

Risk factors of leptospirosis incidence in agricultural area

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ABSTRACT

The rate of leptospirosis incidence in Boyolali regency, Indonesia, during 2017 was high and showing an increasing trend. According to Boyolali District Health Office the number of leptospirosis cases in 2017 was 34 cases. Factors related to leptospirosis in the agriculture area should be understood well to take the right measurements for leptospirosis control in a typical agricultural area. Several risk factors, such as personal hygiene, environmental sanitation, wound presence, occupation, are the factors of leptospirosis infection. This study aimed to determine the risk factors associated with the leptospirosis incidence in Boyolali regency, Indonesia. This research used an observational method with a case-control design. The total number of case sample was 33 people, and the control sample were 99 people (ratio 1:3) with matched by a living area. Data collection were carried out with interviews using a questionnaire to respondents related to personal hygiene, environmental sanitation, wound presence and work as a farmer. The data were tested using logistic regression. Most of the case respondents worked as a farmer and worker. The results showed that the risk factors associated with leptospirosis incidence were a wound presence (OR:17.014;95% CI:5.487-52.761) and worked as a farmer (OR:5,186; 95%CI:1.682-15.989). Unrelated variables were bad personal hygiene (95%CI:0.647-7.885) and environmental sanitation (95%CI:0.793-8.773). The dominant risk factor that causes Leptospirosis was wound presences and occupation as a farmer. Therefore people who work mostly touch the water like farmers must cover any wound on feet and keep personal and environmental sanitation to prevent infection.

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1. INTRODUCTION

Leptospirosis is the most widespread zoonosis in the world. Many leptospirosis cases have been underdiagnosed because of the unspecific symptoms of this spirochetal pathogen [1], [2]. Based on leptospirosis Burden Epidemiology Reference Group, the incidence rate of this disease verylow due to late diagnose; therefore, there was a gap between the reported case and the real case. A high number of leptospirosis incidence happened in Africa (95.5/100.000), West Pacific (66.4/100.000) and Southeast Asia (4.8/100.000) [3]. In Southeast Asia, a Developing country like Thailand, Indonesia had been struggling to manage leptospirosis. According to the leptospirosis expense epidemiology reference group (LERG), the incidence of leptospirosis in the world is very low due to delays in diagnosis by health professionals, resulting in the number of cases being questioned with different changes. The highest incidence rate is in

Africa (95.5 per 100,000 population), then western pacific (66.4 per 100,000 population), America (12.5 per 100,000 population), Southeast Asia (4.8 per 100,000 population) and the lowest is Europe (0.5 per 100,000 population) [3]. In Thailand, in 1998, there were 59 patients reported leptospirosis in Nakornratchasrima. In 2019, 920 leptospirosis cases were reported in Indonesia, with 122 deaths caused by the disease. The cases were mostly reported from nine provinces; Banten, DKI Jakarta, West Java, Central Java, DI Yogyakarta, East Java, Maluku, South Sulawesi and North Kalimantan [4].

From the health profile Central Java, Indonesia 2018, it was showed that leptospirosis were frequent outbreaks happened in Central Java with CFR 20.84%, which is higher than the national CFR 16.65%. Based on data on Indonesia's health profile in 2016, the highest number of leptospirosis sufferers in 2011 was 857 cases, and in 2015 it decreased by 366 cases, in 2015 the high CFR (17.76%) in 2016 increased by 833 cases. The most widespread leptospirosis throughout Indonesia, there were seven provinces reported in the 2014-2016 period and the highest in Yogyakarta Province, Indonesia in 2014 (154 cases), DKI Jakarta, Indonesia in 2014 (106 cases) and Central Java in 2014 (198 cases). The highest mortality rate in Banten province in 2016 was 21.88%. The number of cases was only 32 cases [5]. According to data from Boyolali Public Health Office, the numbers of leptospirosis patients in 2014 were 19 cases with seven deaths, in 2015 there were 17 cases with four deaths, in 2016 there were only seven cases without deaths, while in 2017 there was an increase of 34 cases with one death [6]. In 2017, the number of leptospirosis in Boyolali regency, in Jawa Tengah Province, increased dramatically [7]. Until May 2018, it was reported that there were 13 cases of leptospirosis with three deaths [6]. This number was high and is showing an increasing trend.

Several factors have been reported to a risk of leptospirosis infection. According Himani *et al.* [8], personal hygiene affects the incidence of leptospirosis (p-value 0.024; OR=7.429). Injuries are likely related to leptospirosis transmission because leptospira bacteria easily enter through wounds on skins, especially those on the feet and hands. This is in line with Prastiwi's study [9]; a history of injury has a 10 times greater risk of developing leptospirosis. Occupation as a farmer and butcher is also related to leptospirosis. Environmental factors are also very influential in leptospirosis transmission, and environmental factors can be assessed from the presence of mice around the house, poor sewer and trash conditions, and the presence puddle [10], [11]. The presence of mice in the house can transmit leptospirosis bacteria to humans through food or direct contact with rats that are contaminated with rat urine infected with leptospirosis [12]. Auliya's research [13] shows that waste disposal facilities that do not meet the requirements have a 5.4 times greater risk of developing leptospirosis.

Previous research had shown the factors of leptospirosis infection mostly in urban areas; however, infection in the agricultural area is not fully understood. In Indonesia, Jawa Tengah Province, there are many agriculture areas where it is mostly irrigated and processed traditionally. Indonesian farmers and other workers are at risk of leptospirosis infection. Factors related to leptospirosis in agriculture area that happened in Boyolali regency should be understood well to take the right measurements to control and manage leptospirosis in a typical agricultural area. Therefore, this study aimed to determine the risk factors associated with the leptospirosis incidence in Boyolali regency.

2. RESEARCH METHOD

This research used case-control design and conducted on period June 2018. The case population were collected from the Public Health office in Boyolali, Central Java, Indonesia during May 2017-May 2018 with a total sampling Leptospirosis case group (n=33) and control group (n=99) (ratio 1:3). Inclusion criteria for the leptospirosis group were patients with laboratory positive leptospirosis proof and recorded by the local public health office during 2017. However, the died patient was excluded. Inclusion criteria for the control group were people who live closed to the patients or matched by the living area, which could be families or neighbours, aged between 15-55 years old. The patients were interviewed relating several risk factors as variables; knowledge about Leptospirosis, personal hygiene, environmental sanitation, occupation and wound presence (athlete's feet, animal bite and scratch wound). The Independent variable measured was knowledge about leptospirosis, personal hygiene, environmental sanitation, occupation and wound presence, and the dependent variable measured was the patients' leptospirosis incidence. Each of them was tested using Chi-Square to test the relationship or effect of independent and dependent variables and then tested using multivariate logistic regression. Bivariate analysis to determine the relationship between knowledge about leptospirosis, personal hygiene, environmental sanitation, occupation and wound presence with the incidence of leptospirosis using. Multivariate analysis was used to determine which variable was most responsible for the incidence of leptospirosis (confidence limit $\alpha=0.05$).

Personal hygiene consisted of questions relating to shoe wear, rodent control, bath in the stream, water use. Environmental Sanitation consisted of questions relating to garbage, rubbish bin condition, waste

discharge, sewerage condition. Occupation as a farmer worked in the rice field and did farming (planting, plowing, harvesting). Those variable were measured using Gutman scale (good or bad). Wound presence consisted of questions relating to wound presence, especially on feet or hand, including animal bite, scratch or tinea pedis (athlete's foot).

3. RESULTS AND DISCUSSION

A distribution of respondent's occupation is presented in the pie charts and multivariate test (logistic regression) result is presented in the Figure 1.

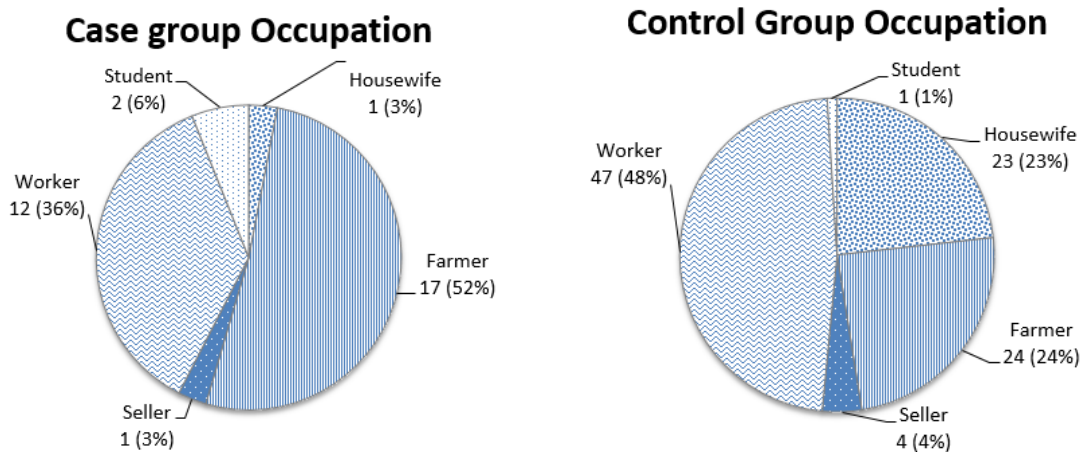


Figure 1. Occupation types of case and control group

Of 33 people in the case group, 25 were male (75.8%), and eight were female (24.2%). Figure 1 showed that most of the case-patients worked as a farmer (51.52%) or worker (36.36%). While in the control group, most people worked as a worker (48%) and farmer (24%).

Table 1 shows that the variable factors that had a significant relationship with leptospirosis incidence were wound presence. Regarding OR value, was wound presence OR=17.014, 95% CI: 5.487-52.761, therefore it can be assumed that wound presence is exposure risk of leptospirosis incidence and can risk leptospirosis infection 17 times greater. Occupation as a farmer had a relationship with leptospirosis with a value OR: 5.186; 95% CI: 1.682-15.989. Those value can be interpreted that someone who works as a farmer is 5.1 greater to the risk of leptospirosis. Other factors, bad personal hygiene and environmental sanitation did not show any significant relationship towards leptospirosis incidence. Knowledge was taken out from the logistic regression test because the number of significance was bigger than 0.25.

Table 1. Risk factors and leptospirosis incidence

Risk factor	Patients (n=33) (%)	Control (n=99) (%)	OR (95% CI)*
Bad personal hygiene	17 (51.5)	15 (15.2)	2.258 (0.647-7.885)
Poor environmental sanitation	25 (57.6)	36 (36.4)	2.638 (0.793-8.773)
Occupation as farmer	17 (51.52)	24 (24.24)	5.186 (1.682-15.989)
Wound presence	22 (66.67)	11 (11.1)	17.014(5.487-52.761)

*Significant value 95%

3.1. Personal hygiene and leptospirosis

There is no relationship between personal hygiene and leptospirosis incidence (OR:2.258;95% CI: 0.647-7.885). Even though the case group showed more bad personal hygiene, bad personal hygiene is likely not affecting leptospirosis incidence in Boyolali. Though it has no relation, in this study, there was a mother who previously worked as an assistant in food stalls and admitted that she washed dishes in the irrigation stream. Three days after that, she had a fever and headache and confirmed to get leptospirosis after a blood test. Personal hygiene affects the incidence of leptospirosis. In personal hygiene, several factors affect

individuals infected with leptospirosis, including bathing and washing habits in rivers or irrigation channels, not washing hands with soap after contact with water suspected of being contaminated, and the habit of not wearing footwear when working or not working. In another case, construction workers in this case group said they washed after work in the water stream next to the rice field. They thought the water was clean and safe, so they use it every day after. This behaviour may increase leptospirosis transmission since they use contaminated water to wash dishes and themselves. In the agricultural area, there are usually streams next to the rice field to flow the water for irrigation. The water looks clean, but this type of open water is accessible for ricefield rats as well and possibly urinated by them.

In this study, bad personal hygiene was not related to leptospirosis incidence. There might be another factor that supports leptospirosis transmission though the people have good personal hygiene. Even though personal hygiene has no relationship to leptospirosis incidence, personal hygiene is important to be maintained to prevent any germ infection. In San Jose, Peru, leptospirosis risk factors include unwearied shoes in the field, and most inhabitants stay in poor housing near to small-scale agriculture [10]. It may relate to unwearied footwear in the ricefield as well. Many Indonesian farmers are indolent to wear boots because boots are easily stuck in the mud and slow to move. To maintain personal hygiene, there are some efforts that must be made to avoid transmission of leptospirosis. Personal hygiene was measured by asking about their bathing habits, the use of personal protective equipment when working, the used footwear when going out of the house, washing hands before eating. It all can affect the incidence of leptospirosis. Personal hygiene could be assessed by gaining information so that behaviour can change. Respondents' habits are very difficult to change, and therefore, there is a need for continuous counselling, but changes in behaviour must also be supported by resources to support them, such as boots for work, gloves, equipment bath. Efforts to maintain personal hygiene is an effort to prevent the transmission of leptospirosis. Quina *et al.* [14] suggested that information dissemination through mass media and increasing awareness among susceptible groups can be a preventive strategy to avoid leptospirosis. The awareness sharing includes maintaining hygiene and sanitation surrounding and using proper personal safety equipment like shoes.

3.2. Poor environmental sanitation and leptospirosis

Based on the results, the proportion of people with poor environmental sanitation in the case group was bigger than those in the control group (57.6% > 36.4%). However, there is no relationship between environmental sanitation and the incidence of leptospirosis in Boyolali (OR=2.638; 95% CI: 0.793-8.773). Many researchers consider environmental sanitation as a risk factor for leptospirosis. Ullmann and Langoni [15] stated that in a developing country, leptospirosis outbreaks relate to lack of sanitation, inadequate housing and climate condition. He said that rural area has a higher risk, particularly in a tropical climate. In addition, Reis *et al.* [16] explained that bad sanitation infrastructure could be an environmental source of leptospirosis transmission. However, in this study, poor environmental sanitation was not related to the leptospirosis incidence. There might be another factor that supports leptospirosis transmission though the people have good environmental sanitation. Boyolali is a semi-urban area where there are many rice-field and open field. This regency rarely has a flood for the last 20 years, and it is close to Surakarta city, which is an urban city. Nevertheless, Boyolali still has a semi-urban area that consists of many rice field. There is no slums area and overcrowding population in Boyolali. Poor environmental sanitation in the semi-urban area is likely different from that in an urban area. Poor sanitation and abundance of rats usually happen in urban slums with overcrowding housing, while in Boyolali is mostly an agricultural area with a traditional house.

In Boyolali, most respondents had an open sewer where rats can easily access. Even though this condition did not relate to the leptospirosis infection, it could be a potential factor for leptospirosis infection. Araujo *et al.* [17] concluded that contact with open sewers, flood waters, and garbage were risk factors for leptospirosis. Some important environmental factors are the presence of rats, poor sewer conditions, poor trash conditions and the presence of standing water [11]. Poor sewer conditions affect the incidence of leptospirosis [16]. In this study, most of the environmental sanitation conditions in the respondent's house have open sewer or sewerage conditions. Some of the risk factors can be prevented by closing the sewage drainage, controlling the rodent populations in peri-domiciliary environments.

3.3. Occupation as farmer and leptospirosis

There is an association between occupation as farmer and leptospirosis (OR:5.186; 95% CI:1.682-15.989). It is likely that occupation as a farmer has a five times greater risk to get leptospirosis than other occupation. It is related to farmer workplace and activities. Farmer work in the ricefield where it is usually wet and submerged with water for a couple of weeks. Mwachui *et al.* [18] found that in Brazil, farmers who cultivate rice or engage in small scale livestock production were highly susceptible to leptospirosis. Some activities prior leptospirosis illness are walking through water, applying fertilizer, plowing in, planting and pulling out rice plants sprouts in wet fields for more than six hours a day. However, activities with dry filed

like harvesting and preparing stalk bundles were not risks. Rice fields are normally habited by some rodents such as *Rattus argentiventer*. They bury underground and look for food, particularly when harvest time. Rats are a reservoir for leptospirosis bacteria, and water is its media. Therefore the rice field becomes a risky place for leptospirosis. The bacteria can survive in the water and enter human blood capillary through wounds. Though it is a risky place for leptospirosis, farmers can be protected by using boots or rubber gloves, especially when they have wound on feet and hands. However, most Indonesian farmers ignore wounds on their skin and rarely use boots and gloves when they work. Mwachui *et al.* [19] assumed that agricultural practices of rice and crop cultivation were connected with leptospirosis risk. Pets, rodents and livestock exhibited a high variation among studies. Therefore, the number of farmers who infected with leptospirosis is always above average in an agricultural country.

In this study, many case-patients live near the rice field. Some cases in this study were construction worker who experienced washing after work on the irrigation water stream next to the rice field. It is coherent with Ullmann and Langoni [15], saying that leptospirosis can happen in construction worker in Calicut, India. Leptospirosis is not only related to the occupation but also related to the disaster (flood) or events such as triathlon (swimming). Plank and Dean [2] believed that farmers, miners, sewer workers, meat workers and fisherman are the occupation with high risk to leptospirosis incidence. Especially in the urban population, urban decay and flooding. Leptospirosis is associated with irrigation in dryland or farm. The water from the irrigation was streamed from the open water such as river and lake. Where human habitation becomes higher, the domestic rodent and animal becomes higher and increases the risk of leptospirosis to human.

In this study, a student admitted that he got leptospirosis after getting bitten by his pet hamster. Hamster is one animal that can bring leptospira strains. Syrian hamster can be infected by serovars of *Leptospira interrogans*, with bacteria traveling rapidly to the bloodstream via the lymphatics [20]. Another occupation in the case group was a construction worker. Not only a farmer, other occupation that work in an outdoor environment and workplace that expose to floodwater, but sewage and mud are also likely to associate with leptospirosis. For example, leptospirosis are prevalent among slaughterhouse workers and butchers [21], [22]. Plank and Dean [2] believed that farmers, miners, sewer workers, meat workers and fisherman are the occupation with high risk to leptospirosis incidence. In this study, men were observed as 75.8% of the case-patients while women were only 24.2%. Men are likely to have a higher risk than women [2]. Based on interviews with case respondents, they said they did not know what leptospirosis is, but they knew that rat urine was one of the leptospirosis sources. They did not know that the disease was contagious and could be infected through a wound on the hands and feet.

3.4. Relationship between the presence of wound and leptospirosis

Based on the statistical tests results, it can be concluded that there is a significant relationship between wound presence and leptospirosis incidence (OR=17.014, 95% CI:5.487-52.761). Therefore, it is believed that someone with a wound can risk getting leptospirosis 5,4 times greater than those who do not have it. This study is in line with the study of Maniihah [23] where a history of injury is a risk factor for leptospirosis (OR= 8,196; 95% CI=2,311-29,073). In addition, Prastiwi's study [9] and Cahyati *et al.* [8] believe that wound has a relationship with the incidence of leptospirosis. It is easier for leptospirosis bacteria to enter the body through a wound skin [24]. Tangkanakul *et al.* [18] and Kamath *et al.* [25] concludes that cuts or wounds is associated with the disease. Leptospirosis outbreaks have been reported following drinking and swimming in contaminated water. Kamath *et al.* [25] believed that the strongest risk factor related with leptospirosis infection is the presence of the wound or cut in the skin during the work. Phraisuwan *et al.* [26] indicated that wearing long pants can reduce the leptospirosis infection and the presence of more than two wounds associated with the infection (OR 3.97).

In this study, most farmers had wound such as tinea pedis (athlete's foot), animal/rat bites, scratches. The wounds in the case group were mostly caused by an animal bite or high humidity (tinea pedis), and spiky plants. Farmers admitted that they rarely used shoes when working, they did not cover or heal any wounds in their feet, and they washed their feet and hands on the water stream next to the rice field were possibly contaminated. aEither in urban or rural areas, anthropogenic activities related to open water and poor condition may influence leptospiral transmission to humans [17], [27]. It was reported that leptospiral bacteria were found more in the stream than in the underground sources, well and rainwater collection. One of the common wound in farmers is tinea pedis or Athlete's foot. It occurs when the *tinea sp.* fungus grows on the feet. The fungus can be exposed through direct contact with an infected person or by touching surfaces contaminated with the fungus. The fungus thrives in moist and warm environments. It is commonly found in swimming pools, showers, open water or streams.

Wound care is needed to avoid the transmission of leptospirosis through injured skin and also use shoes when working, especially for farmers. Prevention efforts can be made by covering wounds, providing

antiseptic fluids, maintaining personal hygiene and the environment, especially when there are injuries to the body, and using shoes when working, especially for workers who are often in contact with water. Farmers or anyone should not wash hands or feet in irrigated rice fields, particularly when there are injuries. Washing them using closed-source water with soap is recommended [28].

3.5. Dominant risk factor of leptospirosis

In this study, all the variables were tested with regression logistic except knowledge, and the result showed bad personal hygiene and poor environmental sanitation showed no association to leptospirosis. On the other hand, occupation, as farmer is a risk to get leptospirosis infection (OR:5.186) and wound presence, tends to be the most influential factor (OR:17.014) in Boyolali. It indicated that leptospirosis was easily transmitted through the skin wound. Therefore, people who work primarily in water need to treat their skin wound or cover them when working. This is in line with Handayani's research [29] that wound care is a protective factor of leptospirosis (OR=0.249;95% CI=0.095-0.664). Farmers are usually unaware of their safety-related to pesticide toxic, hygiene and infection. Mahyuni *et al.* [30] stated that support from government endorsement is needed to develop knowledge and awareness among farmers.

This research gives a better understanding of leptospirosis infection in an agricultural area. This research's limitation was that the author had not tested the value adjusted add ration (aOR). Further research related leptospirosis infection in other occupation and the bigger area should be conducted for better understanding.

4. CONCLUSION

There was an association between wound presence (OR:17.014;95% CI:5.487-52.761) and occupation as a farmer (OR:5.186;95% CI:1.682-15.989) towards leptospirosis incidence. Other factors such as bad personal hygiene and poor environmental sanitation showed no significant association towards leptospirosis incidence. Wound presence on feet could increase the risk to get leptospirosis particularly those who work as a farmer. Therefore, a farmer who has wounds on their feet (athlete's foot, animal bite or scratch wound) should cover them or wear suitable personal protective equipment. Support to increase the awareness of people who work in the agricultural area is required. It is suggested further research related leptospirosis infection in other occupation.

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