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Research Article

Leptospirosis: The Relationship Between Rats, Clean and Healthy Living Behavior, and Living Environment Conditions

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A B S T R A C T

Background: Leptospirosis is a zoonotic disease that remains a public health problem in tropical regions, including Indonesia. Demak Regency, particularly the Sayung 1 Community Health Center (Puskesmas Sayung 1), is an endemic area with a high incidence and mortality rate of leptospirosis. This study aims to determine the relationship between the presence of rats, clean and healthy living behaviours, and environmental conditions with the incidence of leptospirosis.

Methods: An observational, analytical design was chosen, employing a cross-sectional approach. 100 respondents were selected using a purposive sampling technique. Data collection used a structured questionnaire that had undergone expert testing. Bivariate analysis used the chi-square test ($p \leq 0.05$). Results: The presence of rats was significantly associated with the incidence of leptospirosis ($p = 0.000$). Most respondents had not fulfilled all indicators of clean and healthy living behaviour, such as waste separation and rat vector control. Furthermore, the physical condition of households is still suboptimal, as evidenced by the low proportion of houses with roofs and ventilation that meet health standards.

Conclusion: Although only the presence of rats proved statistically significant, leptospirosis prevention efforts still require a comprehensive approach encompassing behavioural education, physical environmental improvements, and ongoing vector control. This is crucial in areas with a high risk of leptospirosis transmission.

Keywords: Presence of Rats, Clean and Healthy Living, Environmental Conditions, Leptospirosis

Introduction

Leptospirosis is caused by the bacteria Leptospira spp., which are transmitted through exposure to water or environments contaminated with bacteria from animal urine. The most suspected animal is the rat group. Indonesia ranks third highest in the world in terms of mortality rates due to leptospirosis, reaching 16.7%.[1,2] Central Java is one

of the provinces with the highest number of leptospirosis cases in Indonesia, including Demak Regency.[3,4] The Demak Regency area, especially Sayung District, is included in the leptospirosis endemic area with a fairly high incidence and mortality rate. Data from Sayung 1 Health Center show 11 cases of leptospirosis and 7 deaths during the 2020–2023 period. This indicates a high fatality rate of leptospirosis cases, so it is important to identify risk factors that play a role in its transmission.[5]

In a previous report, leptospirosis is influenced by a combination of environmental factors, community behaviour, and the presence of animal reservoirs. Physical environments such as the condition of drainage channels, standing water, and housing quality play a major role in supporting the presence of rats as the primary reservoir of leptospirosis.[6,7] Suboptimal public hygiene and healthy living practices also increase the risk of leptospirosis transmission. These poor behaviours include not washing hands after contact with dirty water and littering.[8] Many residential areas in the Sayung 1 Community Health Center area still do not meet health standards. Dirt floors, holes in walls, and poor sanitation conditions are contributing factors to the proliferation of rats around residential areas. Limited access to clean water leads to the use of open water sources such as dug wells and rivers for daily needs. Poor groundwater quality and contamination with Leptospira spp. Bacteria further increase the risk of transmission. An approach that simultaneously considers the presence of rats, healthy living behaviours, and environmental sanitation conditions is necessary to comprehensively manage the determinants of leptospirosis incidence.[9,10]

The high density of rats in endemic areas of Semarang City is associated with poor environmental conditions. The presence of rats (Rattus norvegicus) was significantly influenced by proximity to stagnant waters, a history of flooding, open trash bins, and piles of garbage around homes. High trap success rates (2.5–26.5%) and high bi-index values in densely populated areas are clear indicators of a high risk of transmission.[11]

Methods

Research design and site

This study employed an analytical cross-sectional design. The study site was the Sayung 1 Community Health Center (Puskesmas Sayung 1), Demak Regency, Central Java Province, Indonesia.

Population and sample

The study population was located in an area prone to leptospirosis. Cases were consistently detected from 2018 to 2025. The highest number of cases occurred in 2020 and 2022, with deaths accounting for 50% of the total number of leptospirosis cases (Figure 1).

The study population consisted of all leptospirosis patients and the community living near the patients within the Sayung 1 Community Health Center's coverage area. The sample size was calculated using the Slovin formula, resulting in 100 persons. The sample was selected purposively, consisting of all 18 leptospirosis cases and 82 non-sufferers from the area surrounding the patients' residences.

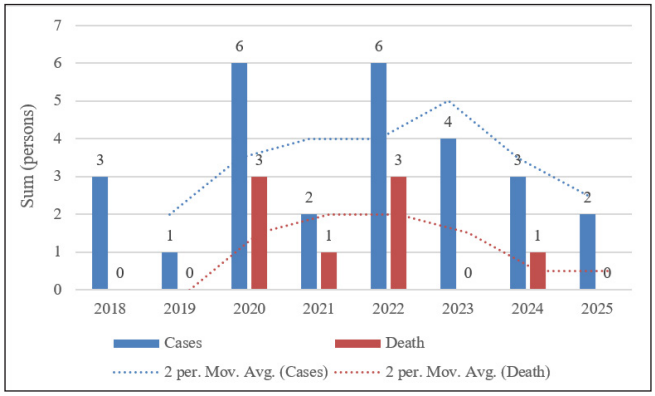

Figure 1.Number of cases and deaths due to Leptospirosis

Data collection

Medical records from Sayung 1 Community Health Center regarding leptospirosis cases served as baseline data on the presence of patients. Other data were collected using a questionnaire. The questionnaire was expertly reviewed by two experts from the Department of Environmental Health, Muhammadiyah University of Semarang, and was deemed appropriate. The questionnaire was used to interview all respondents.

Rats were caught using 20 x 20 x 30 cm wire mesh traps. Salted fish and meatballs were used as bait. A trap was placed in each respondent's home in the kitchen or a dark area near food supplies. The traps were set in the late afternoon, approaching dusk. The rat catch was observed the following day. The captured rats were identified, then exterminated with narcotics and buried near the respondent's home.

Data on respondents' clean and healthy lifestyle behaviours were obtained through direct interviews, while environmental conditions were observed around the respondents' homes using observation sheets.

Data analysis

Univariate analysis was conducted to calculate the proportion of each variable category. Bivariate analysis using the chi-quare test was conducted to determine the relationship between the independent and dependent variables, with a maximum margin of error of 5%.

Ethics approval

The ethics certificate was released by the Health Research Ethics Committee of the Faculty of Public Health, Universitas

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Results

The Sayung 1 Community Health Center is located in a leptospirosis endemic area in Demak Regency, Central Java Province. This area has geographic characteristics that support the spread of leptospirosis, including the presence of tidal flooding that occurs almost year-round and suboptimal environmental sanitation conditions. Annual data from Sayung 1 Community Health Center show a trend of increasing leptospirosis cases, especially during the rainy season.

The survey results found that rats were still found in 15% of respondents' homes. Unfortunately, the majority of respondents' clean and healthy living habits were categorised as "poor". This indicates that most respondents have not consistently adopted clean and healthy habits. Environmental conditions are very unfavourable, with almost the entire area in "poor" condition. This is due to the presence of tidal flooding that occurs nearly year-round in this region. The number of leptospirosis cases, which reached 18%, indicates a relatively high incidence of this disease (Table 1).

The rat species caught in the respondents' homes was Rattus norvegicus. The identified rats were then destroyed and buried in an area around the respondents' homes that was not submerged in tidal water (Figure 2).

Table 1.Distribution of research variables (n= 100)

Variable	Frequency (f)	Percentage (%)
Rats existance		
Found	15	15.0
Not found	85	85.0
Clean and Health Living Behavior		
Good	24	24.0
Poor	76	76.0
Environmental condition		
Good	8	8.0
Poor	92	92.0
Leptospirosis incidence		
Yes	18	18.0
No	82	82.0

Figure 2.Results of catching rats and their burial

Good behaviour was identified through interviews. All respondents made it a habit to wash their hands with soap after leaving the house, before eating, and after using the toilet. However, 12% of respondents still did not use a gooseneck toilet. 4% of respondents still consumed unboiled water. Household waste was still not separated into organic and inorganic waste, according to 53% of respondents. Fifty-six percent of respondents also did not set rat traps in their living areas. Almost all respondents stated that they routinely cleaned their home environment, but natural conditions such as tidal flooding were unavoidable (Table 2).

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An environmental condition that respondents could not manage independently was the presence of tidal flooding due to rising sea levels. This flooding presents a challenge for the community in preventing disease transmission (Figure 3).

Table 2.Respondents' clean and healthy living behaviour (n = 100)

Respondent behavior	Yes		No	
	f	%	f	%
Washing hands with soap after activities outside the house	100	100	0	0
Washing hands with soap before eating	100	100	0	0
Washing hands with soap after going to the toilet	100	100	0	0
Gooseneck form of toilet and has a septic tank	88	88	12	12
Boiled or filtered water for family drinking	96	96	4	4
Separation of organic and inorganic waste	47	47	53	53
Setting a mouse trap	44	44	56	56
Routine cleaning of the home environment	98	98	2	2

Figure 3.Condition of the home environment with tidal flood water

The data showed insignificant results for all independent variables. This does not mean that the presence of rats, healthy lifestyles, and environmental conditions are unrelated to leptospirosis cases. The incidence of leptospirosis cases was only 2 out of 100 respondents, making it insufficient to provide statistical evidence. However, a closer look at the cross-tabulation reveals that both leptospirosis cases occurred in the group of houses where rats were found, accompanied by healthy lifestyles and poor environmental conditions (Table 3).

Respondents with poor health habits were more likely to find rats in their homes. The same was true for those with poor environmental conditions (Figure 4).

The environmental conditions of the house were generally good, according to most of the observed variables. The waterproofness of the floor, the condition of the walls, nighttime waste management, food storage, bathroom waste storage, ventilation, and standing water around the house were all found to be in good condition. Only the tightness of the roof and the presence of trash can covers inside were found to be inadequate (Table 4).

Ninety-one percent of respondents had waterproof floors, and sixty-three percent had houses with solid, permanent walls. The behaviour of storing food and drinks, owning covered trash cans, and removing trash outside the home were 94%, 37%, and 85%, respectively. These indicate that the majority of respondents owned homes and behaved well. Unfortunately, 39% of homes were still found to be inundated by tidal flooding. Wet, damp soil is highly favoured by rodents, who contaminate it with their faeces and urine. Although only 15% of respondents' homes were found to have rats, the presence of rats was significantly related to the incidence of leptospirosis (p = 0.000).

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Table 3.The relationship between Leptospirosis and the observed independent variables

Independent variable	Leptospirosis		p-value	Statistic decicion
	Yes	No		
Rat existence				
Not found	2	83	0.548	Not significant
Found	0	15		
Healty living behavior				
Good	0	24	0.422	Not significant
Poor	2	74		
Environmental conditions				
Good	0	8	0.674	Not significant
Poor	2	90		

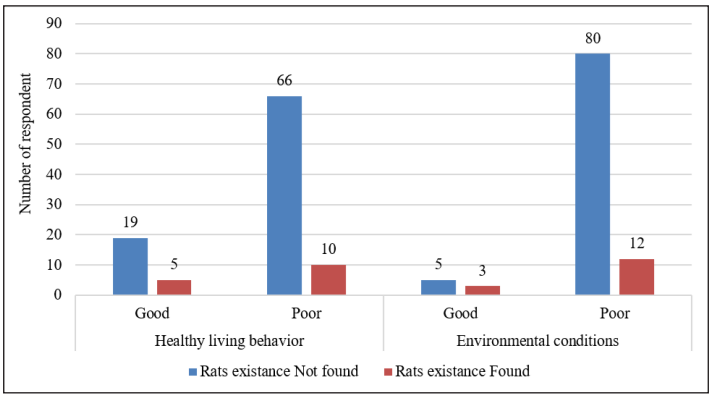

Figure 4.The existence of rats by healthy behavior and environmental conditions

Table 4.Exploration of respondents' home environmental conditions

Environmental condition	Good		Poor	
	f	%	f	%
Waterproof house floor	91	91	2	2
Permanent tight house walls	63	63	37	37
Tightly ceilinged of the roof	33	33	67	67
Closed indoor trash can	37	37	63	63
Moving rubbish out of the house at night	85	85	15	15
Covered food and drinks	94	94	6	6
Closed bathroom waste water channel	60	60	40	40
Wire mesh ventilation	66	66	34	34
Puddles of water around the house	61	61	39	39

Discussion

The discovery of rats in 15% of respondents' homes indicates the potential for the spread of leptospirosis. Rats in an area will leave their droppings and urine everywhere. The Leptospira spp. bacteria that live in the rats' bodies are excreted in the droppings and urine.[12] It's understandable that if a large rat population is found in an area, the soil is potentially contaminated with Leptospira spp.[13] can potentially infect anyone who comes into contact with the contaminated surface.

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The results showed that respondents with poor health habits were more likely to encounter rats in their homes. This is understandable, as poor habits lead to dirty homes and potentially create entry and exit routes for rats searching for food. Homes that store organic waste at night are also more likely to attract rats searching for food.[14] Densely populated neighbourhoods with poor conditions can also attract the presence of rats.[15] Clogged gutters with stagnant water become a favourite destination for rats.[16] On the other hand, houses located in areas of tidal flooding are certainly difficult to clean. As long as water remains in the house, the home environment will never be in good condition.[17]

Walls made of non-permanent materials and lacking tightness make it easier for rats to enter. Having an open trash can inside the house without a lid makes it even more attractive, especially as it serves as a dumping ground for organic waste, which is their food source.[18] Houses without ceilings and open ventilation also open entry points for rats, which will further increase the risk of transmitting leptospirosis.[19]

Stagnant water in the home environment can become a breeding ground for Leptospira spp. carried by rats. One report found that 42% of soil samples in endemic areas contained Leptospira spp. DNA20. Stagnant water caused by poor drainage and mixed with domestic waste is also associated with the transmission of leptospirosis.[21]

While clean and healthy living behaviours may not be directly related to leptospirosis, poor behaviours can lead to the emergence of risk factors for disease transmission.[22] Behaviours that are directly related include walking in stagnant water contaminated with bacteria without wearing boots.[23] Trap ownership also influences mousetrap-setting behaviour. Understanding how to catch mice will have no impact without the availability of mousetraps. Various factors are interrelated in controlling and preventing the transmission of leptospirosis.[24] An integrated effort is needed, involving improvements in clean and healthy living behaviours and the physical home environment, as a comprehensive effort to prevent leptospirosis transmission.[25]

Conclusion

The presence of rats is significantly associated with the incidence of leptospirosis, meaning that a larger rat population in an area increases the risk of leptospirosis transmission. In general, healthy lifestyles and home environmental conditions are indirect risk factors for leptospirosis.

Recommendation

Education is ongoing to increase understanding, which is expected to impact public health behaviors. Efforts are needed to reduce the rat population by increasing the number and frequency of traps. Comprehensive measures to address the problem of tidal flooding to minimize rat habitats and improve the physical environment in residential areas at risk of leptospirosis.

The stagnant water at the research site cannot be drained because it originates from the sea, which is higher than the land. Improving housing conditions, such as installing ceilings, is an option, but improving the surrounding environment is a priority. Another option is relocating residents to safer areas, but it's difficult for residents who have lived there for generations to leave their hometowns. Strengthening understanding of leptospirosis and how to prevent it is the most feasible alternative. This includes recognising the signs and symptoms of leptospirosis so that the community can independently control leptospirosis transmission.

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Conflicts of interest: None

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