Risk Factors of the Incidence of Pulmonary Tuberculosis in Banjarmasin city, Kalimantan, Indonesia

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Article Info

ABSTRACT

Pulmonary tuberculosis remains a major cause of morbidity and mortality in the world, including Indonesia. In South Kalimantan, an increasing incidence of tuberculosis up to the year 2010 which were taken using a smear-positive reached 3,237 cases, the largest was in Banjarmasin city which reached 642 cases and the detection rate still low, which is 52, 1%. To investigate the relationship among environmental risk factors of the house (residential density, the air temperature, humidity, ventilation, and natural lighting), smoking behavior and alcohol consumption among tuberculosis patients with the incidence of pulmonary tuberculosis in Banjarmasin city. This study was an analytic observational with case control study. The subjects were tuberculosis patients with smear-positive as a case group and smear-negative as a control group. Residential density, the air temperature, ventilation, natural lighting, smoking behavior and alcohol consumption significantly associated with the incidence of pulmonary tuberculosis in Banjarmasin city. While the humidity was not significantly associated. The most dominant risk factors in the incidence of pulmonary tuberculosis in Banjarmasin city were inappropriate of the air temperature in subjects with a history of household contact with tuberculosis patient, natural lighting, and house ventilation.

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1. INTRODUCTION

Tuberculosis is a chronic disease caused by Mycobacterium tuberculosis, remain a major cause of morbidity and mortality in the world, including Indonesia (1,2). Based on the Global Tubeculosis Control for the year 2009, the incidence of all types of tuberculosis in Indonesia is 430,000 cases, mostly in the age group of 15-54 years with a total of 169,213 smear-positive cases and the prevalence of 660,000 cases with mortality number of 62,000 cases. In South Kalimantan, showed an increasing in the incidence of pulmonary tuberculosis. In the year 2001, smear-positive cases reached 4.05 per 100,000 popullation to 9.68 per 100,000 population in 2006, as many as 3,203 cases. Most cases were happened in the Banjarmasin city, with a number of 709 cases. In 2010 this number was again increasing to 3,237 cases of smear-positive, with most cases also found in the Banjarmasin city, reached 808 tuberculosis patients, with 642 new cases of smear-positive with CDR (Case Detection Rate) still low, which was 52,1% (2,3).

Tuberculosis is a contagious disease. It spreads through air contaminated by Mycobacterium tuberculosis that was released by tuberculosis patients when they cough, spit, sneeze or talk. This means that the occurence of tuberculosis is highly correlated with environmental factors(4). The situation in a house can affect the incidence of pulmonary tuberculosis for the residents. A study conducted by Baker found an increasing tuberculosis incidence 8% for each 1% of increasing of density in that area (5). Tuberculosis

bacteria is mesophilic bacteria which will grow optimally in the temperature of 31-370C and high humidity is a good medium for the growth and proliferation of that bacteria. Ventilation have the benefit of reducing humidity within the house, while sunlight possess bactericidal property against bacteria in the air. A house with inadequate ventilation will be lacking of air circulation and sunlight which subsequently lead to increased humidity which favors the growth of tuberculosis bacteria (6,7). Research conducted by Desmon showed that people living in unhealthy housing conditions have 1.93 times chance to suffer from pulmonary tuberculosis as compared to people living in healthy house (8).

Banjarmasin is one city in South Kalimantan with a population that always increase in number each year and has the largest population density than urban / other districts in South Kalimantan, until by the year 2008 there were 627,245 people with a density of 8,712 people/km2, with a number of healthy housing only 62.7 and only 29.0% houses applied the clean and healthy life style. In the year 2009 the population had increased to 638,902 popullation with a population density of 8,874 people/km2 (9).

In addition to environmental factors, the incidence of pulmonary tuberculosis is also influenced by patient's behaviour such as smoking habits or consuming alcoholic drinks. One study in South Korea proved that smoking increases the risk of tuberculosis infection, number of mortality caused by tuberculosis, and recurrency of tuberculosis (10). Meta analysis conducted by Rehm et al. also stated that the incidence of pulmonary tuberculosis was associated with alcohol use since alcohol might also damage the immune response and increase disease transmission (11). Based on the results of basic medical research in 2010, the prevalence of smokers in Indonesia reached 34.7%, while in South Kalimantan, smokers are 30.5% and 6.9% of the population are former smokers (12).

This study aims to investigate the relationship of environmental risk factors of the house (residential density, the air temperature, humidity, ventilation and natural lighting), smoking behavior and alcohol consumption with the incidence of pulmonary tuberculosis in Banjarmasin city. The hypotheses in this research are:

1. There is a relationship between residential density with the incidence of pulmonary tuberculosis;
2. There is a relationship between the air temperature with the incidence of pulmonary tuberculosis;
3. There is a relationship between humidity with the incidence of pulmonary tuberculosis;
4. There is a relationship between ventilation with the incidence of pulmonary tuberculosis;
5. There is a relationship between natural lighting with the incidence of pulmonary tuberculosis;
6. There is a relationship between smoking behavior with the incidence of pulmonary tuberculosis;
7. There is a relationship between alcohol consumption with the incidence of pulmonary tuberculosis;
in Banjarmasin city.

2.   RESEARCH METHOD

This was an analytic observational with a case-control study. Subjects were taken from three areas of public health centers that have the most patients with pulmonary tuberculosis smear-positive in Banjarmasin city on the year 2010, which the Public Health Center Pekauman, Teluk Tiram, and South Alalak. A case group was tuberculosis patients with smear-positive that registered in public health centers with a number of 77 persons, while a control group was subject with smear-negative as many as 77 people. The control group was matched by age and sex.

Variables consisted of the independent variables (residential density, the air temperature, ventilation, humidity, natural lighting, smoking behavior and alcohol consumption), the dependent variable (the incidence of pulmonary tuberculosis), and external variables (nutritional status, history of in-house contact with tuberculosis patients, a history of BCG immunization, education, and economic status). Instrument used was the form of questionnaires, thermohygrometer and luxmeter (digital instrument), measuring tape, and scale. Analysis of data using univariable, bivariable (chi square and OR) analysis at 95% confidence interval and multivariable analysis using logistic regression.

3.   RESEARCH FINDINGS AND DISCUSSION

The research was conducted in November 2011 to January 2012. Characteristics of research subjects were described as follows. Based on Table 1, the majority of research subjects is male and aged between 35 - < 45 years. Experience shows that the greatest incidence of tuberculosis occurred in the age group above 30 years, probably in that age group had a history of contact in a place and in a long time. Patterns of social relations which closely causes people tend to socialize with peers age group, so the tendency to contact is also happening at the same age group. In addition, smoking behavior and alcohol consumption were also encountered in adulthood, it can be risk factors for pulmonary tuberculosis (7).

Table 1. Characteristics of research subjects based on sex and agein Banjarmasin city

No.	Characteristics of research subjects	Category	Case		Control	
			n	%	n	%
1.	Sex	Male	43	55.84	43	55.84
		Female	34	44.16	34	44.16
		Total	*77*	*100.00*	*77*	*100.00*
2.	Age	15 - < 25 years	5	6.49	5	6.49
		25 - < 35 years	16	20.78	16	20.78
		35 - < 45 years	20	25.97	20	25.97
		45 - < 55 years	19	24.68	19	24.68
		≥ 55 years	17	22.08	17	22.08
		Total	*77*	*100.00*	*77*	*100.00*

If viewed in terms of gender, pulmonary tuberculosis incidence data in Banjarmasin city, the majority was male sex, as many as 58.92%. This could be caused by differences in the level of social interaction between men and women, and men have more other risk factors, such as smoking behaviour and alcohol consumption. Results of research conducted by Desmon showed that males had 2.32 times greater risk to suffer from tuberculosis as compared to female (8).

Table 2. Distribution and results of bivariable analysis between the independent variables with the incidence of pulmonary tuberculosis in Banjarmasin city

Variables	Case		Control		OR	95% CI	*Chi square*	*p*
	n	%	n	%				
Residential density					2.222	1.134 – 4.355	4.742	0.019
Inappropriate	35	45.45	21	27.27				
Appropriate	42	54.55	56	72.73				
Total	*77*	*100.00*	*77*	*100.00*				
Air temperature					13.142	5.816 – 29.697	43.434	0.000
Inappropriate	67	87.01	26	33.77				
Appropriate	10	12.99	51	66.23				
Total	*77*	*100.00*	*77*	*100.00*				
Ventilation					14.444	6.528 – 31.961	48.691	0.000
Inappropriate	65	84.42	21	27.27				
Appropriate	12	15.58	56	72.73				
Total	*77*	*100.00*	*77*	*100.00*				
Humidity					1.446	0.764 – 2.736	0.945	0.257
Inappropriate	38	49.35	31	40.26				
Appropriate	39	50.65	46	59.74				
Total	*77*	*100.00*	*77*	*100.00*				
Natural lighting					17.541	5.076 – 60.619	28.988	0.000
Inappropriate	32	41.56	3	3.90				
Appropriate	45	58.44	74	96.10				
Total	*77*	*100.00*	*77*	*100.00*				
Smoking behavior					2.436	1.251 – 4.743	6.144	0.008
Smoker	38	49.35	22	28.57				
Non-smoker	39	50.65	55	71.43				
Total	*77*	*100.00*	*77*	*100.00*				
Alcohol consumption					15.438	1.966 – 121.238	9.507	0.001
Drinker	13	16.88	1	1.30				
Non-drinker	64	83.12	76	98.70				
Total	*77*	*100.00*	*77*	*100.00*				

Table 2 shows that the residential density of houses, the air temperature, ventilation, natural lighting, smoking behaviour and alcohol consumption were significantly associated with the incidence of pulmonary tuberculosis. Only the humidity was notsignificantly associated with the incidence of pulmonary tuberculosis. People living in house with inappropriate of residential density had 2.22 times higher risk, people living at house with the inappropriate the air temperature had 13.14 times greater risk, who living in a house with inadequate ventilation had 14.44 times greater risk and people living at house with not good natural lighting had 17.54 times greater risk for suffering from sick of pulmonary tuberculosis. Meanwhile, people who was smoked at 2.44 times risk and the ones who had history of consuming alcoholic drinks had 15.44 times greater risk to suffer form pulmonary tuberculosis.

Humidity was not significantly assosiated, because there was a similar proportion between case and control groups from the aspect of humidity. Air humidity in the house can be influenced by the outside air

humidity, ventilation width, temperature, natural lighting, topography, and the water intrusion. When research was conducted, the Banjarmasin city was a rainy season, with high humidity (74-91%). Banjarmasin city is a swamp area so the most of the houses were the stage houses with floors made of wood board arrangement, which allows water vapor rising from the soil into the house so that it can increase humidity in the house.

Table 3. Distribution and results of bivariable analysis between the external variables with the incidence of pulmonary tuberculosis in Banjarmasin city

Variables	Case		Control		OR	95% CI	Chi square	P
	n	%	n	%				
Nutritional status					1.550	0.729 – 3.297	0.906	0.253
Less	21	27.27	15	19.48				
Good	56	72.73	62	80.52				
Total	77	100.00	77	100.00				
Contact history					1.613	0.732 – 3.553	0.986	0.233
There is	19	24.68	13	16.88				
No	58	75.32	64	83.12				
Total	77	100.00	77	100.00				
BCG immunization					1.056	0.553 – 2.014	0.000	0.869
Never	47	61.04	46	59.74				
Ever	30	38.96	31	40.26				
Total	77	100.00	77	100.00				
Level of education					1.229	0.594 – 2.546	0.137	0.578
Low	59	76.62	56	72.73				
Height	18	23.38	21	27.27				
Total	77	100.00	77	100.00				
Economic status					1.150	0.552 – 2.395	0.035	0.709
Poor	20	25.97	18	23.38				
Not poor	57	74.03	59	76.62				
Total	77	100.00	77	100.00				

Table 3 note that all external variables are not significantly associated with incidence of pulmonary tuberculosis in Banjarmasin city. Multivariable analysis was subsequently conducted with logistic regression for all variables with p-value < 0.25 initiated by examination of interaction betwen variables and judgement of the existence of confounding to achieve an end model for each main independent variables. From multivariable analysis, temperature was the only variable which was found to have interaction with contact history. After analysed and controlled of confounders, results of end model for each independent variables were described as below:

Table 4. The final model of each of the main independent variables

Model	Variables	β	OR	95% CI	P
I	Residential density	0.4	1.49	0.68 – 3.28	0.32
II	Air temperature + contact history	3.2	24.01	6.06 – 95.17	0.00
	Air temperature + no contact history				
		0.8	0.39	0.03 – 4.28	0.44
III	Ventilation	1.9	6.43	2.49 – 16.56	0.00
IV	Natural lighting	2.8	15.92	3.38 – 75.10	0.00
V	Smoking behavior	0.6	1.91	0.70 – 5.21	0.21
VI	Alcohol consumption	1.0	2.68	0.25 – 28.56	0.41

Table 4 shows that the first model with residential density of homes as main independent variable, an adjusted OR value of 1.49 was obtained, which means that people living in house with inadequate residential density (< 9m2 per person) had 1.49 times greater risk to suffer from pulmonary tuberculosis after confounding variables were controlled. For temperature variable, an interaction with contact history was found, which subsequently led to the existence of 2 adjusted ORs. For inadequate house temperature and positive contact history, the OR was 24.01 which meant that people living together with tuberculosis patient(s) in houses with inadequate temperature had 24.01 times higher risk to suffer from pulmonary tuberculosis. Meanwhile, in houses with inadequate temperature with negative contact history with pulmonary tuberculosis patients, an OR value of 0.39 which meant that temperature was not a risk factor, but served as protective factor instead. This was in concordance with research conducted by Ruswanto which

obtain a significant correlation between density of inhabitants and the air temperature with the occurence of pulmonary tubeculosis in Pekalongan district (13). The higher the density of people within one house, the bigger interaction that occurs. This will facilitate the spread of disease including pulmonary tuberculosis. Tubeculosis bacteria are mesophilic bacteria that will grow optimally in inadequate room temperature of 310 – 370 C. The air temperature in the house can be influenced by the season, the outside air temperature, natural lighting and fresh air flow entering through the ventilation holes, so that if the house is less ventilation, the air temperature in the house will tend to increase (6). In addition, it is also influenced by material and color of the roof and walls, ventilation and angle of roof space, and ceiling materials. Tin roof, a dark color of the roof, the ceiling from asbestos, a small ventilation and angle of the roof causes the temperature in the house to be higher (14).

In third model with ventilation width as main independent variable, the value of adjusted OR was 6.43 which meant that subjects living in houses with inadequate ventilation had a 6.43 times higher risk to suffer from pulmonary tuberculosis after confounding variables were controlled. Meanwhile, in fourth model with lighting as main independent variable, an adjusted OR value of 15.92 was obtained. This meant that subjects living in houses with inadequate natural lighting had the 15.92 times higher risk to suffer from pulmonary tuberculosis.

Ventilation is beneficial for air circulation within the house. It may reduce humidity and affect the air dilution process so the concentration of tuberculosis bacteria can be reduced. Meanwhile, sunlight especially ultraviolet, could kill bacteria, including tuberculosis bacteria which are unable to survive the direct sunlight(7). Lack of natural lighting in the houses of tuberculosis patients in the Banjarmasin city consistent with the lack of ventilation. In addition, not all of the houses of tuberculosis patients had a glass windows, some of them made of wood. Existing glass windows were mostly covered by a cloth curtain, and the location of the house which is attached to another house, thus blocking the sun's light into the house. This was in concordance with research conducted by Silviana which revealed significant correlation between the width of ventilation and lighting with the occurence of pulmonary tuberculosis in Muaro Jambi district (15).

In fifth model with smoking behavior as main independent variable, the value of adjusted OR was 1.91 which meant that subjects who smoked or had a history of smoking were at 1.91 times higher to have risk to suffer from pulmonary tuberculosis. Cigarette with various toxic substances contained in it could damage pulmonary defense mechanism where cilia and other defense mechanisms are destroyed which subsequently will increase its vulnerability to bacterial infections, including tuberculosis bacteria. Smoking also increase the resistance in respiratory tract and damage phagocytic cells and decrease response to antigen, so subjects could be easily infected by tuberculosis bacteria (10).

In sixth model with alcohol consumption as main independent variable, the value of adjusted OR was 2.68 which meant that people with history of alcoholic consumption had 2.68 times higher to have risk of suffering from pulmonary tuberculosis after confounding variables were controlled. Alcohol consumption also increased the risk of infection since it damaged immune response and accelerate disease transmission. There had been clear evidences that alcohol consumption could inhibit pulmonary defense response to bacterial infection, damaging cytokines such as TNF-alpha and disturb phagocytosis of tuberculosis bacteria by macrophages that it left the lungs susceptible to infection by tuberculosis bacteria (11).

4. CONCLUSIONS AND SUGGESTIONS

Based on the research results, it can be concluded as follows:
a. Inappopriate of residential density of house (OR = 2.22), the air temperature (OR = 13.14), ventilation (OR = 14.44), and natural lighting (OR = 17.54), smoking behavior (OR = 2.44) and alcohol consumption (OR = 15.44) are risk factors for the incidence of pulmonary tuberculosis in Banjarmasin city. While the humidity is not a risk factor for pulmonary tuberculosis in Banjarmasin city.
b. The most dominant risk factors in the incidence of pulmonary tuberculosis in Banjarmasin city are inappropriate of the air temperature in subjects with history of in-house contact with tubeculosis patient (an adjusted OR 24.01), natural lighting (an adjusted OR 15.92), and ventilation (an adjusted OR 6.43).

After conducting research, analysis, and discussion, the author would like to deliver advices as follows:
a. Health Office and related institution should improved promotion about tuberculosis and do more effort for better housing in community to obtain healthy houses, as well as the promotion of family planning to reduce the residential density.
b. People in community should improved the condition of their houses and avoid unhealthy habits such as smoking and consuming alcoholic drinks.

c. Do further research on the relationship among smoking and alcohol consumption with the incidence of pulmonary tuberculosis.

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