



The Correlation between Physical Environmental Factors and the Occurrence of Leptospirosis

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Article Info

Article History:
Submitted February 2018
Accepted August 2018
Published November 2018

Keywords:
Environmental Based
Disease,
Zoonosis, Leptospirosis

DOI
<https://doi.org/10.15294/kemas.v14i2.13527>

Abstract

Leptospirosis is a disease caused by a bacteria called *Leptospira*. Environmental risk factors for leptospirosis include biological, social, and physical (river or bodies of water, ditches, puddles, and the distance between the settlement area with garbage disposal area). This research aimed to determine the correlation between the physical environmental factors with the evidence of leptospirosis in Sukahaji Village, Babakan Ciparay District of Bandung City in 2017. The design of this research is a survey with cross-sectional approach. We used 100 population samples in this research. The Technique of obtaining data with observation sheet is using sheet checklist. We did univariate and multivariate data analysis using chi square. The results showed that most of the population experienced leptospirosis, and most of the physical environment such as rivers or bodies of water, ditches, puddles, and the distance between settlement area with the garbage disposal area are the risk factors of leptospirosis.

Introduction

Leptospirosis is a zoonotic disease caused by infection from bacteria called *Leptospira*. Leptospirosis is caused by spirochaeta leptospira *icterohaemorrhagiae* that lives in the kidney and urine of rats (Effendi, 2009). Common features of leptospirosis are sudden fever, headache, chills, severe myalgia (calves and legs) and redness in conjunctiva, enlarged liver and spleen, and kidney damage (Morgan, 2002).

The most important leptospirosis reservoir was rodent group, especially rats. Rats, mice, dogs, pigs, and cows were the major sources of infection in humans (Reis, 2008). *Leptospira* mainly multiply in the kidneys (convoluted tubules). *Leptospira* would survive and were excreted with urine. *Leptospira* could

survive in the urine for about 8 days to years after infection (Smith, 1955). The infected animals showed no symptoms of illness and only acted as carriers (maintenance host). They could develop clinical symptoms (accidental host) depending on the infecting serovars (Allan, 2015).

From Marbawati's research, humans usually acquire infection by contact with urine from the infected host, contaminated water or soil, or infected animal tissue. *Leptospira* pathogen enters the human body through mucosal membrane, conjunctiva, wounded or scratched skin (De Vries, 2014). Transmission can also occur through animal bite from a previously infected animal with leptospirosis or in contact with leptospirosis cultures in the laboratory. Populations who have high risk of

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transmission incidence were those who work in rice field, animal farm, mining, animal slaughter, fishery industry, and veterinary. The activities that are at risk of transmission included river swimming, hunting, and in-forest activity (Smith, 1955). The exposure also happens in daily activities with higher risk during rainy season and floods. The occupants of urban slums with poor sanitation are also at risk for this disease (Victoriano, 2009).

From Sulistyawati's research, the transmission of infectious leptospirosis disease in general occurs through direct contact with infected animals such as the bites of animals like rodent and the open wounds which are exposed to urine or body fluids from infected animals. The disease can also be transmitted through direct contact with the water environment and soil contaminated with the *Leptospira* bacteria. The diagnosis of leptospirosis is done through confirmation of laboratory results to determine the cause of the infection in the suspected source of infection and the reservoir containing leptospirosis bacteria (Sulistyawati, 2016).

Public Health Office of Leptospirosis Report in Indonesia, the case of Leptospirosis in 2009 were 335 cases, 23 died with 6.87% Case Fatality Rate (CFR), in 2010 there were 398 cases 43 died with 10.80% Case Fatality Rate (CFR), in 2011 there were 857 cases 82 died with 9.57% Case Fatality Rate (CFR). The mortality rate reaches almost 56% in patients aged 50 years.

Leptospirosis is one of the neglected infectious diseases (NIDs). NIDs are endemic infectious diseases in poor communities or populations of farmers and workers that relates to water and soil in developing countries. Nevertheless the development of leptospirosis can infect all levels of society.

Leptospirosis is a zoonotic disease caused by an acute infection by a bacteria called *Leptospira*. Characteristic features that are common in this disease are fever with a sudden, painful headache, shivering, severe myalgia (calves and legs), red conjunctiva, enlarged liver and lymph nodes, and kidney damage (Auliya, 2014).

Leptospira interrogans with various subgroups which can further be divided into different serotypes may be present in the

kidneys or urine of dogs, oxen, pigs, buffalo and the likes, as well as wild animals such as rodents, weasels, squirrels and so on. Humans get infected in the case of contact of the skin or mucous membranes or wound or erosion with water, soil, mud and so on that has been contaminated by the urine of animals infected with *leptospira* (Arif, 2000).

These bacteria are sensitive to acids, and are aerobic obligate with optimum growth temperature ranges between 28–30°C and pH 7,2–8,0. Although in water bacteria can survive for about a month, but within concentrated water such as sewer water and sea water *leptospira* will die faster. The environment suitable for living leptospires is the soil, hot and humid environment such as in tropical areas. These bacteria can live up to 43 days on the right soil and up to weeks week in water, especially fresh water.

Agricultural areas such as rice fields, river banks and bushes in coastal environments have the potential to become a habitat for rats that have a role in leptospirosis transmission. Paddy fields are an ideal place for the development of *leptospira* bacteria because the density of rats living in paddy fields is the highest (Yuliadi, 2013). This is also supported by a research in Southeast Asia which stated that some species of rodents tend to have a high density rain-fed area (Cosson, 2014). In addition, *leptospira* bacteria can live in temperatures between 28–30°C which is a high enough temperature and a pH of 7 (Haristuti, 2011). With such conditions, high temperatures lead to evaporation of the water sources (paddy etc.) and at the same time, there is human activity. When leptospirosis bacteria is in the area, it will be an infection source for humans.

House sanitation is a risk factor for leptospirosis. Houses that have no ceiling and unstructured building conditions will make it easier for rats to enter it. A permanent house wall makes it easier for rats to climb. The presence of garbage around the house also increases rat population around the house (Okatini, 2007).

According to the public health office In Bandung area, leptospirosis has the potential to become an outbreak or extraordinary event in Babakan Ciparay District, especially in Sukahaji

Village which has been recorded to have 2 fatal cases reported in 2016 because of leptospirosis.

Based on the results of preliminary research conducted by researchers, Sukahaji Village was categorized into flood-prone area which every time the rain comes, the water will surely overflow to the surface. The shallow and inadequate ditches can cause the overflowing of water. The roads were already paved, leaving no infiltration area for water therefore causing water puddles in holes and bumpy areas. The distance between the garbage disposal area was close to the settlement area, and not far from it were rivers and bodies of water.

The above conditions are closely related to risk factors for the occurrence of leptospirosis. The rats passing through water can spread leptospira bacteria. Sewers and rivers are one of the rats stopovers. Similarly, the garbage disposal area became the habitat where mice reside to find their food or to breed. Leptospira in rats can survive as long as the animal is alive without causing illness and Leptospira will be excreted through the urine and contaminate the environment.

The purpose of this research was to determine the correlation between physical environmental factors with the occurrence of leptospirosis in Sukahaji Village, Babakan Ciparay District of Bandung in 2017.

Method

The type of this research is an analytical survey, which is a survey or research that tries

to explore how and why a health phenomenon occurs. Then we analyzed the correlation dynamics between phenomena, either between risk factor or between factor of effect. Factor of effect is a result of the existence of risk factors, while the risk factor is a phenomenon that causes the effect (influence). In analytical survey there are 3 approaches (types), namely cross sectional analytical survey, case control (retrospective) analytical survey, and cohort (prospective) analytical survey.

This research used cross sectional approach which is a research studying correlation dynamics between risk factors and effect by observation or data collection at one time (point-time approach). Each subject is only observed once and the measurement is done on the variable character status at the time of examination (Notoatmodjo, 2010). Cross-sectional studies are often called transversal studies, and are often used in epidemiological studies. This research was conducted to discover the physical environmental factors that affect the incidence of leptospirosis.

Research variable is the characteristic, nature or size of an individual, group, or environment that is of interest in a research. Variables in this study consist of independent variable which is risk or cause-variable (Notoatmodjo, 2010). Independent variable in this research is the physical environment (existence of bodies of water or river, existence of ditch, water puddle, house distance with

Table 1. Number of Respondents in Each RW Kelurahan Sukahaji

NO	Population / RW	Sample from each RW	Implementing samples
1	3,256	14.1	14
2	3,662	15.9	16
3	3,040	13.2	13
4	2,390	10.3	10
5	2,228	9.6	10
6	2,850	12.3	12
7	1,790	7.7	8
8	1,793	7.7	8
9	620	2.6	3
10	1,384	6.0	6
Total	23,013	99.6	100

garbage disposal area) in Sukahaji Village of Bandung, and dependent variable is the effect or effect variable (Notoatmodjo, 2010). The result variable or dependent variable in this research is Leptospirosis incidence in Sukahaji District City of Bandung.

The sample in this research is all population of Sukahaji Village which amounted to 23,013 people. Based on the minimum sample formula, 100 samples were needed. Determination of sample is done by proportional stratified random sampling. This technique is done based on RW (population) level gradually.

The inclusion criteria are the criteria or standards applied before the research or study is conducted. The inclusion criteria are used to determine whether a person can participate in this study (Notoatmodjo, 2013). Our inclusion criteria are the residents who live in the village of Sukahaji and are willing to become respondents. The exclusion criteria are the standards applied prior to the study or review, the exclusion criteria used to determine whether a person should participate in this study (Notoatmodjo, 2013). The exclusion criteria that we used were households who have two *Kepala Keluarga*/KK (Head of Family), in which condition we would only use one KK. Sampling technique was done by entering number of the house into the lottery, then shuffled to be evenly distributed.

Result and Discussion

Leptospirosis cases are more common in residential locations, especially near bodies of water such as rivers, ponds, rice field, sand puddles. Poor sanitation conditions such as the presence of midden and the presence of rats is a determinant variable leptospirosis cases. The presence of midden is used as indicators of the presence of rats. The poor shelter condition which contains midden is a risk factor for leptospirosis case (Sumanta, 2015). Leptospirosis is affected by the presence of litter, presence of rodents and bacteria *Leptospira* factors, it is possible there are other biotic factors associated with the incidence (Sumanta, 2015).

Risk factors affecting the incidence of leptospirosis are the physical environmental risk factors, biological environmental risk factors, behavioral factors, socioeconomic factors

and health service factors. Factors associated with the incidence of leptospirosis in DIY are occupation as a farmer, a frequent going to the paddy fields and the rats. Indirect transmission occurs when leptospira are excreted through the urine or excretion of carrier animals to water environment, such as puddles, lakes, rivers, swamps, sewage, drainage, and mud puddles. The spread of the disease to other area are due to flood waters contaminated with rat urine containing leptospira bacteria (Sumanta, 2015).

The existence of rivers or bodies of water can be an indirect media of leptospirosis transmission. The role of the river as a media occurs when river water is contaminated by rat urine or pets infected with bacteria. The process of transmission through bodies of water or rivers is closely related to the habit or the activity of population in using water from the river. Excrements from animals and humans containing bacteria and viruses, drifting in rivers can contaminate unprotected wells or springs.

Based on the Decree of Settlement and Regional Infrastructure No. 534/KPTS/M/2001, the distance of the river or bodies of water should be > 2 meters with the population density > 200 people/hectare. The results showed that most of the environmental condition of the houses had a distance of bodies of water or river ≤ 2 meters with an average population density of over 200 people/hectare. The research from Soares *et al.*, (2010) showed a positive correlation between the individual characteristics such as the economic level and the occurrence of leptospirosis. The increasing cases mostly occur in the poor society who live in slum areas who had poor sanitation (due to low economic levels) as a source of leptospirosis transmission (Soares, 2010).

The presence of river around the settlement area became one of the risk factors for leptospirosis occurrence. Based on the results of the study there were about 95.2% of leptospirosis patients who lived in a home near the river. The presence of river near the settlement area, statistically showed the relationship of house distance to the river with incidence of leptospirosis ($p = 0,000$).

In some villages in the District of Demak

Table 2. Frequency Distribution Table of Leptospirosis Occurrence

Category	Frequency	Percentage (%)
Frequency Distribution of The Occurrence of Leptospirosis		
Not sick	32	32.0
Sick	68	68.0
Frequency Distribution of Physical Environmental Factor; River or Water Body		
Not risk	38	38.0
Risk	62	62.0
Frequency Distribution of Physical Environmental Factors: Sewers		
Not risk	35	35.0
Risk	65	65.0
Frequency Distribution of Physical Environment Factor; Puddle		
Not risk	28	28.0
Risk	72	72.0
Frequency Distribution of Physical Environmental Factors; the distance of Settlement to garbage disposal		
Not risk	33	33.0
Risk	67	67.0
TOTAL	100	100.0

Table 3. Relationship of Physical Environmental Factors With The Incidence Of Leptospirosis

Category	Not sick		Sick		P value
	F	%	F	%	
River					
No Risk	29	76,3%	9	23,7%	0,000
Risk	3	4,8 %	59	95,2%	
Sewer					
No Sewer	23	65,7%	12	34,3%	0,000
Sewer	9	13,8 %	56	86,2%	
Puddle					
No puddle	24	85,7%	4	14,3%	0,000
Puddle	8	11,1%	64	88,9%	
The Distance Of Settlement To The Garbage Disposal					
Not risk	21	63,6%	12	36,4%	0,000
Risk	11	16,4%	56	83,6%	

which found three types of mice namely *Rattus*. In this study, the type of rats were found to be more diverse. Mice residing in the settlements tend to be more varied due to the availability of resources to feed mice around the settlement and there was a rat nest place (rats ditches) in

the channelwater/sewer and *wirok* rats in the garden around the house (Asuti, 2013).

Ditches or sewer are a place that is often used as a settling place for rats or as their gate to come into the house. The ditch is a media of leptospirosis transmission when the water is

contaminated by rat urine or pets infected with the *Leptospira* bacteria. Ditches conditions at the time of observations did not fulfill the requirements i.e. they were not closed covered and the water flow tend to stagnate. A densely populated areas had many reservoir auxiliaries, an environment that is often waterlogged and slum neighborhoods are places with a high risk of exposure to rat urine.

The presence of sewer around the settlement becomes one of the risk factors for leptospirosis occurrence. Based on the results of the research there were about 86.2% of leptospirosis patients who have a home with a sewer. The presence of sewer near the settlement, statistically showed the relationship of sewer with incidence of leptospirosis ($p = 0,000$).

This is exacerbated by poor ditches conditions clogged by garbage. The presence of a collection of garbage in the house and surrounding areas will make a place favored by rats. Poor sanitary conditions such as the presence of garbage collection and the presence of rats is a determinant variable in cases of leptospirosis. The presence of waste collection is used as an indicator of the presence of rats (Sulistyawati, 2016).

The water and soil contamination by the rats urine contained in the water will facilitate the entry of *Leptospira* bacteria into the human body through direct or indirect contact with rats and another media. *Leptospira* bacteria, especially *L. interrogans* species attacked the rats (*Ratus norvegicus*) and mice (*Ratus Diardi*) while the *L. Ballum* attacked small rats (*Mus Musculus*).

Most of the environments around the population have water puddles. The results of this research showed that around the houses there were stagnant liquid waste which originated from household activities. The presence of puddles is one of the risk factors of leptospirosis transmission because it becomes the breeding ground for *Leptospira* from rats, cats, dogs and goats that pass through it. The presence of puddles around the house as a pathway of leptospirosis transmission occurs when the puddles is contaminated by rat urine or pets infected with *Leptospira* bacteria. The puddles around houses were formed

from hollow footpath and shallow ditch and could potentially be a place for the growth of *Leptospira* bacteria. *Leptospira* can live for months in a warm environment (22°C) and relatively neutral pH (pH 6,2-8). When they are in water and sludge, the most suitable environment for leptospira to thrive is within a pH between 7,0-7,4 and temperatures between 28°C-30°C. These bacteria can live in water that is inundated. Characteristics of water in rice fields suitable for *Leptospira* is stagnant water with a height of 5-10 cm and pH between 6,7-8,5.

The presence of puddle around the settlement becomes one of the risk factors for leptospirosis occurrence. Based on the results of the study there were about 88,9% of leptospirosis patients who had a home with puddle. The presence of puddle near the settlement, statistically showed the relationship between puddle and the incidence of leptospirosis ($p = 0,000$).

This is in accordance with a research by Rejeki in Sulistyawati which stated that "the observations showed that in 9 cases out of 11 which enter the buffer zone come from area with puddles such as permanent sewer and also the fields around the house with a distance of less than 2 meters. Permanent ditches and paddy fields are transmission media of leptospirosis". The correlation between the cases of leptospirosis with the fields in this study is likely because the majority of patients with leptospirosis work as farmers and the rice field becomes the habitat for rats as well as the source of alternative feed for rats (Sulistyawati, 2016). In addition to rice paddies, a puddle is also a risk factor for the occurrence of leptospirosis because it is the natural environment of leptospirosis bacteria. These bacteria can survive for several months in a puddle. Appropriate temperature and pH puddles will prolong the life of leptospirosis bacteria. When high rainfall causes water to overflow in the gutters, flood will occur. Flood becomes one of the risk factors associated with the occurrence of leptospirosis (Sulistyawati, 2015).

The SaTScan analysis result showed that there was one cluster formed which was suspected as the source of infection. The formations of clusters were in the area of Bantul

City, Bambanglipuro District and Pandak District which had 11 cases (31.4%). This indicated that the three were areas with greater risk of leptospirosis infection as compared to the other nearby areas. Radius cluster formed on clustering analysis was as far as 4.6 km, showing the risk radius of transmission of leptospirosis in the region. Bantul City, Bambanglipuro District and Bantul Pandak District were central parts which had a sloping and flat topography including a fertile agricultural region. The sloping and flat topography allowed the formation of permanent puddles which is strongly associated with the formation of the flood and becomes a potential source of transmission of leptospirosis (Febrian, 2013). This was thought to be the trigger of leptospirosis cases in urban areas of Bantul. The rapid urbanization in the city triggered the growth of irregular settlements; which encouraged the growth of slums which tended to not have good environmental sanitation and becomes a trigger of leptospirosis cases. However, it does not mean that the incidence of leptospirosis in Bantul always occurred in slum area. However, it should be suspected in similar characteristics, such as the drains which were stagnant and could not flow smoothly or their landfill was not in place.

Epidemiological investigations also suggested that both cases of leptospirosis had a history of contact with puddles. Puddle alone was known to be one of the risk factors for leptospirosis. Both leptospirosis patients were also known to have a history of wounds on their feet, one of them even stated a history of disposing a dead mouse while cleaning his warehouse and had cleaned the water channel in front of his house (Marbawati, 2017).

Decree of the Minister of Settlement and Regional in 2001, domestic mice like to hang around in the trash for finding food. Most of the residents' houses were close to temporary garbage disposal. The close distance between the house and the garbage disposal area could cause rats passing around the house and urinating in any place. A distance less than 500 meters between the house and the garbage disposal areas one of the risk factors. The distance of garbage disposal with settlement should be over 500 meters.

A garbage disposal close to a settlement, adjacent to a river, a closed and not waterproof garbage disposal becomes a preferred condition for rats. Mice like to hang around in the trash to look for food. The close distance between the house and the garbage collection resulted in rats being able to enter the house and urinate in any place. A house spacing less than 500 m from the garbage collection indicated a greater leptospirosis case than that of more than 500 m (Okatini, 2007).

In the presence of trash variables there are garbage and no garbage. The presence of waste is an indicator of the presence of rats at home. The presence of respondents with houses close to landfills accounted for 83,6% of leptospirosis. Statistics showed the relationship between house distance to landfill with incidence of leptospirosis ($p = 0,000$). The conditions of the settlement in Sukahaji area were prone to flooding, densely populated, high slum area and many stagnant ditches and garbage disposal. These conditions can be a breeding ground for rats, so it is possible to be one of the spreading causes of leptospirosis.

Leptospirosis was influenced by the presence of waste, the presence of mice and leptospira bacterial factors. In Salvador, Brazil stated that poor sanitation conditions in the presence of garbage collection were risk factors for leptospirosis occurrence (Okatini, 2007).

Conclusion

The physical environmental risk factors associated with the occurrence of leptospirosis in Sukahaji Village, were as follows: most of the physical environmental factors of houses such as rivers or bodies of waters, ditches, puddles, and garbage disposal do not fulfill the requirement and may be risk factors for leptospirosis occurrences. Most of the residents in Sukahaji Village, Babakan Ciparay District of Bandung suffered from leptospirosis. There is a relationship between the river or bodies of water and the occurrence of leptospirosis in Sukahaji Village, Babakan Ciparay District of Bandung City. There is a relationship between the ditches and the occurrence of leptospirosis in Sukahaji Village, Babakan Ciparay District of Bandung City, and there is relationship between puddles with the occurrence of leptospirosis in Sukahaji Village, Babakan Ciparay District of

Bandung City. There is a relationship between the distances of settlement areas to garbage disposal areas with the incidence of leptospirosis in Sukahaji Village, Babakan Ciparay District of Bandung City.

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