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Original Article

Tuberculosis risk factors in children with smear-positive adults in the household

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Abstract

Background Children in household contact of adults with smear-positive tuberculosis (TB) are at higher risk of TB infection. Screening of these children is a main strategy for eliminating childhood TB.

Objective To determine risk factors of TB among children in household contact with smear-positive adult TB patients.

Methods This case-control study was conducted in 5 public health centers at Batu Bara District, North Sumatera. We studied children from birth to 18 year-old living in the same house as adults with smear-positive TB. A tuberculosis scoring system was used to diagnosis TB in the children. Associations between risk factors and the incidence of TB were analyzed using Chi-square, Mann-Whitney U, and logistic regression tests.

Results We enrolled 145 children who had household contact with smear-positive adult TB patients. Subjects were allocated to either the case group [TB score >6; 61 subjects (42.0%)] or the control group [TB score <6; 84 subjects (58.0%)]. Bivariate analysis revealed that nutritional status, immunization status, number of people in the house, sleeping in the same bed, and duration of household contact had significant associations with the incidence of TB. By multivariate logistic regression analysis, nutritional status and duration of household contact were significant risk factors for TB, with OR 5.89 and 8.91, respectively.

Conclusion Malnutrition and duration of household contact with smear-positive adult TB patients of more than 6 hours per day are risk factors for TB among children. **[Paediatr Indones. 2018;58:66-70; doi: http://dx.doi.org/10.14238/pi58.1.2018.66-70]**.

Keywords: *risk factors; tuberculosis; household contact; smear-positive*

Mycobacterium tuberculosis infection in childhood continues to be a worldwide problem because of its high prevalence.[1] Childhood TB infection has a limited influence on TB epidemiology. However, children with TB infection could contribute to future adult TB cases.[2] Tuberculosis is a major cause of morbidity and mortality in all age groups worldwide.[3]

Childhood TB carries a large proportion of the overall TB burden, representing 15 to 40% of all cases and causing more than 10% of pediatric hospital admissions and deaths. To limit TB incidence, the US and European countries provide preventive treatment for people with TB infection.[2] The aim of this study was to determine risk factors of TB among children with smear-positive TB adult patients in the household.

This study was presented at the *Pertemuan Ilmiah Tahunan Ilmu Kesehatan Anak VII/PIT IKA VII* (The 7th Annual Scientific Meeting for Child Health), Surabaya, November 2-4, 2015.

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Methods

This case-control study was conducted from January to March 2015 in 5 public health centers at Batu Bara District, North Sumatera. We studied children from birth to 18 years, who lived in the same house as smear-positive TB adults. A tuberculosis scoring system was performed to diagnosis TB in this study (**Table 1**).4 Children with TB scores below 6 were classified into the control group, while children with TB scores of 6 or above were classified into the case group. Associations between risk factors and the incidence of TB were analyzed using Chi-square, Mann-Whitney U, and logistic regression tests.

Table 1. Tuberculosis scoring system[4]

Scoring / Features	0	1	2	3	Score
Contact	Not clear	-	Reported, AFB (-)	AFB (+)	
Tuberculin skin test	-	-	-	Positive	
Body weight	-	< red line, decreased BW	Severe malnutrition	-	
Fever	-	Unexplained	-	-	
Cough	< 3 weeks	≥ 3 weeks	-	-	
Node enlargement	-	≥ 1 node, ≥ 1 cm, painless	-	-	
Bone joint	-	Swelling	-	-	
Chest x-ray	Normal	Sugestive	-	-	
				Total score	

AFB=acid fast bacilli; body weight on *Kartu Menuju Sehat*/KMS (local growth chart)

Data was processed using *SPSS* software. Chi-square and Mann-Whitney U tests were used to determine risk factors of TB among children with smear-positive TB adults in the household. Bivariate analysis was performed first. Variables with P values < 0.25 were further subjected to multivariate logistic regression analysis. Results were considered to be statistically significant for P values > 0.05, with 95% confidence intervals. The study was approved by the Ethics Review Committee of University of Sumatera Utara Medical School.

Results

We enrolled 145 children who had household contact with smear-positive adult TB patients, comprising 61 (42.0%) cases and 84 (58.0%) controls.

The mean age of subjects was 5.7 (SD 3.21) years in the case group and 5.5 (SD 2.66) years in the control group. Distribution of males and females was similar between groups. The majority of subjects in both group had BCG immunization. The majority of subjects in the case group had malnutrition, but that of the control group had normal nutritional status (**Table 2**).

Table 3 shows that nutritional status was associated with the incidence of TB. A significantly greater percentage of children in the case group had malnutrition than in the control group [51 (83.6%) vs. 17 (20.2%), respectively, (P=0.0001)]. Number of

Table 2. Characteristics of subjects

Characteristics	Case (n=61)	Control (n=84)
Sex, n (%)		
Male	33 (54.0)	41 (48.8)
Female	28 (45.9)	43 (51.8)
Mean age (SD), years	5.78 (3.21)	5.5 (2.66)
Nutritional status, n (%)		
Malnutrition	51 (83.6)	17 (20.2)
Normal	10 (16.3)	67 (79.7)
BCG scar, n (%)		
No	24 (39.3)	11 (13.0)
Yes	37 (60.6)	73 (86.9)
Index cases, n (%)		
Father	26 (42.6)	30 (49.1)
Mother	50 (59.5)	21 (25)
Other	5 (8.1)	13 (15.4)

Table 3. Bivariate analysis of characteristics of subjects and tuberculosis

Characteristics	Case (n=61)	Control (n=84)	OR	95% CI	P value
Nutritional status, n (%)					
Malnutrition	51 (83.4)	17 (20.2)	3.81	1.88 to 7.74	0.0001
Normal	10 (16.3)	67 (79.7)			
BCG scar, n (%)					
No	24 (39.3)	11 (13.0)	2.03	1.44 to 2.87	0.01
Yes	37 (60.6)	73 (86.9)			
Number of people in the house, n (%)					
> 6	44 (72.1)	26 (30.9)	2.59	1.89 to 3.55	0.01
≤ 6	17 (27.9)	58 (69.1)			
Sleeping in the same bed , n (%)					
Yes	31 (50.8)	9 (10.7)	2.71	1.92 to 3.83	0.001
No	30 (49.1)	75 (89.2)			
Duration of contact, n (%)					
> 6 hours/day	45 (73.7.9)	8 (9.5)	4.88	3.08 to 7.70	0.0001
≤ 6 hours/day	16 (26.2)	76 (90.4)			

people in the house was significantly associated with TB incidence (P=0.0001), as 72.1% of the case group lived with more than 6 people in the house. Sleeping in the same bed was also significantly associated with TB incidence (P=0.001), and raised the risk of TB infection by 2.7 times (OR 2.713; 95%CI 1.92 to 3.83). The immunization BCG status was associated with incidence of TB. This study showed that 73 children (86.9%) in the control group had received BCG immunization. Duration of contact with adult TB patients was also significantly associated with incidence TB (P=0.0001). There were 45 children (73.8%) in the case group who had >6 hours/day of close contact with adult TB patients.

Table 4 shows that the variables significantly associated with incidence of TB were nutritional status and duration of contact, as revealed by multivariate analysis. Longer duration of contact per day was the highest risk factor associated with TB cases (OR 8.91).

Table 4. Multivariate analysis of risk factors for TB

Risk factors	OR (95% CI)	P value
Nutritional status	5.88 (1.48 to 23.40)	0.012
BCG status	2.22 (0.79 to 6.21)	0.118
Number of people in the house	1.98 (0.82 to 6.01)	0.12
Sleeping in the same bed	2.72 (0.76 to 9.78	0.110
Duration of contact	8.91 (2.58 to 30.75)	0.001

Discussion

In this study, we examined environmental characteristics associated with the risk of tuberculosis in children who lived with smear-positive adult TB patients. A previous study showed that environmental characteristics pose a risk of tuberculosis in children who live with adult TB patients.[5] A Surabaya study showed that the number of family members in the house and houses with poor sanitation were risk factors of tuberculosis incidence.[5] In our study, a history of contact with the index case of more than 6 hours per day increased the risk of tuberculosis by 8 times.

Another study assessed the risk factors of TB infection in children with adult TB patients in the household and found a TB infection incidence of 24-69% and a TB disease case incidence of 3.3-5.5%.[6] In addition, Loredo *et al.* showed that the prevalence of TB in children with smear-positive adults in the household was 2-2.7%.[7] Several studies have indicated that close contact with adult TB patients raise the risk of becoming infected.[8,9] *The World Health Organization* (WHO) recommends that all children aged ≤ 5 years living with a smear-positive adult TB patient be screened.[10] Screening this population of children is one strategy to eliminate TB.[11] About 10% of children with latent TB infection develop signs and symptoms of TB disease.[10] The TB assessment of children who have contact with adult TB patients was done by tuberculin skin test and chest radiography.[12]

Children under 5 years of age have a greater

risk to develop from infected TB to TB disease because their immune system has not fully developed. T lymphocyte-mediated immunity is cellular immunity. T lymphocytes consist of T lymphocyte memory cells and effector T lymphocytes. Memory T lymphocytes consist of CD4 and CD8 memory lymphocytes. Effector T lymphocytes consist of cytotoxic T lymphocytes which lysis target cells and effector T CD4 which activate macrophage, B cells and other cells.[11] If the cellular immunity has been formed, newly TB organism will be demolished by cellular immunity.[12]

Nutritional status had a significant association with TB incidence. Evidence has suggested that malnutrition affects genetic expression and immune function, which are predisposing factors for tuberculosis progression.[9] We found a significant association between malnutrition and TB.

The thymus has an important role in the maturation of T lymphocytes and requires proper nutrition in the perinatal period and early childhood. Thymus atrophy in children with malnutrition was associated with increased of infant mortality due to infection. Protein energy malnutrition decreased the size of the thymus and cortical thymocyte apoptosis, changed the microenvironment surrounding lymphoid tissue and epithelial cells, as well as decreased hormone production and proliferation of thymocyte thymulin. Zinc deficiency also contributed to dysfunction of the thymus.[13]

High humidity and poor ventilation can increase the risk of TB. Moreover, a high population density in a housse and a large number of household members increase the infection rate spread from active adult TB to children. Children living with tuberculous adults may develop TB disease depending both on the closeness of the contact and the concentration of the Mycobacterium tuberculosis agent in the sputum index.[14]

This study had strengths and limitations. The limitation of this study was that it was the first study to track children with a history of contacts with adult patients with smear-positive sputum in Batubara, that's why make us difficult to investigaste children, especially for sputum examination in diagnosing tuberculosis in children. Sputum examination is a tool for diagnosing tuberculosis in Batubara, but obtaining sputum from children remains a challenge. Hence, we used the less precise TB scoring system to define active TB disease in our subjects. Other limitations were not assessing the index case, such as by chest X-ray examination, the state of the home environment, such as sanitation and house size, or the socioeconomic status of the family. Chest X-rays of the index cases may be used to assess the severity and location of abnormalities in the lungs.[15] Extensive infiltrates and cavities in the upper lobe were risk factors in the transmission of tuberculosis from adults to children.[12] Adverse environmental conditions such as poor ventilation, humid housing conditions, and the number of occupants in the home may also increase tuberculosis incidence.[14]

In conclusion, malnutrition and duration of household contact with adults having smear-positive TB for more than 6 hours per day are risk factors for TB among children who reside with an adult TB patient.

Conflict of interest

None declared.

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