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The Relationship Between Environmental Sanitation and Rat Density in Tanjung Uma Subdistrict, Working Area of Lubuk Baja Health Center, Batam City

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Abstract
Introduction: *Rats can have a significant negative impact on public health as they can act as reservoirs for various pathogens that cause diseases in humans. One of the diseases associated with the presence of rats is Leptospirosis.* ***Objective:*** *This study aims to determine the relationship between environmental sanitation and rat density in Tanjung Uma Subdistrict, Batam City.* ***Method:*** *This study used a quantitative method with a cross-sectional approach. The population in this study consisted of all residents of Tanjung Uma Subdistrict, Batam City, with a sample size of 98 respondents. Statistical analysis was conducted using the chi-square test, and the research instrument was a questionnaire.* ***Result and Discussion:*** *The results of the study showed no relationship between the presence of garbage bins and rat density (p-value = 0.361); there was a relationship between accumulated garbage and rat density (p-value = 0.015); there was no relationship between the existence of water channels and rat density (p-value = 0.109); there was a relationship between wastewater drainage and rat density (p-value = 0.034).* ***Conclusion:*** *It can be concluded that there is a significant relationship between accumulated garbage and rat density in Tanjung Uma Subdistrict, Batam City.*

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Introduction

Urban pests are animals that inhabit human settlements and their surroundings, posing both physical and psychological disturbances to residents. One of the most challenging urban pests to control is the rat. Rats are wild rodents (Rodentia) that live in close association with humans and are hosts to various parasitic organisms, including both endoparasites and ectoparasites (Pramestuti et al., 2014). Rats are considered pests because they disrupt human comfort and cause significant economic losses in agriculture, plantations, residential areas, and public health. In agriculture and plantations, rats are a major cause of crop failure. In residential areas, they damage building structures, electrical and telephone cables, plastic pipes, and various household appliances. Damaged electrical cables can lead to fire hazards, requiring high repair costs. (RAHMADAYANI, 2019).

High rat population density in an area poses significant public health risks, as rats serve as reservoirs for several pathogens. One of the major diseases transmitted through rat urine is leptospirosis (Nugroho, 2015a). In Indonesia, 153 species of rats belonging to the subfamily Murinae have been identified. Rats have long been recognized as reservoirs of infectious diseases, dating back to 1320 BC. Globally, 31 helminth, 28 viral, 26 bacterial, 14 protozoan, and 8 rickettsial pathogens are known to infect rats. Consequently, rats significantly affect human health, safety, welfare, and economic stability (Nuraini, 2018). Rats are known reservoirs of several zoonotic pathogens. Their urine and saliva can transmit leptospirosis, while fleas carried by rats are vectors of plague. Other diseases transmitted by rats include murine typhus, salmonellosis, rickettsialpox, rabies, and trichinosis. Diseases transmitted between animals and humans, known as zoonoses, can be fatal if not promptly treated (Adhi et al., 2018). Leptospirosis, yersiniosis, and salmonellosis are among the primary zoonotic diseases associated with rats, whereas other pathogens such as Giardia muris, Lymphocytic choriomeningitis virus, and Entamoeba histolytica are also transmitted to humans. Transmission occurs directly through rat bites or indirectly via saliva, urine, and feces, which may contain bacteria, viruses, rickettsia, protozoa, helminths, and fungi (Nugroho, 2015a).

Environmental sanitation is a crucial factor influencing rat populations. Maintaining proper sanitation is one of the primary preventive measures to interrupt the chain of disease transmission by controlling various risk factors that serve as vectors or reservoirs of pathogens (Nugroho et al., 2019). Poor environmental conditions, such as inadequate drainage systems, accumulated waste, and open waste disposal sites, significantly contribute to rat infestations. Areas with poor sanitation are more likely to harbor higher rat populations compared to cleaner environments (Sukismanto et al., 2017). Cluttered storage areas facilitate rat nesting, and their nocturnal and diurnal activity poses additional health risks (Zukhruf & Sukendra, 2020)

The World Health Organization (WHO) has identified rodent-borne diseases, particularly leptospirosis, as a global public health issue, especially in tropical and subtropical regions with high rainfall. The International Leptospirosis Society (ILS) reported that South and Southeast Asia, the Western Pacific, Central and South America, and Africa have the highest estimated leptospirosis burden (Fajriyah et al., 2017). The International Leptospirosis Society (ILS) reported that Indonesia, as a tropical country, has a relatively high incidence of leptospirosis, with mortality rates ranging from 2.5% to 16.45% and an average of 7.1%, ranking third highest in the world in terms of mortality. This is evident from the increasing trend of leptospirosis-related deaths between 2015 and 2018, with the highest number recorded in 2018, totaling 148 deaths (Aprilia Puji Lestari,

2014). Poor environmental conditions provide a favorable habitat for the survival and proliferation of pathogenic bacteria, making such environments suitable for the growth of Leptospira spp. Leptospirosis has been a long-standing but neglected public health issue in Indonesia, and therefore represents a serious health concern (Agustin, 2019). The incidence of leptospirosis in Indonesia is considerably high, with a mortality rate ranking third globally (16.7%), following Uruguay (100%) and India (21%) (Azmi, 2015).

According to the Indonesia Health Profile (2020), several provinces reported an increase in leptospirosis cases compared to 2019. In Jakarta, cases rose from 37 in 2019 to 209 in 2020, while East Java experienced an increase from 147 to 272 cases during the same period. Central Java reported the highest number of cases, whereas Banten showed a significant decrease (from 52 to 8 cases), Maluku reported no cases (down from 2 cases), and South Sulawesi recorded a stable incidence with only 1 case in 2019 (Kemenkes, 2020). The number of leptospirosis cases tends to rise during the rainy season and may reach epidemic proportions during flooding events associated with extreme weather patterns. Floodwaters facilitate the spread of Leptospira, enabling human infection through contact with contaminated water, soil (mud), or vegetation tainted by the urine of infected animals. The difficulty in diagnosing leptospirosis contributes to its underreporting, classifying it as a Neglected Tropical Disease (NTD) (Haryono et al., 2020).

A study by Manyullei et al. (2024) in flood-prone areas of Jakarta identified several Leptospira serovars, including those detected in Kedoya Selatan, Tegal Alur, and Cipete Utara, confirming the potential risk of leptospirosis in these regions (Manyullei et al., 2024). Furthermore, a study by Ardanto et al. (2021) on endemic rats in South Jakarta found that out of 120 rats captured, several species tested positive for Leptospira sp., including Rattus marmosurus, R. hoffmanni, Bunomys chrysocomus, B. andrewsi, and B. coelestis, with these rats predominantly inhabiting waste accumulation sites. The presence of Leptospira was confirmed using both Microscopic Agglutination Test (MAT) and Polymerase Chain Reaction (PCR) (Wijaya et al., 2023). Rat population density plays a significant role in accelerating Leptospira transmission. A survey conducted by Candra (2020) in Tandang Village, Tembalang District, Semarang City, reported a rat density exceeding acceptable limits, reaching 28.1% based on the success trap method(Candra, 2020); (Afianto dkk., 2021). According to the Indonesian Ministry of Health Regulation No. 2 of 2023, when rat density exceeds the established environmental health standard of <1%, immediate control measures are required to limit disease transmission (Permenkes, 2017).

Batam City, a tropical area with an average temperature ranging between 24–35°C (77–95°F) and humidity levels between 73–96%, receives an annual rainfall of approximately 2,600 mm, increasing the risk of flooding. The Riau Islands Health Department (2023) reported 33 leptospirosis cases, distributed across Tanjungpinang (12 cases), Karimun (7 cases), and Batam City (10 cases). In Batam, cases were concentrated in Baloi Permai Health Center (1 case), Sei Pancur (2 cases), Lubuk Baja (5 cases), and Sei Panas (2 cases) (Dinkes, n.d.). Amid Batam's rapid urban development, Tanjung Uma, a coastal slum area, has become a major waste accumulation site for decades. Waste originates from both urban centers (shopping districts) and tidal marine debris, accumulating beneath stilt houses and eventually shifting the coastline by approximately 15 meters, now covered by waste deposits. The once-clear coastal waters have turned black and polluted, damaging local marine ecosystems. The strong stench permeates the floating village of Agas, Tanjung Uma, Lubuk Baja District, Batam City, Riau Islands

Province. On land, Tanjung Uma also hosts multiple Temporary Waste Disposal Sites (TPSS) located dangerously close to residential homes. Dry and wet waste accumulates for extended periods, attracting flies and rats. A preliminary survey conducted on March 14, 2024, recorded seven TPSS locations along the roadside, with waste collection delays exceeding three days, as confirmed by local residents.

Method

This study employed a comparative observational field study using a quantitative cross-sectional approach. The study population consisted of 130 households residing in Tanjung Uma Village, while the sample comprised 98 households. The research was conducted in Tanjung Uma Village, Lubuk Baja Public Health Center working area, Batam City, with the study location selected based on the latest 2024 report from the Batam City Health Office. The independent variables in this study were: Condition of Temporary Waste Disposal Sites (TPSS), Accumulated Waste Condition, Presence of Drainage Channels, Wastewater Disposal System (Saluran Pembuangan Air Limbah, SPAL), The dependent variable was rat population density. Univariate and bivariate analyses were used to describe the environmental sanitation conditions and rat density. The results were presented in the form of frequency distribution tables for each variable.

Research and Discussions

1. Result

Overview of the Condition of Waste Bin in Tanjung Uma Village, Batam City

Table 1
Waste Bin

Waste Bin Conditions	Frequency	Percent
Good ≥ 75%	46	46.9
Poor < 75%	52	53.1
Total	**98**	**100.0**

Source: Primary Data 2024

Based on table 1 above, it can be seen that of the 98 respondents who were distributed by the Questionnaire who stated that they had the condition of the waste collection with the Good category as many as 46 respondents with a percentage (46.9%), while those who stated the condition of the waste collection with the bad category as many as 52 respondents with a percentage (531%).

Overview of the Condition of Waste That Accumulates in Tanjung Uma Village, Batam City

Table 2
The Condition of Accumulated Waste

The Condition of Accumulated Waste	Frequency	Percent
Good ≥ 75%	41	41.8
Poor < 75%	57	58.2
Total	**98**	**100.0**

Based on table 2 above, it can be seen that of the 98 respondents distributed by the Questionnaire who stated the condition of waste that accumulated with the Good category as many as 41 respondents with a percentage (41.8%), while those who stated the

condition of waste that accumulated with the bad category as many as 57 respondents with a percentage (58.2%).

Overview of the Existence of Waterways in Tanjung Uma Village, Batam City

Table 3
Drainage system

Drainage system	Frequency	Percent
Good ≥ 75%	71	72.4
Poor < 75%	27	27.6
Total	98	100.0

Based on Table 3, it can be seen that out of 98 respondents who completed the questionnaire, 71 respondents (72.4%) reported having good drainage system conditions, while 27 respondents (27.6%) reported poor drainage system conditions.

Description of Wastewater Disposal System (SPAL) in Tanjung Uma Village, Batam City

Table 4
Description of Wastewater Disposal System (SPAL)

Wastewater Disposal System (SPAL)	Frequency (n)	Percentage
Good (≥ 75%)	67	68.4
Poor (< 75%)	31	31.6
Total	**98**	**100.0**

Based on Table 4, out of 98 respondents who completed the questionnaire, 67 respondents (68.4%) reported having a properly maintained SPAL, while 31 respondents (31.6%) reported poor SPAL conditions.

Description of Rat Density in Tanjung Uma Village, Batam City, 2024

Tabel 5
Rat Density

Rat Density	Frequency	Percent
Acceptable (< 1%)	30	30.6
Unacceptable (> 1%)	68	69.4
Total	**98**	**100.0**

Based on Table 5, out of 98 traps installed, 30 traps (30.6%) showed acceptable rat density, while 68 traps (69.4%) indicated unacceptable rat density.

Association Between Environmental Sanitation Variables and Rat Density

Table 6
Association Between Waste Bin Conditions and Rat Density

Waste Bin	Rat Density				Total		*p-value*
	Acceptable		Unacceptable				
	n	%	n	%	N	%	
Good	12	26.1	34	73.9	46	100	0.361
Poor	18	34.6	34	65.4	52	100	
Total	**30**	**30.6**	**68**	**69.9**	**98**	**100**	

Based on Table 6, the analysis of the association between waste bin conditions and rat density in Tanjung Uma Village, Batam City, 2024, showed that among 98 respondents (100%), those with good waste bin conditions and acceptable rat density totaled 12 respondents (26.1%), while 34 respondents (73.9%) reported unacceptable rat density. Conversely, respondents with poor waste bin conditions and acceptable rat density totaled 18 respondents (34.6%), while 34 respondents (65.4%) reported unacceptable rat density.

The statistical analysis produced a p-value of 0.361 ($p > 0.05$), thus Ho was accepted, indicating no significant association between waste bin conditions and rat density in Tanjung Uma Village, Batam City, 2024.

Association between accumulated waste conditions and rat density in Tanjung Uma Village, Batam City, 2024

Tabel 7
Association Between Accumulated Waste Conditions and Rat Density

Accumulated Waste Condition	Rat Density				Total		*p-value*
	Acceptable		Unacceptable				
	n	%	n	%	N	%	
Good	18	43.9	23	56.1	41	100	0.015
Poor	12	21.1	45	78.9	57	100	
Total	**30**	**30.6**	**68**	**69.4**	**98**	**100**	

Based on Table 7, the analysis of the association between accumulated waste conditions and rat density in Tanjung Uma Village, Batam City, 2024, showed that among 98 respondents (100%), those with good waste management (non-accumulated waste) and acceptable rat density totaled 18 respondents (43.9%), while 23 respondents (56.1%) reported unacceptable rat density. Conversely, respondents with poor waste conditions (accumulated waste) and acceptable rat density totaled 12 respondents (21.1%), while 45 respondents (78.9%) reported unacceptable rat density.

The statistical test yielded a p-value of 0.015 ($p < 0.05$), thus Ho was rejected, indicating a significant association between accumulated waste conditions and rat density in Tanjung Uma Village, Batam City, 2024.

Association Between Drainage System Conditions and Rat Density in Tanjung Uma Village, Batam City, 2024

Table 8
Association Between Drainage System Conditions and Rat Density

Drainage System	Rat Density				Total		*p-value*
	Acceptable		Unacceptable				
	n	%	n	%	N	%	
Good	25	35.2	46	64.8	71	100	0.109
Poor	5	18.5	22	81.5	27	100	
Total	**30**	**30.6**	**68**	**69.4**	**98**	**100**	

Based on Table 8, the analysis of the association between drainage system conditions and rat density in Tanjung Uma Village, Batam City, 2024, showed that among 98 respondents (100%), those with good drainage systems and acceptable rat density totaled 46 respondents (64.8%), while 25 respondents (32.2%) reported unacceptable rat density. Conversely, respondents with poor drainage systems and acceptable rat density totaled 5 respondents (18.5%), whereas 22 respondents (81.5%) reported unacceptable rat density. The statistical analysis yielded a p-value of 0.109 ($p > 0.05$), thus Ho was accepted, indicating no significant association between drainage system conditions and rat density in Tanjung Uma Village, Batam City, 2024.

Association Between Wastewater Disposal System (SPAL) and Rat Density in Tanjung Uma Village, Batam City, 2024

Table 9
Association Between Wastewater Disposal System (SPAL) and Rat Density

Wastewater Disposal System	Rat Density				Total		P *value*
	Acceptable		Unacceptable				
	n	%	n	%	N	%	
Good	25	37.3	42	62.7	67	100	0.034
Poor	5	16.1	26	83.9	31	100	
Total	**30**	**30.6**	**68**	**69.4**	**98**	**100**	

Based on Table 9, the analysis of the association between the wastewater disposal system (SPAL) and rat density in Tanjung Uma Village, Batam City, 2024, showed that among 98 respondents (100%), 25 respondents (35.2%) with properly maintained SPAL reported acceptable rat density, while 46 respondents (64.8%) reported unacceptable rat density. In contrast, among respondents with poor SPAL conditions, only 5 respondents (18.5%) had acceptable rat density, while 22 respondents (81.5%) reported unacceptable rat density. The statistical analysis yielded a p-value of 0.034 ($p < 0.05$); thus, Ho was rejected, indicating a significant association between SPAL conditions and rat density in Tanjung Uma Village, Batam City, 2024.

2. Discussion

Association Between Waste Bin Conditions and Rat Density in Tanjung Uma Village, Batam City

Based on the analysis of the relationship between waste bin conditions and rat density in Tanjung Uma Village, Batam City, 2024, out of 98 respondents (100%), those who reported good waste bin conditions and had rat density within acceptable limits totaled 12 respondents (26.1%), while 34 respondents (73.9%) reported rat density

exceeding acceptable limits. Conversely, among respondents with poor waste bin conditions, 18 respondents (34.6%) had acceptable rat density, while 34 respondents (65.4%) had unacceptable rat density.

The statistical test yielded a p-value = 0.361 ($p<0.05$), thus Ho was accepted, indicating no significant association between waste bin conditions and rat density in Tanjung Uma Village, Batam City, in 2024. These findings are consistent with a study by Mely Fitry & Yulis Marita (2023), which reported no significant association between waste bin conditions and rat density in Pamekasan Regency (p-value = 0.467) (Mely Fitry & Yulis Marita, 2023). However, the findings contradict those of Husni et al. (2023), who found a significant association between waste bin conditions and rat density in residential areas surrounding a market in Semarang City. Similarly, they are inconsistent with Rika (2015), who reported no association between waste bin conditions and rat density in Boyolali Regency (p-value = 0.771) (Husni et al., 2023).

Rats tend to congregate in areas with easy access to food sources. Damaged or frequently open waste bins facilitate rat access to food, whereas properly managed and tightly closed waste bins reduce the attractiveness of the area to rats and limit their access (Humaidi, 2022). The researcher assumes that inadequate or poorly managed waste bins may increase rat density by providing food sources and shelter. Poor environmental sanitation or accumulated waste creates favorable conditions for rat nesting and foraging, consequently increasing rat population density in the area.

Association Between Accumulated Waste Conditions and Rat Density in Tanjung Uma Village, Batam City

The analysis of the relationship between accumulated waste conditions and rat density in Tanjung Uma Village, Batam City, 2024 revealed that among 98 respondents (100%), those reporting properly managed waste conditions with acceptable rat density totaled 18 respondents (43.9%), while 12 respondents (21.1%) reported unacceptable rat density. Conversely, among those reporting poorly managed waste conditions, 45 respondents (78.9%) had acceptable rat density, while 68 respondents (69.4%) reported unacceptable rat density. The statistical analysis yielded a p-value = 0.015 ($p < 0.05$), thus Ho was rejected, indicating a significant association between accumulated waste conditions and rat density in Tanjung Uma Village, Batam City, in 2024.

These findings are consistent with Prabandari et al. (2022), who reported a statistically significant association between accumulated waste and rat density in Ngemplak Simongan Village (p-value = 0.000), as well as with Nugroho (2015b), who reported a significant association in Usak Village residential areas (p-value = 0.021) (Prabandari et al., 2022); (Nugroho, 2015b). However, these findings contrast with Nur (2022), who found no significant association between accumulated waste and rat density in Anggrek Housing Area, Mas suduarjo (p-value = 1.000) (Nur, 2022).

Accumulated waste significantly impacts rat population density (Wahyuni & Sari, 2021). Food waste provides abundant food sources for rats, which prefer to hide and breed in areas with easy access to food. Thus, poorly managed waste disposal sites serve as ideal habitats for rats (Kasjono, 2019)

According to the Batam City Health Office (2020), waste disposal facilities must meet public health requirements to prevent vector-borne diseases, including being collected within 3 × 24 hours, properly sealed, and waterproof. The researcher assumes that poor waste management practices, such as failure to properly separate and dispose of

waste, contribute to increased rat populations. Areas with improper waste management tend to have higher rat population density.

Association Between the Presence of Drainage Channels and Rat Density in Tanjung Uma Village, Batam City

The analysis of the association between the presence of drainage channels and rat density in Tanjung Uma Village, Batam City, 2024 showed that among 98 respondents (100%), households with properly maintained drainage channels and acceptable rat density totaled 46 respondents (64.8%), while 25 respondents (32.2%) reported unacceptable rat density. In contrast, among respondents with poor drainage conditions, only 5 respondents (18.5%) had acceptable rat density, whereas 22 respondents (81.5%) reported unacceptable rat density.

The statistical analysis produced a p-value = 0.109 ($p < 0.05$); thus, Ho was rejected, indicating a significant association between the presence of drainage channels and rat density in Tanjung Uma Village, Batam City, in 2024.

These findings are consistent with Rahayu (2021), who reported no significant association between drainage channel conditions and rat density in Suduarjo Regency (p-value = 0.152) (Rahayu, 2021), as well as with Fatma (2021), who found no significant association in Gandus District, Palembang (p-value = 0.076).

Properly managed drainage systems can function as a suppressive factor for rat populations. A study found that 87% of households with poorly maintained drainage systems had higher rat capture rates (Husni et al., 2023). Poor drainage contributes to both environmental and public health problems. Therefore, drainage systems should be cleaned at least once every three months by flushing with hot water or using specialized cleaning tools. Additionally, food waste and foreign objects should not be discarded into drainage channels, and drainage covers should be installed to prevent rat access (Rusmini & Handayani, 2011). The researcher assumes that the lack of a significant association in this study may be due to well-maintained drainage channels, which are sealed and free of food waste, thus limiting rat access.

Association Between Wastewater Disposal System (SPAL) and Rat Density in Tanjung Uma Village, Batam City

The analysis of the association between Wastewater Disposal System (SPAL) conditions and rat density in Tanjung Uma Village, Batam City, 2024 showed that among 98 respondents (100%), those with properly managed SPAL and acceptable rat density totaled 25 respondents (35.2%), while 46 respondents (64.8%) reported unacceptable rat density. In contrast, among respondents with poorly maintained SPAL, only 5 respondents (18.5%) had acceptable rat density, whereas 22 respondents (81.5%) reported unacceptable rat density. The statistical test yielded a p-value = 0.109 ($p < 0.05$); thus, Ho was accepted, indicating no significant association between SPAL conditions and rat density in Tanjung Uma Village, Batam City, in 2024. Household wastewater disposal systems (SPAL) can potentially serve as rat nesting sites. Properly managed SPAL systems minimize rat presence, whereas poorly maintained SPALs often emit foul odors, disrupt environmental aesthetics, and provide ideal nesting sites for rats, increasing the potential for disease transmission (Safitri, n.d.).

The findings of this study are consistent with Hapsari (2022), who reported a p-value of 0.067, indicating no significant association between wastewater disposal systems (SPAL) and rat density in residential areas across three regencies in South Sumatra.

However, these results contradict the findings of Hadiguna (2021), who reported a p-value of 0.000, suggesting a significant association between SPAL conditions and rat density in Ogan Komering Ulu. The researcher assumes that the lack of a significant association in this study is due to the presence of well-maintained and sealed wastewater disposal systems in the study area, which likely restricted rat access and reduced potential nesting sites.

Conclusion

Based on data from 98 respondents in Tanjung Uma Village, Batam City, 2024, it was found that 53.1% reported poor conditions of temporary waste storage facilities, 58.2% reported poor conditions of accumulated waste, 27.6% reported inadequate drainage systems, and 31.6% reported substandard wastewater disposal systems. From the 98 traps installed, 69.4% indicated rat population density exceeding acceptable limits. Statistical analysis revealed a significant association between accumulated waste conditions and rat density (p-value = 0.015), while no significant associations were found between waste bin conditions (p = 0.361) or wastewater disposal systems (p = 0.034) and rat density. The drainage system variable yielded a p-value of 0.109, suggesting a weak association with rat density. These findings highlight that poorly managed waste accumulation is a key environmental factor contributing to increased rat populations in the area.

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