Paddy Field Area and Geographical Condition on Leptospirosis Risk Factors in Bantul Regency, Indonesia

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Abstract. Leptospirosis is a bacterial disease which is transmitted through rat urine and associated with standing water. This study aims to identify the geographical risk factors of leptospirosis in Bantul Regency. This research using cross sectional design with variables of paddy field area, altitude, distance to shoreline, and distance to capital. The unit analysis is sub-district, using data in 2010-2020. Leptospirosis data obtained from Health Office. Data on altitude, distance to capital, and paddy fields area were obtained from the Statistics Agency. Shoreline distance obtained by using GIS processing. Leptospirosis during 2010–2020 were 969 cases. Spearman rank test showed that only distance to capital showed a negative correlation with leptospirosis (p 0.000; r -0.543). Altitude (p 0.153; r -0.05), paddy field area (p 0.338; r 0.248) and distance to shoreline (p 0.143; r 0.208) did not correlate with leptospirosis. This indicate that leptospirosis in Bantul Regency is not a rural disease and not related to paddy fields area. This provides information that prevention of leptospirosis should pay more attention to urban areas. Further research is needed to reveal the species of rat as vector, so that it can be studied in relation to control leptospirosis in Bantul Regency.

1 Introduction

Leptospirosis is a zoonotic disease caused by Leptospira bacteria. This bacterial infection can cause death due to organ failure. The prevalence of leptospirosis in the world is estimated to increase along with demographic shifts where there is an increase in the number of urban poor people, especially in tropical areas where floods frequently occur.[1] Flood disasters are increasing along with climate change due to global warming. Overall, the incidence of leptospirosis is estimated at 1.03 million cases and 58,900 deaths each year. These estimates place leptospirosis as a major zoonotic cause in terms of morbidity and mortality. The greatest morbidity and mortality occur in poor areas of the world, although there has been no routine surveillance.[2]

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Leptospirosis in Indonesia is not included in the top 10 infectious diseases, but WHO stated that leptospirosis in Indonesia in 2019 was 920 cases with 122 deaths. These cases were distributed in nine provinces, including Yogyakarta Province.[3] According to reports in the mass media, leptospirosis in Yogyakarta Province until October 2022 recorded 81 cases spread across five regencies/cities, with the highest cases in Bantul Regency (34 cases), Gunung Kidul (19 cases), Sleman (18 cases) and Kulonprogo (4 cases).[4] The leptospirosis mortality rate is 0.05 per 100,000 inhabitants in Ecuador,[5] but at the age of > 50 years, the mortality rate can reach 56% depending on the infected organ. This shows that leptospirosis is an infectious disease that is quite important for public health, moreover the incidence of flooding will increase along with global warming.

Studies on risk factors shows that climate, especially rainfall, flooding, and the tendency of damp/wet soil, is a risk factor in most leptospirosis endemic areas.[6,7] The main risk factor in both urban and rural areas is exposure in places with rodent tracks followed by flooding in urban and agricultural-livestock areas in rural Brazil.[8] Research on the role of knowledge and behaviour shows that this factor does not correlate with the incidence of leptospirosis in Yogyakarta but is related to the distance between the house and the garbage disposal.[9] The results of these studies indicate that leptospirosis is related to dirty environmental conditions and climate, especially those related to stagnant water/floods. Floods usually occur in low lying areas with poor drainage.

Bantul Regency is a leptospirosis endemic area with the highest number of cases in Yogyakarta Province. Bantul Regency has various geographical environmental conditions, namely lowlands, highlands, rural areas, and urban areas. Bantul Regency is bordered by the south coast so that it has a wide lowland area. Low-lying areas are more at risk of stagnant water, so they are more likely to be infected with leptospirosis. This study aims to identify geographic risk factors for leptospirosis. Geographical factors that will be examined are land cover (paddy fields area), altitude, distance to shoreline, and distance to the capital. The risk factors found can be used to support leptospirosis control programs and the development of a leptospirosis early warning system in Bantul Regency.

2 Material and Methods

This was an analytic observational, with a cross sectional design. Independent variables include altitude, area of paddy fields, distance to the capital, and distance to the shoreline. The dependent variable is the incidence of leptospirosis.

The research unit is the sub-district, using data for the 2010-2020 period. Data on the incidence of leptospirosis were obtained from the Health Office of Bantul Regency. Data on altitude, paddy field area and distance to the capital were obtained from the Statistics Agency of Bantul Regency. The data of distance to shoreline is obtained by using the distance function in Geographics Information System (GIS). Spearman Rank Test statistical analysis was used to determine the correlation between environmental variables and the incidence of leptospirosis. If there is a significantly correlated variable, it is interpreted as a risk factor. This research has received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences Universitas Muhammadiyah Yogyakarta by the letter no. 053/EC-EXEM-KEPK FKIK UMY/III/2023.

3 Results and Discussion

Based on the data from Statistic Indonesia, Bantul is one of the five Regencies/Cities in Yogyakarta Province, which occupies an area of 506.85 km2 (15.91% of the area of Yogyakarta Province) in the southern part of Yogyakarta Province (7º44'04"-8º00'27" SL

and 110º12'34"- 110º31'08" E). The southern part of Bantul Regency is bordered by the Indian Ocean, the eastern part is bordered by Gunung Kidul Regency, the northern part is bordered by Yogyakarta City and Sleman Regency, and the western part is bordered by Kulonprogo Regency. The stretch of the area is relatively elongated from North to South, with a relatively low altitude, which is between 12-200 m asl, with the higher plains are in the eastern and western regions. Bantul Regency has a tropical climate, with two seasons namely dry (April-October) and rainy (November-March), with an average temperature ranging from 25-36 ºC. Land use data shows that most (69.35%) are yard and paddy fields, the rest is forest and moors.

This study aims to reveal geographical factors that may be risk factors for leptospirosis in Bantul Regency. The geographical factors examined were the area of paddy fields, the distance from the capital city and the distance from the coast. There were 969 cases of leptospirosis that occurred in the period of 2010-2020, fluctuating with a downward trend and the lowest number of cases was 48 in 2012 (Figure 1).

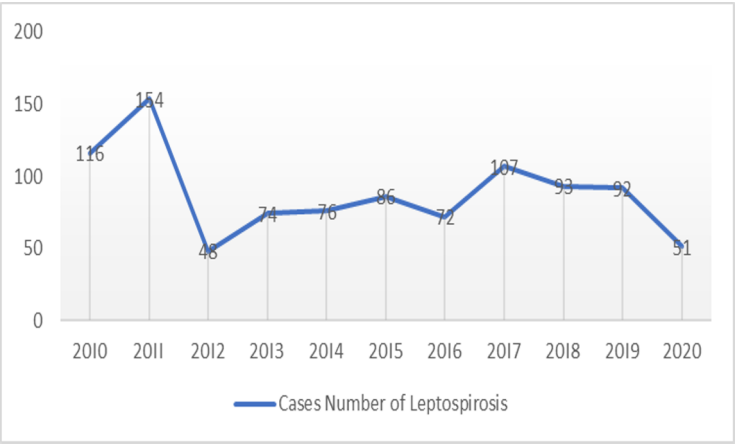

Fig 1. Trends of Leptospirosis Cases in Bantul Regency in 2010-2020

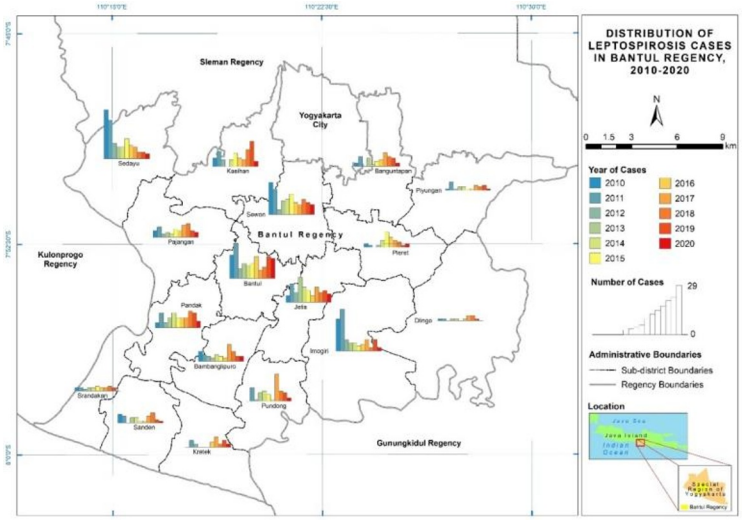

Fig. 2. Geographic Distribution of the Incidence of Leptospirosis in Bantul Regency Periods of 2010-2020

Figure 2. shows the geographical distribution of leptospirosis cases by sub-district in Bantul Regency from 2010-2020, it appears that all sub-district in Bantul Regency have cases of leptospirosis, but the high incidence is precisely in areas close to the capital of Bantul Regency. It also appears that in areas close to the coast, and in the eastern region bordering Gunungkidul Regency, the cases of leptospirosis are lower than the number of cases on the mainland, especially those close to the capital.

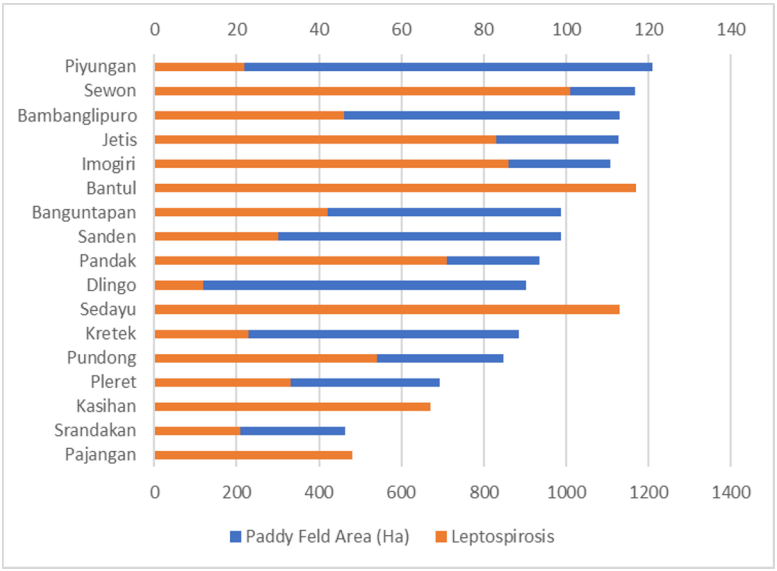

Fig 3. Correlation between Paddy Field Area and the Incidence of Leptospirosis in Bantul Regency

Figure 3. shows the inconsistency of the relationship between paddy field area and the incidence of leptospirosis. The results of the correlation analysis using the Spearman Rank Test showed that there was no correlation between paddy field area and the incidence of leptospirosis (p 0.338; r 0.248), with the direction of the correlation is positive.

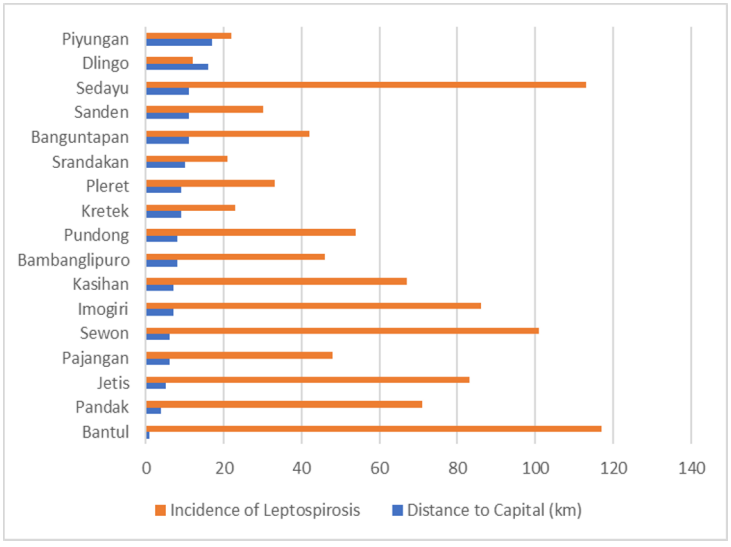

Fig 4. The Correlation between Distance to Capital and the Incidence of Leptospirosis in Bantul Regency

Figure 4 shows that sub-district which has high cases of leptospirosis, is closer to the capital, while areas with low cases of leptospirosis are far from the capital, except for Sedayu sub-district, although it is far from capital, the cases of leptospirosis are high. The results of statistical analysis showed that there was a moderate negative correlation between the distance from the capital and the incidence of leptospirosis (p 0.000; r -0.543). This means that the closer to the capital of Bantul Regency, the higher the incidence of leptospirosis.

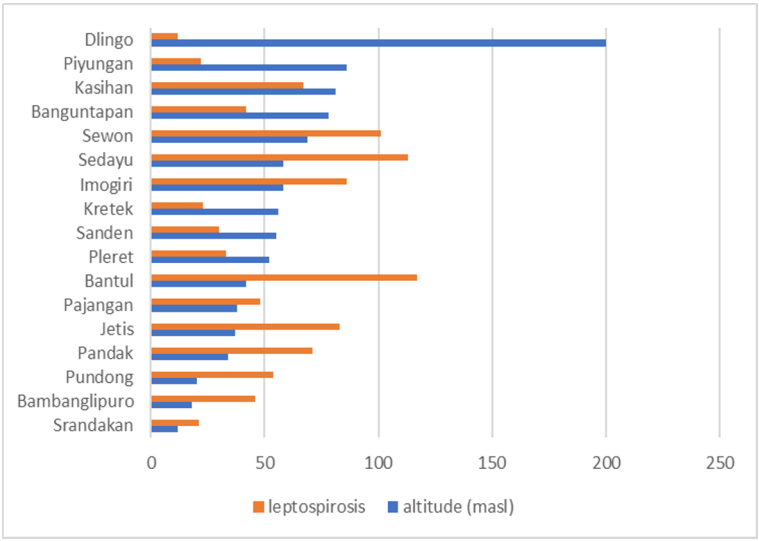

Fig 5. The Correlation between Altitude and the Incidence of Leptospirosis in Bantul Regency

Figure 5 shows that there is inconsistence correlation between altitude and the incidence of leptospirosis. The results of the correlation analysis using Spearman Rank Test showed that the correlation between altitude and the incidence of leptospirosis was not significant (p 0.153; r -0.05) with the negative direction.

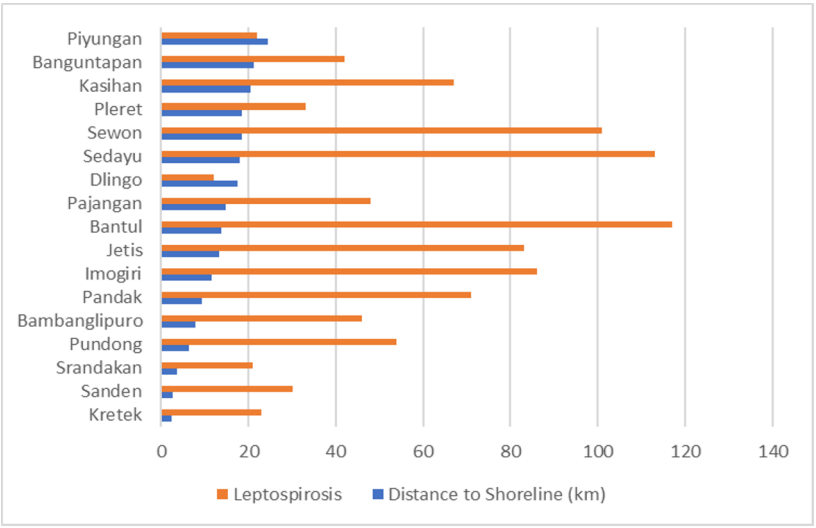

Fig. 6. The Correlation between Shoreline Distance and the Incidence of Leptospirosis in Bantul Regency

Figure 6 shows that the correlation between shoreline distance and the incidence of leptospirosis is inconsistent. The correlation analysis using Spearman Rank Test shows that

there is no significant correlation between shoreline distance and the incidence of leptospirosis (p 0.143; r 0.208). However, there is a tendency for the correlation to be positive, which means that the farther from the coast the higher the leptospirosis incidence.

Leptospirosis is the largest zoonotic disease that attacks humans. This disease is caused by infection with the Leptospira bacteria, which is transmitted through the urine or blood of carrier animals (reservoirs). The main vector of leptospirosis is rats, apart from livestock and pets. Various types of rats are known to act as leptospirosis vectors, including *Rattus tanezumi* (house rat); *Rattus norvegicus* (Norway rat), *Bandicota indica*, *Bandicota bengalensis*, *Rattus tiomanicus*, *Rattus exulans*.[10,11] However, Haake and Levvets [1] stated that Rattus norvegicus is the most prevalent type of rat infected with leptospirosis and is an important vector of human leptospirosis. The type of leptospira bacteria that most infects mice worldwide is Serovar Icterohaemorrhagiae.[12] The infection caused by this serovar bacteria can be lethal to humans; symptoms include fever, jaundice, haemorrhage into numerous organs, including the lungs and kidneys, and renal impairment. A typical lesion is on the liver. Renal failure or intrapulmonary haemorrhage are two causes of death.[13]

Rats naturally like places that are damp, dirty and have hiding places. Rat habitats vary depending on the species, for example *Rattus norvegicus* is found in drains/gutters in settlements or ports; *Bandicota indica*, *B. bengalensis and B. savilei* are found in gardens around houses, swamps, or paddy fields; *Rattus tanezumi* is found on roofs, kitchens, or rooms; *Rattus exulans* is found in gardens, bushes or paddy fields; *Rattus argentiventer* is found in paddy fields or grasslands. [14,15]

Rat breeding is influenced by food availability and temperature.[16] The existence of this rat carriers raises the assumption that leptospirosis occurs in areas that contain lots of water, such as rice fields, rivers, lowland areas (close to the coast). The rat outbreak in China in 2007 which occurred in areas near rivers and lakes [17] also confirmed that many rats live in areas close to water.

The results this study showed that leptospirosis was more common in urban areas of Bantul Regency, tended to be farther from the coast and at higher altitudes, and was not related to the area of paddy fields. This shows that leptospirosis in Bantul Regency belongs to the urban type. The same thing also happened in Brazil, where spatial studies showed that urban-type leptospirosis was more common than rural-type leptospirosis in Brazil.[8] In Yogyakarta City, leptospirosis is associated with the presence of flood history, puddles, and watery sewers around the house.[18]

In rural locations, working in paddy fields presented typical environmental dangers due to the prevalence of rodents, cattle sheds, and pets, whereas urban areas were more likely to use water for recreational purposes.[19] This supports the assumption that leptospirosis in Bantul Regency is an urban type, where the area of paddy fields is not related to the incidence of leptospirosis. It is assumed that the area of paddy fields in a sub-district is related to the large population working as farmers. Based on research by Kembhavi et al, [19] it is necessary to be aware of recreation that has a lot of contact with water, such as water parks or swimming as a risk factor for urban-type leptospirosis. Another possible source of urban leptospirosis transmission is flooding in places at risk of transmission.[20] According to Mutalip et al,[21] several risk factors for urban-type leptospirosis can also be related to non-recreative matters, such as work, social living conditions and exposure to contaminated environments. In addition, the existence of animal reservoirs and activities associated with leptospirosis infection. The types of rats most likely to become vectors of leptospirosis in urban areas are *Rattus norvegicus* and *Rattus rattus* because these types of rats are most found in urban and peri-domestic environments.[12] Further research is needed to reveal the types of rats and leptospirosis reservoir animals in urban areas of

Bantul Regency, so that the source of infection and more appropriate control measures can be identified.

In the rural type of leptospirosis, the risk factors are more related to agriculture and animal husbandry.[8] Research in rural areas in Yogyakarta (Gunungkidul Regency) showed that no rats were positive for leptospirosis, but leptospirosis infects many livestock (cattle 50%; goat and sheep 45%).[10] However, the types of rats examined in this study were rats that live in and around the house, not paddy field rats. Several studies have shown that *Rattus argentiventer* (paddy field rat) can be a leptospirosis carrier although it is relatively small, namely 7% in Vietnam, 1.8% in Central Java, Indonesia. [22,23] The small percentage of paddy field rats infected with leptospirosis is probably the reason why there is no apparent correlation between paddy field area and leptospirosis in Bantul Regency. However, to prove this hypothesis, it is necessary to carry out further investigations regarding leptospirosis infection in paddy field rats and livestock in Bantul Regency.

4 Conclusion

Leptospirosis in Bantul Regency is more common in urban areas, its occurrence is not related to paddy field area, altitude, and distance to the shoreline.

5 Suggestion

These findings provide information that leptospirosis control programs can be more focused on urban areas. Further research is needed to reveal the species of rats as reservoir and the pattern of transmission of leptospirosis in Bantul Regency so that it can support a more effective disease control program.

Conflict of interest. There is no conflict of interest in this research and publication.

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