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Original Research Article

Spatial analysis of COVID-19 in North Minahasa Regency of North Sulawesi Province

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ABSTRACT

Background: COVID-19 is an infectious disease that is currently a concern and has become a global problem. The trend in the number of confirmed cases and deaths due to COVID-19 every day is still increasing significantly. North Sulawesi Province currently has 7 regencies/cities which are declared as local transmission areas including North Minahasa Regency. The population density factor can affect the process of transmission of this disease. This study aims to determine the spatial description of the distribution of COVID-19 events in North Minahasa Regency.
Methods: This quantitative research with descriptive observational design using a geographic information system approach. The location is in 10 sub-districts of North Minahasa Regency. Study population was all patients who were confirmed positive for COVID-19 based on data from the North Minahasa District Health Office as of 13 February 2021, as many as 1,273 cases. Simple random sampling was used and obtained 300 samples.
Results: Results showed that the highest number of cases was for the age group 30-49 years (40%), female gender (54.7%), symptom onset date interval 4 days (26.7%), confirmation date grouped by month, namely October in 2020 (23%), the status of the patient recovered (86%), and there were no comorbidities (82%).
Conclusions: Most of the cases of COVID-19 were found in densely populated areas and passenger transit areas between districts/cities. Policies on prevention and supervision of health protocols that are implemented must synergize across sectors and need to be improved.

Keywords: COVID-19, Outbreak, Spatial

INTRODUCTION

COVID-19 is an infectious disease that is currently a concern, not only in one country, but has become a global problem. COVID-19 is caused by a new type of coronavirus that belongs to the coronaviridae family. The beginning of the COVID-19 case appeared in Wuhan, on 30 December 2019. At that time the case that occurred was diagnosed as "pneumonia of unknown cause", and then followed by other reports referring to 4 cases of pneumonia that could not be diagnosed at the same time, which also comes from the same place, namely South China seafood market. And then there was an increase in the same cases in Wuhan.[1]

Currently, based on a report from the World Health Organization (WHO), as of 12 November 2020 at 04.41 pm CEST (Central European Summer Time), the number of COVID-19 cases was 51,848,261 confirmed, and 1,280,868 deaths reported to WHO. In the Southeast Asia region, the number of COVID-19 cases was 9,855,189 with a death toll of 151,880. The trend in the number of confirmed cases and deaths due to COVID-19 every day is still increasing significantly.[2]

In Indonesia, based on a report from the Ministry of Health's public health emergency post, as of 12 November 2020, the number of confirmed cases was 452,291 cases with 14,933 deaths. With a distribution in 34 provinces and specifically for North Sulawesi Province as many as 5,827 confirmed cases or 1.3% and ranks 16th most out of 34 provinces in Indonesia (COVID-19 Handling Task Force, 2020).[3]

North Sulawesi Province currently has 7 regencies/cities which are declared as local transmission areas, including North Minahasa Regency. The number of COVID-19 cases in North Minahasa Regency as of 27 January 2021 was ranked 4th out of 16 regencies/cities in North Sulawesi (including outside the city). The first case that occurred in North Minahasa Regency on 07 April 2020 (case number 7) according to the report, there was no history of travel outside the region. Currently, the number of positive cases in North Minahasa Regency has reached 1,147 cases with 35 deaths (North Sulawesi Government, 2020).[4]

In relation to the outbreak, Achmadi explained that when an extraordinary event or outbreak of a certain disease occurs in an area, it can be seen as a process of propagation of viruses in a giant culture media pool called "city dwellers". The population of the city area can then be analogized as a stretch of cultural media for the virus that causes the outbreak. The virus will then multiply freely, there can be transfer from one person (component of culture media) to another person (component of other culture media) who do not or do not have immunity. Population factors such as population density can affect the process of disease transmission from one person to another. Therefore, an adequate understanding of disease risk factors based on population factors can reduce the risk of outbreaks. In learning area-based disease management, there are two methods that can be used and one of them is doing spatial analysis.[5]

Spatial analysis can be used to pave the way for research or research that requires more detailed and accurate results, besides that spatial analysis also offers alternative approaches such as being able to generate, prioritize, and analyze data to find causes and risk factors for disease. Spatial analysis can be done with a geographic information system (GIS) approach.[6]

Currently, the use of GIS is a vital tool in the process of analyzing and visualizing the spread of COVID-19 cases in the world.[7] The Johns Hopkins University research center otherwise known as the Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE) has used GIS to provide information regarding the global spatial distribution of COVID-19 including the total number of confirmed cases, the number of deaths and the number of patients recovered.[8] In Indonesia itself, GIS is used by the national disaster management agency (BNPB) and the national aeronautics and space agency (LAPAN) as a remote sensing application portal and GIS for COVID-19 risk distribution analysis. Therefore, mapping of COVID-19 cases with spatial analysis is expected to produce information related to the distribution of COVID-19 events in North Minahasa Regency. Based on the background that has been described, the formulation of the problem that will be raised is "what is the spatial description of the COVID-19 incidence in North Minahasa Regency?"

METHODS

The type of research conducted is quantitative research with a descriptive observational design using a GIS approach. This research was conducted in North Minahasa Regency with 10 sub-districts. The time of this research was carried out in February 2021-October 2021. The population in this study were all patients with COVID-19 who were recorded at the North Minahasa district health office as of 13 February 2021, as many as 1,273 cases. The sampling technique is probability sampling with a simple random sampling approach. Calculation of the sample size with the formula to get the minimum number of samples required as many as 300 cases. The inclusion criteria in this study were cases that were confirmed positive for COVID-19 based on the results of the reverse transcriptase polymerase chain reaction (RT-PCR) examination and had complete data based on the database of the North Minahasa district health office. The exclusion criteria in this study was if the patient's domicile address was not within the administrative area of North Minahasa Regency. The variables studied in this study were the incidence of COVID-19 in North Minahasa Regency based on gender, age, date of symptom onset, date of confirmation, final patient status and comorbid diseases. Research instruments are tools or facilities that will be used by researchers during data collection activities. The tools used in this study include informed consent, observation sheets, global positioning system (GPS), quantum GIS 3.16 Hannover, and Google maps. GPS is a tool that will be used to map the condition of the area around the sample house (mapping geographic boundaries such as the location of degrees north latitude and east longitude) while quantum GIS 3.16 Hannover and Google maps are computer programs (software) that will be used to map the results in illustration form. The process of spatial data analysis was carried out using the quantum GIS 3.16 Hannover program. The data on the coordinates of the houses of COVID-19 sufferers is collected using GPS, then the data will be sent to the source map. The data obtained will then be analyzed using the quantum GIS program in mapping and displaying spatial/regional information based on the data that has been collected. The results of spatial data processing will be presented in the form of regional map images based on research variables. The distribution data of COVID-19 sufferers that have been filled in through the observation sheet are then examined or validated. The data is then inputted and analyzed using the statistical package for the social sciences (SPSS) 22 program. Univariate analysis will be carried out to obtain statistical results in the form of descriptive tables related to the variables studied.

RESULTS

Overview of research locations

The capital of North Minahasa Regency is located in Airmadidi district. Based on the profile of North Minahasa Regency in Figures 2021, the administrative area of North Minahasa Regency consists of 131 villages and 10 sub-districts, namely Kema, Kauditan, Airmadidi, Kalawat, Dimembe, Talawaan, Wori, West Likupang, East Likupang and South Likupang.

The sub-district with the largest area is East Likupang with 290.84 km^2 while the smallest area is South Likupang with 11.82 km^2.[9]

The population of North Minahasa Regency based on the 2020 population census is 224,993 people, consisting of 114,530 male residents and 110,463 female residents. Compared to the population in 2010, the population of North Minahasa grew by 19.10 percent. Meanwhile, the number of sex ratios in 2020 for the male population to the female population is 103.7. Based on the area and population in 2020, the population density in North Minahasa Regency in 2020 will reach 212 people/km^2.[9]

The highest population in North Minahasa Regency is in Kalawat sub district with 32,780 residents, followed by Airmadidi sub district with 30,980 residents, while the lowest population is in South Likupang district with 5,790 residents.[9]

Health facilities located in the North Minahasa Regency area based on 2020 data include 3 hospitals, 4 polyclinics, 12 health centers, 26 sub-health centers, 13 pharmacies, and 149 posyandu. The number of health workers in North Minahasa Regency includes 203 doctors, 18 dentists, 233 nurses, 153 midwives, 51 pharmacists, 23 public health workers, 34 environmental health workers, 25 nutritionists, and 22 medical laboratory technology experts.[9]

The highest number of diseases found in North Minahasa Regency according to the North Minahasa profile in Figures 2021 is upper respiratory tract infection (ARI). When compared with the data for the 10 most diseases in North Minahasa Regency in 2016, ARI is still in first place with 46,731 cases.[9] This shows a vulnerability to COVID-19 disease where COVID-19 also generally attacks the upper respiratory tract.

Description of research respondents' characteristics

Respondent age group

The distribution of age groups in the form of a description of the distribution of respondents based on age characteristics can be seen in Table 1.

The age group of respondents showed that the age group of 30-49 years was the largest age group, amounting to 120 people with a percentage of 40% and the age group of 12-17 years being the lowest age group of 7 people with a percentage of 2.3%.

Respondent's gender

An overview of the distribution of respondents by gender can be seen in Table 2.

Table 1: Distribution of respondents age characteristics.

Age group (years)	Amount	
	N	%
0-11	51	17
12-17	7	2.3
18-29	60	20
30-49	120	40
50-59	39	13
>60	23	7.7
Amount	300	100

Table 2: Gender distribution of respondents.

Gender	Amount	
	N	%
Man	136	45.3
Woman	164	54.7
Amount	300	100

The gender of the respondents showed that most of the respondents were female with a total of 164 people (54.7%) while the respondents were male with a total of 136 people (45.3%).

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Symptom onset date

Symptom onset date is the time when a disease started, in this case COVID-19. The date of onset corresponds to the incubation period of the disease. The average incubation period for COVID-19 is 5-6 days, with a distance between 1 and 14 days but can be up to 14 days. The highest risk of transmission is obtained in the first days of the disease due to the high concentration of virus in the secretions.

Infected persons can be directly infectious up to 48 hours before symptom onset (presymptomatic) and up to 14 days after symptom onset. The description of the respondent's symptom onset date can be seen in Table 3.

Table 3 shows that the interval or distance between the dates of symptom onset before the confirmation date is 4 days with a total of 80 people (26.7%) while the lowest

interval or distance to the date of onset of symptoms is 7 days with a total of 33 people (11%).

Confirmation date

A confirmed case is a person who is tested positive for the COVID-19 virus as evidenced by an RT-PCR laboratory examination. Confirmation cases are divided into 2, namely confirmed cases with symptoms (symptomatic) and confirmed cases without symptoms (asymptomatic). The description of the respondent's confirmation date which has been calculated by month can be seen in Table 4.

Table 3: Respondents symptom onset date interval.

Symptom onset date interval (days)	Amount	
	N	%
3	50	16.7
4	80	26.7
5	73	24.3
6	64	21.3
7	33	11
Amount	300	100

Table 4: Grouping of respondents' confirmation date by month.

Confirmation date by month	Amount	
	N	%
April 2020	3	1
May 2020	9	3
June 2020	19	6.3
July 2020	67	22.3
August 2020	2	0.7
September 2020	49	16.3
October 2020	69	23
November 2020	43	14.3
December 2020	10	3.3
January 2021	19	6.3
February 2021	10	3.3
Amount	300	100

Based on Table 4, the number of confirmation cases according to the confirmation date based on the highest month was in October 2020 with 69 cases or 23% followed by July 2020 with 67 cases or 22.3%, while the lowest number of cases was in August 2020 with a total of 2 cases.

Patient status

The status of a COVID-19 patient in this case is declared cured or discarded if it meets one of the following criteria: A person with a suspected case status with 2 negative RT-PCR results for 2 consecutive days with an interval of >24 hours or a person with contact status those who have completed the 14-day quarantine period. While the operational definition of COVID-19 death for surveillance purposes is a confirmed/probable case of COVID-19 who died. An overview of the final status of COVID-19 Patients in North Minahasa Regency can be seen in Table 5.

Table 5: Distribution of respondents' final status.

Status	Amount	
	N	%
Healed	258	86
Die	42	14
Amount	300	100

Table 5 shows that more than 80 percent of respondents were declared cured of COVID-19 with a total of 258 cases (86%) while respondents who were declared dead were 42 cases (14%).

Comorbid

Comorbid/comorbid disease is a condition where the patient already has a disease that has been suffered previously, is chronic and will aggravate the course of his COVID-19 disease. Comorbid/comorbid diseases include immunocompromised disease, heart, liver, diabetes mellitus (DM), asthma, hypertension, chronic obstructive pulmonary disease (COPD), tuberculosis (TB), human immunodeficiency virus (HIV), kidney, post-stroke, cancer, and other chronic diseases that can aggravate the course of COVID-19. The description of comorbid COVID-19 in North Minahasa Regency can be seen in Table 6.

Table 6: Description of respondents' comorbidities.

Comorbid	Amount	
	N	%
There is	54	18
There is not any	246	82
Amount	300	100

DISCUSSION

Distribution of the number of COVID-19 cases based on spatial mapping

The number of COVID-19 cases and population density in North Minahasa Regency can be seen in Figure 1.

Based on Figure 2, it can be seen that the highest number of COVID-19 cases are in areas with the highest population density, including Kalawat district, Airmadidi district, and Talawaan district. This proves that the level of population density greatly affects the transmission of infectious diseases, in this case COVID-19, in North Minahasa Regency. The occurrence of crowds or people gathering increases the potential for human contact and is a major source of human-to-human transmission. COVID-19 is growing significantly in more densely populated areas (Therese, 2020).[10-18]

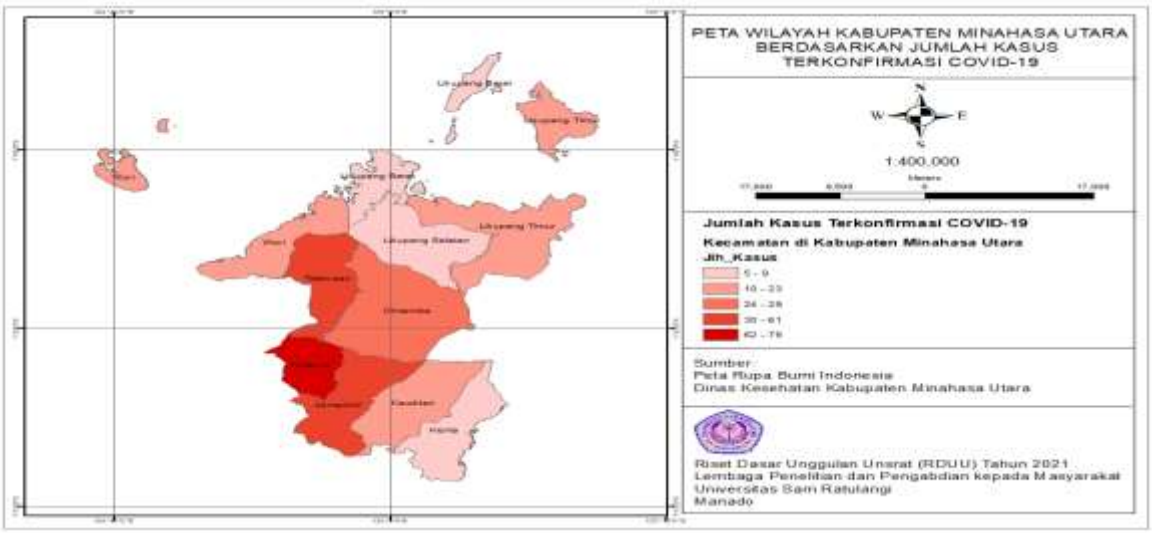

Figure 1: Map of North Minahasa Regency based on the number of confirmed cases of COVID-19.

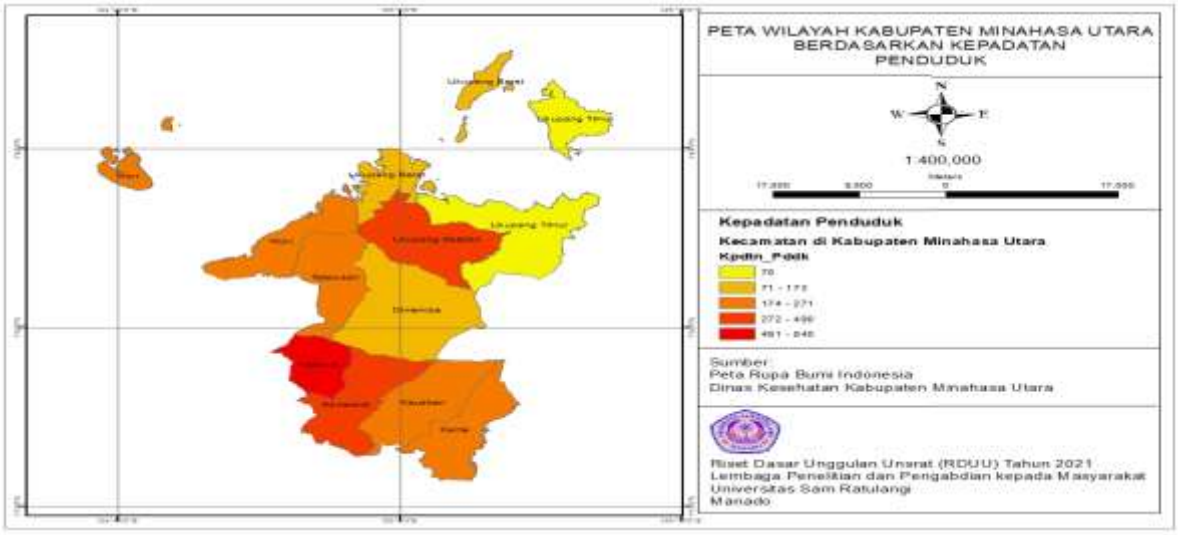

Figure 2: Map of North Minahasa Regency based on population density.

CONCLUSION

The results showed the highest number of cases was for the age group 30-49 years (40%), female gender (54.7%), symptom onset date interval 4 days (26.7%), confirmation date grouped by month, namely October 2020 (23%), Patient status recovered (86%), and there were no comorbidities (82%). Most of the COVID-19 cases were found in densely populated areas and passenger transit areas between regencies/cities. Policies on prevention and supervision of health protocols implemented in North Minahasa Regency must synergize across sectors and need to be improved.

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