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The Relationship between External and Internal Risk Factors with Pulmonary Tuberculosis in Children Aged 0-59 Months in Slums in Indonesia, 2013

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Abstract

Background: Tuberculosis (Tb) remains a health problem throughout the world. World Health Organization (WHO) has set it as a "Global Emergency" disease. The difficulty of confirming the diagnosis of it in children, different from it in adults, causes the treatment of it in children often neglected. This problem is exacerbated by the supporting environmental conditions, namely living in slums, which makes the risk of transmission even higher.

Objective: To identify internal and external factors related to Tb in children aged 0-59 months living in slums in Indonesia.

Material and Method: The data source used was the 2013 Basic Health Research (Riskesdas) using a sample of children less than five years old who lived in slums in 34 provinces in Indonesia.

Results: Logistic regression analysis found three risk factors, namely BCG immunization status (age-based), at-risk home environment, and gender (residential area-based). Vaccinated children under one year of age have the best probability of not suffering from pulmonary tuberculosis. Those who live in a house inhabited by less than five people, or in that occupied by more than four with no one of which smokes or does not suffer from pulmonary tuberculosis has a probability of not being exposed to it. Likewise, women who live in rural areas have almost two times less probability of suffering from it, compared to men in urban areas.

Conclusion: Factors contributing to the prevalence of pulmonary tuberculosis in infants in slums are the status of BCG immunization, air cleanliness in the neighborhood, which can be seen from the differences of risks in rural and urban, and the number of inhabitants per house and their behavior.

Keywords: pulmonary tuberculosis, children, slums, Indonesia

1. Introduction

Tuberculosis (Tb) is a global health problem that has been designated a "Global Emergency" disease (WHO, 1994). Worldwide, it becomes one of the ten leading causes of death from one infectious agent. It even is above HIV/AIDS with an estimated number of sufferers of 10 million, 1.1 million of whom are children (WHO, 2019). Prevalence is still high in people in slums and, even, 6.7% of the cases are in children aged <15 years (Ogbudebe et al., 2015). As in other countries, children's health is also a critical factor in Indonesia, whose number of children under 15 years is 40-50% of its total population (Statistical Center of Indonesia, 2016). The proportion of Tb cases in children, among all cases treated in Indonesia from 2007 to 2013, ranged from 7.9% to 12%. This figure is still within the normal range for the proportion of Tb cases in children, compared to all cases (Ministry of Health of Indonesia, 2020).

Tb in children is a unique problem different from that in adults and tends to be ignored (Tsai et al., 2013). The difficulty of confirming its diagnosis in children and the assumption that it is not a contagious disease have resulted in it not being a priority in Tb control efforts in Indonesia (Tsai et al., 2013; Thomas, 2017). Many children who suffer from Tb do not get the right treatment under the provisions of the strategy Directly Observed Treatment Shortcourse (DOTS), thereby increasing their morbidity and mortality. The DOTS program has proven to be successful in suppressing Tb prevalence in developing regions, and several factors have been identified to be

improved (Skye Crawford & Romaniuk, 2011).

Several factors contribute to Tb infection, whose highest incidence primarily occurs in people who live in crowded, poorly ventilated, and unclean conditions, such as slums (Skye Crawford & Romaniuk, 2011). Slums are synonymous with regions inhabited by people with low socioeconomic status, living in dense settlements with limited water sources, unemployed, poorly educated, lacking access to health services, and being the center of health problems due to unhygienic conditions (Fry, Cousins, & Olivola, 2002). Slums are regions with most environmental risk factors that cause Tb to have a high prevalence (Banu et al., 2013). Children living in such areas have far worse health status (Mberu, Haregu, Kyobutungi, & Ezeh, 2016), including nutritional adequacy status (Ahsan, Arifeen, Al-Mamun, Khan, & Chakraborty, 2017), compared to those in other regions.

In general, only about 2% of cases of infection will develop into active Tb after one year of exposure, and only 10% of infected people will become sick during their lifetime (Skye Crawford & Romaniuk, 2011). Meanwhile, children aged under five years have a higher risk to suffer from Tb disease after the first infection because their cellular immunity has not been fully developed (immature). Still, the risk of Tb disease will gradually decrease with age. In infants aged under one year who are exposed to Tb, 43% will become sick with Tb, while in those aged 1-5 years, only 24% will become sick. In infants, the period between the occurrence of infection and the onset of Tb disease is concise and usually arises with acute symptoms (Soegijanto & Rachmawati, 2016).

The administration of the Bacille Calmette-Guerin (BCG) vaccine has been one of the efforts to prevent children from suffering from Tb. It has been required in several countries and is recommended in several others, including Indonesia (Ministry of Health Indonesia, 2017). The results of the effectiveness test showed that the BCG vaccine proved effective in preventing pulmonary Tb in several countries (Favorov et al., 2012; Michelsen et al., 2014). Other research results also show a relationship between BCG immunization and pulmonary Tb occurrence (Katelaris et al., 2020).

Children who live with adults with pulmonary Tb are at high risk for infection (Triasih et al., 2012; Laghari et al., 2019) due to contact between them. Children who live in smokers are also more at risk of Tb infection (Laghari et al., 2019). The family plays a critical role in preventing the transmission of Tb to children (Lancella et al., 2015). Previous analysis showed that some variables were found to be insignificant because of the existence of other variables that were probable to play a role (Nurjana, Gunawan, & Tjandrarini, 2019).

Based on the description above, the researchers were interested in further analyzing the incidence of Tb in children aged 0-59 months living in slums in Indonesia, to identify internal and external factors associated with Tb in children aged 0-59 months living in slums in Indonesia. The factors identified included the characteristics of children under-five, BCG immunization, smoking behavior of household members, and family history of Tb.

2. Method

The data source used for analysis was a sub-set/part of the 2013 Basic Health Research (Riskesdas) data owned by the Health Research and Development Agency. The design of Riskesdas was a cross-sectional design. The sample area covered 34 provinces in Indonesia. Variables used in this research were pulmonary Tb disease as the dependent variable. Meanwhile, the independent variables included gender, age, residence, number of people in the household, BCG immunization, smoking status of household members aged ≥ 15 years, and family history of Tb.

The sample for this analysis was children aged 0-59 months living in slums. Data about slums was available by considering the environment outside the houses observed. The definition of slums used in this study was a region with muddy conditions, no sewage disposal nor defecation facilities were available in most of the houses; dirty, littered with garbage, and a very low-distance between adjacent houses. In total, the sample analyzed according to these criteria was 14,428 children under five.

The data were then analyzed using a statistical logistic regression test to assess the relationship between the dependent variable and the independent variables under study with a p-value significance limit <0.05.

3. Results

Children under five who lived in slums were distributed almost equally between urban areas (53%) and rural areas (47%), where the most were those over one year. The number of children under five with pulmonary tuberculosis was found more in urban areas (1.4%) than in rural areas (1.3%). (Figure 1)

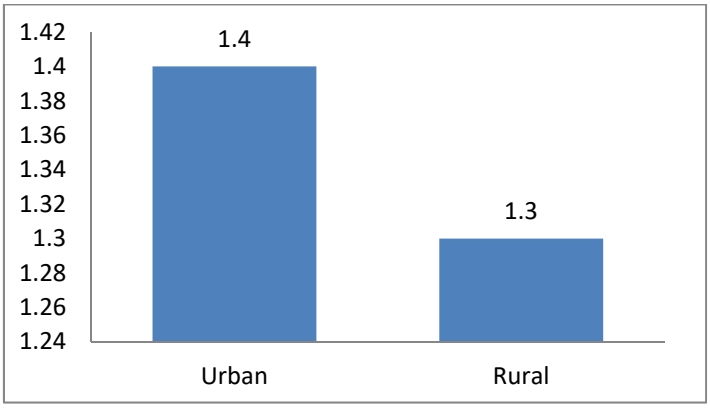

Figure 1. Percentages of children aged 0-59 months with pulmonary tuberculosis in slums in urban and rural areas in Indonesia, 2013

The proportion of pulmonary Tb in children under five in overall slums was 1.3%, where the highest one was of Kalimantan Tengah Province (3.5%). In this study, two provinces proved to have a tiny number of cases, namely Bangka Belitung and Bali. Thus, the values of the proportion were not visible. (Figure 2)

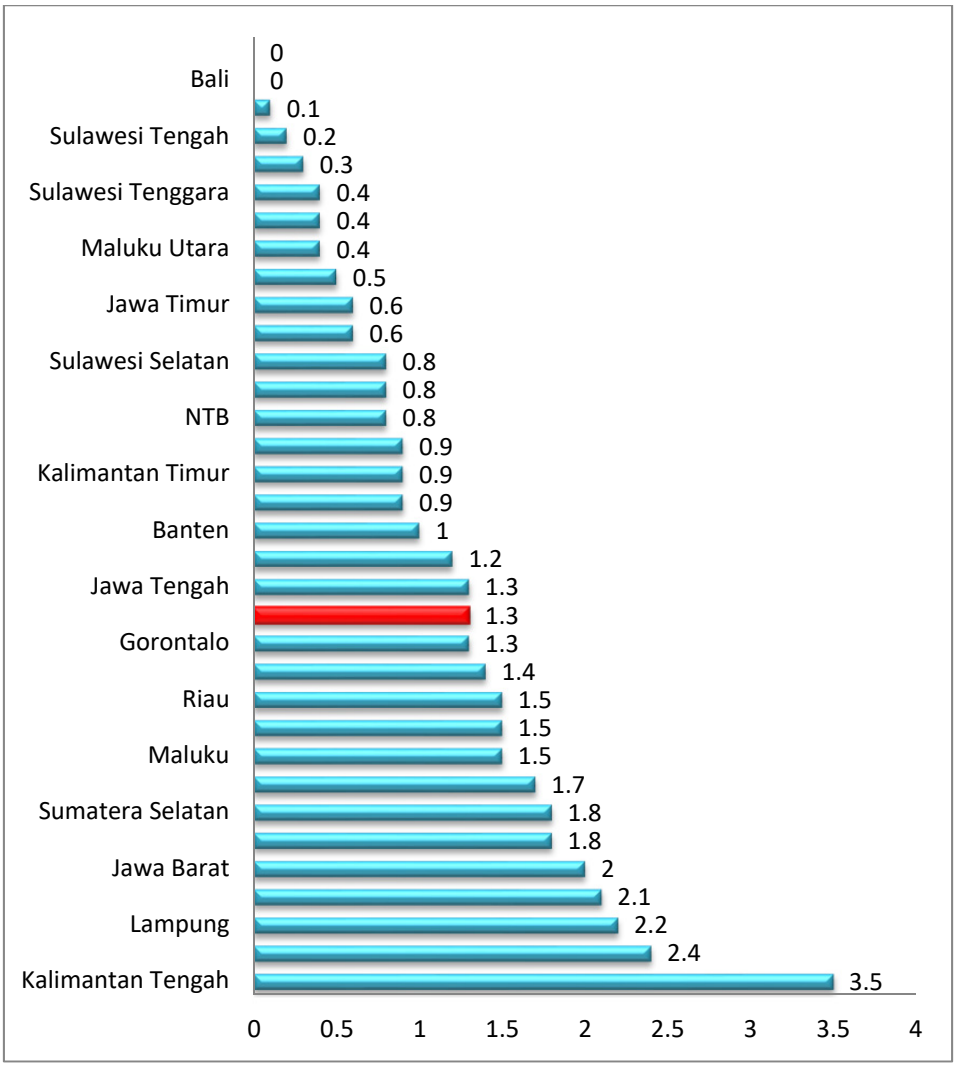

Figure 2. Percentages of children aged 0-59 months with pulmonary tuberculosis in slums in Indonesia, 2013, by province

The results of the bivariable analysis would appear in Table 1. Composite indicators, which consider the small number of cases, were used, thus causing the cells blank and essential variables cannot be included in the model to produce conclusions. Furthermore, the composite indicators formed were significant to describe the different risks in their categories. These figures would be broken down in Table 1.

Table 1. Internal and external risk factors for pulmonary Tb in children aged 0-59 months in slums in Indonesia, 2013

	Pulmonary Tb Status		Total (n)	*p*-value	OR	95% CI	
	Yes (%)	No (%)				Upper	Lower
Gender by Region of Residence							
1. male in urban areas	1.6%	98.4%	3,806		1.000		
2. female in urban areas	1.3%	98.7%	3,897	.27	1.242	.681	2.264
3. male in rural areas	1.7%	98.3%	3,415	.52	.886	.514	1.528
4. female in rural areas	0.8%	99.2%	3,311	.01	1.933	1.020	3.661
BCG immunization status by Age Group							
1. age≥ 1 year, not immunized	1.4%	98.6%	9,228		1.000		
2. age <1 year, having not been immunized yet	0.9%	99.1%	1,375	.06	1.846	.494	6.899
3. age≥ 1 year, immunized	1.5%	98.5%	2,644	.36	.855	.520	1.405
4. age <1 year, immunized	0.5%	99.5%	1,181	.02	2.298	.733	7.199
Risky Family Environment							
1. There are more than four people in one household, whose member suffers from Tb or smokes	1.6%	98.4%	5,955		1.000		
2. There are less than five people with/no members suffering from Tb/smoking or more than four people with no members suffering from Tb/smoking.	1.1%	98.9%	8,473	.23	1.091	.716	1.663
Total	1.3%	98.7%	14,428				

Note. Tb= tuberculosis; OR=odd ratio; CI=confident interval.

Table 1 shows the differences in the probability values for not experiencing pulmonary Tb, by gender, differentiated by region of residence. Female children under five in urban areas have a higher probability of not suffering from pulmonary Tb, compared to the male ones in urban areas. Female children under five in rural areas had a protective risk value, while the male ones in rural areas had a higher risk of getting pulmonary Tb. There were significant differences in the percentage and magnitude of risks between female children under five in rural areas compared to the male ones in urban areas.

Indicator BCG immunization status for children under five at the time of data collection shows that those aged <1 year and not immunized had a greater probability of not suffering from Tb than those aged ≥ one year without immunization. The same opportunities occured in children under five immunized for BCG. The probability values of these two categories were very significant, namely about twice greater than the values for those aged ≥ one year having not been immunized.

Other factors that were not significant but were necessary to note are at-risk family environmental factors. Children under five who lived at a house inhabited by less than five people, some of which suffered from Tb or smoked, had a probability value good enough not to suffer from Tb. A similar probability also belonged to those who lived at a house occupied by more than five people with no member having suffered from Tb.

The results of the multivariable analysis in Table 2 show that children under one year of age immunized for BCG

had twice the probability of not suffering from Tb, compared to those aged over one year who were not vaccinated. Differences in opportunities were also seen significantly among female children under five in rural areas with a probability value of not suffering from Tb of 1.9 times higher than that of the male ones in urban areas. Another critical factor, although not meaningful, was the at-risk family environment. In a house inhabited by one to four people or that, in which none of its members has a history of Tb, children under five had a probability value of not suffering from Tb 1.2 times higher than that of those who lived in a house with more than four people, some of which were suffering from Tb or were smoking. The probability value was controlled between variables.

Table 2. Relationship model of internal and external risk factors for pulmonary Tb in children aged 0-59 months in slums in Indonesia, 2013

	B	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
Children age group and immunization status		.012			
1. Age≥ 1 year, not immunized for BCG			1.000		
2. Age <1 year, having not been immunized for BCG yet	.609	.060	1.839	.974	3.472
3. Age≥ 1 year, immunized for BCG	-0.164	.340	.849	.606	1.188
4. Age <1 year, immunized for BCG	.851	.017	2.342	1.161	4.722
Occupancy density and risk exposure		.148			
1. There are more than four people in one household, whose member suffers from Tb or smokes			1.000		
2. There are less than five people with/no members suffering from Tb/smoking or more than four people with no members suffering from Tb/smoking	.213	.148	1.237	.927	1.651
Gender and region of residence		.006			
1. Male children under five in urban areas			1.000		
2. Female children under five in urban areas	.192	.327	1.211	.826	1.777
3. Male children under five in rural areasn	-0.131	.482	.878	.610	1.263
4. Female children under five in rural areas	.659	.005	1.934	1.220	3.066
Constant	3.974				

Note. B=betta; Sig.=significant; CI=confidence interval.

4. Discussion

Tb is caused by the bacterium *Mycobacterium tuberculosis* transmitted through the air from human to human within only a few minutes of contact (WHO, 2014). he condition of slums with low-distance between houses increases the risk of transmission of this disease. In Indonesia, the proportion of households located in slums is 18.7%, most of which take place in DKI Jakarta (29.4%). Slums are more common in urban areas (19.3%) than in rural areas (18.1%) (Health Research and Development Agency, 2014). Slum environmental conditions are increasingly increasing health problems in Indonesia, one of which is the transmission of pulmonary Tb. The 2013 Riskesdas data showed that the proportion of pulmonary Tb in children aged <5 years who have been diagnosed by health workers in Indonesia was 0.6% (Health Research and Development Agency, 2014). . This number might be underreported as the case of Tb children in the world (Thomas, 2017). However, it had shown considerable problems to get attention, given the death rate due to Tb at the age of 0-4 years was the highest, compared to that in other age groups (Thomas, 2017). This underreporting occurred because the information was only obtained from interviews without checking. The incidence of pulmonary Tb in children aged 0-59 months in slums in Indonesia was 1.3%. This condition must be a concern considering the development of Tb in slums was five times greater (Noykhovich, Mookherji, & Roess, 2019) and slums are actually not right places for children (Ernst, Phillips, & Duncan, 2013).

In the provinces of Bangka Belitung and Bali, no cases of Tb were found in children in slums (0%), possibly because the two regions were regions with the least number of families living in slums after Sulawesi Barat,

Gorontalo, Lampung, and Bengkulu. In Bangka Belitung, the number of families living in slums was 10.9% while in Bali was 10% (Health Research and Development Agency, 2014). Also, the number of children under five living in slums in the two provinces was relatively less than that in other provinces in Indonesia (0.9 - 1.2% of the total sample), thus affecting the results of this survey. Data on the Indonesian Public Health Development Index (IPHDI) in 2013 also showed that four districts/cities in Bali were in the ten best ranks of 2013, while Gorontalo with its all districts/cities rose in the period 2007 to 2013 (Health Research and Development Agency of the Republic of Indonesia, 2014).

Kalimantan Tengah Province was the region with the highest rate of the prevalence of Tb in children under five years, namely 3.5%, compared to that in other provinces. This figure was very far above the national rate (1.3%). This was possible because seven of the 14 districts/cities in Kalimantan Tengah experienced a downgraded IPHDI ranking in 2013, compared to 2007, and none of the districts/cities experienced a significant increase (Health Research and Development Agency of the Republic of Indonesia, 2014). The percentage of families living in slums in Kalimantan Tengah Province is 13.6%, below the national average (18.7%) (Health Research and Development Agency, 2014).

The results of this study indicated that there was a relationship between age-controlled BCG immunization status and Tb in children under five in slums. The WHO recommended that BCG immunization is done soon after children are born in countries with high Tb prevalence rates (Tsai et al., 2013). The BCG vaccine has been used for more than 80 years as one the most widely used vaccines. According to the State of the World's Children in 2009, 89% of one-year-old children have been immunized for BCG to prevent Tb (Skye Crawford & Romaniuk, 2011). Research in the United Kingdom also showed the same thing (Katelaris et al., 2020). The findings of this study showed that immunization is very effective at the age of before one year, considering children under one have a probability of suffering from Tb of 43% higher than those above one year old (24%) (Soegijanto & Rachmawati, 2016). After one year of age, they will depend on their environment while those under one year can still be protected with good breastfeeding. Even so, in general, immunization in slums covers only half of children who live in other areas and is worsened by mothers and children receiving less antenatal care (Fry et al., 2002).

Other important factors that were analyzed, although not significant, were the risky family environment, in which five or more people lived in one house and there were household members who smoked or had a history of Tb (Triasih et al., 2012; Patra et al., 2015). The risk of respiratory problems, including Tb, is higher in smokers as the case happened to the spinning mill workers in India (Saoji, Aniruddha, Meenal, Jaydeep, & Mudey, 2010) and Iran (Alavi-Naini, Sharifi-Mood, & Metanat, 2012).

The proportion of Tb incidence in children under five where there are pulmonary tuberculosis sufferers in their families is 18%. A study of children who have a history of contact with adult Tb sufferers in Abuja, Nigeria, as a region with the highest cases of Tb in Africa showed that contact with adult Tb patients becomes a risk factor. Infection occurs in the home, and children with high contact intensity with sufferers who live at the same home have a higher risk of becoming infected. Children <5 years of age, in particular, are the most vulnerable group. (Nakaoka et al., 2006). The results of this study indicated an important factor, namely the density of people who live in one residential building. This finding was supported by the results of previous studies which revealed a significant relationship between other household members who smoke or who have a history of Tb to the incidence of Tb in children. The risk would be reduced if the residence is not crowded, even if someone smokes or has a history of Tb.

The results showed that female children under five in rural areas had a smaller risk of experiencing pulmonary Tb, compared to the male ones in urban areas. This was possible because boys tended to be more active playing outside the home than girls, especially after puberty (Stival et al., 2014). Therefore, female children under five years became more likely to interact with Tb sufferers, thus increasing the possibility of contracting.

Based on the three risk factors found in this analysis, pulmonary Tb disease can be prevented through changes in individual behavior. Prevention of Tb transmission related to residential density can be done by opening the windows of the houses every day and drying up the mattresses in the sun regularly. The problem of transmission through social activities in the community can be prevented by reminding pulmonary Tb sufferers to close their mouths when coughing and preparing a particular container to remove their sputum. Continuous socialization of information followed by changes in social behavior can increase awareness of people living in slums about all aspects of Tb (Basavaraju & Yellappa, 2017). Immunization for each child must also be timely and complete before reaching one year of age. After one year of age, children must be taught to behave in a clean and healthy life. Equally important is to carry out routine tests, especially in areas with high density, as one of the four main factors that must be combined to improve case detection (Okuonghae & Omosigho, 2010). The problem of Tb in children

as a vulnerable group is no longer ignored through 10 critical actions in the 2013 children tuberculosis roadmap (WHO, 2018).

5. Conclusion

Internal and external factors that play a role in the occurrence of pulmonary Tb in children under five in slums in Indonesia are the status of age-based BCG immunization and the air cleanliness in the residential environment that can be seen from differences in risks in rural and urban areas, occupancy density, and occupant behavior.

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All the authors were the main contributors in the preparation of this article: MAN contributed to the concept of the contents of the article and discussion part, DHT contributed to the analysis and the writing of the results, and G and ON contributed to the discussion part and layout article.

Competing Interests Statement

The authors hereby declare that there is no potential conflict of interest in writing this article.

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