can spread to children due to contact with active pulmonary TB in one household. This study aims to determine the relationship between nutritional status and living conditions with TB incidence in children. This case-control study involved 76 samples consisting of 38 cases and 38 controls. Research subjects were taken using the purposive sampling method. The subjects were children aged 0-18 years diagnosed with TB based on anamnesis, physical examination, tuberculin skin test, and chest X-ray. This study was conducted at Bhakti Medicare Sukabumi Hospital from July to December 2019. The results of the Chi-square test found that there was a relationship between nutritional status (p=0.023), ventilation area (p=0.043), and humidity (p=0.001). There is no relationship between age (p=0.639), gender (0.490), parental education (p=0.803), lighting (p=0.200), temperature (0.260), density (p=1.000), and type of floor (p=0.240).

Introduction

Tuberculosis (TB) is an infectious disease caused by bacteria from the Mycobacterium group, namely Mycobacterium tuberculosis (M.tb), which can attack the lungs and other organs (Roya-Pabon & Perez-Velez, 2016). TB in children can cause various problems, ranging from failure to thrive, disability, and even death. Clinical symptoms in children can be systemic or according to the related organs (Apriliasari et al., 2018; Osman et al., 2021; Thomas, 2017; Velayati, 2016). Common symptoms include persistent cough, weight loss, failure to thrive, fever for a long time, lethargy, and inactivity (Roya-Pabon & Perez-Velez, 2016).

In 2020, 1.5 million people will die from TB (including 214,000 people with HIV). TB is the 13th leading cause of death and the second infectious killer after COVID-19 worldwide. By 2020, eight countries accounted for two-thirds of the total 86% of new TB cases, with India leading the tally, followed by China, Indonesia, Philippines, Pakistan, Nigeria, Bangladesh, and South Africa (WHO, 2021). The number of tuberculosis cases in West Java Province reached 99,398, the highest in Indonesia in 2018 (Hariyani et al., 2020). By 2020, an estimated 1.1 million children worldwide will have TB. The proportion of pediatric TB cases among all cases treated in Indonesia from 2010 to 2018 ranged from 9.4% to 11% (Kementerian Kesehatan Republik Indonesia, 2011). TB in children and adolescents is often overlooked by healthcare providers and is difficult to diagnose and treat (WHO, 2021).

The increase in TB cases is influenced by individual factors. Such as the immune system, nutritional status, personal hygiene, and the density of the residential environment. Housing that does not meet physical requirements will cause health problems. Such as pulmonary tuberculosis. Room area, ventilation, floor construction, and sunlight lighting must meet sanitary needs (Hayana et al., 2020). Research

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supports this (Haeruddin et al., 2020) that environmental factors such as occupancy density, ventilation, and inappropriate room temperature can cause pulmonary TB. TB is more easily transmitted to people who live in dense residential areas, lack of sunlight entering the house and less sunlight (Haeruddin et al., 2020).

One of the risk factors for contracting TB is nutritional status. If it is poor, it can cause immune system disorders, thereby increasing the risk of contracting TB. Children with poor nutrition will be thin, weak, and susceptible to TB infection. It is because the immune system is reduced in children. Poor nutritional status can affect the body's response to the formation of antibodies and lymphocytes against disease germs. This formation requires protein and carbohydrate raw materials so that in children with poor nutrition, the production of antibodies and lymphocytes is inhibited (Ren et al., 2019). This study aims to determine the relationship between nutritional status and living conditions with TB incidence in children.

Method

This case-control study was conducted at Bhakti Medicare Sukabumi Hospital from July to December 2019. Research subjects were taken using the purposive sampling method. The number of samples for the case and control groups was 38 samples each. All subjects were diagnosed with tuberculosis based on anamnesis, physical examination, tuberculin skin test, and chest X-ray.

The inclusion criteria for this study were children aged 0-18 years diagnosed with TB. Exclusion criteria for this study were HIV-positive or parental history of HIV, recent contact with a case of active TB, children with long-standing TB who recovered, on treatment with immune-suppressing agents, and patients undergoing long-term systemic corticosteroid therapy (> of six weeks). Determination of nutritional status is carried out based on body weight (BB) according to body length (PB) or height (TB) (BB/PB or BB/TB). The growth chart used as a reference is the 2006 WHO charts for children under five years old and the 2000 CDC chart for children over five years old. For ages above five to 18 years, the growth chart refers to the 2000 CDC, with the 2007 WHO chart not having a weight/TB chart and data from WHO 2007 representing the 1981 NCHS smoothing (Ikatan Dokter Anak Indonesia (IDAI), 2011). Standards for determining ventilation area, humidity, lighting, temperature, occupancy density, and floor type follow the Regulation of the Minister of Health of the Republic of Indonesia No. 1077 (Kementerian Kesehatan, 2011).

Data analysis used the Chi-square test to determine the relationship between nutritional status and living conditions with the incidence of pulmonary TB in children. Residential conditions include ventilation area, humidity, lighting, temperature, occupancy density, and type of floor. Data analysis using SPSS version 25 software. P-value < 0.05 indicates a significant relationship.

Result and Discussion

We recruited 76 samples of 38 TB-positive children (case group) and 38 TB-negative children (negative group). A total of 46 (61%) were aged 0-5 years, and 30 (39%) were 6-18. Most positive TB were aged 0-5 years, each 22 (29%). Children aged 0-5 years are more susceptible to infection because they have immunity that has not yet functioned and developed optimally (Kollmann et al., 2017; Patra et al., 2015). In this study, there was no relationship between age and the incidence of pulmonary TB in children (p=0.639). This result is similar to the study (Yani et al., 2018), which found no relationship between age and the incidence of pulmonary TB in children (p = 0.609).

Table 1. Result of The Study

Variable	Diagnosis TB (N=76)		Total	p-value	OR (95%CI)
	Negative n (%)	Positive n (%)	n (%)		
Age (year)					
0-5	24 (32)	22 (29)	46 (61)	0.639	1.247 (0.496 – 3.133)
6-18	14 (18)	16 (21)	30 (39)		
Gender					
Male	22 (29)	19 (25)	35 (46)	0.490	0.727 (0.294 – 1.798)
Female	16 (21)	19 (25)	41 (54)		
Nutritional status					
Severely wasted	1 (1)	0 (0)	1 (1)	0.023	
Wasted	8 (11)	19 (25)	27 (36)		
Normal	29 (38)	19 (25)	48 (63)		
Parental Education					
Did not graduate from high school	11 (15)	12 (16)	23 (30)	0.803	0.883 (0.331 – 2.351)
Graduated from senior high school	27 (36)	26 (34)	53 (70)		
Ventilation Area					
not eligible	23 (30)	31 (41)	54 (71)	0.043	0.346 (0.122 – 0.986)
qualify	15 (20)	7 (9)	22 (29)		
Humidity					
Not qualify	9 (12)	23 (30)	32 (42)	0.001	0.202 (0.075 – 0.545)
qualify	29 (32)	15 (20)	22 (29)		
Lighting					
Not qualify	25 (33)	30 (40)	55 (72)	0.200	0.513 (0.183 – 1.434)
qualify	13 (17)	8 (11)	21 (28)		
Temperature					
Not qualify	32 (42)	28 (37)	60 (79)	0.260	1.905 (0.614 – 5.909)
qualify	6 (8)	10 (13.2)	16 (21)		
Occupancy Density					
Not qualify	23 (30)	23 (30)	46 (61)	1.000	1.000 (0.399 – 2.509)
qualify	15 (20)	15 (20)	30 (39)		
Type of Floor					
Not qualify	3 (4)	0 (0)	3 (4)	0.240	
qualify	35 (46)	38 (50)	73 (96)		

Source: Primary Data, 2019

In this study, there was no relationship between gender and the incidence of TB in children (p=0.490). The male and female sexes had the same percentage in the case group, namely 19 (25%) subjects. In the control group, 22 (29%) were male. These results are similar to studies (Yani et al., 2018) that there is no gender relation with TB incidence in children. However, this result is different from research (Nurjana et al., 2019) which found that male children were most likely to be infected with pulmonary TB 1.6 times greater than females.

Overall, the normal nutritional status was 48 (63%). In the case group, 19 (25%) had less and normal nutritional status. There were no children severely wasted in the case group. Based on statistical analysis, there was a relationship between nutritional status and the incidence of pulmonary TB in children (p=0.023). This result is the same as the research (Hajarsjah et al., 2018; Widyastuti et al., 2021). The first factor that plays a role in the nutritional status of malnutrition is age. Age less than 60 months was associated with significantly more detrimental nutritional status than age over 60 months (Dieu et al., 2017). Nutritional status is related to the risk of suffering from TB (Aibana et al., 2016; Farhadi & Ovchinnikov, 2018; Feleke et al., 2019). Poor nutritional status caused by inadequate dietary

intake can result in low body resistance, making it susceptible to TB germs. Malnourished children are more susceptible to infection due to altered immune responses (Jenum et al., 2014). Nutrition in the perinatal period and early childhood is necessary for the thymus, which has an essential role in the maturation of T lymphocytes (Savino & Dardenne, 2010). Thymic atrophy in malnourished children is associated with increased infant mortality due to infection (Losada-Barragán et al., 2019; Nabukeera-Barungi et al., 2021). Protein-energy malnutrition reduces the size of the thymus and cortical thymocyte apoptosis, changes the microenvironment around lymphoid tissue and epithelial cells, and decreases the hormone production and proliferation of thymocytes (Hajarsjah et al., 2018). Studies show that malnutrition affects genetic expression and immune function, which are predisposing factors for the development of tuberculosis (Stevens et al., 2014). Malnutrition adversely affects the host immune response to mycobacterial infection by impairing various steps of cell-mediated immunity and affecting T lymphocyte function and cytokine production (Bourke et al., 2016; Chandrasekaran et al., 2017; Ibrahim et al., 2017). Therefore, the risk of localized lesions developing into progressive disease increases (Chhetri et al., 2018; Jaganath & Mupere, 2012; Tamara et al., 2022). Research conducted by (Silva et al., 2018) found that people with poor nutrition are nine times more likely to suffer from TB.

The level of education affects the absorption of various information that will result from inactivity in health maintenance (Piirtola et al., 2016). Parents' education levels in the case and control groups were primarily high school seniors, 26 (34%) and 27 (36%). There was no relationship between the education level of parents and the incidence of TB in children (p=0.803). This result is different from research (Apriliasari et al., 2018) that there is a relationship between the level of parental education and the incidence of TB. This could be because, in the study, most of the subject's parents were educated enough or graduated from senior high school.

Overall, both the case and control groups had ventilation areas that did not meet the standards. In the case and control groups, 31 (41) and 23 (30) ventilation areas did not meet the criteria. This study found a relationship between the extent of ventilation and the risk of TB in children (p=0.043). These results are similar to studies (Hayana et al., 2020). Ventilation is beneficial for the circulation of air changes in the house and reduces humidity. Ventilation is where the entry of ultraviolet light. The presence of ultraviolet light can kill TB germs and other germs (Apriliasari et al., 2018; Gwynne & Gallagher, 2018; Martinez et al., 2019). Pulmonary TB transmission generally occurs in a room where, when coughing or sneezing, TB bacteria spreads into the air in the form of phlegm (droplets). It can reduce the number of splashes with ventilation, while direct sunlight can kill the pulmonary TB bacteria. In addition, the level of O2 needed by the house's occupants is not maintained, and the level of CO2, which is toxic to the occupants' decreases and cannot free the room air from bacteria, especially pathogenic bacteria. The house must be equipped with ventilation of less than 20% of the floor area with a cross-ventilation system (Kementerian Kesehatan, 2011). When a person with smear-positive TB coughs or sneezes, the bacteria in the phlegm spreads into the surrounding air, and one cough can produce about 3000 sputum sprinkling (Arifin et al., 2020). The area of house ventilation that does not meet the standards can increase exposure to tuberculosis by increasing the concentration of TB bacteria in the household. However, ventilation that meets the criteria will reduce the concentration of TB bacteria, which will decrease TB transmission (Adane et al., 2020; Thanh et al., 2014).

In this study, there was a relationship between humidity and the incidence of pulmonary TB (p=0.001). House humidity in the control group met the requirements of as many as 29 (32%) subjects. Twenty-three (30%) did not meet the appropriate humidity standards in the case group. From the observations during the study, this was because most respondents did not open windows during the day so that sunlight could not enter directly, which resulted in the room in the house becoming dark and becoming humid so that TB germs could survive longer. The humidity value, according

to the health standard, is between 40-80% (Wolkoff, 2018). The results of this study are in line with (Apriliasari et al., 2018) that humidity that does not meet the requirements has a risk of 3 times causing the incidence of TB.

In the case group, 25 (33%) subjects and 30 (40%) subjects in the control group did not meet good lighting standards. The results of the analysis of the lighting level variable showed that there was no relationship with the incidence of pulmonary TB in children (p=0.200). This result is different from the study (Apriliasari et al., 2018). During field observations during the survey, generally lighting that did not meet health requirements was caused by insufficient or even closed ventilation. The sunlight entering the respondent's house is also inadequate. So the incoming light does not meet health requirements. In addition to the ventilation factor, poor lighting conditions can also be caused by the close distance between houses. Sometimes, it is so tight. It causes the incoming light to be blocked by the walls and roof tiles of the house.

Most subjects in the case and control groups had 32 (42%) and 28 (37%). Based on the observations, many respondents' houses have room temperatures of more than 30°C. In the Regulation of the Minister of Health of the Republic of Indonesia, No. 1077/MENKES/PER/V/2011 concerning requirements for indoor air quality related to room temperature that meets the requirements is 18-30°C. Another factor causing the high room temperature in the respondent's house is the building materials and structures used, such as zinc roofing and mild steel made of metal, thus triggering an increase in the indoor temperature of the respondent's house. Statistical analysis showed no relationship between temperature and TB risk in children (p=0.206). M.tb is a bacterium that grows in the range of 25°C – 40°C or mesophilic (Lagier et al., 2015), but bacteria will grow optimally at a temperature of 31°C – 37°C. The room temperature in the house that does not meet the requirements will be a medium for the growth of pathogenic bacteria and can last a long time in the house air; this will be a source of disease transmission, one of which is M.tb bacteria. By heating at 60oC for 15-20 minutes, the M.tb will turn off (Myneedu & Aggarwal, 2020; Sabiiti et al., 2019). Bacteria in dry phlegm that stick to dust can last longer, 8-10 days (Sabiiti et al., 2019).

Most case and control groups had floor types that met the standards, namely 38 (50%) and 35 (46%). Based on the results of statistical tests, there was no relationship between the type of floor and the incidence of TB (p=0.240). A healthy home must own the element that the house is equipped with a waterproof floor so that the humidity is good. The floor of the house that meets the requirements of a permanent home according to the Indonesian Ministry of Health No. 829/MENKES/SK/IIV/1999, is waterproof and easy to clean (Kementerian Kesehatan, 2011). The floor of a house made of wood or houses on stilts has a minimum floor height requirement of 75 cm from the ground, according to the Ministry of Public Works in 2011. From the observations, the respondent's house with this type of floor uses ceramics, but there are also respondents whose floors are only with cement plaster. The top of the plaster is covered using thick patterned plastic; the use of this plastic is to make cleaning easier. The house with this ceramic floor and cement plaster has a waterproof floor. It is not easily moist to prevent the growth of bacteria on the floor, while the respondent's house, which lives with a wooden house/house on stilts, has met the requirements where the floor height of the house is more than 75 cm from the surface soil.

Most case and control groups had occupancy densities that did not meet the requirements, namely 23 (30%). In this study, there was no relationship between occupancy density and TB in children (p=1,000). This result is similar to the survey (Marquez Id et al., 2020; Seddon et al., 2013). It can be caused because most of the house area is quite large with a small number of family members. Houses that are not too crowded can minimize contact if a family member has TB (Rakhmawati et al., 2019). The occupancy density of a sleeping home that meets the requirements is a minimum bedroom area of 8 meters. It is not recommended to use more than two people sleeping in one bedroom (Kementerian Kesehatan, 2011). Occupancy density will allow household contact, with more intense contact such as those who share the same room/bed with TB sufferers will

be more likely to have more significant and constant exposure to infectious M. TB aerosols (Acuña-Villaorduña et al., 2018). Occupancy density is related to household contacts if family members are positive for active pulmonary TB (Beyanga et al., 2018; Laghari et al., 2019). Close contact will allow the transmission to children, especially if parents suffer from pulmonary TB. Our study has limitations because it did not assess any history of contact between parents or family members with the child.

Conclusion

There is a relationship between nutritional status, ventilation area, and humidity on the risk of TB incidence in children. Further research is needed on other variables or risk factors, such as the history of childhood immunizations, attitudes, and parents' behavior. The results of this study are expected to be information related to taking policies in promotive, preventive, and curative efforts that can be done to reduce the incidence of tuberculosis in children.

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