SPATIAL ANALYSIS AND RISK FACTORS OF LEPTOSPIROSIS IN INDONESIA. A SYSTEMATIC REVIEW

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ABSTRACT

Leptospirosis is a disease that often occurs in tropical climates caused by Leptospira sp. bacteria which is spread through urine or blood in infected animals. The purpose of this study was to provide some information on spatial analysis reviews and risk factors for leptospirosis that has been studied in Indonesia. This was a review study conducted by identifying, recording, and analyzing research that has been previously studied from 14 scientific articles related to the incidence of leptospirosis. Studies on leptospirosis are necessary to prevent morbidities and mortalities resulting from the disease. Studies on leptospirosis that had been carried out showed that the mapping was done by buffering and the pattern of the spread of the disease in Indonesia was uneven. The most influential risk factors in the spread of leptospirosis cases in Indonesia were the conditions of the ditches, the presence of rats, the presence of rice fields, the presence of a river, age, sex, occupation, landfill, standing water, and the presence of pets. These risk factors had a significant relationship to the incidence of leptospirosis.

INTRODUCTION

Leptospirosis is a disease that often occurs in tropical climates and is widespread throughout the world, including in Indonesia. The occurrence of this disease is becoming more common as a result of global warming. Parts of Southeast Asia are endemic areas for this disease[1]. Leptospirosis has been a neglected health problem for many years[2]. Mice were the first animals known to be carriers of leptospirosis and can infect leptospires throughout their lives without showing clinical symptoms as long-term carriers. They are considered to be the main cause of infection in humans[3].

Some of the causes of leptospirosis that occur in humans include drinking water contaminated with Leptospira bacteria, entering into the water, or having direct contact with contaminated soil when there are wounds, contamination of eyes, nose, and mouth with water or soil containing *Leptospira bacteria*, and consuming food and drink contaminated with leptospirosis bacteria. There are several risk factors that cause a person to be infected with leptospirosis, including living in a flood-prone area, having jobs related to water such as cleaning gutters, and rivers, mining workers and others, pets, military personnel, carrying out outdoor activities such as swimming. and camping in a lake or river.

Based on the 2020 Indonesia Health Profile, a total of 1170 cases occurred in Indonesia and 106 people were found dead with a CFR of 9.06 %. Based on the 2021 Indonesia Health Profile, the total cases of leptospirosis that occurred in Indonesia were 734 cases with 84 deaths with a CFR of 11.44%. [3] Based on data from the Ministry of Health in 2021, Central Java Province recorded 113 cases of leptospirosis and with 25 deaths and the Case Fatality Rate of leptospirosis cases in Central Java Province in 2021 was 22.12%[3].

Based on the results of another study conducted in Semarang, Indonesia, it was shown that as much as 91.8 % of the incidence of leptospirosis was spread in the area around the landfills with a distance of less than 500 meters. Leptospira bacteria enter the human body through broken skin or mucous membranes of the mouth, digestive tract, respiratory tract, and eye membranes. Leptospira bacteria follow the bloodstream to the body and attack important organs such as the liver, heart, kidneys and brain.

Another study conducted in Demak, Indonesia, stated that as many as 41.8 % of the homes of people with leptospirosis cases were in the flood zone which was a tidal flooding area of 6.3%[4]. In addition, based on the results of research in China, one of the risk factors for leptospirosis is population density[5]. Based on 14 articles, risk factors for leptospirosis were found to be sewer conditions, stagnant water, pets, landfill conditions, history of injuries, environmental conditions, use of PPE, hand washing behavior[4]. There has been an increase in cases of leptospirosis in Indonesia. For this reasson several researchers conducted a spatial analysis of the incidence of leptospirosis using a Geographic Information System (GIS).

This study analyzed several articles that discuss the spatial distribution of leptospirosis cases in Indonesia using GIS and the environmental risk factors spatially and spatial distribution of leptospirosis cases. The results of spatial data analysis can help provide guidance on the most relevant locations for implementing health interventions effectively[4].

This study aimed to provide information about the results of research that has been examined regarding spatial analysis and risk factors that influence the incidence of Leptospirosis based on the studies in Indonesia. The results of this research can be useful for the development of science, especially in the field of leptospirosis because there are not many articles discussing it and because leptospirosis is a disease that continues to exist and develops every year.

MATERIALS AND METHODS

This study used a systematic review method, to summarize the results of previous studies. The research was conducted in March-May 2022. Based on 296 relevant articles, 14 main articles met the criteria and discussed further in this article. The articles that had been obtained were collected, tabulated, compared, then summarized, and concluded. Sources of data were from national and international journals. The article selection method used the *Prism method,* Journal searches were carried out through databases, Pubmed, Scopus, ProQuest, Garuda Indonesia Portal, Google Scholar, E-journal and the official website. Henceforth, articles were identified, evaluated and synthesized on the results of research and the thoughts of researchers and practitioners on the work they have produced. We analyzed research journal articles and reviews for the last 5 years as well as theses and book on

leptospirosis for the last 10 years. The literature criteria in this study were related to the spatial analysis of leptospirosis, especially risk factors for leptospirosis in Indonesia.

This research was conducted through a systematic review of various articles. The articles were selected by the following steps: the title of the article was read at a glance and the abstract was reviewed to determine the suitability of the topic. Then the data obtained from the articles were thoroughly analyzed and then arranged systematically. The analysis of the article was presented in narrative form.
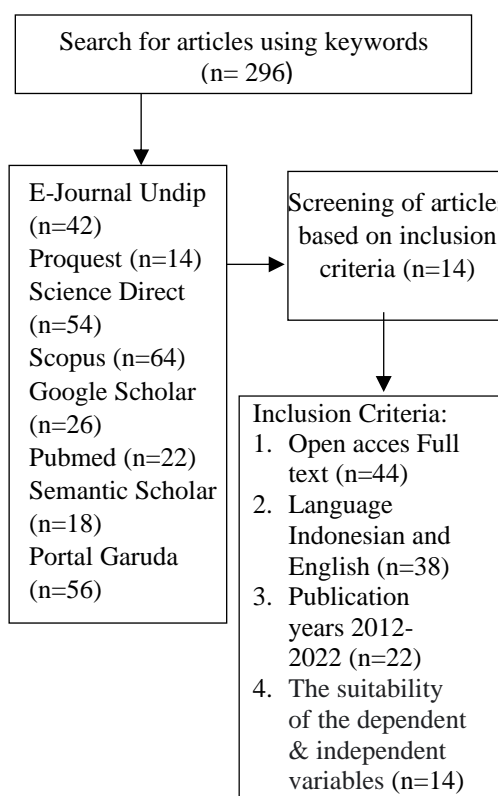
Search for articles using keywords (n= 296)

E-Journal Undip (n=42)
Proquest (n=14)
Science Direct (n=54)
Scopus (n=64)
Google Scholar (n=26)
Pubmed (n=22)
Semantic Scholar (n=18)
Portal Garuda (n=56)

Screening of articles based on inclusion criteria (n=14)

Inclusion Criteria:
1. Open acces Full text (n=44)
2. Language Indonesian and English (n=38)
3. Publication years 2012-2022 (n=22)
4. The suitability of the dependent & independent variables (n=14)

Figure 1. Flow chart of article selection

RESULTS

Table 1. Categories in the review literature based on previous research

No	Writer	Year Rise	Draft	Variable	Results
1	Aulia Fajriatun Niza, Budi Utomo, Hikmandari	2018	observational	The variables are the behavior of respondents who use footwear, ratproofing conditions, landfills, stacking of goods, wound care, and contact after working with standing water[7].	The results of the study using the chi-square statistical test showed that there was a variable relationship with the incidence of leptospirosis, namely contact with stagnant water with a p value of 0.03 and OR=10.
2	Silviana Nur Fajriyah	2015	Cross Sectionals	The variables studied included environmental conditions, presence of rats, waste disposal facilities, garbage disposal facilities, presence of risky pets, presence of rivers, history of flooding, history of tidal flooding, vegetation, history of contact with rats, and use of PPE[8].	The results of the study in Banyumas were distributed to 14 districts with 45% of cases in Cilongok. The results of the spatial analysis showed that 77.14% of the most affected were in residential areas. 70% of population density was moderate, 62.85% altitude, 63.57% low rainfall. P value=0.009 (primary cluster) in Cilongok and Ajibarang.
3	Isnaini Alfazcha Zukhruf, Dyah Mahendrasari Sukendra	2020	Cross Sectionals	The variables used are: Gender, history of work ups and downs, history of flooding, presence of saw, ditch conditions, and garbage disposal conditions[4].	The results showed that 54% of respondents were male, 46% of respondents had risky jobs, 61% of respondents whose residence had a history of flooding, 39% of respondents had a history of flooding, 39 of respondents lived at a distance of > 200 meters from the paddy fields, 54 % of respondents with bad gutters, 61% of respondents with poor landfill conditions The most common risk factors are history of flooding, ditch conditions and TPS. The

					distribution pattern of leptospirosis cases in Karang Tengah is a clustered pattern.
4	Lia Diah Kumalasari	2019	Cross Sectionals	Learned variables: 1. History of flooding/rob 2. Existence of the river 3. Individual container conditions 4. Existence of ponds 5. Population density	In Bonang District, the results of the study showed an uneven distribution of leptospirosis cases. The most influential risk factor was the presence of rice fields and a river near the case's house.
5	Asr Tunisia	2008	Case Control	The variables studied are: Body of water, air temperature, light intensity, rainfall index, water pH, correlated soil, presence of vegetation, rat catching success and prevalence of leptospirosis in rats correlated[9].	Spatial analysis showed that 52.94% of the incidence of leptospirosis occurred in locations that have potential abiotic and biotic environments. Furthermore, 47.06% of the incidence of leptospirosis in non-potential locations. It can be concluded that abiotic and biotic environmental risk factors play a role in the incidence of leptospirosis.
6	Monica Popi Rikananda	2017	Cross Sectionals	Learned variables: 1. Mouse presence, 2. Waste disposal 3. Existence of Garbage 4. Vegetation 5. There is a river with the incidence of leptospirosis.	Klaten District, the distribution pattern of leptospirosis is even. The percentage of respondents whose house has lots of rats is 95.4%. The percentage of respondents with poor waste disposal facilities is 64.1%. Respondents in areas with low vegetation density were 79.5%. The percentage of respondents who are within 200m of the paddy field is 61.1%.
7	Beby Prima Amaliya, Syamsuar, Erniwati Ibrahim	2018	Cross Sectionals	Variables: 1. Age 2. History of Floods 3. Kind of trash 4. presence of trash 5. Presence of mice[10].	The results of blood tests using the Rapid Diagnostic Test method showed that 100% of the respondents were negative for Leptospirosis. An overview of environmental factors in the study area shows that 100% of respondents experience flooding in their home environment every year, 30% have trash scattered around their house, 70.6% have gutters that don't flow smoothly, and 78.3% of respondents said there were rats. in or around his house.
8	Miftakhul Jannah, Dwi Sawarni Sri Rejeki, Sri Nurlaela.	2021	Cross Sectionals	Variables used: age, gender and occupation, land use, population density, altitude, rainfall, history of flooding, rivers and TPS[11].	The results of the leptospirosis study in Banyumas spread over 14 sub-districts where 45% of cases were in Cilongok, the results of spatial analysis were 77.14%, the most sufferers were in residential areas, 70% medium population density, 62.85% altitude, 63.57% rainfall low rain. Statistically, the P. value is 0.009 for the primary clusters located in Cilongok and Ajibarang.
9	Nanda Pratiwi	2012	Ecological Studies	The variables studied were: climate elements (rainfall, humidity, and temperature), population density and flood-prone areas[12].	The results showed that there was a significant relationship between rainfall with a p value=0.003, average humidity with a p value=0.001, and flood-prone areas with a p value=0.003 to the incidence of leptospirosis.
10	Ivan Tinarbudi Gavinov, Syaiful Huda	2019	Case control	Age, sex, pets, history of flooding, presence of rats, distance from the patient's house[13].	All independent variables showed a relationship with the dependent variable based on bivariate analysis, including: the presence of rats inside and outside the house with a value of p=0.002, the presence of pets p=0.012. 54.2%, with a radius of <700 m, the presence of rats inside and outside the house with a value of p=0.002.

11 [14]	Novie Ariani, Tri Yunis Miko Wahyono	2020	Cross-sectional	age , sex, presence of pets, presence of rats, contact with stagnant water, closed food storage areas[15].	Based on the results of the study, the factors that influenced the incidence of leptospirosis in 2017-2019 in 2 districts where sentinel leptospirosis surveillance was located in Banten Province were as follows: Gender POR 2.2 95% CI ,1.099-4.327, Age POR 0.13 95% CI=0.134-0.523, Closed food storage, POR 0.44 95% CI: 1.012-5.109, Age POR 0.13 95% CI: 0.134 - 0.523, Rats POR 4.08 95% CI: 1.738-9.566, Presence of pets, POR 2, 24 95% CI: 1.104-4.544 and contact with standing water POR 2.88 95% CI 1.418-5.827
12	Cornelia Palmasari Ariesta Putri, et al	2020	Case Control	Presence of trash, presence of pets, history of injuries and activities in the field[16].	The results showed that there was a significant relationship between the variables and the incidence of leptospirosis. These variables include the presence of garbage with a value of P=0.039 and OR=2.133 and the presence of pets with a value of P=0.011, OR=0.15.
13	Soawapak Hinjoy, et al	2019	Case control	Bathing in water, house near plantation [14]	Living near rubber plantations (OR 11.65, 95% CI 1.08-125.53) and bathing in natural water bodies (OR 10.45, 95% CI 1.17-93.35) were both significantly associated with an increased risk of leptospirosis
14.	Kanokwan Suwannarong, et al	2022	Cross-sectional	gender, age, occupation, knowledge, attitudes, and practices (KAP), including their cultural context, and beliefs [17]	results showed that males encountering rodents was statistically significant (adjusted OR=3.137, 95% CI 1.914–5.139, p<0.001). Low monthly household income (<THB 15,000 or <USD 450) was also statistically significant and negatively associated with exposure to rodents (adjusted OR=0.57, 95% CI 0.33–0.99, p=0.99). 0

DISCUSSION

Risk factors for Leptospirosis

Leptospirosis is a disease that often occurs in tropical climates and is widespread throughout the world, including Indonesia. The occurrence of this disease is becoming more common as a result of global warming. Parts of Southeast Asia are endemic areas for this disease.[1] Leptospirosis has been a neglected health problem for many years[2]. Mice were the first animals known to be carriers of leptospirosis and can infect leptospires throughout their lives without showing clinical symptoms, so that were called long-term carriers. They were considered to be the main cause of infection in humans[3].

Some of the causes of leptospirosis that occur in humans include drinking water contaminated with Leptospira bacteria, entering into water or or having direct contact with contaminated soil when there are wounds, contamination of eyes, nose, and mouth with water or soil containing *Leptospira bacteria*, and consuming food and drink contaminated with leptospirosis bacteria. There are several risk factors that cause a person to be infected with leptospirosis, including living in a flood-prone area, having jobs related to water such as cleaning gutters, rivers, mining workers and others, pets, military personnel, carrying out outdoor activities such as swimming. and camping in a lake or river.

Based on 14 articles, it was found that the risk factors for leptospirosis were sewer conditions, standing water, pets, landfill conditions, history of injuries, environmental conditions, use of PPE, hand washing behavior[4].

The limitation of this article was that it was difficult to obtain articles that matched the dependent and independent variables, because the topics discussed include rare diseases and not in all areas.

Age

Leptospirosis sufferers have different ages. Patients found in several areas on average are those of the age but still working[18]. Cases of leptospirosis in adolescents have been reported from several regions. In several areas, leptospirosis sufferers varied where they were found on average in productive age and the elderly. However, there are several areas where cases of leptospirosis have been reported in adolescents. Miftahul's research in 2021 shows that the majority of sufferers are >56 years old, 62.1% are men[11]. In children, cases of leptospirosis have not been diagnosed or have different clinical manifestations than adults, so it is rarely reported. In Ariani's study (2020) the number of respondents with Leptospirosis RDT + cases was 58.5%, more respondents were male, namely 59%, most respondents were in the age group >46 years, amounting to 57.1%[15]. In Kanokwan's 2020 study there were 113 respondents with gender 47 male and 66 female, aged between 20 and 45 years[17].

The similarity in Miftakhul and Novie's research (2020) was that the age of the respondents was above 45 years, while in the Kanokwan study the respondents were between 20-45 years old. From the 14 research articles, there were several differences in age which are known to be one of the risk factors that can affect the development of leptospirosis, so they have different increased risk values.

Gender

Leptospirosis can occur in both male and female gender. Leptospirosis can affect teenagers and young adults, about 50% of cases are generally between 10-39 years old and 80% men[9].

In Isnaini's research, 54% of the respondents were male. This indicated that men are more predisposed to get infected by leptospirosis than women[4]. Based on Miftakhul's research (2021), there were 62.1% male patients. This relates to the view that risky jobs for men are more affected by leptospirosis than women[11]. Some 14 research articles found that man have highest risk which to experience incident leptospirosis compared with woman.

Work

Leptospirosis is a disease that can be caused by work (*occupational disease*). Occupations that are at risk of being infected with leptospira bacteria directly or indirectly are farmers, military, ranchers, fishermen, plantation workers, mining workers, slaughterhouse workers, gutter cleaning workers, veterinarians, and meat observers or other jobs that are directly related to animals[19].

Based on Zukhruf's research in 2020, 46% of respondents had risky jobs, namely construction workers, farmers and fishermen who did not use personal protective equipment when respondents went to work[4]. From the results of the study, the distribution of leptospirosis in Banyumas shows that 40% of the respondents work as farmers[11].

Puddle

Leptospirosis disease has many possibilities of stagnant water during the rainy season and does not pay attention to the cleanliness of the environment inside and outside the home. This leptospirosis disease has a close relationship with environmental conditions that cause bacteria to multiply rapidly in poor

environmental conditions. In its development, mice are the main vector of leptospirosis. Leptospirosis infection contamination is very likely to occur when mice breed and live in these poor environmental conditions[15].

Niza's study (2018) using chi-square statistical test showed that there was a variable relationship with the incidence of leptospirosis, in which the contact variable with waterlogging has a 10 times greater risk than none[20]. However, this was Ariani's study (2020), in which she found that puddles are associated with the incidence of leptospirosis with a risk of 18 times greater than those who do not pass through puddles[15].

The presence of mice

Rat is one animal that serves as reservoirs for the bacteria *Leptospira*. Rats are mostly associated with the incidence of leptospirosis in Indonesia, reaching 50%. Types of rats that are often serves as reservoir for leptspirosis are brown rats (*Rattus norvegicus*), black rats (*Rattus diardii*), garden rats (*Rattus exulans),* and house rats (*Rattus exulans, Suncus murinus*). Research conducted in line with Ariani's research (2019) in Semarang in 2006 stated that people who saw rats around the house inside and outside had a 4.544 times greater risk of developing leptospirosis than people who did not see rats around the house outside or inside[15]. The presence of rats can be indicated by the presence of signs or characteristics. Based on Amaliyah's research (2018), the presence of rats experienced by most respondents was the presence of rat droppings, which was 68.3% and 66.7% of respondents who heard rat sounds[10].

Presence of pets

The greatest exposure to leptospirosis in some tropical countries, including developing countries, is caused by infection from farm animals, domestic animals and wild animals. Based on the results of Ivantinarbudi's research (2019), the presence of pets has a relationship with the incidence of leptospirosis (p=0.012)[13]. The results of Palmasari's research (2020) also showed that there was a significant relationship between pets and the incidence of leptospirosis with a p value=0.011, OR=0.15[16]. The results showed that there were 0.15 times more cases of leptospirosis in respondents who had pets compared to respondents whose homes did not had pets[14].

Conditions of waste disposal site

A garbage dump is a site where rats like to stay. The condition of the garbage dump in the house which is open and has no impermeable water will make it easy for rats to enter and ruffle the rubbish. Rats that have been infected with Leptospira bacteria can excrete infective urine for the rest of their lives. So it is very likely that there is trash around the house[21]. Based on Amaliya's research (2018), 30% of respondents have trash scattered around their house. Based on Defriyana's research (2017), the presence of garbage in the house increase the risk as many as 2.03 greater risk than those who do not have a landfill. The results showed that there was a significant relationship between the presence of garbage and the incidence of leptospirosis[22]. This study is not in line with a study in Semarang, where 91.8 % of cases were <500 meters from a landfill. The area adjacent to the landfill has a lot of garbage accumulation that makes it possible to become a rat habitat. The differences in this study were due to differences in research locations and the environment. Based on the results of what was done by the residents, a lot of garbage was piled up on vacant land around the house, such as in the

yard. The accumulation of garbage invites the existence of reservoirs such as rats so that there is a very high chance of contact with leptospirosis transmission[11].

Ditch conditions

Gutter is a site where rats like to live. The gutter will become a place of transmission of leptospirosis when it is contaminated by rat urine containing Leptospira bacteria[4].

Based on Zukhruf's and Sukendra 2020, it was found that 54% of respondents had bad gutter conditions[4]. According to Beby's research in 2018, as many as 51 residents had ditches in their yards and 9 other people did not have ditches, or 70.6% of respondents had ditches that did not flow smoothly[10]. Ditch conditions that are not smooth will be a place for rats to walk. So that it can increase contact with rat urine and faeces directly or indirectly. Based on the results of interviews with respondents, another factor is the condition of the gutter that is overflowing during rain. The overflow of water is caused by the drain which is made of concrete so it cannot absorb water. According to Priyanto, the bad condition of the gutters has led to leptospirosis in Demak, Indonesia[23].

CONCLUSION

Based on the results of the review and analysis of 14 research journal articles, the distribution of leptospirosis in Indonesia is uneven (in a random pattern). The risk factors that mostly influence the occurrence of leptospirosis include age, gender, occupation, the presence of rats, landfills, standing water, the presence of pets, and the condition of the sewers.

CONFLICT OF INTEREST

All Authors have no conflict of interest.

AUTHOR CONTRIBUTION

Martinis, Mursid Raharjo as a supervisor who guides, corrects data and directs in writing systematic review articles. Thank you to the reviewers of the Journal of Community Medicine and Public Health Research (JCMPHR).

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