

Jurnal Info Kesehatan

Vol. 21, No. 2, June 2023, pp. 316-324

P-ISSN 0216-504X, E-ISSN 2620-536X

DOI: [10.31965/infokes.Vol21Iss2.1225](https://doi.org/10.31965/infokes.Vol21Iss2.1225)Journal homepage: <http://jurnal.poltekkeskupang.ac.id/index.php/infokes>**RESEARCH****Open Access****Spatial Analysis of the Occurrence of Multi-Drug Resistance (MDR) Escherichia coli in Pet Dogs in Kupang City**Novalino H.G. Kallau^{1a*}, Maxs U.E. Sanam^{1b}, Tri Utami^{2c}, Yeremia Y. Sitompul^{2d}¹ Department of Animal Diseases and Public Health, Faculty of Medicine and Veterinary Medicine, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, Indonesia² Department of Clinical, Reproductive, Pathology and Nutrition, Faculty of Medicine and Veterinary Medicine, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, Indonesia^a Email address: novalino.kallau@staf.undana.ac.id^b Email address: sanam@yahoo.com^c Email address: utami.t@staf.undana.ac.id^d Email address: yeremia.sitompul@staf.undana.ac.id

Received: 14 June 2023

Revised: 28 June 2023

Accepted: 30 June 2023

Abstract

Antibiotic resistance is an important health problem and a threat to public health. Dogs as pets can be both spreaders and reservoirs of antibiotic-resistant bacteria. Based on spatial analysis, this study aims to determine the distribution pattern of multidrug resistance (MDR) Escherichia coli found in pet dogs in Kupang City. The spatial analysis method used is based on the convex hull technique, elementary analysis of disease, and the Nearest Neighbour Index (NNI). Information on antibiotic-resistant E. coli has been obtained from the laboratory analysis results and secondary data obtained for spatial analysis. The results of this study have shown that the distribution pattern of the incidence of MDR E. coli in the City of Kupang in 2020 is a clustered pattern with the Nearest Neighbor Index (NNI) value of 0.783 which is higher than the NNI AMR E. coli in the City of Kupang of 0.763. The incidence of MDR E. coli that has occurred in domesticated dogs takes place with a prevalence rate of 35% in an area of 5079 Ha. These results have shown that the incidence of MDR E. coli has spread to several areas in Kupang City and is a threat to public health. It requires appropriate prevention and control measures by implementing good hygiene and sanitation in the relationship between humans and their pets.

Keywords: Escherichia coli, Kupang City, MDR, Pet dog, Spatial Analysis.***Corresponding Author:**

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1. INTRODUCTION

Antibiotic resistance has become an important issue again at the beginning of the 21st century (O'Neill (2016) predicts the tendency of AMR to become a threat to world health in 2050. This condition is accelerated and expanded by the misuse and overuse of antibiotics (Gochez, 2019), (Awosile et al. 2018), (Patel et al. 2020). Another reason for the spread of resistant bacteria is the increasing interaction between humans and pets by not prioritizing hygiene and sanitation in the surrounding environment (Bouki et al. 2013). Pets such as dogs are known to have a close relationship with humans (Budinegara 2018) and tend to spread resistant bacteria to humans and others (Pomba et al. 2017). Increasing antibiotic resistance in society and the world of animal health is a very important public health problem at this time (Laxminarayan et al. 2013).

Many people keep pets as pets, one of the most common types is dogs besides cats.. Dogs have shown better interactions with humans when compared to other pets (Westgarth, et al. 2019). The social aspects of the community that support the existence of dogs in the environment encourage many people to keep dogs in their home environment. The number of dogs and the degree of closeness between dogs and humans is an aspect of health studies related to resistance that is important to know (Butaye et al. 2003). Several zoonotic health threats can arise from this interaction, if hygiene and sanitation are not considered in the maintenance of these animals. Diseases caused by parasites, bacteria and those caused by other microorganisms can be transferred from animals to humans (WHO 2014).

The more intensive maintenance of dogs as pets has resulted in more and more attention being paid to handling dog health, on the other hand, the use of antibiotics is increasingly being used in animals. This tendency is one of the factors for the emergence of resistant bacteria in dogs (Carvalho et al. 2016). The emergence of resistant bacteria in dogs is not only due to the use of antibiotics but can also occur due to contact with humans. The incidence of resistance can increase with the emergence of bacteria that are resistant to more than 3 classes of antibiotics which are often called Multidrug resistance (MDR) (Magiorakos et al. 2012), (Sweeney et al., 2018).

A spatial approach is used to improve the analysis of animal diseases further, this is done using Geographic Information System (GIS) software (Samkhan et al. 2013); (Davis et al. 2014). Monitoring through disease mapping can provide information about the incidence of disease in an area, especially the incidence of antibiotic resistance (Achmad, 2005) or environment-based (Nuckols et al., 2004), (Sunaryo, 2015). This research aims to determine the spread of MDR *E. coli* in pet dogs based on a spatial approach.

2. RESEARCH METHOD

The research was carried out using the cross-sectional study method which will be carried out in April-November 2020. Rectal swab sampling/dog feces samples have been carried out on pet dogs in the Kupang City community. Laboratory testing, namely the isolation and identification of antibiotic-resistant *E. coli* as well as antibiotic sensitivity tests were carried out at the Laboratory of Bacteriology and Veterinary Public Health, Faculty of Veterinary Medicine Universitas Nusa Cendana.

Sampling has been done by simple random sampling (simple random sampling). Data collection was carried out through direct observation of swab/dog feces samples obtained from dog-owning households in Kupang City. Swab/feces samples have been taken as much as one sample per farm household and come from sick or healthy dogs. The feces samples that have been obtained are then isolated and identified to determine the presence of *E. coli*. The *E. coli*

isolates obtained were then confirmed by biochemical tests (Kallau et al. 2020). Testing the sensitivity of *E. coli* to antibiotics using the Kirby-Bauer method (CLSI 2014).

After going through the data collection stage, the data that has been collected will be analyzed using a descriptive analysis model to link whether there is an incidence of antibiotic-resistant *E. coli* contamination in dogs in Kupang City. The data is presented in the form of tables and figures to describe the point of spread of antibiotic resistant *E. coli*, extent, and pattern of spread of *E. coli* resistance in pet dogs in Kupang City. Spatial data has been analyzed to determine the distribution (elementary analysis of disease), pattern of distribution (nearest index/NNI), and extent of distribution (convex hulls) of *E. coli* on pet dogs in Kupang City. Furthermore, the classification of the prevalence rate of *E. coli*, the assessment of the pattern of spread of resistance, and the assessment of the extent of the spread of *E. coli* have been carried out according to Kallau et al. (2019).

3. RESULTS AND DISCUSSION

This research was conducted on 57 samples of domestic dogs in the city of Kupang, with the location of the distribution of samples as shown in Figure 1. Researchers have obtained an overview related to the results of laboratory tests for antibiotic resistance shown by Kallau *et al.* (2020) earlier.

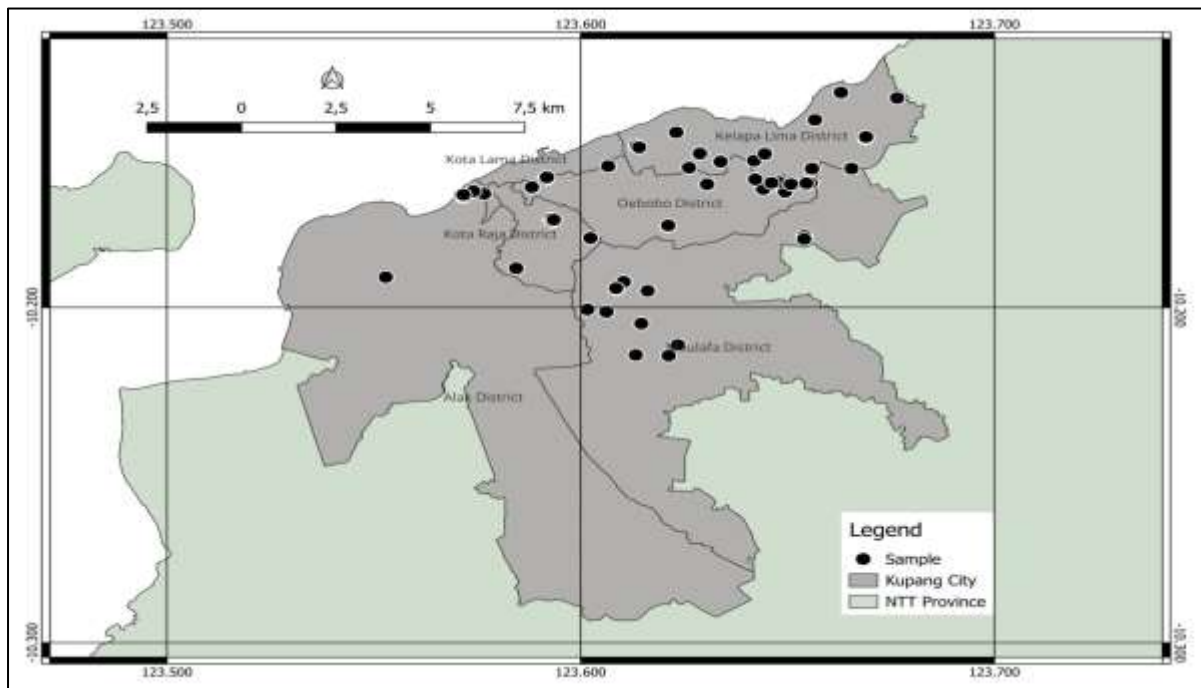


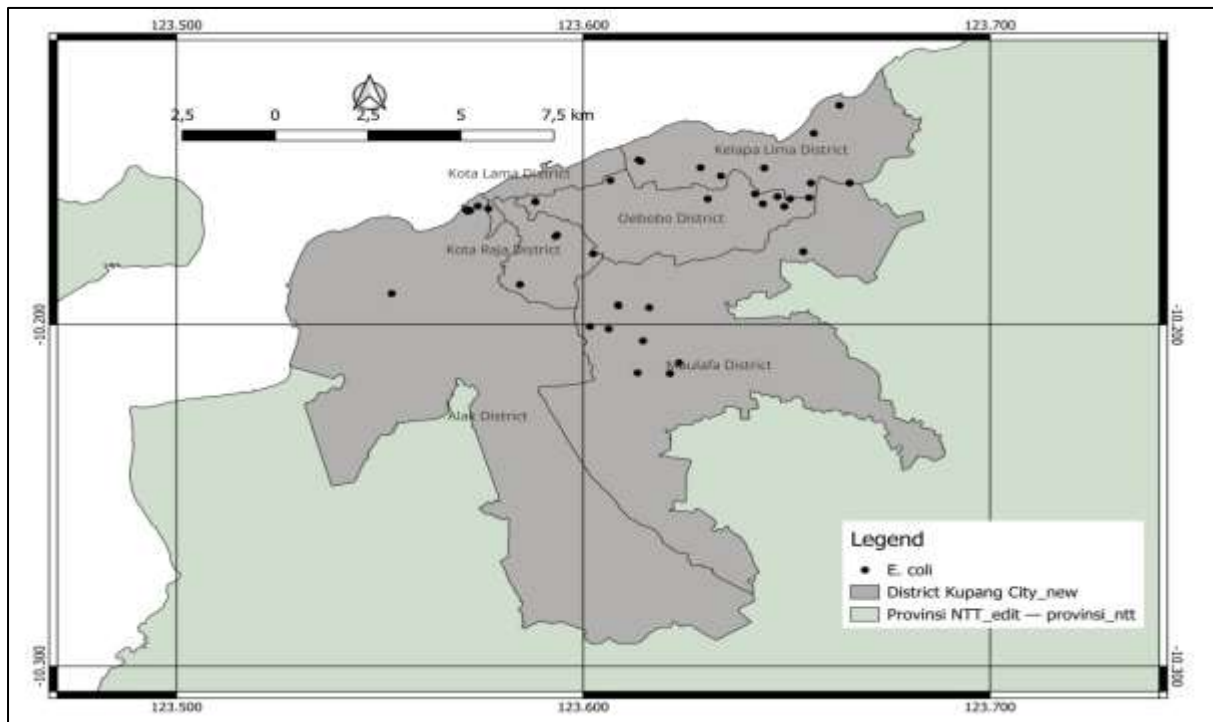
Figure 1. Sampling locations in Kupang City (Elementary analysis of disease).

Based on Figure 1, it has been shown that pet dogs can be found throughout the City of Kupang which are spread over 6 Districts (Kepala Lima District, Kota Lama District, Oebobo District, Kota Raja District, Maulafa District, and Alak District).

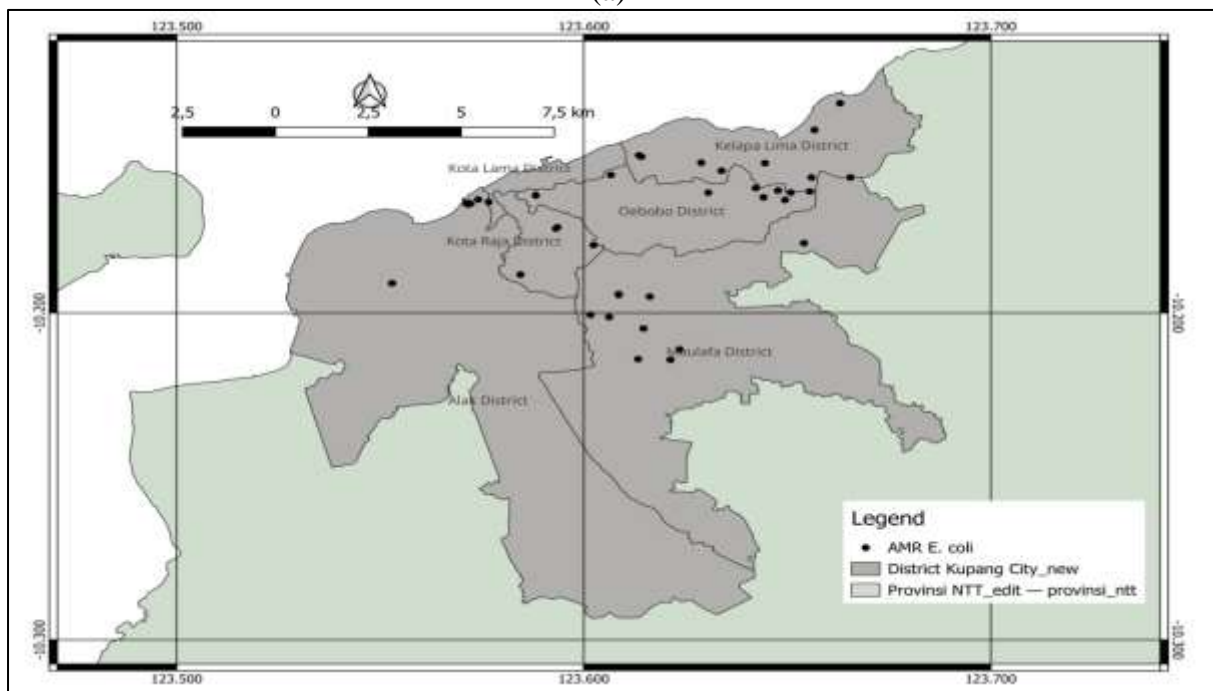
Test results data that has been carried out in Kallau et al. (2020), shows that *E. coli* has a prevalence of 65% (37/57). The spread of *E. coli* in domestic dogs in Kupang City can be seen in Figure 2a. *E. coli* has been found in Kelapa Lima District, Oebobo District and Maulafa District. The spatial analysis results of the spread of *E. coli*, shown in table 1. the area of distribution based on the convex ull test was 5983 Ha, and the NNI value was 0.763, which illustrates the distribution pattern being random. Z-score value of -2.821. The results of spatial analysis of AMR *E. coli* in Table 1 and Figure 2b have also shown the same value. All *E. coli* samples that have been tested have varied resistance from 1-7 types of resistance (Kallau et al.

2020). These results are almost similar to data from *E. coli* research on pigs (Kallau et al. 2018a).

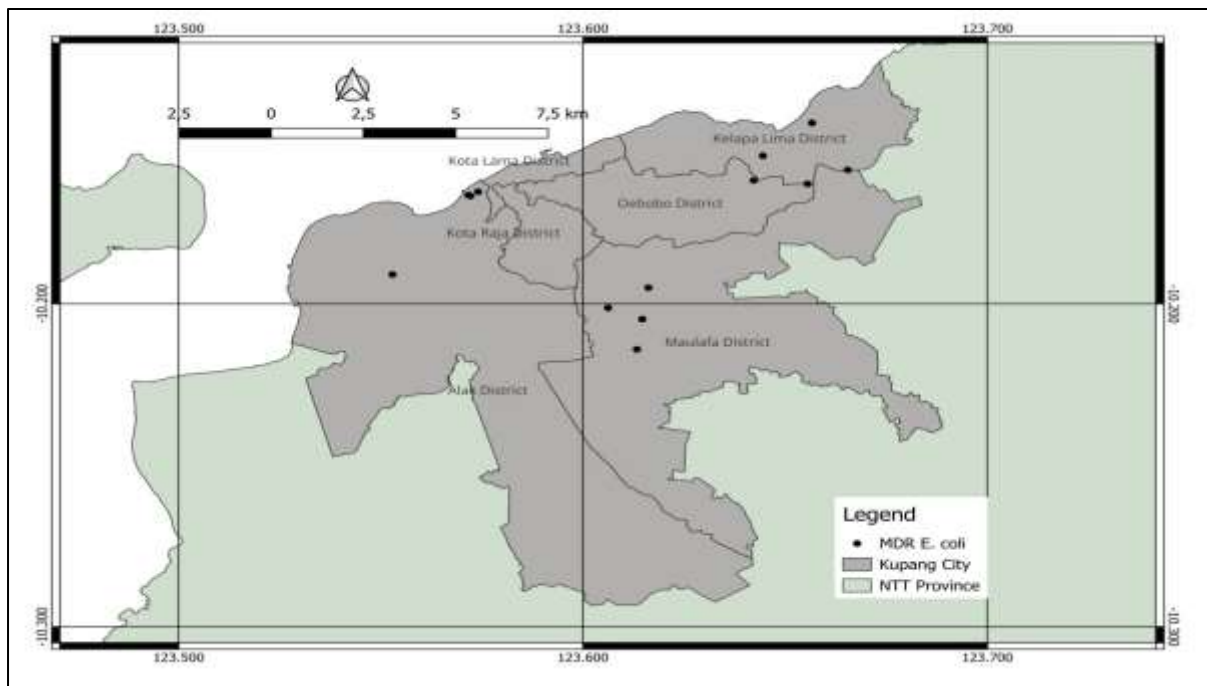
Spatial analysis data on MDR *E. coli* in table 1 and figures (2c and 3) provided information on the distribution area of 5079 Ha which covered 13 positive samples for MDR *E. coli*. The results of the NNI value have shown a value of 0.783 with a random distribution pattern, as well as a Z-score result of -1.495.



(a)



(b)



(c)

Figure 2. Map of the distribution of *E. coli* (a), AMR *E. coli* (b), and MDR *E. coli* (c) in domestic dogs in Kupang City (Elementary analysis of disease).

Table 1. The pattern of results of spatial analysis of the spread of *E. coli*, AMR *E. coli*, and MDR *E. coli* in pet dogs in Kupang City.

Parameters	<i>E. coli</i>	AMR <i>E. coli</i>	MDR <i>E. coli</i>
Distribution area (Ha)	5983	5983	5079
Number of AMR <i>E. coli</i> case points	37	37	13
NNI	0,763	0,763	0,783
Spread pattern	Random	Random	Random
Z-score	-2,821	-2,821	-1,495

Data on the distribution of *E. coli* in domestic dogs in Figure 2a shows that *E. coli* is spread over six subdistricts in Kupang City, with the highest levels found in Kelapa Lima District (13 points) and Maulafa District (10 points). The results of the distribution of *E. coli* did not differ much from the AMR *E. coli* data shown in Table 1 and Figure 2b. This study has shown that the occurrence of AMR occurs in every sample of *E. coli* (37 samples) that has been found. The results are in line with research conducted by Kallau et al. (2018b), (Kallau et al. 2019), and (Kallau et al. 2020). The incidence rate of antibiotic resistance in Kupang City can be influenced by several factors, such as the high level of dog ownership, as it has been shown by ownership of local dogs and breeds that continue to grow in Kupang City (Yanuartono 2008); (Kallau et al. 2020). The number of pet shops and veterinary clinics that have sprung up indicates that more and more people are raising animals and are starting to prioritize the health quality of their pet dogs.

The results of the z-score for AMR *E. coli* have shown negative results, this has shown that the level of resistance events that occurred at that location is lower than the general average in the same area. This is also related to areas with a lower level of risk or areas where effective interventions have started in the use of antibiotics to control the incidence of antibiotic resistance. Intervention using antibiotics in animal hospitals/animal clinics and practicing veterinarians can help reduce the incidence of resistance (Wayne et al. 2011).

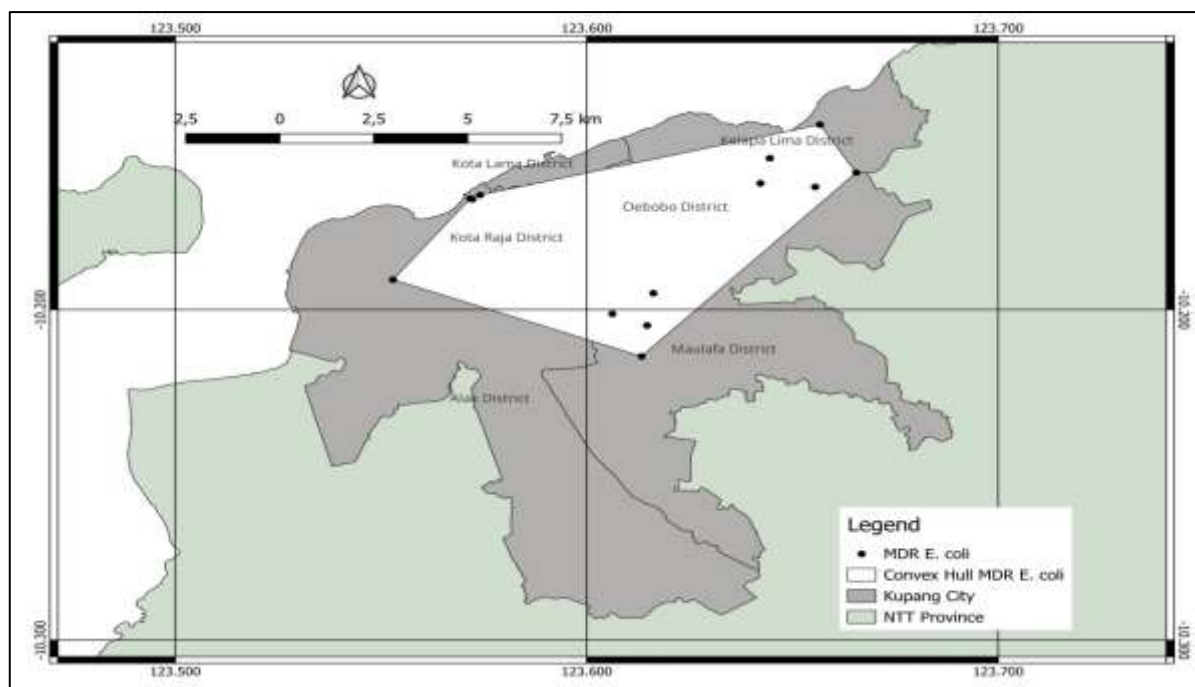


Figure 3. Map of MDR *E. coli* distribution area in domestic dogs in Kupang City (convex hull analysis).

The MDR *E. coli* data displayed in this study illustrates the distribution of the number of points of occurrence of MDR *E. coli* with a low level of 13/37 (35% prevalence). The distribution area of MDR *E. coli* is 5.079 Ha with a random distribution pattern based on NNI. Z-score value has shown -1.495. The area of distribution can be seen in Figure 3. The area of distribution of MDR *E. coli* is still lower than the AMR of *E. coli*, but this has shown a tendency that the point of presence of MDR *E. coli* is in a large area pattern. This is almost in line with the research conducted by Kallau et al. (2019) on pig farms. Srivani et al. (2017) showed that geographic disease distribution patterns can vary due to differences in location and management of animal rearing. Besides that, there are also differences in resistance patterns related to the use of types of antibiotics, regional differences and different management systems (Bywater et al. 2004).

As with the results of the z-score for the AMR *E. coli*, the Z-score results that the spread of MDR *E. coli* has shown show a negative result (-1.495), this has provided information that the level of resistance events that occurred at that location was higher lower than the general average within the same area. This is also related to the existence of areas with a lower risk of occurrence of resistance or the existence of certain areas with effective interventions in controlling the incidence of antibiotic resistance. Management of animal diseases from pets can be supported by implementing dog population control management as part of planning and implementation (Acosta-Jamett et al. 2010).

Spatial studies that have been shown in this study indicate the distribution of MDR *E. coli* which is close to the human population. Interaction between humans and pets (dogs) has provided a higher chance of contact and encouraged wider spread. In general, the risk of spreading resistant bacteria from domestic dogs to humans is still difficult to predict and the pattern of spread is complex and requires further research (Pomba et al. 2017). Several patterns of the spread of zoonotic diseases of animal origin to humans can be through several ways,

namely direct contact with resistant animals or indirect contact such as through vectors, consuming contaminated food (specific diseases of bacterial origin) (Khairiyah 2011), The spread of MDR E. coli has been expanded in Kupang City due to the sale of tank water originating from groundwater sources, and the possibility of spreading that occurs with access to water sales throughout Kupang City through water tankers (Kallau et al. 2019). Hygiene and sanitation measures need to be implemented to reduce this rate of spread (Kallau et al. 2018a). This research needs to be continued by looking at other risk factors that encourage the emergence of multidrug resistance in relation to the relationship between pet dogs and dog owners.

4. CONCLUSION

MDR E. coli has a low number of events (35% prevalence) with a distribution area of 5079 Ha with a random distribution pattern. The observed Z-score value has shown -1.495. Results This dissemination has provided information for the implementation of preventive measures to suppress the wider spread of MDR by increasing understanding of the prudent use of antibiotics and the principles of hygiene and sanitation that need to be properly applied between animal owners and their pets.

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