

Mantoux tests of children in household contact with adult acid fast bacilli-positive or -negative pulmonary tuberculosis

Wardah, Ridwan M. Daulay, Emil Azlin, Wisman Dalimunthe, Rini S. Daulay

Abstract

Background Tuberculosis (TB) is the leading cause of mortality and morbidity in developing countries. In children, the major source of TB transmission is adults with pulmonary TB who have acid fast bacilli (AFB)-positive sputum. However, tuberculosis infection can also occur in children in household contact with adults who have AFB-negative pulmonary TB.

Objective To compare Mantoux test results and induration diameters in children with adult pulmonary TB household contact who were either positive or negative for AFB, and to assess for possible associations between Mantoux test results with age, family income, and house ventilation in both groups.

Methods A cross-sectional study was conducted from January to March 2014. Mantoux test was performed in children aged 3 months to 15 years who had household contact with either AFB-positive or -negative adult pulmonary TB patients.

Results A total of 106 children were enrolled in the study. All subjects had household contact with adult pulmonary TB patients who were either AFB-positive (54 children) or AFB-negative (52 children). Mean Mantoux test induration diameters were significantly different between groups (10.9 (SD 6.55) mm vs. 6.2 (SD 5.91) mm, respectively; $P=0.001$). In addition, there was significantly higher risk of positive Mantoux test in children in contact with adult AFB-positive TB patients than in the AFB-negative group (OR 5.66; 95%CI 2.36 to 13.59; $P=0.0001$). However, there were no significant differences in positive Mantoux test results in each of the AFB-positive and -negative groups, with regards to age, family income, or house ventilation.

Conclusion Mean Mantoux test induration diameter in children who had household contact with AFB-positive adults is significantly larger than that of the AFB-negative group. Positive Mantoux test results in children are associated with AFB-positive adult TB in the household. There is no association between positive Mantoux test results and age, family income, or house ventilation in both groups. [Paediatr Indones. 2017;57:310-5 ; doi: <http://dx.doi.org/10.14238/pi57.6.2017.310-5>]

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Tuberculosis (TB) is a disease caused by *Mycobacterium tuberculosis* (*M. tuberculosis*) and is one of the leading causes of mortality and morbidity in developing countries.¹ Indonesia ranks fourth worldwide after India, China, and South Africa, as the country with the highest TB burden.² In 2011, TB prevalence in Indonesia was 281 per 100,000 people and TB incidence reached 187 per 100,000 people. The mortality rate was 27 per 100,000 people.^{2,3} Tuberculosis in Indonesian children was 9% of total TB cases.³

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From the Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik Hospital, Medan, North Sumatera, Indonesia.

Reprint requests to: dr. Wardah, Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik Hospital, Jl. Bunga Lau No.17, Medan 20136, North Sumatera, Indonesia. Telp. (061) 8361721 – 8365663; Fax. (061) 8361721; Email: wardah_farid@yahoo.co.id.

Several factors facilitate TB infection spread to children such as contact with adult TB patients, living in endemic areas, poverty, and poor sanitation.⁴ In terms of prevalence, more children suffer from TB infection and TB disease after contact with adult patients than the general population. The risk for infection in children increases when they have household contact with adult pulmonary TB patients with sputum positive for acid fast bacillus (AFB).^{5,6} Infection could also occur with AFB-negative adult pulmonary TB household contacts.⁷ Tuberculin test is used to detect *M. tuberculosis* infection.⁴ Children in contact with adults who had positive TB smears and active TB infection had larger Mantoux test induration diameters.⁸

The purpose of this study was to compare Mantoux test results and induration diameters in children with AFB-positive or negative adult TB patient household contact. We also assessed for possible associations between Mantoux test results with age, family income, and house ventilation, in both the AFB-positive and -negative groups.

Methods

This cross-sectional study was conducted in private practices of pulmonary physicians and the Institute for Lung Health Society (*Balai Kesehatan Paru Masyarakat, BKPM*) Medan, North Sumatra from January to March 2014. The subjects were children aged 3 months to 15 years who had household contact with adult pulmonary TB patients. Children with an immunocompromized state (undergoing treatment with long-term corticosteroid therapy, cytotoxic drugs, or other immunosuppressive drugs), malnutrition, measles, mumps, severe tuberculosis, abdominal typhoid, or malignant disease were excluded. Children who underwent Mantoux test within the 2 weeks prior or had polio or measles immunization in the 6 weeks prior were also excluded. This study was approved by the Research Ethics Committee of the University of Sumatera Utara Medical School, Medan. Subjects' parents provided written informed consent.

Adult pulmonary TB patients were identified by their medical records. Pediatric subjects were divided into two groups based on contact history, either AFB-positive or negative adult TB patients.

Subjects' characteristics and information were obtained from questionnaires that were filled out by parents. Mantoux test was performed on all subjects, with 0.1 mL of 2TU PPD RT-23 intradermally on the volar surface of the left forearm. The induration was measured after 48 to 72 hours. Mantoux test was considered to be positive if the induration diameter was ≥ 10 mm.

Household contact was defined as a child living in the same home with an adult pulmonary TB patient for at least 3 months. Adults were diagnosed with pulmonary TB based on suggestive symptoms and signs, confirmed by either presence of TB bacilli on Ziehl-Neelsen staining of sputum (referred to as AFB-positive) or diagnostic chest radiography in the absence of TB bacilli in sputum (AFB-negative). Family income was assessed by monthly parental income, compared to the or minimum wage (*Upah Minimum Kota, UMK*) of Medan municipality, North Sumatra, and classified as higher or lower than the UMK. House ventilation was assessed by measuring the house surface area and ventilation surface area. House ventilation was considered to be good if the ventilation area size was more than 10% of the house surface area, and not good for $< 10\%$.

The collected data were processed, analyzed, and presented using *SPSS 16 version* software. Chi-square test was used to assess for an association between a history of TB contact and Mantoux test results. Independent T-test was used to analyze for differences in the induration diameter size of the Mantoux test. Significance was set at $P < 0.05$ with 95%CI.

Results

A total of 106 children were admitted to the study, of whom 54 children had contact with AFB-positive adults and 52 children had contact with AFB-negative adults with pulmonary TB. A total of 67 adults with TB had household contact with children, 33 AFB-positive and 34 AFB-negative. Characteristics of pediatric subjects in both groups are shown in **Table 1**. The mean age, sex, weight, and height of between the AFB-positive and -negative groups were slightly different. The majority of parents had graduated from senior high school and were self-employed. Family income less than UMK for subjects in the

AFB-positive and -negative groups were 64.8% and 53.8%, respectively. In the AFB-positive group, the majority of subjects' household TB contact was fathers. However, in the AFB-negative group, the same percentage of children had fathers and mothers as the contact source (42.3% for each). No significant difference was found in both groups.

Mantoux test induration diameters ranged from 0 to 25 mm in the AFB-positive group and 0 to 27 mm in the AFB-negative group. **Table 2** shows that the mean induration diameter of the Mantoux test of the AFB-positive group was significantly greater than that of the AFB-negative group (P=0.001).

Positive Mantoux test results were found in 31 (57.5%) children with AFB-positive household contact. However, in the AFB-negative group, 10 (19.2%) children had positive and 42 (80.8%) children had positive Mantoux test results. Chi-square test revealed significant differences in Mantoux test results in both groups (P=0.0001) (**Table 3**).

Table 4 shows the relationships between the Mantoux test results in the AFB-positive and -negative groups with age, family income, and house ventilation, none of which had significant associations.

Table 1. Characteristics of subjects

Characteristics	AFB-positive (n=54)	AFB-negative (n=52)
Age, n (%)		
≤ 5 years	10 (18.5)	15 (28.9)
> 5 years	44 (81.5)	37 (71.1)
Sex, n (%)		
Male	23 (42.6)	28 (53.8)
Female	31 (57.4)	24 (46.2)
Mean weight (SD), kg	27.5 (11.93)	24.5 (12.21)
Mean height (SD), cm	127.5 (24.43)	119.6 (24.16)
Nutritional status, n (%)		
Wasted	19 (35.2)	16 (30.8)
Normoweight	33 (61.1)	34 (65.4)
Overweight	2 (3.7)	2 (3.8)
Paternal education, n (%)		
Elementary school	4 (7.5)	1 (2.0)
Junior high school	6 (11.3)	9 (18.4)
Senior high school	31 (58.5)	28 (57.1)
University	12 (22.7)	11 (22.4)
Maternal education, n (%)		
Elementary school	2 (3.7)	4 (7.7)
Junior high school	13 (24.1)	10 (19.2)
Senior high school	36 (66.7)	30 (57.7)
University	3 (5.5)	8 (15.4)
Family income, n (%)		
< UMK	35 (64.8)	28 (53.8)
≥ UMK	19 (35.2)	24 (46.2)
House ventilation, n (%)		
Not good	27 (50.0)	22 (42.3)
Good	27 (50.0)	30 (57.7)
Contact source, n (%)		
Father	26 (48.1)	22 (42.3)
Mother	18 (33.3)	22 (42.3)
Sibling	3 (5.6)	2 (3.8)
Grandfather/grandmother	5 (9.3)	6 (11.5)
Uncle/aunt	2 (3.7)	0

Table 2. Mantoux test induration diameters

	Positive, n(%)	Negative, n(%)	Mean diameter (SD)	Mean difference (SD)	95% CI	P value
AFB-positive (n=54)	31 (57.4)	23 (42.6)	10.9 (6.55)	4.84	2.45 to 7.24	0.001
AFB-negative (n=52)	10 (19.2)	42 (80.8)	6.2 (5.91)			

Table 3. Mantoux test results

Contact	Mantoux test		OR	95%CI	P value
	Positive, n(%)	Negative, n(%)			
AFB-positive	31 (57.4)	23 (42.6)	5.66	2.36 to 13.59	0.0001
AFB-negative	10 (19.2)	42 (80.8)			

Table 4. Mantoux test results in children by AFB group and age, family income, and house ventilation

Variables	AFB-positive				AFB-negative			
	Mantoux tes		OR 95%CI	P value	Mantoux test		OR 95%CI	P value
	Positive (n=31)	Negative (n=23)			Positive (n=10)	Negative (n=42)		
Age, n (%)								
≤5 years	4(12.9)	6(26.1)	0.42	0.297	2(20.0)	13(31.0)	0.56	0.704
>5 years	27(87.1)	17(73.9)	(0.10 to 1.71)		8(80.0)	29(69.0)	(0.10 to 2.99)	
Family income, n(%)								
<UMK	22(71.0)	13(56.5)	1.88	0.272	7(70.0)	21(50.0)	2.83	0.291
≥ UMK	9(29.0)	10(43.5)	(0.61 to 5.83)		3(30.0)	21(50.0)	(0.64 to 12.44)	
House ventilation, n(%)								
Not good	15(48.4)	12(52.2)	0.86	0.783	5(50.0)	17(40.5)	1.47	0.725
Good	16(51.6)	11(47.8)	(0.29 to 2.53)		5(50.0)	25(59.5)	(0.37 to 5.87)	

Discussion

We found that the mean induration diameter of the Mantoux test in children in household contact with adult AFB-positive TB patients was significantly higher than that of the AFB-negative group, similar to a Spanish study.⁸ Household contact with adult TB patients is a risk factor for TB infection in children. A study in Laos reported that the risk of TB infection in children with TB contact is greater for children in contact with smear-positive TB patients.⁹ Also, a Turkish study showed that the risk of TB infection in children was higher for those in contact with adults who were smear-positive and had cavities in the lungs on chest x-ray.¹⁰ Furthermore, we found significantly more positive Mantoux test results in the AFB-positive group than in the AFB-negative group, with an odds ratio of 5.6. This result was greater than that of an Indian study, which reported an odds ratio of 3.2.⁵ A Manado study also showed that household contact with AFB-positive adult TB was a risk factor for TB infection in children.¹¹

Parents, both fathers and mothers, were the majority contact source of TB in our study. A Brazilian study showed fathers to be the main contact,¹² while a Pakistani study showed mothers to be the main contact, because they spent more time with the children than other family members.¹³ Having contact with more than one TB patient in a house also increased the risk of TB illness.¹² In our study we found only one child with more than one adult TB household contact. The prevalence of TB infection in children having household contact with AFB-negative

adult pulmonary TB in this study was 19.2%. This prevalence was higher than in West Java, with a 10% prevalence for TB infection and 16% for TB disease.⁷ A study in Nigeria showed positive tuberculin tests in 49% and 16% of children with AFB-positive and -negative adult TB household contacts, respectively,⁶ while a study from India reported 46.4% and 21.3%, respectively.⁵

The incidence of TB infection increases in accordance with age. A systematic review showed that TB disease was more commonly found in children less than 5-year-old, but TB infection was more commonly found in older children.¹⁴ We noted that positive Mantoux test results were more common in children older than 5 years, regardless of the AFB status of their household contact.

Density and poor ventilation increase the probability of TB infection. People living in crowded areas or with poor ventilation have higher risk of TB exposure. The risk of a positive tuberculin test in subjects with adult TB household contact increased as house density increased. A Bangkok study showed that children living in dense environments had five times higher risk of being infected with TB than children living in less dense environments. The residential area also contributes to the spread of TB due to environmental conditions, poor ventilation, poor hygiene, and crowding.¹⁵ Unfortunately, we did not assess house density. We only assessed house ventilation, which was not associated with Mantoux test results.

Tuberculosis has been associated with poverty, as reflected by low family income. Poor socio-

economic condition may increase infection through poor nutrition and high population density. Studies in Great Britain, the Philippines, and Cambodia showed that the incidence of TB was closely related to poverty.¹⁶⁻¹⁸ However, we found no such relationship between low income and TB infection. This difference may be due to poverty assessment methods. We used the minimum regional wage (UMK) in Medan, where the study was conducted, as a cut-off point for household income. Similarly, a study in West Java also found no relationship between family income and positive tuberculin test in children with adult pulmonary TB household contact.¹⁹

Some limitations were noted in the study, such as not performing TB scoring and defining infection based on Mantoux test reaction, regardless of presence/absence of symptoms. In addition, history of BCG immunization weren't assessed. Further study is required to determine TB disease in children and assess the risk factors for TB infection in children.

In conclusion, mean induration diameter of Mantoux test in children with AFB-positive adult TB patient household contact is significantly larger than in children in the AFB-negative group. In addition, a greater number of positive Mantoux test results are associated with AFB-positive household contact. There are no associations between positive Mantoux test results and age, family income, or house ventilation in either group.

Conflict of Interest

None declared.

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