ANALYSIS OF VULNERABILITY AND SPATIO-TEMPORAL DISTRIBUTION TOWARD THE SEVERITY LEVEL OF COVID-19 IN BENGKULU, INDONESIA

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Abstract: The pandemic caused by Covid-19 has had a huge effect in various parts of the world. The global situation of COVID-19 as of January 20th, 2021 were 99.864.391 cases with a death rate of 2.2% with 183 countries infected by local transmission. The COVID-19 situation in Indonesia as of January 27th, 2021 were 1.024.298 cases with a death rate of 2.8%, occurred within 182 regions by local transmission. Bengkulu Province is one of the areas experiencing local transmission of Covid-19 since March 31st, 2020 and this condition continues to develop. This study aimed to determine the regional vulnerability and temporal distribution of Covid-19 in Bengkulu. There were 956 confirmed cases of Covid-19 within the period of July-October 2020. The overlay results between clustering analysis and population density were gathered by using the Kernel Density Estimation method and ArcGIS software version 10.3. The area that has a high risk of contracting the Covid-19 disease is Bengkulu City. The use of technology-based information systems is indispensable in the digital era, including spatio-temporal analysis, disease and health mapping, geographic dimensions which can be the basis for decision making in an area.

Keywords: Covid-19, Spatial distribution, Temporal distribution, Bengkulu City

Introduction

The pandemic caused by Coronavirus Disease (Covid-19) has had a huge effect in various parts of the world. The resulting number of morbidity and mortality caused massive concern. Covid-19 itself is a new type of infectious disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-

CoV-2) which was identified in Wuhan, Hubei Province, China in December 2019 (1). The Sars-CoV-2 virus is related to the SARS-CoV virus which has caused SARS (Severe Acute Respiratory Syndrome) and MERS-CoV which causes MERS (Middle East Respiratory Syndrome). Several studies have shown that despite being related, the SARS-CoV-virus has different characteristics from biological characteristics and transmission patterns with the viruses that cause SARS and MERS (2).

Indonesia reported its first case of COVID-19 on March 2, 2020 and the number continues to grow to recent days. As of January 27[th,] 2021, the Ministry of Health of Indonesia reported 1.024.298 confirmed cases of Covid-19 with 28.855 deaths (CFR 2.8%) spreading across 34 provinces. As many as 51.5% of cases occurred in men. Most cases occurred in the age range of 45-54 years and the least occurred at the age of 0-5 years (3).

Covid-19 infection can cause mild, moderate or severe symptoms. The main clinical symptoms are usually fever (temperature > 38°C), cough and difficulty of breathing. In addition, it can be accompanied by severe tightness, stiffness, myalgia, gastrointestinal symptoms such as diarrhea. In severe cases deterioration can occur rapidly and progressively, such as Acute Respiratory Distress Syndrome (ARDS), septic shock, intractable metabolic acidosis and bleeding (4–6).

Limited information related to the nature, pathophysiological mechanisms, detection systems for diagnostics and therapy has caused all medical personnel and researchers in various regions to really be looking for everything related to this virus in an effort to prevent the spread of infection and minimize the negative effects that will or have been caused. These various limitations also triggered data collection both locally, regionally, nationally and even globally related to Covid -19. Geographical Information Systems (GIS) and remote sensing are powerful tools in surveillance for the prevention and eradication of infectious diseases (7). This system is also very relevant to be used in the investigation of outbreaks and the rapid response to action. This GIS provides precise location of cases, rapid communication of information and mapping of epidemic dynamics of the disease (7).

Geographical information systems and sensing are powerful tools in surveillance for the prevention and eradication of infectious diseases. The role of geographic information systems for public health, especially in disease mapping and mapping of health care systems, is studied in health geography (7).

The phenomenon of the spatial approach to disease was originally presented by Hippocrates (360-370 BC). Hippocrates reported that location greatly influenced health status. The Hippocrates' concept of health and illness emphasizes the relationship between humans and their environment, regional differences are associated with health and illness profiles that change over time (8).

Maps are a unique and efficient method of describing the distribution of phenomena in a specific area. Some maps are designed to depict the boundaries of an area or country. Making maps are used

primarily to show facts, shows the spatial distribution with an accuracy that cannot be achieved by description or statistics. Maps can help in making analyzes, stimulate ideas and help formulate hypotheses and for communication of findings (9). Mapping of disease and analysis of geographic variation and spatial patterns of disease can make an important contribution to the detection of causes of disease that are currently unknown etiologically (9).

In integrated geography, to approach the problem, various approaches are used, namely the spatial analysis approach, ecological analysis and regional complex analysis (10). In health geography, one approach that has been known for a long time is diffusion of disease, which is a form of spatial analysis approach (10). In health geography, one approach that has been known for a long time is diffusion of disease, which is a form of spatial analysis approach (9). Geographical information systems can be identified by their ability to perform analytical functions. One of the capabilities of GIS in analyzing is spatial analysis. There are three important spatial analyzes in GIS, namely: topological and network analysis, proximity analysis, overlay analysis (8).

Based on the above background, efforts to prevent the spread of Covid-19 need an information system that is fast and precise. One such information system is the Geographical Information System relating to Covid-19 and its severity. This system is needed for mapping the vulnerability of the Covid-19 infection in Bengkulu Province both individually and regionally. The purpose of this study was to determine the regional vulnerability and spatial distribution of Covid-19 in Bengkulu Province. It is hoped that this can be used as useful information to determine the spatial distribution of Covid-19 cases and accelerate the handling of Covid-19 in Bengkulu Province.

Methods

This research was conducted in July 2020 and has been approved by Health Research Ethics Commite of the Faculty of Medicine and Health Sciences Universitas Bengkulu, by numbers 189/UN30.14.9/LT/2020. The study used an analytic observational study with cross-sectional design (11). The target population in this study was all patients with Covid-19. The accessible population in this study was all patient with Covid-19 around July 2020 to October 2020 at Dr. M. Yunus Hospital, which is a referral center for rRT-PCR (Real Time-Reverse Transcriptase Polymerase Chain Reaction) examinations for Covid-19 in Bengkulu Province.

The research sample was 956 people. The research sampling technique used total sampling for 4 months. Data collection begins with the signing of the consent sheet by the respondent and then completes the identity data sheet, then the characteristics of the research subject the RT-PCR examination at the Covid-19 Laboratory Dr. M. Yunus Hospital. The overlay results between clustering analysis and

population density were gathered by using the Kernel Density Estimation method and ArcGIS version 10.3.

Result

Table 1 shows the characteristics of the research subjects. Patients age ranged was from 15 months to 57 years of age. The number of male was 403 patients (42,15%) and female was 553 patients (57,85%). Most of the symptom of Covid-19 patients were asymptomatic or there were no symptoms as many as 553 people (57.85%).

In 2019, the population in Bengkulu Province amounted to 1,991,800 people. The population density for every 1 km^2 area in Bengkulu Province is 100 people with a sex ratio of 100: 104 (female: male). Approximately 19.18% of the population at Bengkulu Province live in Bengkulu City with the largest density at 2,539 per km^2, while the Mukomuko area is the area with the smallest population density at 48 per km2 as shown in Table 1 (12).

Table 1. Population Density by Regency/City in Bengkulu Province in 2019.

No	Regency/City	Population Density (/km^2)	Sex Ratio
1	Bengkulu Selatan	134	101
2	Rejang Lebong	159	102,5
3	Bengkulu Utara	72	105,3
4	Kaur	51	107,2
5	Seluma	81	105,5
6	Mukomuko	48	108,4
7	Lebong	61	103,8
8	Kepahiang	206	104,5
9	Bengkulu Tengah	94	104,7
10	Bengkulu City	2539	100,5

Source: Bengkulu Province Central Bureau of Statistics, 2019

Distribution of Covid-19 Cases

Bengkulu City is the capital of Bengkulu Province with the highest Covid-19 cases, namely 496 cases, this is due to the largest population in Bengkulu City and the accessibility of inspection is also in Bengkulu City. The distribution of Covid-19 cases can be seen in Table 2 and Figure 1.

Table 2. Distribution of Covid-19 Cases in Bengkulu Province July-October 2020.

No	Regency/City	Population	Confirmed Case
1	Bengkulu Selatan	158.400	10
2	Rejang Lebong	260.900	169
3	Bengkulu Utara	310.000	29
4	Kaur	121.200	20
5	Seluma	193.800	43
6	Mukomuko	193.900	70
7	Lebong	116.600	4

8	Kepahiang	137.200	74
9	Bengkulu Tengah	114.700	41
10	Bengkulu City	385.100	496

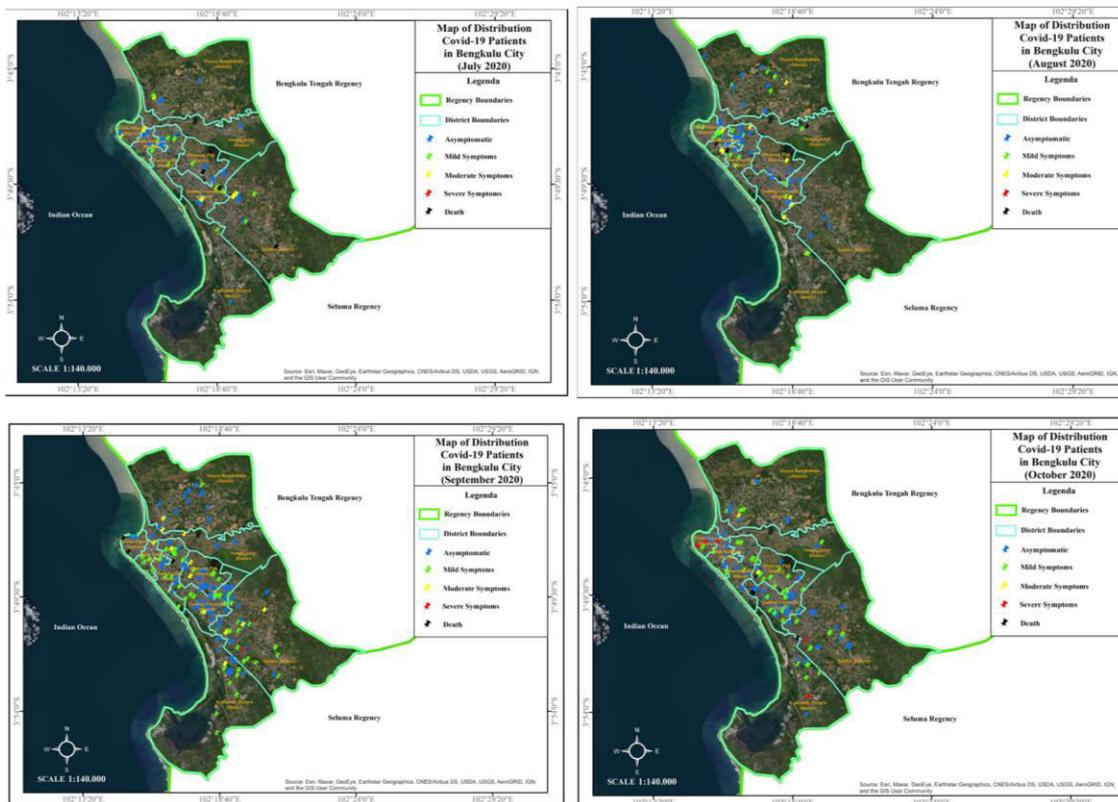Sumber: Bengkulu Provincial Health Office, 2020

Figure 1. Distribution of Spatio-Temporal Covid-19 in Bengkulu City

Discussion

The highest incidence of Covid-19 cases is in Bengkulu City with the highest population density rate in Bengkulu Province at 2,539 per km^2. Uncontrolled population growth causes an uneven distribution in an area. The existence of a very high population resulted in the clearing of new land for settlement. Disorganized land use can create slum areas and facilitate the transmission of diseases, one of which is Covid-19 which is currently a pandemic.

The analysis showed a relationship between population density and the number of Covid-19 cases with a value of p = 0.01 (p <0.05). It is in line with research conducted by Xie in China in 2020 that population distribution, transportation accessibility, health facilities and the economy are the most influencing factors in the spread of Covid-19 cases (13). Similar research conducted by Chen in Wuhan in 2020 on the distribution of Covid-19 cases in Wuhan City, China and its relationship to population density (14).

Areas that have an unequal population distribution and become centers of community mobility are factors that can accelerate disease transmission and the tendency for disease cases to cluster in the region. Therefore, different strategies are needed in each area so that disease control can be effective (15,16).

Geographical dimensions and spatial-temporal analysis by Pardo in Mexico in 2020 state that cross-disciplinary measures are needed in tackling the Covid-19 pandemic such as health facilities, mapping or contact history and political responses to facilitate tracking and making spatial analysis. An understanding of the spatial-temporal dynamics of Covid-19 is very important to facilitate mitigation, as shown in Figure 2 (17).
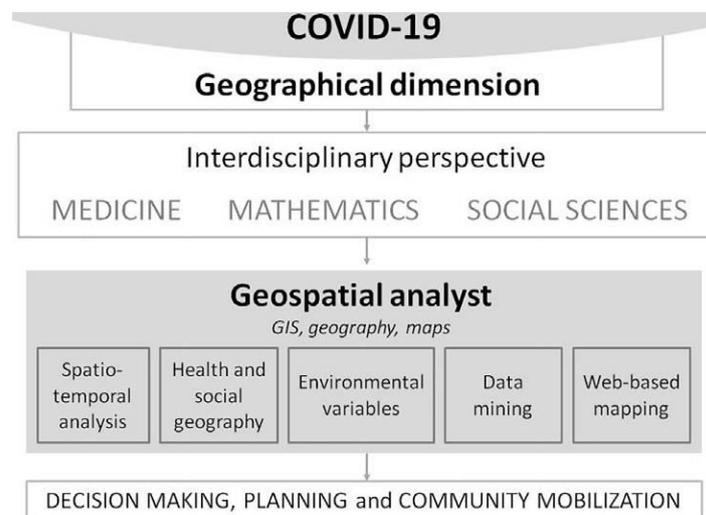

Figure 2. Geographical Dimensions of Covid-19 (Franch-Pardo, 2020)

Overlay results between clustering analysis and population density using the Kernel Density Estimation method, the results of the prediction of areas at risk are obtained using the Covid-19 case density analysis approach. An area that has a high risk of contracting the Covid-19 disease is Bengkulu City.

Conclusions

There is a relationship between population density and Covid-19 cases based on spatial analysis. There were 956 confirmed cases of Covid-19 in the period July-October 2020. The use of technology-based information systems is indispensable in this digital era, including spatio-temporal analysis, disease and health mapping, geographic dimensions which can be the basis for decision making in an area.

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