The Spread Pattern and Various Risk Factors of Human Leptospirosis in Yogyakarta, Indonesia

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Yogyakarta is one of the big cities in Indonesia. This city is passed by three rivers that flood annually. This flood emerges disease such as leptospirosis. This disease is spread through Leptospira-contaminated water from the infected urine animals. This study was conducted to know the spread pattern and risk factors leptospirosis in Yogyakarta from 2011 to 2013. The data cases were come from the medical record review of hospital in Yogyakarta. An interviewe was held to determine odd ratios (OR), 95% confidence intervals and computed in order to know the association between potential risk factors using bivariate analysis. The spatial spread leptospirosis was analyzed by spatial auto correlation Moran index and Average Nearest Neighbour. The result showed that the patterns of spread leptospirosis cases in Yogyakarta city was clustered. The were six risk factors leptospirosis included puddle (OR = 3.667 , 95 % CI = 1.238 – 10.863), sewers watery (OR = 3 , 95 % CI = 1.385 – 6.499) , and flood history (OR = 2.688 , 95 % CI = 1.226 – 5.895), midden (OR = 4.75, 95%CI 1.266 – 17.819), occupational (OR = 2.625, 95%CI = 1.21 – 5.691) and skin lessions (OR=4.2, 95%CI 1.93 – 91.41).

Key words: Flood history, leptospirosis, skin lessions, sewers watery.

Leptospirosis is one of the re-emerging zoonotic diseases that particularly happen in poor countries. The leptospirosis cases is always associated with environmental problems, such as flood and natural disasters.[1] Leptospirosis is found in both developing countries and some industry countries. Indonesia is one of tropical countries with high leptospirosis cases.[2] It was estimated that more than 500.000 cases per year around the world, with case fatality rate more than 10%.[3] Leptospirosis is an issue in urban area which increase along with the improvement of urbanization.[4] The increasing migrations rates from rural to urban area had caused an urban environment becomes dirty. That urban condition is quite suitable for rodensia life that spread Leptospira bacteria (Rodent borne transmission).[5] *Leptospira interrogans* caused an acute anthropo-zoonotic infectious. This bacterias has 23 serogroups and more than 200 serovars.[6] Leptospira bacteria was transmitted by direct and indirect contact through urine, blood, fluids and tissues of infected animals. The occupation that has highly risk leptospirosis among other is farmers, veterinary, miners, a ditchdigger workers, soldiers, fishers, laboratory workers. [7, 8]

In Indonesia, leptospirosis cases increased from 2004 to 2011.[9] Leptospirosis cases were 766, with 72 deaths cases in 2011. According to administration Ministry of health, the highest case fatality rate (CFR) was 15.06 in 2004.[10] According

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to previous report, in 2009 to 2011, the highest leptospirosis cases was found in Yogyakarta province. In 2011, the health department of Yogyakarta city recorded 26 cases with CFR was 19.23. This result of the research was used as a holistic approach to prevention leptospirosis in Yogyakarta.

MATERIALS AND METHODS

The research had been held since May 2014 to April 2015. The research was observational descriptive by case control design. The research objects as positive cases group were 60 patients who were hospitalized from 2011 to 2013 with serologically confirmed leptospirosis based on medical records hospital in Yogyakarta city. Negatives controls were 60 individuals without reported clinical leptospirosis, who resided in the same neighborhood as a case during the study. Study locations were all subdistrict areas in Yogyakarta city, which had reported leptospirosis cases. Samples were taken by purposive sampling method and collected with a consideration that all elements have qualified for the research. An interviewer was held using questionnaire in order to determine odd ratios (OR) and 95% confidence intervals. The interview result was computed to know the association between potential risk factors using bivariate analysis. The geographical positions of cases were located using the GPS. The spatial correlation and pattern spread leptospirosis were analyzed by spatial autocorrelation Moran index and Average Nearest Neighbour by ArcGis 10.2 software.

RESULTS AND DISCUSSION

In this study, total numbers respondent were 120 consisting 60 cases and 60 controls. Research objects were mostly male (70%) with the average age was 50.6 years. As a comparison, negative controls were also mostly male (70%) with the average age was 47.7 years. There was not any difference between average age cases with control ($p = 0.284$). Mostly leptospirosis cases were found at age range between 41-60 years. The distribution frequency based on correspondences occupation was outdoor type. The cases group and control group occupation frequency were respectively 45% and 33.3%. The distribution frequency based on respondents education backgrounds of cases group was dominated by primary school (33.3%), meanwhile controls group was mostly some secondary school (35%) (Table 1).

The cases group were stated that there was environmental problems that also intervening the disease, such as mud puddles, water ditch, and flood history. The cases group had experienced it more than controls group. There are three environmental problems that can be leptospirosis factors, such as: mud puddle with an OR 3.667 ($p = 0.014$. 95% CI = 1,238 – 10.863); water ditch with an OR 3 ($p = 0.005$, 95% CI = 1.385 – 6,499); and flood history with an OR 2.688 ($p = 0.012$, 95% CI = 1.226 – 5.895) (Table 2). Therefore, the risk factors from abiotic environment include mud puddle, water ditch, and flood history increased the cases of leptospirosis disease in Yogyakarta.

Table 3 describes the risk factors social environmental, such as midden, ditch, road condition, the distance between house to water ditches, landfill condition, garbage collecting service, and number occupant per house. Midden was the one significant social environmental variable. Midden increase the odd of disease with

Table 1. Demographic information for leptospirosis among cases and controls from Yogyakarta City

Variable	Cases N = 60	Controls N = 60
Age (years)		
< 21	3 (5%)	1 (1.7%)
21 – 40	10 (16.7%)	19 (31.7%)
41 – 60	33 (55%)	29 (48.3%)
61 – 80	14 (23.3%)	11 (18.4%)
Occupational		
Student	2 (3.3%)	1 (1.7%)
Unemployed	7 (11.7%)	13 (21.7%)
Outdoor	27 (45%)	20 (33.3%)
Domestic work	8 (13.3%)	11 (18.3%)
Indoor non-labor	16 (26.7%)	15 (25%)
Gender		
Males	42 (70%)	42 (70%)
Females	18 (30%)	18 (30%)
Education		
None	3 (5%)	2 (3.4%)
Some Primary	17 (28.3%)	15 (25%)
Primary	20 (33.3%)	12 (20%)
Some Secondary	15 (25%)	21 (35%)
University	5 (8%)	10 (16.6%)

OR= 4.75 (p = 0.013, 95% CI = 1.266 – 17.819). The presence of garbage around the house in cases group was more likely than controls.

There are two variables behavioral significantly as risk factors leptospirosis disease (Table 4). Occupation type and skin lessions increase the odd of disease with OR = 4.2 and 2.625, respectively. On the other hand, the contact with carcase-, wearing footwear, take a bath in the river, discharging self protective instrument, and hand washing are not significant as risk factors leptospirosis cases (Table 4). The risk of occupation type and skin lessons on the cases group was higher than the controls.

All the variables were transferred to the ArcGis 10.2 software to calculate the

Table 2. Univariate and bivariate analysis for matched odds ratios (OR) and confidence intervals 95% (95% CI) of human leptospirosis from abiotic environmental

Risk factors by category	Cases	Control	p_{value}	OR	95% CI
Mudpuddle			0.014	3.667	1.238 – 10.863
Yes	15 (25%)	5 (8.3%)			
No	35 (58.3%)	33 (55%)			
Water ditch			0.005	3	1.385 – 6.499
Wet	30 (55%)	15 (25%)			
Dry	30 (45%)	45 (75%)			
Flood history			0.012	2.688	1.226 – 5.895
Yes	27 (45%)	14 (23.3%)			
No	33 (55%)	46 (76.7%)			

Table 3. Univariate and bivariate analysis for matched odds ratios (OR) and confidence intervals 95% (95% CI) of human leptospirosis from social environmental

Risk factors by category	Cases	Control	p_{value}	OR	95% CI
Midden			0.013	4.75	1.266 - 17.819
Yes	12 (20%)	3 (5%)			
No	48 (80%)	57 (95%)			
Sewers			0.57	1.385	0.45 - 4.265
Yes	54 (90%)	52 (86.7%)			
No	6 (10%)	8 (13.3%)			
Road condition			0.206	1.714	0.74 – 3.47
Bad	18 (30%)	12 (20%)			
Well	42 (70%)	48 (80%)			
Distance house – water ditches			0.831	0.913	0.396 – 2.107
< 10 m	45 (75%)	46 (76.7%)			
> 10 m	15 (25%)	14 (23.3%)			
Landfill condition			0.402	0.483	0.085 – 2.741
Bad	2 (33%)	4 (6.7%)			
Good	58 (96.7%)	56 (93.3%)			
Garbage collecting service			0.85	1.074	0.513 – 2.249
Yes	37 (61.7%)	38 (63.3%)			
No	23 (38.3%)	22 (36.7%)			
Number occupant (s) per house			0.854	1.07	0.52 – 2.2
1 – 4 person	27 (45%)	26 (43.3%)			
> 4 persons	33 (55%)	34 (56.7%)			

autocorrelation according to the Moran index and to analyze the spatial distribution and pattern spread of these variables according to district. The result showed that Z score: 1.199 with Z á/2: 2.58. So, there was no spatial relation the incidence of leptospirosis. By Average Nearest Neighbour (ANN) analysis, Z score: -2.186, with ANN: 0.87 < 1. It means that the pattern spread was *clustered*.

Table 4. Univariate and bivariate analysis for matched odds ratios (OR) and confidence intervals 95% (95% CI) of human leptospirosis from behavioral

Risk factors by category	Cases	Control	p_{value}	OR	95% CI
Occupational			0.013	2.625	1.21 – 5.691
Risk	28 (46.7%)	15 (25%)			
Not risk	32 (53.3%)	45 (75%)			
Contact with carcase			0.432	1.514	0.535 – 4.286
Yes	10 (16.7%)	7 (11.7%)			
No	50 (83.3%)	53 (88.3%)			
Skin lessions			0.0001	4.2	1.93 – 91.41
Yes	35 (50.3%)	15 (25%)			
No	25 (41.7%)	45 (75%)			
Wearing footwear			0.471	0.706	0.273 – 91.41
No	48 (80%)	51 (85%)			
Yes	12 (20%)	9 (15%)			
Bathe in the river			0.509	0.643	0.172 – 2.405
Yes	4 (6.7%)	6 (10%)			
No	56 (93.3%)	54 (90%)			
Discharging self protective instrument			0.402	0.483	0.085 – 2.741
Yes	56 (93.3%)	58 (96.7%)			
No	4 (6.7%)	2 (3.3%)			
Hand washing			0.243	0.379	0.072 – 2.037
Yes	55 (91.7%)	58 (96.7%)			
No	5 (8.3%)	2 (3.3%)			

DISCUSSION

This research shows that leptospirosis cases were mostly male. This result is similar with research in Sri Lanka [11] and Thailand[12]. But this is different with Agampodi's research, since the prevalence is mostly female[13]. In Yogyakarta city, the spread pattern of leptospirosis was seemed clustered and there was no relation spatial. This result is not different with the other place like Semarang (Indonesia)[14], Sao Paulo[5], Salvador, Brazil[15] and Palau[16]. The abiotic risk factors, social environment, and behavioral of leptospirosis incidence in Yogyakarta included mud puddle (OR = 3.667), water ditch (OR = 3), flood history (OR = 2.688), midden (OR = 4.75), occupational (OR = 2.625) and skin lessions (OR=4.2). Patients with leptospirosis were found in the flood areas and river nearby areas. Leptospirosis was clustered in the common characteristic areas expecially the same level sanitation. After the flood, water puddle will be a spread site of Leptospirosis. A density population is often concerned with dirty environment condition and poor sanitation. This condition will be an ideal place for rats breeding. The incidence leptospirosis correlated positively in suburband involved in many cases in the suburb than the downtown.

According to Barcellos and Sabroza, leptospirosis cases is found in flood areas with high density population[17]. The leptospirosis cases is decrease in the hill, which have lower density population and good sanitation facilities. Leptospirosis cases are found in region that is within 250 to 500 meters from landfill. The other way, the cases is decrease along with the farther distance from landfill. In addition, leptospirosis also caused by the open drainage ditch, house

location that nearby the waste disposal, rats and animals within the house, and low income level household. Climate also has correlation with leptospirosis occurrence[18]. Living in low-land area was more tends to be flooded. The area which located less than 250 meters from pig husbandry can be as the risk factor leptospirosis[19]. The contaminated mudpuddle will become the source of indirect transmission of disease dissemination. House and rats is potential animal to transmit leptospirosis to human. The presense of more than five rats in the household can be the indicator of leptospirosis risk factors[20]. Rats as host agent of leptospira bacteria, such as *Bandicota indicata, Rattus diardrii, Mus muscullus, Rattus norvegicus*, and *Rattus tanezumi*[4]. In Malaysia, the prevalence leptospirosis *Rattus tiomanicus* is 12.3%[21]. The serovar *Leptospira interrogans* infects *Apodemus agrarius* and *Rattus norvegicus* in Korea[22]. Rats can be found every where, such as the field irrigations, yard, house, and ditches. In rainy season, the ditches usually filled by occupied water. When urine rats contaminated the water, it will transmit Leptospira bacteria. The leptospirosis spreading distance by rats is depends on social environment and interaction between rats[22]. According to Herbreteau *et al*., the mapping of the rats spread is important to mark the risk leptospirosis area[23]. The existence of rats in the slum community indicates the risk leptospirosis area criteria[24].

The midden around the household will be a suitable nest of rats. Household garbage around the house can increase the risk 4.75 times for exposed leptospirosis. Household leftovers that discarded in open garbage will increase the presence of rats. The dust men and ditch cleaning service are the examples occupations that have highly risk of leptospirosis. The direct contact towards a contaminated ditch water and mud has risk 3 times higher to be exposed by leptospirosis[25, 26]. People working on rice agriculture and fishery manufactures also have high risk to be exposed[19, 27]. The behavioral risk factors leptospirosis in Yogyakarta was not different from the other cities in Indonesia. The direct contact with the public open water resource, such as take a bath, washing clothes and cattles in the river would be easily expose to Leptospira bacteria. Furthermore, the weakened human body because of skin injuries has risk 2.69 times higher exposed leptospirosis. Domestic animals, rats, and mammal are not disease symptom of leptospirosis, but they spread Leptospira bacteria in their urine. If their urine contaminated the fresh water with slightly alkaline, the pathogenic Leptospira would live longer in the lake, swamps and river.

CONCLUSION

The patterns of spread leptospirosis cases in Yogyakarta were clustered. There was no spatial autocorrelation in the leptospirosis spread. The various risk factors like mudpuddle, water ditches, flood history, midden, occupational, and skin lessions were potential impact leptospirosis cases in Yogyakarta city.

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