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## **Effective Methods of Controlling Rats in Settlements In the Kagok Community Health Center Working Area**

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**Abstract .** Leptospirosis is a zoonotic disease that poses a serious public health challenge in densely populated urban areas. Semarang City, specifically the UPTD Puskesmas Kagok working area, recorded 10 cumulative cases with one mortality (Case Fatality Rate of 10%) in 2025. This fatality rate underscores the urgent need to re-evaluate the effectiveness of current residential rat control methods at the upstream level. Objective: This study aims to formulate effective, safe, and sustainable residential rat control methods through the integration of natural material innovations and the One Health approach. Methods: The research employed a literature review design, conducting a critical synthesis of 13 reputable scientific journal articles published between 2021 and 2025. The analysis focused on environmental dynamics, reservoir populations, community behavior, and vector control innovations. Results: Analysis reveals that rat density in urban Semarang (7.7% trap success) is strongly correlated with poor drainage systems and organic waste accumulation. A significant knowledge-practice gap was identified within the community, triggering a "risk normalization" phenomenon toward environmental hazards and delays in seeking medical assistance. Conventional chemical rodenticides were deemed high-risk for domestic health. As a solution, the "Brotokol" innovation (Brotowali and Jengkol extract) at a 75% concentration proved lethally effective against rats while remaining environmentally friendly. Conclusion: The most effective rat control method in the Puskesmas Kagok area is the integration of sanitation infrastructure improvements, the utilization of non-toxic biological control agents such as Brotokol, and the implementation of One Health-based surveillance involving cross-sectoral collaboration. This strategy is expected to sustainably suppress *Leptospira* transmission.

**Keywords:** Rat Control, Leptospirosis, Puskesmas Kagok, Brotokol, One Health.

## **INTRODUCTION**

Leptospirosis is a zoonotic disease that poses a threat to global public health, especially in tropical and subtropical regions with rapid urbanization. This disease is caused by infection with pathogenic bacteria of the genus *Leptospira* sp., which is transmitted directly or indirectly through contact with the urine of reservoir animals, with rats (rodents) being the main host in urban environments(1).

Globally, climate change and urban environmental degradation have created ideal microhabitats for the growth of rat populations, which in turn increases the risk of disease transmission to humans through contaminated environments(1). In Indonesia, the complexity of leptospirosis management requires a One Health approach that integrates human health, animal health, and environmental sanitation to reduce the fluctuating morbidity rate(2).

The city of Semarang consistently ranks as one of the areas with the highest prevalence of leptospirosis in Central Java. Its geographical characteristics, which include coastal areas with problems of waterlogging, tidal flooding, and poor drainage systems, are the main factors driving the sustainability of the life cycle of *Leptospira* sp. in residential environments(3). This critical condition is very evident in the working area of the Kagok Community Health Center. Based on Local Area Monitoring (PWS) data for 2025, there were 10 cumulative cases of leptospirosis in the area. Although all patients received optimal medical treatment (100%), there was one recorded death (CFR: 10%) in Candi Village. This death is an indicator that early detection and control of risk factors at the upstream level, namely rat population control, are still not effective.

The high density of rats in densely populated residential areas such as Candi Village and its surroundings is greatly influenced by the availability of food sources and nesting places. Recent studies show a linear correlation between poor household waste management and an increase in the distribution of zoonotic disease vectors in urban environments(1). In addition to waste piles, environmental infrastructure such as open sewers and the physical condition of buildings that are not rat-proof provide access for reservoirs to breed rapidly(2) This is exacerbated by the presence of ectoparasites on the bodies of rats found in various settlements and markets in the city of Semarang, which theoretically can increase the potential for double transmission of other zoonotic diseases(4).

Various control methods have been attempted, ranging from active surveillance using live traps to the use of local bait to calculate the rat density index in urban areas(5) However, the use of technology such as bacterial detection through PCR methods on rat samples in the field shows that the presence of pathogenic bacteria is much more widespread than reported cases in humans (6). Therefore, evaluating the effectiveness of various control methods, whether physical, chemical, or environmental management, is crucial.

This study aims to analyze and formulate the most effective methods of controlling rats in residential areas based on a review of the latest literature. The main focus of this study is to provide recommendations for practical, evidence-based control strategies to be implemented in the Kagok Community Health Center working area, particularly in affected areas such as Candi Village, in order to break the chain of leptospirosis transmission and prevent future deaths.

## **METHODS**

This study was conducted using a literature review method with a narrative approach aimed at synthesizing the latest findings on rat control strategies in urban environments(7). The article was prepared through several systematic stages, starting from problem identification, literature search, selection of references based on inclusion criteria, to drawing conclusions contextualized with the specific conditions in the working area of the Kagok Community Health Center Technical Implementation Unit.

The literature search was conducted between December 2025 and January 2026 by accessing various reputable scientific databases, including Google Scholar and PubMed. In addition, the AI-powered research tool SciSpace was used to sharpen the accuracy of the search for journals with strong thematic relevance. The search strategy used a combination of keywords, including: “rat control,”

“leptospirosis,” “Semarang City,” “urban rodent control,” “rodent reservoir,” and “environmental sanitation.”

Inclusion criteria established in the selection of original journal articles or review articles published within the last 5 years (2021–2025) to ensure the novelty (state of the art) of the data. The research focuses on rat vector control methods, rat density indices, or leptospirosis risk factors in densely populated and urban areas; as well as case studies that have similar characteristics to the city of Semarang. From the screening results, 13 main articles were selected and then analyzed in depth.

The data obtained from the literature was synthesized using a synthesis matrix technique to map the variables of control methods, effectiveness levels, and other key findings. In addition to relying on literature studies, this article also integrates secondary data in the form of the 2025 Local Area Monitoring (PWS) report from the Kagok Community Health Center (UPTD Puskesmas Kagok) to provide a realistic picture of the epidemiological situation in the field, particularly in Candi Village. The results of the synthesis between literature theory and real data were then used to formulate recommendations for control strategies that are applicable, effective, and sustainable for local health authorities.

## RESULT

Based on a systematic search, 13 scientific articles that met the inclusion criteria were selected. All of these articles were published within the last five years (2021–2026), providing an up-to-date overview of the effectiveness of various rat control methods in urban environments. A summary of the findings from these articles is presented in Table 1 below:

**Tabel 1. Literature Synthesis on Rat Control and Leptospirosis Risk (2021-2026)**

No	Author (Year)	Title	Focus/Control Method	Results
1	Zahro, <i>et al.</i> (2025)(1)	Correlation Between Waste Density and Vector Distribution as Reservoirs of Zoonotic Diseases in Urban Environments	Urban solid waste management.	The density of organic waste correlates positively with an increase in the environmental carrying capacity for reservoir populations.
2	Husni, <i>et al.</i> (2023)(3)	Environmental Factors Affecting the Presence of Rats and Identification of <i>Leptospira</i> sp. Bacteria in Settlements Around Semarang City Market	Microhabitat and sanitation analysis.	<i>Leptospira</i> sp. bacteria were identified in rat kidney samples in Semarang; open sewers were the most dominant environmental risk factor.
3	Zufri, <i>et al.</i> (2025)(6)	Status of rat density and detection of leptospira bacteria in the Tanjung Balai Karimun port area	Active PCR-based surveillance.	The PCR method successfully detected pathogens in reservoirs in areas with high mobility; detection effectiveness was higher than conventional methods.
4	Afianto, <i>et al.</i> (2021)(5)	Survey of rat density in Tandang Village, Tembalang District, Semarang City	Descriptive Survey (Trapping)	The Trap Success rate reached 7.7%; the dominant species were <i>Rattus norvegicus</i> (brown

No	Author (Year)	Title	Focus/Control Method	Results
5	Wijaya (2023)(8)	Prevalence of <i>Leptospira</i> Sp. in Rats and Chickens from Dense Settlements in South Denpasar	Cross-sectional & Lab Tests	rat) and <i>Rattus tanezumi</i> (house rat). The prevalence of <i>Leptospira</i> sp. was found in rats in densely populated settlements, indicating a high risk of transmission in environments with poor sanitation.
6	Rasyid, <i>et al.</i> (2025)(9)	Environmental and Behavioral Impacts on Leptospirosis Cases in the Lepo-lepo Community Health Center Area	Environmental Correlational Study	Behavioral factors (not wearing APD) and exposure to flood environments significantly increase the risk of leptospirosis infection.
7	Zeppelini, <i>et al.</i> (2021)(10)	Demographic drivers of Norway rat populations from urban slums in Brazil	Ecological Modeling	Modifying infrastructure (sealing building gaps) reduces the rate of rat re-infestation more permanently than the use of poison.
8	Putri & Saputra (2022)(11)	The Effectiveness of “Brotokol” as an Environmentally Friendly Rat Repellent	Experimental (Natural Ingredient “Brotokol”)	Brotowali and Jengkol extract (“Brotokol”) at a concentration of 75% effectively reduced rat activity ( $S_p = 0.001$ ) to the point of lethality/death without resistance effects <sup>1</sup> .
9	Akbar, <i>et al.</i> (2024)(12)	Evaluation of Rat Density and the Associated Factors in Leptospirosis Endemic Areas: The First Report on the Use of Bi-Index	Density Evaluation (Bi-Index)	The use of the Bi-Index method proves that rat density inside homes is significantly influenced by access to food and outdoor sanitation conditions.
10	Lestari, <i>et al.</i> (2025)(13)	Temporal and Spatial Analysis of Weather Factors in Leptospirosis Cases in Semarang City	Spatial & Temporal Analysis (GIS); focus on weather effects (rainfall/humidity)	High rainfall and humidity > 70% are strongly correlated with the emergence of clusters of cases in residential areas with poor drainage.

No	Author (Year)	Title	Focus/Control Method	Results
11	Sandoval, <i>et al.</i> (2025)(14)	A One Health approach to the prevention, control, and management of leptospirosis: a scoping review	Scoping Review (One Health)	A synthesis of 344 studies confirms the importance of interdisciplinary collaboration at the human-animal-environment interface for leptospirosis management.
12	Stuart, <i>et al.</i> (2024)(15)	Alternative domestic rodent pest management approaches to address the hazardous use of metal phosphides in low- and middle-income countries	Domestic Strategy Review	Identify non-toxic methods (physical and environmental) to replace hazardous metal phosphides in order to prevent human poisoning.
13	Djafar & Manyullei (2025)(16)	Health Literacy Gaps in Leptospirosis Prevention: Evidence from an Analysis of KAPP in Limboto Lake	Reservoir Surveillance & Health Literacy	A Health Literacy Gap was found; even though people know that rats are reservoirs, low risk perception leads to reluctance to use PPE and maintain consistent sanitation.

Overall, the synthesis of the 13 literature sources above shows that leptospirosis control cannot be separated from interventions on environmental factors and rat reservoir density. These findings underscore a paradigm shift from the use of hazardous chemical rodenticides to safer, more natural, and integrated control methods within the One Health framework. The data from these literature sources will be used as the basis for analysis to examine specific problems occurring in the Kagok Community Health Center working area.

## DISCUSSION

The high number of leptospirosis cases found in the working area of the Kagok Community Health Center, which recorded a total of 10 cases with a fatality rate (Case Fatality Rate/CFR: 10%) in 2025, reflects systemic challenges in controlling zoonoses in urban areas. This phenomenon cannot be viewed as a single medical problem, but rather as the result of dynamic interactions between environmental degradation, uncontrolled reservoir populations, and barriers in human behavior.

**Environmental Dynamics and Reservoir Carrying Capacity** The working area of the Kagok Community Health Center, with its dense settlement and topography characteristic of Semarang City, has high ecological vulnerability. Based on the findings of Husni, et al(3) Poor sanitation infrastructure such as open sewers and accumulated waste are major predictors of the presence of *Leptospira* sp. bacteria in sewer rats (*Rattus norvegicus*). This condition is exacerbated by inadequate organic waste management, which significantly increases the carrying capacity of the environment for rat colonies(1).

Spatially and temporally, this risk is fluctuating but certain. Lestari et al emphasizing that high rainfall and humidity above 70% in the Semarang area create a transmission bridge that facilitates the transfer of bacteria from rat kidneys to puddles around residents' homes(13). Given that the trap success rate in Semarang reaches 7.7%, every puddle in residential areas has the potential to become a source of infection for residents who carry out activities without protection(5).

**Behavioral Dimension and Knowledge-Practice Gap** The emergence of fatalities in one of the hotspots, as occurred in Candi Village, is a stark warning of failure in the human interface dimension. This phenomenon indicates a wide knowledge-practice gap, where adequate public knowledge about leptospirosis is often not implemented in consistent protective behavior in the field(16).

There is a phenomenon of “risk normalization” in which people tend to become accustomed to the presence of rats and exposure to floodwater/standing water. The perception that skin contact with contaminated water is only dangerous if there are large wounds is a fatal mistake, given that bacteria have the ability to penetrate through mucous membranes and skin that has softened due to water maceration(9). The deaths of residents in Candi Village show that delays in seeking medical help are often caused by a lack of awareness of fever symptoms, which are considered normal, ultimately leading to serious complications.

**Transformation of Innovation Control “Brotokol” as a Socio-Technical Solution** In response to high vector density, biosafety aspects for residents must be prioritized(15). Stuart, et al. provide critical notes to avoid the use of hazardous chemical rodenticides in domestic areas due to the risk of secondary poisoning in humans(15). Therefore, the rat-proofing approach or physical modification of buildings needs to be supported by environmentally friendly control agents(10).

The natural ingredient innovation “Brotokol” (Brotowali and Jengkol extracts) researched by Putri & Saputra offers dual advantages. Technically, a 75% concentration has been proven effective in lethal reduction of rat activity(11). Sociologically, “Brotokol” functions as an instrument of behavioral intervention by involving the community in the creation of natural repellents based on local wisdom. Community health centers can change the role of citizens from mere “recipients of socialization” to “active subjects” in self-control.

**One Health Integration and Precision Surveillance** As a strategic step for the future, leptospirosis management in the Kagok region must adopt the One Health framework. The effectiveness of control depends on synchronization between human clinical interventions, animal health surveillance, and environmental quality restoration(14). Strengthening precision surveillance through molecular detection (PCR) in rats in vulnerable residential areas, such as in Candi Village, will enable community health centers to detect the bacteria early before it spreads to the human population.(6). The integration of surveillance data accuracy, natural ingredient innovation safety, and strengthening of collective community behavior are key to realizing a Puskesmas working area free from the threat of fatal leptospirosis.

## **CONCLUSION**

Based on the results of literature analysis and synthesis, it can be concluded that the high number of leptospirosis cases in the working area of the Kagok Community Health Center is a consequence of the interaction between degraded environmental factors and human behavior that is permissive towards risk. The existence of open drainage and the accumulation of organic waste are the main factors contributing to the increase in rat reservoir density. However, the mortality rates recorded in hotspots such as Candi Village provide strong evidence of a knowledge-practice gap, where normalization of the presence of vectors and delays in seeking medical help are the main determinants of death.

Future control strategies must shift from the use of hazardous chemical rodenticides to safer and more participatory approaches. The innovation of the natural ingredient “Brotokol” is not merely a technical solution to lethally reduce the rat population, but a sociological instrument to build community independence in the prevention of zoonoses. Ultimately, the implementation of a One Health framework that integrates the strengthening of precision surveillance (PCR), environmental management, and collective behavioral change is the only sustainable way to break the chain of transmission and prevent leptospirosis fatalities in the future.

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