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Research Article

Population of Rodent and Leptospirosis in Humans: Spatial Aspect of Epidemiology

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I N F O

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A B S T R A C T

Introduction: Leptospirosis is an infectious disease caused by the *Leptospira* bacteria and is transmitted from animals to humans. Leptospirosis can be spread by rodents. In the health aspects, rats play a role as carriers or reservoirs of various diseases transmitted to humans. Apart from leptospirosis, many other infectious diseases can be transmitted through rodents. One of the places where rodents are found in high numbers is the traditional market.

Aim: The purpose of this study was to assess the density of rats and ectoparasites in the market and settlements around it.

Method: In the area of the market building, 50 traps were installed, while in the settlements surrounding the market, 64 traps were installed. This was a descriptive research study with survey method and cross-sectional approach. Also, the research was based on Geographical Information System (GIS).

Results: The relative density of rats in the one traditional market was found to be 7%, while it was 11.8% in the surrounding settlements.

Conclusion: The conclusion is that all the places had a possibility of vector-borne diseases despite the low density of rodents.

Keywords: Rat, Density, Ectoparasites, Spatial, Traditional Market

Introduction

"Leptospirosis is an infectious disease caused by the *Leptospira* bacteria and is transmitted from animals to humans. Leptospirosis is spread throughout the world. However, due to the difficulty of clinical diagnosis and expensive diagnostic tools, many cases of leptospirosis were not reported.[1]

In 2018, there were 895 cases of leptospirosis in Indonesia. These cases were spread in 8 provinces; South Sumatera, Banten, Jakarta, West Java, Central Java, Yogyakarta, East Java, and Maluku. The number of leptospirosis cases fluctuated between 2009 and 2018 reaching an all-time high in 2011, then dropping in 2015, and finally rising again in 2018. Meanwhile, deaths caused by leptospirosis have remained steady from 2013 to 2016 and have then shown an upward trend until 2018. Central Java had the highest number of leptospirosis cases in 2018 with the total cases reaching 427. The CFR in Central Java Province in 2018 was 20.84%, meaning that the number of deaths from leptospirosis in Central Java Province was 89.[2]

In the nine years from 2010 to 2018, the highest total case

fatality rate (CFR) occurred in 2011 at 36% with a total of 70 cases of leptospirosis, meaning that there were 25 deaths. In 2018, there were 56 cases of leptospirosis in Semarang City, an increase of 1.81% compared to the previous year. The mortality rate (CFR) was the same as the previous year (25%).[3]

According to the City Health Office from the Health Centre in Semarang City, in 2020 (January-April) there were 23 cases with 3 deaths. In the working area of the Primary Health Centre of Simongan Semarang, there was one new case in March 2020 and also one case in February 2020.[4] Primary Health Centre of Simongan Semarang in the last 3 years has become the highest Incidence Rate (IR) of leptospirosis cases among primary health centres in Semarang City. In 2018, the IR of cases of leptospirosis was 18.62 per 100.000 population. Meanwhile, from 2019 to April 2020, the IR of cases of leptospirosis was 7.5 per 100.000. The highest cases of leptospirosis were always found in certain locations at housing block 01. The data was obtained from the health city office.[4]

Leptospirosis can be spread by rats. Rats are wild animals that often have contact with humans. Rats in human life have mostly detrimental properties such as being a pest that disturbs agriculture and plantations, a nuisance in homes and warehouses, and vectors that spread and transmit diseases. In the health aspects, rats play a role as carriers or reservoirs of various diseases transmitted to humans.[5]"Diseases transmitted by rats to humans include pes, salmonellosis, leptospirosis, murine typhus, rickettsial pox, lymphocytic choriomeningitis, rat-bite fever, hantavirus haemorrhagic pulmonary syndrome, haemorrhagic fever, Venezuelan equine encephalitis (*Alphavinus*), powassan encephalitis (*Flavivinus*), rabies, Rocky Mountain spotted fever and tularaemia. These diseases can be transmitted by direct contact or through vectors carried by rats.[6]

"Ectoparasite vectors found in the body of rats transmit some diseases. These ectoparasites are different from those in other animals. The ectoparasite arthropods commonly found in rats are insects (fleas and ticks) and mites (mite larvae, adult mites, and ticks).[7] Ectoparasites are parasites that live on the surface of the host's body. The ectoparasites of rodents usually live on the outer surface of the host's body, including the outer ear space. Parasites are independent which means they can move from one host to another and return to the same host as before.[8]

Places that have the potential to be inhabited by rats in high enough numbers are traditional markets. A market is a place for buying and selling food. Traditional market conditions generally do not meet health requirements such as poor sanitation, poor lighting, piled-up goods, and poor waste management. If the market does not meet the requirements of a healthy market, then the rats have a great opportunity to breed. The rats that live in the market area survive by consuming food and then destroying it, contaminating it, and making it a source of disease for the surrounding area.[7] The high density of rats can indirectly affect the presence of ectoparasites.[9,10]

This research is based on Geographic Information System (GIS). GIS is a computer-based data management system that is used to manipulate geographically referenced data. By mapping using a GIS, this study can obtain information on the density of rats and the distribution of cases of leptospirosis in Ngemplak Simongan Village and use it to support the control of rat density. New information can be used for early warning surveillance of increased cases of disease or death due to rats. In addition, according to research by Tamayo-Uria et al., modelling the spatial distribution of the presence of rats is useful for identifying factors associated with an increased risk of urban rat infestation.[11]

Materials and Methods

This research is a descriptive study which aims to describe the mapping of rat density in the traditional market and surrounding settlements. The location of the traditional market is Ngemplak Simongan Village, Semarang City. This descriptive research is an observational study with a cross-sectional research design. This research has received an ethical certificate number 297/EA/KEPK-FKM/2020. The population of this study were all rats caught in the traditional Market Area and the surrounding settlements. The sampling used was accidental sampling, so the research sample was all rats that were caught using a single live mousetrap. Mouse traps were placed using simple random sampling on the places around the market and settlements that surround it. The size of the research sample depended on the number of rats caught. Rats were caught using 114 mousetraps in 2 days in August 2021. In the area of the market building, 50 traps were installed, while in the settlements surrounding the market, 64 traps were installed. We analysed the data with descriptive statistics.

Results

The number of leptospirosis cases in Ngemplak Simongan Village 2014-2020 amounted to 3 cases. Ngemplak Simongan Village is a village that had the maximum leptospirosis cases in the Simongan Health Center Work Area.

Relative Density of Rats

In this study, the total number of traps used in the traditional market and the settlements around it was 100 (50 traps/day for 2 days) and 128 traps were used in the surrounding settlements (64 traps/day for 2 days).

The relative density of rats in the traditional market and surrounding settlements can be seen in Table 1.

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Table 1.Relative Density of Rats by Type of Rat

Location	Species	Relative Density (Trap Success)	
		Rats	Trap Success (%)
Traditional market (n: 7)	*Rattus norvegicus*	5	5.0
	Rattus tanezumi	2	2.0
Settlements (n:15)	*Rattus norvegicus*	5	3.9
	Rattus tanezumi	8	6.3
	Mus musculus	2	1.6

Explanation

n: The number of rats caught in each location

The relative density of rats in the Simongan traditional market was 7.0% with *Rattus norvegicus* being the most common. Meanwhile, in the settlements around the traditional market, the relative density was 11.8% with *Rattus tanezumi* rats being the most prevalent.

Distribution of Mousetraps and Caught Rats

The distribution of mousetrap installation and the location of rats caught in the traditional market can be seen in Figure 1. The most common rats found in the traditional market were *Rattus norvegicus* (5 rats) and *Rattus tanezumi* (2 rats).

The distribution of the trap installed and the location of the rats caught in the settlements around the traditional market can be seen in Figure 2. The most common rats found in the traditional market were *Rattus tanezumi* (8 rats), *Rattus norvegicus* (5 rats) and *Mus musculus* (2 rats).

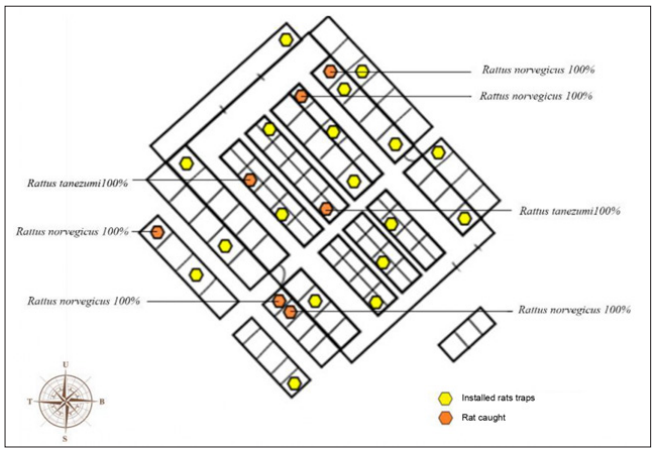

Figure 1.Distribution of Mousetraps and Rat Caught in Traditional Market

Rats Caught

The total number of rats caught was 22. Rats caught in the housing area around the market were twice as large as the rats caught in the market. Table 2 shows the frequency distribution of the types of rats caught.

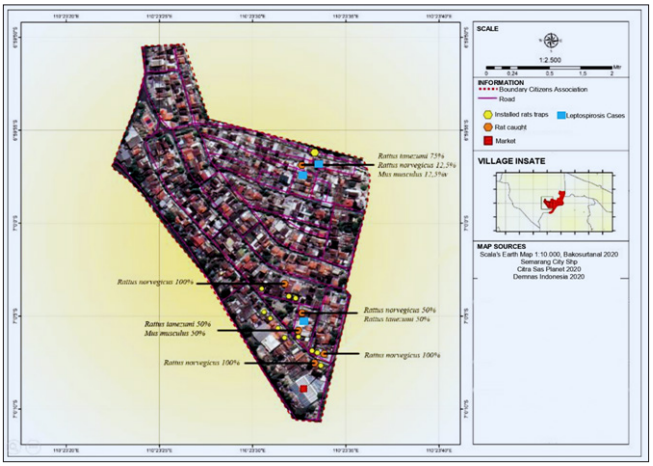

Figure 2.Distribution of Mousetraps and Rats Caught in Settlements around Traditional Market

Table 2.Distribution of Types of Rats Caught

Location	Species	Relative Density (Trap Success)	
		Rats	Trap Success
Traditional market (n=7)	*Rattus norvegicus*	5	71.4 (%)
	Rattus tanezumi	2	28.6 (%)
Settlements (n=15)	*Rattus norvegicus*	5	33.3 (%)
	Rattus tanezumi	8	53.3 (%)
	Mus musculus	2	13.3 (%)

n: The number of rats caught in each location.

The species most caught when combined were *Rattus norvegicus* and *Rattus tanezumi*. The highest percentage of rat species found in each location was different. In the Simongan market, the highest number of rats caught were *Rattus norvegicus* (71.4%). In comparison, the most common rat species found in the settlements around the Simongan market was *Rattus tanezumi* (53.3%). 16 insectivores (*Suncus murinus*) were also caught.

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Gender of Rats Caught

The rats that had been caught were identified by gender, but *Suncus murinus* was not included in the identification because it was not a rat. Table 3 shows the gender distribution of the rats caught.

Table 3.Gender Distribution of Captured Rats

Location	Gender	Rats	Percentage (%)
Simongan traditional market (n=7)	Male	2	28.6
	Female	5	71.4
Settlements (n=15)	Male	9	60.0
	Female	6	40.0

n: The number of rats caught in each location.

In the traditional market, there were 5 female rats (71.4%), which was more than the male rats (28.6%). In the settlements around the traditional market, the number of male rats was (9 (60.0%), more than the female rats (6, 40.0%).

Discussion

The traditional market is a market located near housing complex 01 in Ngemplak Simongan Village, West Semarang District, Semarang City. This market was chosen as the research location for the density of rats and ectoparasites because it is located in the housing complex with the most cases of leptospirosis in the last 5 years based on data obtained from the Primary Health Centre of Simongan. In addition, the location of the research area is a densely populated area. It is located on the edge of a main road so that it becomes the centre of community activity.

The study was conducted for 2 consecutive days using 114 traps per day which were distributed in the traditional market and the surrounding settlements. The numbers of rats and *Suncus murinus* caught were 22 and 16 respectively. The relative density of rats caught in the traditional market was 7.0% and in the surrounding settlements, it was 11.8%. The percentage of success was calculated based on the number of rats caught divided by the number of traps installed.[11] The success and failure of catching rats can be influenced by several factors, namely the quality of the trap, the accuracy of bait selection, the accuracy of placing the trap position, and the behaviour of the rats themselves.[12]

The quality of the mousetrap can affect the success of catching rats because it will become a barrier when rats enter the trap. If the quality of the trap is not good, the rats that have been caught will damage the trap and run away. During the research, many traps were found intact with missing bait; broken traps were also found. This is most likely due to the size of the trap that does not fit the mouse or the hook not being strong enough.

The bait can also affect the success of catching rats. The baits used were meatballs, *pindang* (smoked fish), watermelon, and roasted coconut. Various baits were installed to find out the right and effective bait. Based on the results of the study, the most preferred bait for rats was meatballs and the least preferred bait was watermelon. The position of the trap can also affect the success of catching mice. The trap was placed in a place that is thought to be a mouse path or a place frequented by rats. The success of catching rats indoors is higher than in outdoor habitats.[12]

The behaviour of the rat itself can also affect the success of catching rats. Rats have a clever nature. The fact that rats appeared during the day even though humans were present shows that the population of rats in the area is high. Rats usually have limited mobility; they never pass through open areas especially during the day unless the condition is urgent because their instinct is more active at night. Based on observations at the traditional market and the settlements surrounding it, rats roamed freely during the day. This can be a factor indicating that the density of rats in the traditional market and market settlements is high but due to several factors, the success of catching rats shows less density. Based on research by Kiyokawa et al., it has been observed that human activities also have an important influence on the ecological dynamics of mice.[13]

Most rats caught in the market area were female (71.4%). This is in accordance with Listiyarini et al.'s research on the study of rat density in other traditional markets, namely, the Peterongan market and Wonodri market where the rats found were mostly female (60%).[14] Another study in the Tanjung Emas Harbor Area regarding the density of rats, stated that mostly female rats were found.[13] However, in the settlements around the Simongan traditional market, there were more male rats.

There were 3 types of rats and one insectivore caught in this study, namely *Rattus norvegicus*, *Rattus tanezumi*, *Mus musculus*, and *Suncus murinus*. The results showed that the most common rat found in Simongan traditional market was *Rattus norvegicus* (71.4%), while *Rattus tanezumi* (53.3%) was common in the settlements around the traditional market. *Rattus norvegicus* in the traditional market and surrounding settlements was generally found in drains/sewers, therefore *Rattus norvegicus* is aptly referred to as a sewer rat. *Rattus norvegicus* is known as a reservoir for transmitting leptospirosis disease to humans, therefore it is a true host for leptospira.[14]

The second most commonly found rat after *Rattus norvegicus* was *Rattus tanezumi*. This rat, commonly found in houses,

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was also prevalent in the traditional market because it is close to the surrounding settlements. *Mus musculus* rats have a natural habitat of human settlements and therefore cannot be found in the traditional market. The presence of rats around human habitats can indicate the condition of the cleanliness of the environment. The market produces a lot of leftover food from the sales which can be a source of food for rats. In addition to food scraps, humid market conditions, and open sewers around the house are ideal places for rats to live in.

Based on Figures 1 and 2, there are 2 out of 3 houses with leptospirosis patients located far from the traditional market, a public facility where rats are more common. Meanwhile, the number of rats found in the settlements around the traditional market was far less than in the houses further away. It is possible that there are other factors that affect the case of leptospirosis and also the density of the rats. These factors can be in the form of environmental conditions. The presence of water puddles, bad condition of trash bins, and condition of ditches may affect the transmission of leptospirosis.[15-20] In addition to environmental conditions, the condition of the house can also affect the presence of rats. Houses that have less lighting, ceilings that are not closed, and are without ventilation are perfect breeding grounds for rats.[17,21,22]

Apart from the existence of rats as a reservoir and environmental conditions supporting their habitat, human behaviour can also increase the risk of infection with *Leptospira* bacteria. Not only behaviour in keeping the environment clean and not baiting rats to nest, the behaviour of wearing boots when it rains or floods, and washing feet after outside activities are behaviours that can reduce the risk of transmission of leptospirosis. Most people do not use personal protective equipment when carrying out risky activities such as during floods, tidal inundation, sewage, garbage/ disposal treatment, or even contact with rodents or the habitat of rodents.[15-17,23,24] On the other hand, knowledge and attitudes about leptospirosis in practice reduce the transmission of *Leptospira* among an urban slum population at high risk for exposure to the bacteria.[15,25,26]

It is necessary to increase awareness about rats and the diseases they can spread in order to control rats by paying attention to environmental sanitation. Further research is recommended to confirm the disease agent carried by rats in settlements around the traditional market.

Conclusion

Based on the results of the calculation of the rat density, the traditional market and its surrounding settlements are considered not too crowded but still need to be aware of the possibility of the spread of infectious diseases by rodents and vectors.

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Declaration of Interest Statement

The authors declare that they have no conflict of interest.

Conflict of Interest: None

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