

Analysis of Environmental Risk Factors on the Leptospirosis Disease in Klaten, Central Java, Indonesia

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ABSTRACT

Background: The number of cases and mortality rates of Leptospirosis incidences in Klaten Regency is increasing from year to year. The study aims to analyze the environmental risk factors toward Leptospirosis incidences in Klaten Regency, Central Java, Indonesia.

Subjects and Method: This was a case-control study conducted in Klaten Regency, Central Java. The study sample was all Leptospirosis patients who were recorded in Klaten Health Office. The case population was a total of 39 people and the control population was a total of 171 people. The dependent variable was: Leptospirosis incidences and the independent variables were physical condition of the house, environmental condition of the settlement, the presence of mice, the presence of cattle, adjacent to a river, flooding area, age, sex category, and occupation. The study instruments used were questionnaires and checklist. The data were analyzed by path analysis.

Results: The risk of Leptospirosis was directly increased by the presence of mice ($b= 7.34$; 95% CI= 4.44 to 10.24; $p<0.001$) and flooding area ($b= 8.99$; 95% CI= 5.02 to 12.96; $p <0.001$). The risk of Leptospirosis was directly decreased by age ≥ 20 to <60 years ($b= -1.45$;

95% CI= -3.68 to 0.79; $p=0.205$) and female sex ($b= -2.97$; 95% CI= -5.52 to -0.42; $p= 0.022$). The risk of Leptospirosis was indirectly affected by the presence of mice, presence of cattle, flooding area, poor settlement condition, and poor house physical condition through area adjacent to a river, and poor physical condition of the house, working in the wet area.

Conclusion: The risk of Leptospirosis is directly increased by the presence of mice and flooding area. The risk of Leptospirosis is directly decreased by age ≥ 20 to <60 years and female sex. The risk of Leptospirosis is indirectly affected by the presence of mice, presence of cattle, flooding area, poor settlement condition, and poor house physical condition through area adjacent to a river, and poor physical condition of the house, working in the wet area

Keywords: Leptospirosis, environmental risk factors, path analysis

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BACKGROUND

Leptospirosis is a global public health problem, particularly in tropical and subtropical regions (WHO, 2003; WCO India, 2007). Most of Leptospirosis occurs in developing countries. Leptospirosis in tropical and subtropical regions is mostly

caused by the poor condition of farms and housings and waste disposal, which generate a lot of infection sources (WHO, 2003).

Based on data and information on Indonesian health profile 2018 it is discovered that based on the data of 2016-

2018 there are 7 provinces with Leptospirosis. Those 7 provinces namely: Special Capital Region of Jakarta, West Java, Central Java, Special Region of Yogyakarta, East Java, Banten, and Maluku. Central Java Province in 2016 had 164 cases of Leptospirosis with 30 deaths (CFR 18.29); in 2017 the number of cases was 409 cases with 65 deaths (CFR 15.89) and in 2018 the number of Leptospirosis cases were 427 cases with 89 deaths (CFR 20.84) (Kemenkes RI, 2017).

Reported in the Pocket Book of Health Office of Central Java Province 2018, the Leptospirosis cases were 427 cases with 89 deaths. The top three of most Leptospirosis cases in Central Java are Demak Regency (92 cases 24 deaths), Klaten Regency (67 cases 12 deaths), Semarang City (56 cases 14 deaths). Incidence Rate (IR) of Leptospirosis in Central Java is at 1.24 per 100,000 people, whereas based on the Leptospirosis IR of Regencies/ Cities in Central Java 2018, it discovers the top four of the highest IR. At the top are Demak Regency at 7.99 per 100,000 people, Klaten Regency at 5.72 per 100,000 people, Banyumas Regency at 3.33 per 100,000, and the City of Semarang at 3.14 per 100,000 people.

According to diseases data from the Health Office of Klaten Regency 2018, it is discovered that Leptospirosis in Klaten Regency keeps on increasing from year to year. In 2018 the number of Leptospirosis cases is 67 people with 12 deaths. It increases from 2017 with the number of cases is 47 people and 7 deaths. From January to April 2019, it is discovered there are 22 cases with 4 deaths. Leptospirosis incidences in Klaten Regency evenly occur in every sub-district.

The study aimed to analyze environmental risk factors toward Leptospirosis

incidences in Klaten Regency, Central Java, Indonesia.

SUBJECTS AND METHOD

1. Study Design

This was a case-control study conducted at 21 community health centers in Klaten Regency, Central Java, Indonesia, from December 2019 to February 2020.

2. Population and Sample

The targetted population of the study was all Leptospirosis in Klaten Regency. The source population of the study was all Leptospirosis patients recorded in the Health Office of Klaten Regency from January up to June 2019 with a total of 39 people. The study sample was selected by using mixed disease sampling. The number of Puskesmas where the sample would be taken from was 21, with a sample of 10 people for each Puskesmas, that there was a total of 210 study subjects as the sample.

3. Study Variable

The dependent variable was Leptospirosis. The independent variables were house physical condition, settlement environmental condition, the existence of mice, the existence of cattle, area adjacent to river basin, flooding area, age, sex, and occupation.

4. Operational Definition of Variables

Leptospirosis was defined as patients who were diagnosed by a doctor at a hospital/ Puskesmas through clinical and laboratory examination during the month of January to June 2019 and recorded by the Health Office of Sleman Regency.

House physical condition was defined as permanent wall, plastered or tile floor, with a ceiling, the roof is not made into mice' nest, kitchen's and house's cleanliness is maintained, at least 2 weeks before Leptospirosis incidence

Settlement environmental condition was a condition of settlement environment

that consisted of sewerage, condition of sewerage which did not well-up, condition of sewerage that was not potentially passed by mice, condition of trash which was not scattered about, closed trash bin, the distance between the house and trash disposal area >100 meters, there was no puddle around the house, 2 weeks before Leptospirosis incidence at the very least.

The existence of mice was the presence or absence of mice inside or around the house of study subjects which was marked by mice' droppings, mice' footprints, mice' smear marks, gnaw marks, mice' nest, and mice' burrow.

The existence of cattle was the presence or absence of cattle inside and around the house discovered from the result of interviews with the study subjects.

The area adjacent to the river basin was an area of study subjects' dwelling places that were 0 – 100m distance away from the river was categorized as close to the river. An area that was >100 m distance away from the river was categorized as far from the river.

Flooding area was the residence of the study subjects that was flooded when it was raining or there were a lot of puddles, 2 weeks before Leptospirosis incidence at the very least.

Age was study subjects who were \pm 5 years older or younger than study subjects in the case group.

The occupation was the main activities conducted by study subjects to met their daily needs, that was at risk of contracted Leptospirosis, 2 weeks before Leptospirosis incidence at the very least.

5. Study Instruments

Study instruments used to collect data were questionnaires and checklist (observation form).

6. Data analysis

The direct and indirect effects between variables were analyzed by path analysis run on Stata 13.

7. Study Ethics

This study has been approved permits by informed consent, anonymity, confidentiality, had obtained ethical clearance from KEPK No.: 1.392/ XII/HREC/ 2019 of Dr. Moewardi Regional Hospital, Surakarta, Central Java, Indonesia.

RESULTS

1. Study Subject Characteristics

Study subject characteristics are presented in Table 1.

2. Path analysis

The purpose of path analysis is to give the estimated quantity and statistical significance of causal associations which are hypothesized among several variables. Figure 1 depicted path diagram of environmental risk factors variable toward Leptospirosis incidences. Table 2 reported the results of path analysis on the risk factors of Leptospirosis. Table 2 indicated:

1. The effect of the presence of mice toward Leptospirosis incidences

Leptospirosis incidences were directly and positively affected by the presence of mice. The presence of mice inside or around the house held a higher risk of Leptospirosis by 7.34 units than the house without the presence of mice ($b= 7.34$; 95% CI= 4.44 to 10.24; $p<0.001$).

2. The effect of flooding area toward Leptospirosis incidences

Leptospirosis incidences were directly and positively affected by flooding areas. Flooding area held a higher risk of Leptospirosis by 8.99 units than non-flooding area ($b= 8.99$; 95% CI= 5.02 to 12.96; $p<0.001$).

Table 1. Study Subjects Characteristics

Variables	Case		Control		Total		p
	n	%	n	%	n	%	
Age (years)							
< 30	4	20%	16	80%	20	100%	0.917
30-39	1	9%	10	91%	11	100%	
40-49	11	16%	58	84%	69	100%	
50-59	12	18%	54	82%	66	100%	
60-69	6	26%	17	74%	23	100%	
70-79	4	20%	16	80%	20	100%	
≥ 80	1	100%			1	100%	
Sex							
Male	32	22%	115	78%	147	100%	0.069
Female	7	11%	56	89%	63	100%	
Education							
Uneducated	2	13%	14	87%	16	100%	0.030
Elementary School	15	33%	30	67%	45	100%	
Junior High School	9	20%	37	80%	46	100%	
High School	12	14%	76	86%	88	100%	
Associate's Degree	1	12.5%	7	87.5%	8	100%	
Bachelor's Degree			6	100%	6	100%	
Master's Degree			1	100%	1	100%	
Occupation							
Wet area	36	31.3%	79	68.7%	115	100%	<0.001
Dry	3	3.2%	92	96.8%	95	100%	

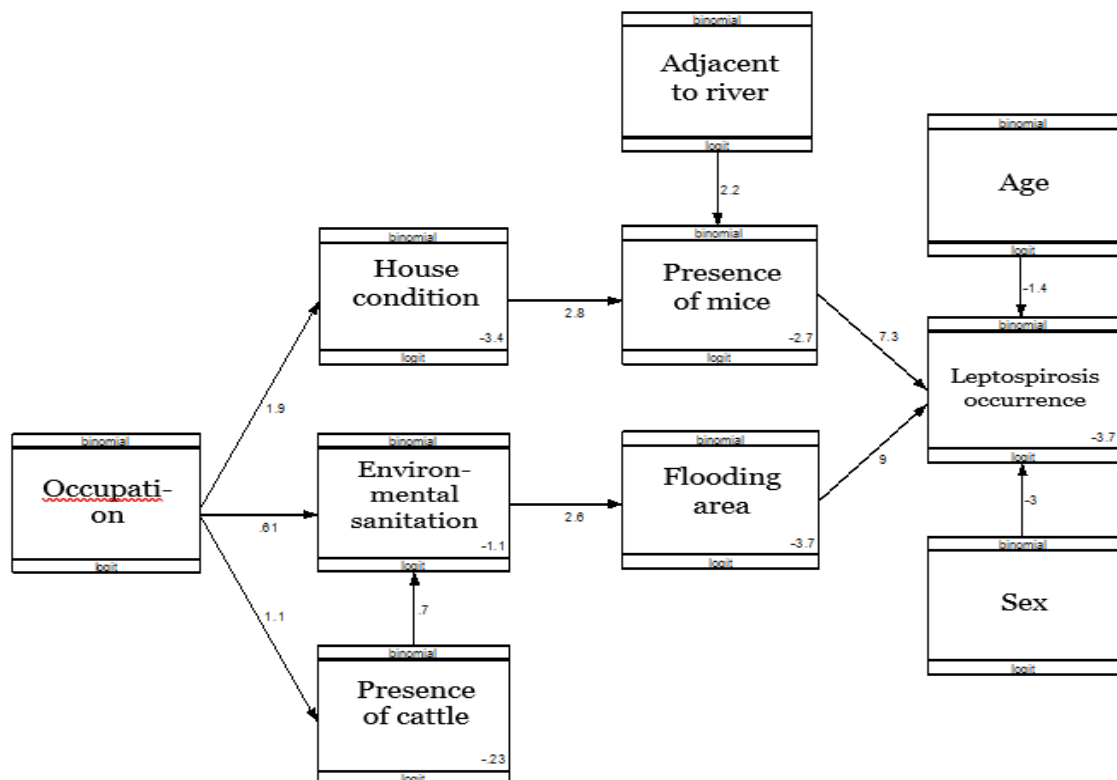


Figure 1. Path diagram of environmental risk factors variable toward Leptospirosis incidences.

Table 2. The results of path analysis on the risk factors of Leptospirosis

Dependent Variable	Independent Variables	b	CI 95%		p
			Lower limit	Upper limit	
Direct effect					
Leptospirosis incidences	← Presence of mice (Yes)	7.34	4.44	10.24	<0.001
	← Flooding area (Yes)	8.99	5.02	12.96	<0.001
	← Age (≥20 to <60 years)	-1.45	-3.68	0.79	0.205
	← Sex (Female)	-2.97	-5.52	-0.42	0.022
Indirect effect					
Presence of mice (Present)	← Area adjacent to river basin (Close 0-100m)	2.20	1.21	3.19	<0.001
	← House physical condition (Poor)	2.81	1.74	3.88	<0.001
Flooding area (Yes)	← Settlement environmental Condition (Poor)	2.59	1.35	3.83	<0.001
Settlement environmental Condition (Poor)	← Presence of cattle (Yes)	0.69	0.10	1.29	0.021
	← Occupation (Wet Area)	0.61	0.03	1.19	0.040
House physical condition (Poor)	← Occupation (Wet Area)	1.92	0.68	3.17	0.002
Presence of cattle (Yes)	← Occupation (Wet Area)	1.10	0.53	1.67	<0.001
N observation= 210					
AIC= 1006.559					
BIC= 1063.46					

3. The effect of age ≥ 20 to < 60 years toward Leptospirosis incidences

Leptospirosis incidences were directly and negatively affected by age, but it was statistically non-significant. Age ≥20 to <60 years had lower risk of Leptospirosis by 1.45 units than age <20 or ≥60 years (b=-1.45; 95% CI= -3.68 to 0.79; p= 0.205).

4. The effect of sex category (female) toward Leptospirosis incidences

Leptospirosis incidences were directly and negatively affected by sex female. Female had lower risk of Leptospirosis by 2.97 units than male (b= -2.97; 95% CI= -5.52 to -0.42; p= 0.022).

5. The effect of the area adjacent to river toward Leptospirosis through the presence of mice

People who lived adjacent to river had higher risk of Leptospirosis through the presence of mice in the house.

6. The effect of the poor physical condition of the house toward Leptospirosis incidences through the presence of mice

People whose house was in poor physical condition had higher risk of Leptospirosis through the presence of mice in the house.

7. The effect of the poor environmental condition of the settlement toward Leptospirosis incidences through flooding area

People who live in a poor environment had higher risk of Leptospirosis through settlement in the flooding area.

8. The effect of the presence of cattle toward Leptospirosis incidences through settlement poor environmental condition

People who owned cattle had higher risk of Leptospirosis through the ownership of the house in a settlement with poor environmental conditions.

9. The effect of working in wet area toward Leptospirosis incidences through the poor environmental condition of the settlement

People who worked in a wet area had higher risk of Leptospirosis through the ownership of the house with poor environmental conditions.

10. The effect of working in wet area toward Leptospirosis incidences through the poor physical condition of the house

People who worked in a wet area had higher risk of Leptospirosis through the ownership of the house with the poor physical condition.

11. The effect of working in wet area toward Leptospirosis incidences through the presence of cattle

People who worked in a wet area had higher risk of Leptospirosis through the presence of cattle.

DISCUSSION

1. The effect of the presence of mice toward Leptospirosis incidences

The result of the discussion indicated that that was a direct effect of Leptospirosis incidences toward the presence of mice. The effect of the presence of mice toward Leptospirosis incidences was positive.

The presence of mice inside or around the house would increase Leptospirosis incidences by 7.34 units higher than houses with no presence of mice and it was statistically significant ($b= 7.34$; 95% CI= 4.44 to 10.24; $p<0.001$).

It was in accordance with a study by Brooks et al., (2001) cited by Kemenkes RI (2017), which concluded that the presence of mice inside the house held 4 times higher risk of Leptospirosis. A study conducted by Bhardwaj et al., (2008) concluded that the presence of mice around the house increased the risk of Leptospirosis incidences.

Similar to a study conducted by Rejeki (2005) that concluded the factor of biological environmental risk that is the presence of mice inside and around the house affected severe leptospirosis incidences.

2. The effect of flooding area toward Leptospirosis incidences

The study result indicated that there was a direct effect of flooding area toward Leptospirosis incidences. The effect of flooding area toward leptospirosis incidences was positive.

Flooding area would increase the Leptospirosis incidences by 8.99 units higher than non flooding area and it was statistically significant ($b= 8.99$; 95% CI= 5.02 to 12.96; $p<0.001$).

The study was in line with a study conducted by Radi et al., (2018), which concluded that flood increased the risk of leptospirosis outbreak in the endemic area ($p<0.001$). A study by Supraptono et al. (2011), concluded that contact probability with flood water was likely to suffer from leptospirosis by 23.0 times than people with no flood contact.

Similar to a study by Rejeki (2005), which concluded the physical environmental factor that was the presence of water puddles around the house held the risk 3.8 times bigger than the environment with no puddle.

3. The effect of age ≥ 20 to < 60 years old toward Leptospirosis incidence

The study result indicated that there was a direct effect of age toward Leptospirosis incidences. The effect of age toward Leptospirosis incidences was negative.

The effect of age toward Leptospirosis incidences was not statistically significant ($b= -1.45$; 95% CI= -3.68 to 0.79; $p= 0.205$).

It was in line with a study conducted by Atil et al., (2020) which concluded that the older age group of workers during

working in Kinabalu was the risk factor of leptospirosis infection, in other words, the older the person, the higher the risk of leptospirosis infection. They possibly had a longer time to get exposed and it might get chronic.

A study by Lopes et al. (2004) concluded that the risk increased with the age, compared to those of 19-29 years old it turned to 3.7 times for those of 40-49 years old and became 7.3 times among those of 60 years old or older.

The study was not in line with a study by Puca et al. (2018), that obtained the highest prevalence of Leptospirosis was at the age of 45-69 years. The study revealed the characteristic similarities of age that it obtained almost similar percentages between case and control group.

4. The effect of sex category (female) toward Leptospirosis incidences

The effect of the female sex category toward Leptospirosis incidence was negative. Sex category (female) decreased Leptospirosis incidence by 2.97 units lower than male, and it was statistically significant ($b=-2.97$; $CI\ 95\% = -5.52\ to\ -0.42$; $p= 0.022$).

In line with a study conducted by Lau and Jagals (2012), the study indicated that male was at risk in increasing leptospirosis incidences. Similar also with a study by Puca et al. (2018), which also indicated that male was more at risk than female. It was related to their occupation.

5. The effect of an area adjacent to a river toward Leptospirosis through the presence of mice

The result of the study indicated that there was an indirect effect of an area adjacent to a river toward Leptospirosis incidences through the presence of mice. The effect of the area adjacent to a river toward the presence of mice was positive and statistically significant.

The study result was in line with a study by Lau et al., (2016) which concluded that people who lived <100 meters of the river increased Leptospirosis incidences.

6. The effect of the poor physical condition of the house toward Leptospirosis incidences through the presence of mice

The study result indicated that there was an indirect effect of the poor physical condition of the house toward Leptospirosis incidence through the presence of mice. The effect of the poor physical condition of the house toward the presence of mice was positive and statistically significant.

The study result was in line with a study by Katulistiwa and Lestari (2015), which concluded that unhealthy house condition was a dominant risk factor that affected leptospirosis incidences which was in line with the probability that of 74.6% and twice at risk of leptospirosis than the house with healthy conditions.

Similar to a study by Sofiyani, *et al.* (2018) which concluded that there was an association between the physical condition of a house and leptospirosis incidences and it was statistically significant.

7. The effect of the poor environmental condition of the settlement toward Leptospirosis incidences through flooding area

The study result indicated that there was an indirect effect of the poor environmental condition of the settlement toward Leptospirosis incidences through flooding area. The effect of the poor environmental conditions of the settlement toward flooding area was positive and statistically significant.

It was in line with a study by Sofiyani, *et al.* (2018) which concluded that there was an association of good environmental conditions of the settlement and leptospirosis incidences and it was statistically significant.

It was different from a study conducted by Suratman (2006), which concluded that environmental conditions of the house did not affect severe leptospirosis incidences.

8. The effect of the presence of cattle toward Leptospirosis incidences through poor environmental conditions of the settlement

The study result indicated that there was an indirect effect between the presence of cattle and Leptospirosis incidences through the poor environmental condition. The effect of the presence of cattle toward poor environmental conditions was positive and statistically significant.

The study result was in line with a study by Lau et al., (2014), which obtained the result that the presence of cattle was an environmental risk factor. It was similar to a study by Munoz-Zanzi et al., (2014), which obtained a result that the presence of pets was positively related to water puddles which were positively contaminated by *Leptospira* bacteria.

However, it was different from the study result conducted by Rejeki (2005), which concluded that biological environmental risk factor which was the presence of cattle or pets was not proven to affect severe leptospirosis incidences.

9. The effect working in wet area toward Leptospirosis incidences through poor environmental conditions of the settlement

The study result indicated that there was an indirect effect of working in a wet area and Leptospirosis incidences through poor environmental conditions of the settlement. The effect of working in a wet area toward poor environmental conditions of the settlement was positive and statistically significant.

There are several studies results related to other occupations among others are a

study by Lau dan Jagals (2012) which revealed that occupation (which demanded) swimming in the sea >once a week, swimming or walking in the puddles of rainwater, fishing increased the risk of Leptospirosis incidences.

Similar to a study result by Kamath et al. (2014) which indicated that fieldwork, contact with soil or water contaminated with mice urine increased the risk of Leptospirosis incidences.

A study by Maze et al. (2018) obtained a result that working in the paddy field, cleaning cattle's manure, feeding cattle, and farming increased Leptospirosis incidences.

10. The effect of working in wet areas toward Leptospirosis incidences through poor physical conditions of the house

The study result indicated that there was an indirect effect of people who worked in a wet area toward Leptospirosis incidences through poor physical conditions of the house. The effect of working in a wet area toward the poor physical conditions of the house was positive and statistically significant.

The study result was in line with a study by Bharti et al., (2003); Hotez et al., (2008); Reis et al., (2008) which concluded that inadequate sanitation and poor housing, increased the risk of Leptospirosis both in rural and urban areas.

11. The effect of working in wet areas toward Leptospirosis incidences through the presence of cattle

The study result indicated that there was an indirect effect of people who worked in a wet area and Leptospirosis incidences through the presence of cattle. The effect of working in a wet area toward the presence of cattle was positive and statistically significant.

The study result was in line with a study by Maze et al. (2018) which obtained

a result that working in paddy fields, cleaning manure, feeding cattle, and farming were at risk of increasing Leptospirosis incidences

Based on the study result it can be concluded that environmental risk factors that directly affect Leptospirosis incidences are the presence of mice and flooding areas. Factors that indirectly affect are an area adjacent to a river, poor physical conditions of the house, poor environmental conditions of the settlement, and the presence of cattle.

AUTHOR CONTRIBUTION

Patria Sari Dewi as the main author collected the study data, formulating the study article, and processed the data. Setyo Sri Rahardjo formulated the study framework. Bhisma Murti contributed to formulating the study method and the study result discussion.

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CONFLICT OF INTEREST

The researchers stated that the study was conducted without any commercial or financial association which can be assumed as the potential conflict of interest.

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