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Analysis of Factors Affecting the Incidence of Leptospirosis in Semarang City in 2024

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ABSTRACT

Leptospirosis is a zoonotic infectious disease caused by Leptospira bacteria and remains a significant public health problem in tropical regions. Semarang City is one of the areas with a high risk of leptospirosis due to its geographical structure, frequent flooding, poor sanitation, and high population density. Data from the Semarang City Health Office in 2024 reported 32 cases and 5 deaths, with cases increasing during the rainy season. Several determinants, including behavioral, environmental, socioeconomic, and demographic factors, contribute to disease transmission. This study aims to identify the factors influencing the incidence of leptospirosis in Semarang City in 2024. A quantitative case-control study was conducted involving 96 respondents residing in Semarang City, consisting of 32 cases and 64 controls. Data were analyzed using univariate, bivariate, and multivariate logistic regression. Bivariate analysis showed that gender (p=0.000; OR=51.13), the presence of rats (p=0.000; OR=0.094), the presence of livestock (p=0.002; OR=4.26), and the presence of garbage (p=0.000; OR=11.88) were significantly associated with leptospirosis incidence. However, age (p=0.393; OR=1.426) and education level (p=0.516; OR=0.684) were not significantly related. Multivariate analysis confirmed that gender (p=0.000; OR=287.491; CI=19.611–421.478), livestock (p=0.003; OR=60.152; CI=4.089–884.845), and garbage around the house (p=0.002; OR=52.681; CI=4.794–578.888) were influential factors. Gender was identified as the dominant factor, increasing the risk up to 287.491 times. Strengthened multisectoral collaboration between government agencies, communities, and healthcare workers is essential to enhance environmental sanitation, rodent control, and surveillance to prevent leptospirosis in Semarang City.

Keywords: *Leptospirosis; Risk Factors; Semarang C*

INTRODUCTION

Leptospirosis is the most common zoonotic infection worldwide, with the highest incidence occurring in resource-poor tropical countries (Bradley EA & Lockaby G, 2023). It is estimated to be responsible for 1.03 million cases and 58,900 deaths annually. Humans can contract the infection through direct contact with infected animal fluids or from water or soil contaminated with these fluids via wounds, rough skin, or mucosal contact (Karpagam and Ganesh, 2020). Leptospirosis cases are usually asymptomatic, but some patients may experience symptoms. The most common symptom observed among leptospirosis patients is acute febrile illness. This infection can be treated with common antibiotics such as doxycycline and azithromycin. If proper treatment is not administered in a timely manner, the disease can progress to more severe clinical manifestations, potentially leading to multiple organ failure and death (Bradley and Lockaby, 2023) . Early and accurate diagnosis plays a key role in managing the infection. The clinical presentation of leptospirosis is nonspecific, making it difficult to distinguish from other infections, such as malaria and dengue fever.

Leptospirosis is caused by spirochete bacteria belonging to the genus Leptospira. More than 300 serovars of Leptospira spp. have been reported to be associated with the infection. The current gold standard for diagnosing leptospirosis is the microagglutination test (MAT). This test typically requires live leptospira (approximately 20 serovars), skilled personnel, and specialized equipment, limiting its availability to central or reference laboratories. To address

these challenges, several diagnostics such as enzyme-linked immunosorbent assays (ELISA), polymerase chain reaction (PCR), and rapid lateral flow immunoassays (LFIs) have been developed (Maze et al., 2018) .

Leptospirosis is a major cause of illness and death, emerging as a significant health problem due to the global expansion of urban slum communities. The disease is associated with severe manifestations such as Weil's disease and pulmonary hemorrhagic syndrome, with mortality rates reaching 10%–50% or even higher. Transmission to slum dwellers occurs in perdomestic environments, where exposure to sewers, floodwater, and contaminated soil are risk factors (Hacker et al., 2020) .

Humans can become infected with leptospira through direct contact with various types of mammalian hosts or through indirect exposure to contaminated surface water or soil (Sayanthi & Susanna, 2024). These organisms can survive for several weeks after being excreted from chronic carriers. Factors such as high temperatures, exposure to animals, poor sanitation, and inadequate sewage systems can all influence the epidemiology of leptospirosis (Teles et al., 2023). Many of these major risk factors are expected to become more frequent and intense due to global climate change and urbanization, potentially increasing the incidence and outbreaks of leptospirosis (Bradley and Lockaby, 2023) .

According to data from the International Leptospirosis Society (ILS), Indonesia ranks third in the world for leptospirosis incidence after India and China in terms of mortality. Leptospirosis is known as flood fever because it becomes an epidemic during floods. The most severe form of leptospirosis, which attacks and damages almost all organs, is known as Weil's Disease. The main carriers of leptospirosis are rodents, especially rats. The *Leptospira* bacteria that cause leptospirosis can infect vital organs such as the liver and kidneys, and in severe cases can lead to death, with reported mortality rates ranging from 2.5% to 16.45% (Nur et al., 2024). In 2014, 14 cases were reported; in 2015, 22 cases; in 2017, 93 cases; and to date, the number remains uncounted.

Leptospirosis cases in Semarang City in 2024 reached 32 cases with 5 deaths, with a sharp increase occurring from January to March followed by a decline in the subsequent months (Semarang City Health Office, 2024). Variations in case numbers are closely related to environmental and seasonal conditions in Semarang. Risk factors for leptospirosis include behavioral, health service, socioeconomic, and demographic factors (Sulistyowati et al., 2023). Individuals within the productive age range and males tend to have a greater risk due to increased exposure to contaminated environments. Education level also affects disease prevention efforts, though higher education does not always guarantee hygienic behavior (Diaswati, Marsanti and Ratnawati, 2024). Transmission frequently occurs through contact with contaminated water, particularly in areas where sanitation, drainage, and waste management are poor (Prabandari et al., 2022). Rats, as the primary reservoir for Leptospira bacteria in Indonesia, experience behavioral shifts during the rainy season that increase interaction with humans and heighten environmental contamination (Sunardi, Mirasa and Alimansur, 2023). Other mammals, including livestock and pets, may also excrete the bacteria and become indirect sources of infection if their waste is poorly managed (Safitri et al., 2023).

Environmental factors play a crucial role in the persistence of Leptospira in soil or water, influenced by pH, oxygen levels, and salinity (Nugroho, Adi and Nurjazuli, 2023). Slum housing, rice fields, recreational water areas, and neighborhoods with stagnant water and

accumulated garbage increase human–rat interaction, raising the risk of infection (Lestari, Septaria and Putri, 2020). The geographic characteristics of Semarang, including densely populated riverbank settlements, further contribute to transmission vulnerability. Although prevention methods such as proper sanitation, PPE use, and wound protection are recommended (Nur et al., 2024), community compliance remains low due to limited awareness and reliance on external assistance. Community empowerment through education and family-based environmental management is essential for sustainable leptospirosis control, especially in flood-affected areas.

Data shows an increase in leptospirosis cases in Indonesia every year. In 2020, there were 1,170 cases with 106 deaths (case fatality rate CFR 9.06%). In 2021, there were 736 cases with 84 deaths (CFR 11.41%), and in 2022, there were 1,408 cases of leptospirosis with 139 deaths (CFR 9.87%). Leptospirosis is increasingly prevalent throughout Indonesia, including in Central Java, particularly in the city of Semarang.

Leptospirosis is an infectious disease influenced by various factors, both individual and environmental. From a socio-demographic perspective, the productive age group (15–60 years) tends to be more susceptible to infection because they are highly mobile and often engage in outdoor activities, especially in areas prone to flooding. Males also show a higher prevalence than females because they are more often involved in risky occupations such as laborers, sanitation workers, and farmers. Education levels also influence awareness and preventive behavior; individuals with low education tend to have limited knowledge about how to avoid exposure to *Leptospira* bacteria, including the importance of maintaining environmental hygiene and using personal protective equipment.

In addition, environmental factors and community living habits also play a significant role in the spread of this disease. The use of unhygienic water, especially from contaminated sources, is one of the main routes of transmission of leptospirosis. The presence of rats in densely populated residential areas with poor sanitation is a natural reservoir for the spread of bacteria. Livestock such as cows and goats, as well as pets such as dogs, can also carry the bacteria without showing clinical symptoms. Other environmental factors such as poor drainage, garbage accumulation, uninhabitable houses, and lack of access to clean water further increase the risk of community exposure to leptospirosis. The combination of these factors highlights the importance of an integrated approach in comprehensively analyzing and addressing the spread of leptospirosis.

The escalating trend of leptospirosis cases in Semarang City constitutes a critical public health challenge that demands immediate and evidence-based interventions. This research addresses a significant gap in the current understanding of leptospirosis transmission dynamics in endemic urban tropical settings by examining the complex interplay between demographic, behavioral, and environmental risk factors. The urgency of this study is underscored by several key considerations: First, the rising case numbers (32 cases with 5 deaths in 2024) and case fatality rates directly threaten community health and strain local health systems, necessitating targeted preventive strategies to reduce morbidity and mortality. Second, understanding localized risk factors specific to Semarang's geographic, climatic, and socioeconomic context is essential for designing context-specific interventions that can effectively reduce disease burden and inform both regional and national public health policy frameworks. Third, the findings will contribute to strengthening Indonesia's zoonotic disease surveillance and control

infrastructure, aligning with WHO recommendations for integrated One Health approaches that comprehensively address the human-animal-environment interface. Fourth, this research provides crucial baseline data for evaluating the effectiveness of future intervention programs, guiding resource allocation decisions in urban flood-prone areas, and establishing evidence-based benchmarks for monitoring progress in leptospirosis control efforts.

This study aims to identify the factors that influence the incidence of leptospirosis in Semarang City in 2024, focusing on the relationship between sociodemographic characteristics, water usage, the presence of rats, livestock, waste, and the occurrence of leptospirosis, as well as determining the dominant risk factor. This research contributes to the development of scientific knowledge in the fields of health ecology and epidemiology by providing a deeper understanding of the causes of leptospirosis in high-risk urban areas. For the government, the findings are expected to support the strengthening of leptospirosis prevention and control programs through improvements in environmental sanitation, waste management, rodent population control, public education on clean water use, and proper livestock handling, while also assisting in the design of more targeted and efficient cross-sectoral interventions. For the community, this research increases awareness and knowledge of risk factors, encouraging the adoption of Clean and Healthy Living Behaviors (PHBS) to reduce exposure to contaminated environments. The escalating trend of leptospirosis cases in Semarang City constitutes a critical public health challenge that demands immediate and evidence-based interventions. This research addresses a significant gap in the current understanding of leptospirosis transmission dynamics in endemic urban tropical settings by examining the complex interplay between demographic, behavioral, and environmental risk factors. The urgency of this study is underscored by several key considerations: First, the rising case numbers (32 cases with 5 deaths in 2024) and case fatality rates directly threaten community health and strain local health systems, necessitating targeted preventive strategies to reduce morbidity and mortality. Second, understanding localized risk factors specific to Semarang's geographic, climatic, and socioeconomic context is essential for designing context-specific interventions that can effectively reduce disease burden and inform both regional and national public health policy frameworks. Third, the findings will contribute to strengthening Indonesia's zoonotic disease surveillance and control infrastructure, aligning with WHO recommendations for integrated One Health approaches that comprehensively address the human-animal-environment interface. Fourth, this research provides crucial baseline data for evaluating the effectiveness of future intervention programs, guiding resource allocation decisions in urban flood-prone areas, and establishing evidence-based benchmarks for monitoring progress in leptospirosis control efforts. This analytical study was conducted in Semarang City in 2024 using a quantitative case-control design. The research utilized secondary data obtained from epidemiological investigations of leptospirosis case reports recorded by community health centers and submitted to the Semarang City Health Office, including individual characteristics, environmental conditions, behavioral risk factors, and contact history with sources of transmission.

METHOD

This study applied a quantitative approach, emphasizing systematic measurement and hypothesis testing using numerical data (Creswell, 2018). It used an epidemiological approach

focusing on the distribution and determinants of leptospirosis, with a case-control design that retrospectively compared individuals with leptospirosis (cases) and those without it (controls) to identify exposure differences (Creswell, 2018). Secondary data were obtained from epidemiological investigations reported to the Health Office in 2024. The population consisted of residents of Semarang City, with samples selected from recorded cases based on criteria related to data completeness, location, and laboratory confirmation. Sample size was determined using the Lemeshow formula with a 5% significance level and 80% power, resulting in a minimum of 31 respondents per group or 62 total samples (Nursalam, 2020).

Data were extracted using epidemiological review forms covering case identity, clinical information, and risk factors such as the presence of rats, livestock, and garbage. Secondary data collection used retrospective documentation to identify patterns and determinants of leptospirosis. Data processing involved coding, editing, structuring, entry (Excel/SPSS), and cleaning to ensure accuracy for analysis. Data analysis followed three levels: univariate to describe characteristics, bivariate using Chi-Square tests to assess relationships, and multivariate logistic regression to identify dominant risk factors (Sugiyono, 2020; Ghozali, 2021; Notoatmodjo, 2020). Model evaluation included Hosmer–Lemeshow goodness of fit, -2LogL difference test, Nagelkerke R Square, and Wald test for hypothesis evaluation at α=0.05 (Ghozali, 2021). The multivariate analysis aimed to identify the main determinant of leptospirosis incidence in Semarang City in 2024.

RESULTS AND DISCUSSION

Univariate Analysis

Univariate analysis is an analysis that aims to explain or describe the characteristics of each research variable. Univariate analysis is presented in the form of a frequency distribution table consisting of respondent demographics, gender, age, and education level. Furthermore, the presence of rats, livestock, garbage, and leptospirosis cases. Based on the data processing results, the following univariate analysis results were obtained:

Table 1. Univariate Analysis (n=96)

Variable	Frequency (f)	Percentage
Gender		
Male	31	32.3
Female	65	67.7
Age		
Adult (26-45 years old)	42	43.8
Elderly (46–65 years old)	54	56.3
Education Level		
Low	45	46.9
High	51	53.1
Presence of Rats		
None	14	14.6
Present	82	85.4
Livestock		
Cattle	47	49.0
Goats	49	51.0
Presence of Waste		

Variable	Frequency (f)	Percentage
None	49	51.0
Present	47	49.0
Leptospirosis Incidence		
No Experience (Control)	64	66.7
Experienced (Cases)	32	33.3

Source: Data Processing Results, 2025

The table above shows that of the 96 people based on gender, the majority were male, numbering 31 people (32.3%), and the rest, numbering 65 people (67.7%), were female. In terms of age, most are between 46 and 65 years old, which is classified as elderly, with 54 people (56.3%), while the remaining 42 people (43.8%) are between 26 and 45 years old and are classified as adults. In terms of education level, most of them, 51 people (53.1%), had higher education (high school graduates), while the remaining 45 people (46.9%) had low education (no schooling - junior high school graduates).

Furthermore, based on the presence of rats, 14 people (14.6%) stated that there were no rats around their homes, while the remaining 82 people (85.4%) stated that there were rats around their homes. Based on the presence of livestock, most respondents stated that there were goats, with 49 people (51.0%), while the smallest number stated that there were cows, with 47 people (49.0%). Based on the presence of garbage, the majority, 49 people (51.0%), stated that there was no garbage around their homes, while the smallest number, 47 people (49.0%), stated that there was garbage around their homes. Finally, based on the leptospirosis case group, 64 people (66.7%) were in the control group who did not experience leptospirosis, while the remaining 32 people (33.3%) were in the case group who experienced leptospirosis.

Bivariate Analysis

Bivariate analysis is an analysis conducted on two variables that are suspected to be related or correlated. Bivariate analysis uses chi-square analysis to determine the factors related to leptospirosis cases in Semarang City in 2024, which originate from socio-demographic factors, the presence of rats, the presence of livestock, and the presence of waste.

Relationship between Respondent Demographics and Leptospirosis Incidence

The following are the results of cross-tabulation and tests of the relationship between respondent demographics, consisting of gender, age, and education level, and the incidence of leptospirosis in Semarang City in 2024, which yielded the following results:

Table 2. Relationship between Respondent Demographics and Leptospirosis Incidence

Variable	Leptospirosis Incidence		P-value	OR	95% CI
	Cases	Control			
	f	F			
Gender			0.000	51.13	14.31-182.69
Male	26 (83.9)	5 (16.1)			
Women	6 (9.2)	59 (90.8)			
Total	32 (33.3)	64 (66.7)			
Age			0.393	1.462	0.622-3.433
Adult	16 (38.1)	26 (61.9)			

Variable	Leptospirosis Incidence		P-value	OR	95% CI
	Cases	Control			
	f	F			
Elderly	16	38			
	(29.6)	(70.4)			
Total	32	64			
	(33.3)	(66.7)			
Education			0.516	0.684	0.290-1.615
Low	13	32			
	(13.5)	(33.3)			
High	19	32			
	(19.8)	(33.3)			
Total	32	64			
	(33.3)	(66.7)			

Source: Data Processing Results, 2025

In the table above, the tabulation between gender and leptospirosis cases shows that of the 96 people, the majority were female (65 people), consisting of 6 people (6.3%) who were cases of leptospirosis and 59 people (61.5%) who were controls who did not have leptospirosis. The statistical test results obtained a p-value of 0.000* (0.000<0.05) for the Fisher exact test, with an OR value of 51.13 and a CI between (14.312-182.687), which indicates a significant relationship between gender and the incidence of leptospirosis in Semarang City in 2024 . The OR result of 51.13 indicates that males **are 51 times more likely** to **experience leptospirosis** than females .

For the tabulation between age and leptospirosis cases, it can be seen that out of 96 people, most were elderly aged 46- >65 years old (elderly) (54 people), of whom 16 people (16.7%) were cases who experienced leptospirosis and 38 people (39.6%) were controls who did not experience leptospirosis. The statistical test results yielded a p-value of 0.393 (0.393 > 0.05) for the Fisher exact test, with an OR value of 1.462 and a CI range of (0.622–3.433), indicating no significant association between age and leptospirosis incidence in Semarang City in 2024 .

For the tabulation between educational level and leptospirosis incidence, it can be seen that out of 96 people, most had a high educational level (high school-university) level, consisting of 19 people (19.8%) who were cases experiencing leptospirosis and 32 people (33.3%) who were controls who did not experience leptospirosis. The statistical test results obtained a p-value from the Fisher exact test of 0.516* (0.516>0.05), with an OR value of 0.684 and CI between (0.290 – 1.615), indicating no significant relationship between education level and leptospirosis cases in Semarang City in 2024.

Relationship between the Presence of Rats and the Occurrence of Leptospirosis

The following are the results of the cross-tabulation and the test of the relationship between the presence of rats and the incidence of leptospirosis in Semarang City in 2024, which yielded the following results:

Table 3. Relationship between the Presence of Rats and the Occurrence of Leptospirosis

Rat Presence	Leptospirosis Incidence		P-value	OR	95% CI
	Cases	Control			
	f	F			
None	11	3	0.000	0.094	0.024-
	(11.5)	(3.1)			0.369
Yes	21	61			
	(21.9)	(63.5)			
Total	32	64			
	(33.3)	(66.7)			

Source: Data Processing Results, 2025

In the table above, the tabulation between the presence of rats and the incidence of leptospirosis shows that out of 96 people, most of them (82 people) had rats around them, consisting of 21 people (21.9%) who were cases of leptospirosis and 61 people (63.5%) who were controls who did not experience leptospirosis. The statistical test results obtained a p-value of 0.000* (0.000<0.05) for the Fisher exact test, with an OR value of 0.094 and a CI between (0.024-0.369), indicating a significant relationship between the presence of rats and the incidence of leptospirosis in Semarang City in 2024. The OR result of 0.094 indicates that individuals with rats around their homes are 0.094 times more likely to experience leptospirosis than individuals without rats around their homes.

Relationship between the Presence of Livestock and the Incidence of Leptospirosis

The following are the results of the cross-tabulation and correlation test between the presence of livestock and leptospirosis cases in Semarang City in 2024, which yielded the following results:

Table 4. Relationship between the Presence of Livestock and Leptospirosis Incidence

Livestock	Leptospirosis Incidence		P-value	OR	95% CI
	Cases	Control			
	f	F			
Cattle	23	24	0.002	4.26	1.694-
	(24.0)	(25.0)			10.69
Goat	9	40			
	(9.4)	(41.7)			
Total	32	64			
	(33.3)	(66.7)			

Source: Data Processing Results, 2025

In the table above, the tabulation between the presence of livestock and the incidence of leptospirosis shows that of the 96 people, most had goats as livestock (49 people), consisting of 9 people (9.4%) who were cases experiencing leptospirosis and 40 people (41.7%) who were controls who did not experience leptospirosis. The statistical test results obtained a p-value of 0.002* (0.002<0.05) for the Fisher's exact test, with an OR value of 4.26 and a CI between (1.69-10.69), indicating a significant relationship between the presence of livestock and the incidence of leptospirosis in Semarang City in 2024. The OR value of 4.26 indicates that individuals who own cattle have a 4**.26 times greater** risk of contracting leptospirosis compared to individuals who own goats.

Relationship between the Presence of Waste and the Incidence of Leptospirosis

The following are the results of the cross-tabulation and correlation test between the presence of waste and the incidence of leptospirosis in Semarang City in 2024, which yielded the following results:

Table 5. Relationship between the Presence of Waste and the Occurrence of Leptospirosis

Waste Presence	Leptospirosis Incidence		P-value	OR	95% CI
	Cases	Control			
	f	F			
Present	27 (28.1)	20 (20.8)	0.000	11.88	3,991–35,364
None	5 (5.2)	44 (45.8)			
Total	32 (33.3)	64 (66.7)			

Source: Data Processing Results, 2025

In the table above, the tabulation between the presence of garbage and the incidence of leptospirosis shows that out of 96 people, most of them had garbage in their homes, namely 47 people, consisting of 27 people (28.1%) who were cases experiencing leptospirosis and 20 people (20.8%) who were controls who did not experience leptospirosis ( ). The statistical test results obtained a p-value of 0.000* (0.000<0.05) for the Fisher's exact test, with an OR value of 11.880 and a CI between (3.991-35.364), indicating a significant relationship between the presence of garbage and the incidence of leptospirosis in Semarang City in 2024. The OR result of 11.880 indicates that individuals whose **homes are surrounded by waste** have **an 11.88 times greater** risk of contracting leptospirosis compared to individuals whose **homes are not surrounded by waste.**

Multivariate Analysis

Multivariate analysis is a statistical method that allows for the simultaneous analysis of more than one independent variable against a dependent variable. Multivariate analysis uses logistic regression analysis. This multivariate analysis aims to test the most dominant factors that could cause leptospirosis in Semarang City in 2024. The initial stage involves selecting bivariate results by entering the main independent variables and all characteristic variables into an analysis with a significance value of <0.25.

Table 6. Bivariate Selection

Variable	Sig.	OR	Description
Gender	0.000	0.020	Multivariate Candidate
Age	**0.393**	**1.462**	Non-Candidate
Level of Education	**0.513**	**0.684**	Not a Candidate
Presence of Rats	0.000	0.094	Multivariate Candidate
Presence of Livestock	0.002	4.26	Multivariate Candidate
Presence of Waste	0.000	11.88	Multivariate Candidate

Source: Data Processing Results, 2025

Based on the bivariate selection results in the table above, the candidates for multivariate testing are gender, presence of rats, presence of livestock, and presence of waste.

Table 7. Multivariate Estimation Results Stage 1

Variable	Sig.	OR	95% CI
Gender	0.000	232,948	15,644–3,468,832
Presence of Rats	**0.475**	**0.427**	**0.41–4,400**
Livestock Presence	0.005	50.12	3,306-759,793
Presence of Waste	0.002	46,881	4,197–523,632

Source: Data Processing Results, 2025

Based on the table above, which shows the results of the first stage of multivariate estimation, there are variables that have a significance value (<0.25), namely gender, the presence of livestock, and the presence of waste, while the variable of the presence of rats (0.475>0.25) needs to be excluded from the model.

Table 8. Multivariate Estimation Results Stage 2

Variable	Sig.	OR	95% CI
Gender	0.000	287.491	19,611-421,478
Livestock Presence	0.003	60,152	4,089–884,845
Waste Presence	0.002	52,681	4,794 – 578,888

Source: Data Processing Results, 2024

Based on the table above, the final stage 2 multivariate estimation results show that all variables, namely gender, livestock presence, and waste presence, have a significance value of <0.25.

Model Suitability (Hosmer and Lemeshow Test)

The initial stage tests data feasibility using the Hosmer and Lemeshow goodness of fit test. Testing conditions: If the Hosmer and Lemeshow goodness of fit test statistical value is > 0.05, then the null hypothesis cannot be rejected, meaning that the model is capable of predicting the observed values or, in other words, the model is acceptable because it fits the observed data.

Table 9. Hosmer and Lemeshow Test

Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
1	1.725	5	0.886

The results of the goodness-of-fit test using Hosmer and Lemeshow showed a significance (p-value) of 0.886 (0.886>0.05), so it can be stated that the null hypothesis cannot be rejected and means that the model is capable of predicting the observed values or can be said that the model is acceptable because it fits the observed data.

Overall Model Fit

Overall Model Fit is a test calculated from the difference in -2LL values between a model consisting only of constants and an estimated model consisting of constants and independent variables. The hypothesis for assessing the fit method is. The results of this test can be seen in the comparison table of the initial -2LL value with the final -2LL value, as follows:

Table 10. Overall Model Fit

Description	Value
-2Log *Likelihood* (block number = 0)	122.226
-2Log *Likelihood* (block number = 1)	35,502

Source: Data Processing Results, 2025

Based on the overall model fit results, there is a decrease in the initial and final -2 log likelihood values. This decrease in -2 log likelihood values indicates that adding independent variables to the model can improve the model fit and show a better regression model, or in other words, a model that fits the data.

Final Modeling Hypothesis Testing

Next, to determine the most dominant factor that could influence the occurrence of leptospirosis in the city of Semarang in 2024, a Wald test was conducted, yielding the following results:

Table 11. Final Modeling Hypothesis

Variable	Sig.	OR	95% CI
Gender	0.000	287.491	19,611-421,478
Livestock Presence	0.003	60,152	4,089–884,845
Waste Presence	0.002	52,681	4,794 – 578,888

Source: Data Processing Results, 2025

Based on the final modeling results, it was found that gender had a p-value of 0.000, an OR of 287.491, and a CI of 19.611-421.478. followed by the presence of livestock with a p-value of 0.003 and an OR of 60.152 and CI 4.089-884.845, and the presence of garbage with a p-value of 0.002, an OR of 52.681, and CI 4.794-578.888. The results indicate that the most dominant factor influencing leptospirosis incidence in Semarang City is gender.

Research Limitations

This research has several limitations. The variables analyzed were limited to sociodemographic characteristics (gender, age, and education), the presence of rats, livestock, and waste, while other important variables such as clean and healthy living behavior (PHBS), population density, personal protective equipment usage, and drainage conditions were not included, even though they may contribute to leptospirosis transmission. The number of samples used, consisting of 32 cases and 64 controls with a 1:2 ratio, was adjusted to the actual 2024 situation in Semarang City. Although this meets the minimum sample requirement, it may still influence sample representativeness and limit generalizability.

Bias may also have occurred due to the retrospective data collection method, including recall bias and social desirability bias, where responses may not accurately reflect actual environmental and behavioral conditions. Furthermore, the case-control design used in this study only allows for identifying associations, not causal relationships, and findings are context-specific to Semarang City in 2024, limiting applicability to other regions with different characteristics. The use of secondary data poses additional constraints since the accuracy and completeness of data depend on previous documentation quality, creating the possibility of

misclassification. Sample characteristics also do not fully represent the general population of Semarang City, particularly related to livestock ownership.

Relationship between Gender and Leptospirosis Incidence

The results of this study show a significant association between gender and the incidence of leptospirosis in Semarang City, where men are 51 times more likely to be infected than women (p=0.000; OR=51.13). These findings align with previous studies by Ariani & Wahyono (2020) and Delight et al. (2024), which explain that men are more frequently exposed to environments contaminated by Leptospira. Differences in roles and daily activities contribute to this risk, as men commonly engage in outdoor occupations such as construction, farming, and drainage cleaning, often in flood-prone and waste-filled areas, which increases exposure to contaminated water and soil. Behavioral factors also influence transmission risk, where women are generally more consistent in applying preventive measures such as personal hygiene and the use of protective equipment (Syahputra & Sari, 2022), while men tend to neglect these practices (Permana et al., 2021). Biological susceptibility also plays a role; men have weaker immune responses due to testosterone, whereas women benefit from the immunoprotective effects of estrogen (Klein & Flanagan, 2020).

These findings have significant implications for public health interventions. Gender-sensitive prevention strategies are needed, particularly for populations whose work increases contact with sources of infection. Strengthening education on the importance of personal protective equipment, improving environmental sanitation, rat control, and waste management are crucial interventions. Additionally, applying the One Health approach that integrates human, animal, and environmental health is considered effective in reducing leptospirosis transmission (WHO, 2022). Collaborative efforts across sectors and stronger support from local government are essential to protecting high-risk groups and reducing disease incidence.

Relationship between Age and Leptospirosis Incidence

The study results showed that most respondents were aged 26–45 years and did not experience leptospirosis. The Fisher's exact test produced a p-value of 0.393 ($p > 0.05$), indicating no significant relationship between age and leptospirosis incidence in Semarang City in 2024. This finding is consistent with previous studies reporting that age is not associated with leptospirosis cases (Sulistiyawatn & Siyam, 2020; Wirata & Saputro, 2021). Leptospirosis transmission is more related to exposure to contaminated water or soil with animal urine, especially rats, rather than age differences (Dhewantara et al., 2021). Behavioral, occupational, and environmental conditions are more influential than biological factors such as age (Fitriani et al., 2020; Mardiah et al., 2021; Mardiah, Wahyuni, & Nugraheni, 2021). Other studies similarly show that poor sanitation, occupational status, and low knowledge levels increase leptospirosis risk regardless of age (Tirtasari et al., 2021; Wahyuni et al., 2023). This explains why no significant difference in leptospirosis risk is observed across age groups with similar levels of exposure.

Relationship between Education Level and Leptospirosis Incidence

The results showed that most respondents had a high level of education and did not experience leptospirosis, with the Fisher's exact test showing a p-value of 0.128 ($p > 0.05$),

indicating no significant relationship between education level and leptospirosis incidence in Semarang City in 2024. This aligns with previous findings showing education level does not correlate with leptospirosis cases (Harisa, Cahyati & Budiono, 2023; Mlowe, 2023). Formal education does not always reflect specific knowledge about leptospirosis transmission and prevention, so infection risk remains if individuals are exposed to contaminated environments (Riyanto & Yuliani, 2021). Although higher education is generally associated with better PHBS practices, homogeneity in the respondents' education levels may limit statistical differences (Putri et al., 2022). Other factors including occupation, environmental exposure, and lifestyle have greater influence on infection risk (Setyowati & Hartono, 2020; Mlowe et al., 2023). In urban settings like Semarang, access to health information is relatively equal across education groups. Environmental conditions remain a more dominant factor than sociodemographics (Harisa, Cahyati, & Budiono, 2023), and preventive behavior is more influenced by direct experience and health information rather than education level itself (Fitriani et al., 2021).

Relationship between the Presence of Rats and the Occurrence of Leptospirosis

The results show that most rats were found in the control group and the Fisher exact test produced a p-value of 0.000 ($p < 0.05$) with an OR of 0.94 and CI (0.024–0.369), indicating a significant relationship between the presence of rats and leptospirosis incidence in Semarang City in 2024. Rats are the primary reservoir of Leptospira interrogans, and their presence in flood-prone and poorly sanitized environments in Semarang contributes to widespread environmental contamination, especially during rainy seasons (Sutiningsing et al., 2024). Poor waste management and drainage increase rat infestation and exposure risks in densely populated settlements (Rachmawati et al., 2023). Previous studies also reported significantly higher leptospirosis risk in areas with rats (Almatsier et al., 2023; Akbar & Widodo, 2022). Behavioral negligence such as lack of protective equipment during floods further supports exposure. Workplaces like markets and farms also pose high rat-related risks (Mlowe et al., 2023). Semarang's endemic conditions, seasonal flooding, and sanitation issues reinforce the environmental plausibility of this association. Prevention efforts require environmental hygiene improvement, public awareness, and integrated rat control programs (Kesetyaningsih et al., 2024).

Relationship between the Presence of Livestock and Leptospirosis Incidence

The results indicate that most respondents owned goats and were in the control group, while Fisher's exact test showed a p-value of 0.002 ($p < 0.05$) with an OR of 4.26 (CI: 1.69–10.69), confirming a significant association between livestock presence and leptospirosis incidence in Semarang City in 2024. Individuals owning cattle have a 4.26 times higher risk than those owning goats. These findings align with earlier studies showing livestock increases leptospirosis risk (Maulana et al., 2025; Ariani & Wahyono, 2024; Rochmadiyanto, 2020). Livestock such as cows, goats, and pigs can shed Leptospira through urine, contaminating soil and water, especially in areas with poor sanitation and frequent flooding (Andriani & Puspitasarim, 2021; Riani et al., 2021). Although good livestock management may reduce risk (Maulana et al., 2025; Ariani & Wahyono, 2024), improper waste disposal and environmental hygiene can worsen contamination.

Serological studies show livestock can act as reservoirs for Leptospira spp., supporting the role of animals in transmission (Chaudhry et al., 2022). Meta-analyses and One Health reviews also confirm human exposure correlates with livestock presence (Moseley et al., 2024). Risk varies based on barn sanitation and livestock handling practices (Rochmadiyanto, 2020; Putra & Handayani, 2020), with education and hygienic behavior playing a protective role (Kartika et al., 2022; Yuliani et al., 2021). Overall, livestock presence contributes to environmental infection risk, yet proper management and integrated control strategies can minimize transmission, consistent with the One Health approach (Susanti et al., 2024).

Relationship between the Presence of Waste and the Occurrence of Leptospirosis

The results show that most areas had no waste and were in the control group, while Fisher's exact test produced a p-value of 0.000 ($p < 0.05$), with an OR of 11.880 and CI (3.991–35.364), indicating a significant relationship between waste presence and leptospirosis incidence in Semarang City in 2024. Waste accumulation creates an ideal environment for Leptospira carriers such as rats, which are the primary reservoir of Leptospira interrogans (Costa et al., 2021). Poor waste management in densely populated areas leads to environmental contamination, supporting findings from previous studies (Fitriyah et al., 2021). Contaminated soil and water become major transmission media, especially during floods (Prabowo et al., 2022; WHO, 2021; CDC, 2022). Similar research in Indonesia shows that inadequate sanitation significantly increases leptospirosis cases (Astuti et al., 2023; Hadi et al., 2020; Hasibuan & Setyawan, 2023).

High rainfall and poor drainage conditions in Semarang further spread contaminated water into residential environments (Kusumawardhani et al., 2021). Within a One Health perspective, environmental factors such as waste must be addressed to prevent outbreaks (Mosquera-Suárez et al., 2022). Spatial analyses confirm cases cluster in areas with poor waste disposal and dense populations (Wahyuni et al., 2020), and nearby regions with flooding and accumulated waste also show higher prevalence (Rahmawati et al., 2023). These findings reinforce that waste serves as a major risk factor driving leptospirosis in urban flood-prone settings.

Dominant Factors Influencing Leptospirosis Incidence

The multivariate logistic regression results show that gender, the presence of rats, livestock, and waste are significant predictors of leptospirosis. In the final model, gender ($p = 0.000$; OR = 287.491), livestock presence ($p = 0.003$; OR = 60.152), and waste presence ($p = 0.001$; OR = 52.681) are dominant determinants. Waste is identified as the strongest factor influencing leptospirosis incidence in Semarang City.

Men show a significantly higher risk due to greater exposure to outdoor and high-risk occupations (Permana et al., 2021). Behavioral differences also contribute, with women having better PHBS compliance and hygiene practices (Syahputra & Sari, 2022). Biological differences reinforce this pattern, as women generally exhibit stronger immune responses, influenced by estrogen, while testosterone weakens immune activity in men, increasing susceptibility to infection (Klein & Flanagan, 2020).

These findings suggest that prevention strategies should target high-risk male populations and prioritize environmental interventions such as waste management and rat control.

Integrating human, animal, and environmental health through the One Health approach is essential for effective leptospirosis control (WHO, 2022).

CONCLUSION

The study of leptospirosis incidence in Semarang City in 2024 found that most respondents were female, aged 46–65, and had at least a senior high school education. Environmental exposure showed widespread presence of rats and varied livestock ownership, with goats being the most common. Living conditions often involve garbage accumulation, promoting disease spread. One-third of the 96 respondents were confirmed leptospirosis cases. Bivariate analysis indicated significant links between leptospirosis and gender, presence of rats, livestock, and garbage, while multivariate analysis identified gender—specifically being female—as the strongest risk factor (p=0.000; OR=287.491). These results highlight the combined impact of environmental hygiene, animal exposure, and demographic factors on transmission. Future research should explore gender-specific behavioral and social factors influencing leptospirosis risk to develop targeted prevention strategies.

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