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Analisis Determinan *Tuberkulosis pada Anak Balita Stunting di Kecamatan Rambipuji, Jember*

Analysis of Determinants of Tuberculosis in Stunted Toddlers in Rambipuji, Jember

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Abstrak

Tuberkulosis dan stunting masih menjadi masalah kesehatan serius di Indonesia. Stunting akan berpengaruh terhadap kemampuan anak untuk melawan infeksi, termasuk infeksi kuman TB. Anak balita stunting akan lebih rentan tertular penyakit TB dibandingkan anak balita dengan gizi nomal. Penelitian ini bertujuan untuk mencari hubungan dan pengaruh dari faktor risiko TB terhadap kejadian TB pada anak balita stunting. Penelitian ini merupakan penelitian deskriptif analitik dengan desain cross sectional. Sampel penelitian sejumlah 183 anak balita stunting dari delapan desa di Kecamatan Rambipuji, Jember. Variabel terikat pada penelitian ini adalah kasus TB anak. Variabel bebas penelitian ini adalah status gizi anak (TB/U), riwayat imunisasi BCG, riwayat kontak erat penderita TB, status ekonomi keluarga, perilaku merokok orang tua atau anggota keluarga serumah, dan karakteristik fisik rumah yang meliputi kepadatan hunian, luas ventilasi, pencahayaan alami, kelembaban dan suhu rumah. Prosedur penelitian meliputi wawancara, observasi langsung, dan pemeriksaan TB anak. Wawancara dilakukan pada orang tua/wali dari responden anak menggunakan instrumen kuesioner penelitian. Observasi dan pengukuran langsung dilakukan untuk mengetahui karakteristik fisik rumah. Diagnosis TB anak ditegakkan berdasarkan tabel skoring TB anak. Peneliti menggunakan metode uji tuberkulin (Tuberculin Skin Test) sebagai pemeriksaan penunjang. Dari hasil penelitian didapatkan 15 anak positif TB (8,2%). Analisis bivariat menunjukkan nilai p<0.05 pada faktor risiko status gizi, riwayat kontak erat, kepadatan hunian, ventilasi, dan pencahayaan alami rumah. Analisis multivariat menunjukkan hasil signifikan pada faktor risiko riwayat kontak erat (p=0.000; OR=39.563), kepadatan hunian (p=0.015; OR=9.659), dan status gizi (p=0.029; OR=6.718). Berdasarkan hasil tersebut, dapat disimpulkan bahwa faktor risiko yang berhubungan dengan kejadian TB pada anak balita stunting adalah status gizi, riwayat kontak erat, kepadatan hunian, ventilasi, dan pencahayaan alami rumah. Sedangkan faktor risiko yang berpengaruh terhadap kejadian TB pada anak balita stunting adalah riwayat kontak erat, kepadatan hunian, dan status gizi.

Kata Kunci: faktor risiko, balita stunting, tuberkulosis

Abstract

Tuberculosis (TB) and stunting remain serious health problems in Indonesia. Stunting can impact a child's ability to resist infections, including TB. Stunted toddlers are more vulnerable to contracting TB compared to those with normal nutritional status. This research aims to explore the relationship and influence of TB risk factors on the occurrence of TB in stunted toddlers. This research is analytical descriptive research with a cross-sectional design. The research sample consisted of 183 stunted toddlers from eight villages in the Rambipuji sub-district, Jember. The dependent variable of this study

was the case of pediatric TB. The independent variables were the nutritional status, history of BCG vaccination, close contact of TB patients, economic status (monthly income), smoking behavior of parents or family members, and physical characteristics of the house, including household density, ventilation area, natural lighting, humidity, and room temperature. The research procedures included interviews, direct observations, and TB examinations in children. Interviews were conducted with the parents/guardians of the child respondents. Observations and direct measurements were performed to determine the physical characteristics of the respondents' living environments. The diagnosis of TB in children was established based on a scoring table for childhood TB. From the research findings, 15 children tested positive for TB (8.2%). Bivariate analysis showed a value of p <0.05 for nutritional status, close contact, household density, ventilation, and natural room lighting. Multivariate analysis revealed significant results for close contact (p=0.000; OR=39.563), household density (p=0.015; OR=9.659), and nutritional status (p=0.029; OR=6.718) as risk factors. In conclusion, it can be inferred that the risk factors associated with TB occurrence in stunted toddlers include nutritional status, close contact with TB patients, household density, ventilation area, and natural room lighting. The factors influencing TB occurrence in stunted toddlers are close contact with TB patients, household density, and nutritional status.

***Keywords**: risk factor, stunted toddler, tuberculosis*

Introduction

Tuberculosis (TB) stands as one of the top ten global causes of mortality, and Indonesia holds the third-highest number of TB patients globally, following India and China (Yanuarti, 2022). As per the 2021 Global TB Report, Indonesia is estimated to have 824,000 TB cases, but only 393,323 (48%) of these cases have been identified, treated, and reported in the national information system (Yanuarti, 2022).

Within East Java Province, Indonesia, Jember is a significant hotspot for TB cases, holding the second position regarding reported incidences. The Health Office of Jember reported a total of 4,497 regular TB cases, signifying the substantial prevalence of the disease within the region. Beyond the overall cases, the data underscores additional challenges, including 193 reported cases of drug-resistant TB, pointing to the complexity and severity of TB management in Jember. Furthermore, the report highlights 457 cases of childhood TB, emphasizing the vulnerability of the younger population to this infectious disease (Health Office of Jember, 2023).

In 2022, the Rambipuji district in Jember recorded a TB prevalence of 348 cases per 100,000 population, representing 16.3% of the community. Moving into 2023, the Health Office of Jember reported a decrease in the overall number of TB cases within the district, with a total of 99 cases documented. This figure encompasses instances of pediatric TB, amounting to 20 cases. These statistics, provided by the Health Office of Jember in 2023, indicate a notable shift in the incidence of TB in Rambipuji, emphasizing the ongoing efforts to address and manage this health concern (Health Office of Jember, 2023).

Toddlers experiencing stunted growth face a condition characterized by inadequate intake of carbohydrates and proteins, essential macronutrients crucial for developing antibodies and lymphocytes. This deficiency weakens immunity, rendering stunted toddlers more susceptible to infections. The impact of stunting extends to the child's ability to combat various infections, including TB. According to Jahiroh (2017), stunted toddlers are at a higher risk of developing TB compared to their customarily developed counterparts. This underscores the intricate link between nutritional status and susceptibility to infectious diseases, emphasizing the critical role of adequate nutrition in supporting a child's overall health and immunity.

In the February 2023 assessment, it was revealed that the number of under-five stunted children in the Rambipuji district of Jember had reached a significant level, with a total of 765 children, constituting 19.27% of the population. This alarming figure surpasses the national target of 14%, indicating a pressing concern for child health and nutrition in the region (Health Office of Jember, 2023). This underscores the need for heightened caution, given that children are in a stage of heightened susceptibility to infections due to suboptimal immunity, particularly with the elevated number of under-fives stunted children in the Rambipuji district. Additionally, the presence of TB patients in the area further amplifies the potential risk of TB transmission to the vulnerable group of stunted children under five.

Observing the elevated prevalence of TB and stunting among children in the Rambipuji District sparked the researchers' interest, prompting the initiation of this study. The primary objective of this research is to delve into the intricate connections and impact of TB risk factors on the manifestation of TB in stunted toddlers.

Methods

This study is an analytical descriptive study with a cross-sectional design. The study protocol has been approved by the Faculty of Medicine Ethics Committee, Jember University, Number: 1.773/H25.1.11/KE/2023.

The population of this study was all stunted young children in Rambipuji District, Jember, with a total of 649 children. The

sample size was determined using the Isaac and Michael formula. Based on the results of this formula's calculation, a sample size of 183 children was obtained. The sampling technique was proportional random sampling. The researchers took samples from eight villages in Rambipuji proportionally according to the percentage of stunted children in each village. Data was collected in August – September 2023.

The inclusion criteria in this study are children less than five years of age (toddlers) at the time of data collection, meeting the stunting criteria based on the WHO Z-score curve from the results of weighing operations in August 2023, parents or guardians of the child respondents are willing to participate in the research through a signed informed consent. The exclusion criterion is if the children have congenital disabilities and other severe illnesses during data collection.

The dependent variable of this study was the case of pediatric TB. The independent variables were the nutritional status, history of BCG vaccination, close contact of TB patients, economic status (monthly income), smoking behavior of parents or family members, and physical characteristics of the house, including household density, ventilation area, natural lighting, humidity, and room temperature. Research procedures include interviews, direct observation, and childhood TB examinations. Interviews were conducted with parents/guardians of child respondents using a research questionnaire instrument. In addition to the interviews, direct observations and measurements were carried out to determine the physical characteristics of the respondent's homes, i.e., household density, ventilation area, natural room lighting, humidity, and room temperature. Measurements were made using a rolling meter, lux meter, and thermohygrometer. The diagnosis of childhood TB is established based on the pediatric TB scoring table. The sample in this study was a young child, so it is difficult to make a microscopic diagnosis of TB from sputum samples. Examiners use the tuberculin test (Mantoux test) as a supporting test for diagnosis. The tuberculin test was performed by injecting 0.1 ml of PPD (*Purified Protein Derivate)* reagent intracutaneously on the volar surface of the child's forearm at an angle of 5-15 degrees. Results read 48-72 hours after injection (Ministry of Health of the Republic of Indonesia, 2016).

Data analysis in this study using a Chi-Square test and multivariate logistic regression analysis at 0.05 confidence level and 95% confidence interval (α=0.05).

Results

The study encompassed a sample size of 183 children, employing a proportional random sampling technique. The researchers applied this method by selecting samples from eight villages within the Rambipuji sub-district in proportion to the prevalence of stunted children under five in each respective village. The characteristics of the research subjects are outlined in Table 1.

The diagnosis of TB in pediatric cases relies on applying the pediatric TB scoring table, wherein a positive TB determination is made when the cumulative score reaches or exceeds 6. To support the diagnostic process, researchers utilize the Tuberculin Skin Test method. Following the examination using the pediatric TB scoring table among the 183 sampled children, findings indicate that 15 children tested positive for TB, as delineated in Table 2. A detailed examination of the table reveals that the highest incidence of pediatric TB is observed in Pecoro Village, constituting 4 cases (2.2%), while Curahmalang Village records no case.

Table 1. Characteristics of respondents

	N	%
Child age (months)		
0 – 24	44	24
>24 – 60	139	76
Mother's age (years)		
<15	0	0
15-49	181	98,9
>49	2	1,1
Child sex		
Boys	81	44,3
Girls	102	55,7
Total	183	100

Table 2. Results of TB examination on stunted toddlers in Rambipuji District

Village	Pediatric TB scoring results		Total (%)
	≥6 (%)	<6 (%)	
Rambipuji	2 (1,1)	16 (8,7)	18 (9,8)
Kaliwining	2 (1,1)	41 (22,4)	43 (23,5)
Rambigundam	2 (1,1)	31 (16,9)	33 (18,0)
Gugut	3 (1,6)	35 (19,1)	38 (20,7)
Pecoro	4 (2,2)	30 (16,4)	34 (18,6)
Nogosari	1 (0,5)	9 (4,9)	10 (5,4)
Rowotamtu	1 (0,5)	3 (1,6)	4 (2,1)
Curahmalang	0 (0)	3 (1,6)	3 (1,6)
Total (%)	15 (8,2)	168 (91,8)	183 (100)

The data collected from the research samples underwent rigorous analysis employing the Chi-Square analysis method. The outcomes of the Chi-square analysis, as depicted in Table 3, revealed a significant relationship between certain independent variables and the incidence of childhood TB. It was found that there were significant values (p-values <0.05) for several variables, namely nutritional status/stunting, close contact of TB patients, household density, ventilation, and natural room lighting. These outcomes indicate a statistically significant relationship between these variables and the occurrence of TB in stunted toddlers in the Rambipuji Subdistrict.

The data analysis process then proceeded with multivariate analysis using binary logistic regression. This test aims to evaluate the combined effects of various independent variables on the dependent variable, namely the occurrence of TB in stunted toddlers. The binary logistic regression analysis results can be found in Table 4, providing an overview of the extent to which each variable contributes to the risk of TB incidence. The results of the multivariate analysis in this study reflect a level of significance (p-value) <0.05 for several variables, namely nutritional status (stunting), close contact with TB patients, and household density. Attainment of p-values <0.05 for these variables indicates a statistically significant influence on the occurrence of TB in stunted toddlers in the Rambipuji Subdistrict. These findings confirm that these factors not only serve as independent variables associated with a bivariate context but also escalate the risk of TB incidence among the group of stunted toddlers.

Table 3. Bivariate analysis of risk factors for childhood TB in Rambipuji District

Risk Factor		**TB+**	**TB-**	***p-value***	**Total**
		N (%)	N (%)		
Nutritional status					
	Stunted	8 (4.3)	110 (60.2)	*0.034**	118
	Very stunted	7 (3.8)	58 (31.7)		65
History of BCG vaccination					
	No	0	0	-	0
	Yes	15 (8.2)	168 (91.8)		183
Household density					
	Not eligible	6 (3.3)	14 (7.6)	*0.000**	20
	Eligible	9 (4.9)	154 (84.2)		163
Ventilation area					
	Not eligible	7 (3.8)	25 (13.7)	*0.023**	32
	Eligible	8 (4.3)	143 (78.2)		151
Natural room lighting					
	Not eligible	15 (8.2)	120 (65.6)	*0.033**	48
	Eligible	0 (0)	48 (26.2)		135
Room humidity					
	Not eligible	14 (7.6)	152 (83.1)	*0.251*	17
	Eligible	1 (0.6)	16 (8.7)		166
Room temperature					
	Not eligible	11 (6)	107 (58.5)	*0.431*	65
	Eligible	4 (2.2)	61 (33.3)		118
Close contacts of TB patient					
	Yes	13 (7.1)	26 (14.2)	*0.000**	39
	No	2 (1.1)	142 (77.6)		144
Smoking behaviour of parents or family members					
	Yes	13 (7.1)	145 (79.2)	*0.578*	158
	No	2 (1.1)	23 (12.6)		25
Economic status (monthly income)					
	<Rp 1.500.000	13 (7.1)	146 (79.8)	0.*979*	
	≥Rp 1.500.000	2 (1.1)	22 (12)		
Total		**15 (8.2)**	**168 (91.8)**		**183**

Note:
Household density: not eligible if it is <8m² and more than two people/room
Ventilation area: not eligible if it is <10% of floor area
Natural room lighting: not eligible if it is <60 lux
Room humidity: not eligible if it is <40% or >60%
Room temperature: not eligible if it is <18°C or >30°C

Table 4. Results of multivariate analysis of childhood TB risk factors

Risk Factors	**S.E.**	**Wald**	**Sig.**	**OR**	**95% C.I.**	**EXP(B)**
Nutritional status	0.870	4.789	0.029	6.718	1.220	- 36.992
Close contact of TB patient	0.921	15.934	0.000	39.563	6.501	- 240.748
Household density	0.935	5.881	0.015	9.659	1.545	- 60.382
Ventilation	0.914	0.264	0.608	1.599	0.267	9.581
Natural room lighting	6.628	0.000	0.996	5.190	0.000	.

Discussion

The research results indicate that most toddler respondents are above two years old. Within this age group, the number of respondents testing positive for TB infection tends to be like the number of respondents in the age group under two years old. This finding is consistent with research indicating that the highest risk of TB infection occurs in children under three years old (Jahiroh & Prihartono, 2017).

In the context of toddlers, their immune system is not yet fully developed. Cellular immunity involves T-cell immunity, consisting of memory T cells and effector T cells. Memory T cells include CD4 and CD8 memory T cells. Effector T cells consist of cytotoxic T cells that destroy target cells and CD4 effector T cells that activate macrophages, B cells, and other cells. Once this cellular immunity is established, TB organisms entering the body will be destroyed by cellular immunity (Hajarsjah et al., 2018). The implication is the need to emphasize efforts in preventing and early detection of TB in toddlers, especially in the more vulnerable age group.

The research findings indicate that most respondents fall into the short stature (stunted) category, with the remaining categorized as very stunted. In bivariate analysis, the number of respondents testing positive for TB infection in the stunted group appeared like the very stunted group, with a p-value of 0.034, signifying a significant statistical relationship between nutritional status (stunting) and the occurrence of TB in stunted toddlers. This aligns with the study by Jahiroh & Prihartono (2017), stating that nutritional status is associated with TB incidence in children. Among 98 toddlers with TB, 25 were stunted, 14 were very stunted, and 59 had normal nutritional status. This is consistent with Haerana's research, which states that the nutritional status of children (stunted and very stunted) is associated with childhood TB incidence (Haerana et al, 2020).

Multivariate analysis shows a significant impact of nutritional status on childhood TB incidence, consistent with Haerana's findings, indicating a correlation between nutritional status (stunting) and childhood TB incidence with an odds ratio (OR) of 3.44 (Haerana et al., 2020). Hajarsjah et al. (2018) similarly reported an increased risk of TB incidence in children with poor nutritional status, such as stunting, by 5.8 times. Jahiroh & Prihartono (2017) stated that stunted toddlers are 2.96 times more likely to experience TB than those with normal nutritional status, while very stunted toddlers have an 8.18 times higher risk of developing TB. Nutritional deficiencies can influence genetic expression and immune function, predisposing individuals to TB infection. The thymus plays a crucial role in T lymphocyte maturation during the perinatal and early childhood. Energy and protein deficiencies in stunted children may reduce thymus size, alter cortical thymocyte apoptosis, and impact the microenvironment around lymphoid and epithelial cells, thereby decreasing thymic hormone production and thymulin thymocyte proliferation. Consequently, a reduction in T lymphocyte production affects cellular immunity against TB bacteria (Hajarsjah et al., 2018).

The research results indicate that a history of close TB contact is associated with childhood TB incidence in stunted toddlers. This is in line with the study by Jahiroh & Prihantono (2017), stating a connection between close contact with TB patients and childhood TB incidence. Other studies also highlight the significance of close TB contact history with pulmonary TB incidence in children, with a p-value of 0.018 (Apriliasari et al., 2018). Multivariate analysis also reveals a significant influence of close TB contact on childhood TB incidence, with an odds ratio of 39.6. This suggests that individuals with close contact with TB patients are 39.6 times more likely to experience childhood TB incidence than those without such contact. Toddlers with household contact with adult TB patients have a 10.73 times higher risk of severe TB compared to those without household contact (Jahiroh & Prihantono, 2017). Hajarsjah et al. (2018) mentioned that a contact history of more than 6 hours per day increases the risk of childhood TB infection by 8 times. Loredo et al. (2014) also reported a TB prevalence of 2-2.7% in children living with adult TB patients who are BTA positive. The closest sources of transmission for infants and children are their parents, household family members, and individuals who regularly visit or interact directly in their daily lives. Intense interaction may involve confined spaces, prolonged contact, and situations where exposure to airborne droplets or particles containing TB bacteria is heightened. If a toddler has a history of close contact with a TB patient, the risk of TB infection increases. Therefore, identifying close contact history, especially involving toddlers, is crucial for effective prevention measures, such as routine health checks, medical supervision, and ensuring early detection and appropriate management if infection occurs.

Household density is also associated with childhood TB incidence in stunted toddlers in the Rambipuji Subdistrict. This aligns with Hajarsjah et al.'s (2018) research, stating that household density is related to TB incidence. Thamiris et al. (2021) mentioned that each increase of 1 person per household is associated with a 25-case/100,000 population increase in TB incidence. Several studies also show a significant relationship between household density and TB incidence. A tightly packed home environment with poor air circulation can support the spread of airborne-transmitted diseases like TB. Most respondents in this study (89%) already had homes with household densities that met the requirements. Spacious and uncrowded homes are more likely to prevent TB bacteria from entering.

Multivariate analysis indicates a significant impact of household density on childhood TB incidence, with an odds ratio of 9.7. This suggests that the higher the household density, the greater the risk of childhood TB incidence by 9.7 times. Hajarsjah et al. (2018) also stated that household density affects childhood TB incidence with an odds ratio of 1.28. TB transmission occurs through droplet nuclei, and individuals can be infected if these sputum particles are inhaled into the respiratory tract. One pulmonary TB patient with a positive BTA has the potential to transmit to 10-15 people per year, and the likelihood of transmission increases with prolonged or intense contact, especially within a confined space and worsens if the house is damp and poorly ventilated (Sayekti, 2020). Therefore, in addition to household density, attention should be given to ventilation conditions, lighting, humidity, and temperature in the home to prevent TB transmission.

The analysis of the ventilation variable indicates an association with childhood pulmonary TB, demonstrated by a p-value of 0.023, although not statistically significant. This is in line with Jahiroh & Prihantono's (2017) research, stating that ventilation is associated with childhood TB incidence but not significantly. Based on the research data, it is known that 82% of respondent’s

homes already have adequate ventilation. Poor ventilation can be related to an increased risk of TB in children. Inadequate indoor ventilation conditions can create an environment where *Mycobacterium tuberculosis* can survive and spread more easily. Factors related to poor ventilation, such as high population density, cramped spaces, and inadequate ventilation, can increase the likelihood of TB transmission, especially in cases where children live with adults with active TB. Children living in poorly ventilated environments or with adults suffering from TB have a higher risk of TB exposure. Therefore, improving ventilation and enhancing home sanitation conditions are important preventive measures to reduce the risk of TB transmission in children. It's important to understand that good ventilation can help reduce the concentration of bacteria in the air, preventing TB from spreading in households and communities at large.

The analysis of the natural lighting variable in homes indicates an association with childhood pulmonary TB, although not statistically significant. Jahiroh & Prihantono (2017) mentioned that home lighting is associated with childhood pulmonary TB with a p-value of 0.024 and an odds ratio of 3.219, meaning respondents with homes with inadequate lighting are 3.2 times more likely to be infected with pulmonary TB than respondents with homes with adequate lighting. Most respondents in this study (74%) had homes with insufficient lighting. Sunlight, especially morning sunlight, is beneficial for health. This is because morning sunlight contains ultraviolet rays that can kill bacteria, including TB bacteria, potentially eliminating many types of bacteria when exposed to sunlight. Researchers suggest installing glass roofs in homes with inadequate lighting, especially for TB patients' homes.

This study is affected by several limitations that need to be considered. One of the main limitations is the limited sample size due to the researcher's time and labor constraints. This limits the capacity of the study to represent a broader variation in the population, so the results obtained may not fully reflect the actual condition. In addition, the invasive method of the research procedures poses an additional challenge. For example, the Tuberculin test (Mantoux test) can be perceived as an invasive and uncomfortable procedure for some respondents. As a result, some respondents refuse to undergo the test, which may affect the study results and bias the representation of TB prevalence and risk factors.

Further research needs to be carried out with a broader area and a larger sample. Further research can also be carried out using secondary data to obtain broader and more accurate results.

Conclusion

Based on the results of the research, it was found that there is a significant relationship between the risk factors of nutritional status (stunting), close contact of TB patients, household density, ventilation, and natural room lighting with the incidence of TB in stunted toddlers. Additionally, there is also a significant influence between the risk factors of nutritional status (stunting), close contact of TB patients, and household density on the incidence of TB in stunted toddlers in the Rambipuji Sub-district. These findings suggest the importance of addressing these risk factors in efforts to prevent and control the spread of TB in stunted children.

Conflict of Interest

The authors reported no potential competing interest.

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Author contribution

The first author contributed to preparing the manuscript, data analysis, data interpretation, revising the final manuscript for publication, and approving the final version to be published. The second author contributed to data analysis, data interpretation, revising the final manuscript for publication, and final approval of the version to be published. The third author contributed to drafting a concept, compiling a research design, data collection, data analysis, and the person in charge of data collection in the field.

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