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Relative Risk Analysis The Spread of Covid-19 Virus in Medan City By Spatial and Non-Spatial Approaches

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ABSTRACT

The city of Medan is the city with the highest cases of COVID-19 virus among cities in North Sumatra. This study was conducted to analyze the relative risk level for the spread of the COVID-19 virus. Estimation of relative risk is a statistic in disease mapping that is used to determine the distribution of disease. Relative risk estimation can be estimated using a direct estimator model or Standardized Morbility ratio and a small area estimation model using Bayesian Conditional Autoregressive (CAR) with the Poisson-Gamma model. The Poisson-Gamma model is one of the models in estimating small areas in the form of count data which is suitable for use in disease mapping cases. This study aims to find the relative risk value as the basis for mapping the spread of the COVID-19 virus in the city of Medan using the Standardized Morbility Ratio and Bayesian Condition Autoregressive models. And look for the value of the Central Error Squared (KTG) / Mean Squared Error (MSE) as a comparison which model is more efficient in estimating this research. Condition Autoregressive models. And look for the value of the Central Error Squared (KTG) / Mean Squared Error (MSE) as a comparison which model is more efficient in estimating this research.

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1. INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) better known as the Corona virus is a new type of corona virus that is transmitted to humans. This virus can attack anyone, such as the elderly (older people), adults, children and infants, including pregnant women and breastfeeding mothers. Corona virus infection is called COVID-19 (Corona Virus Disease 2019) and was first discovered in the Chinese city of Wuhan at the end of December 2019. This virus spreads very quickly and has spread to almost all countries, including Indonesia in just a few months. The COVID-19 virus or SARS-CoV-2 can cause severe respiratory infections, such as lung infections (pneumonia). This virus is transmitted through phlegm (droplets) from the respiratory tract, for example when in a crowded closed room with poor air circulation or direct contact with droplets. According to data released by the Task Force for the Acceleration of Handling COVID-19 of the Republic of Indonesia, the number of confirmed positive cases as of January 25, 2021 is 989,262 people with a death toll of 27,835. The case fatality rate due to COVID-19 is around 2.8%. When viewed from the percentage of death rates divided by age group, the 46-59 year age group has a higher mortality percentage than other age groups. Meanwhile, based on gender, 56.4% of patients who died from COVID-19 were male. male and the remaining 43.6% were female. Therefore, the Indonesian government officially declared COVID-19 a national disaster on April 13, 2020.

Various government policies to anticipate the rapid spread of the corona virus, one of which is by forming a task force to accelerate the handling of COVID-19 in each province based on presidential decree Number 7 of 2020 which was signed on March 13, 2020 (Sembiring, et al., 2020). COVID-19 spreads very quickly throughout Indonesia, especially in provinces with large populations. One of them is North Sumatra province, which is the fourth largest province by population in Indonesia after West Java, East Java, and Central Java, consisting of 25 districts, 8 cities, 450 sub-districts, 693 urban villages and 5,417 villages. The North Sumatra government has formed a task force to accelerate the handling of COVID-19 in each district and city. However, it is undeniable that despite the formation of a task force for handling COVID-19 in each sub-district in the city of Medan, the positive number of COVID-19 is still increasing.

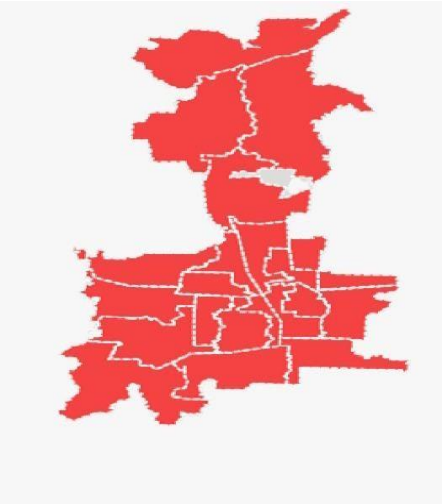

Figure 1 Map of the spread of COVID-19 in the city of Medan

Based on the distribution map updated in April 2021, the Medan city government released that all sub-districts in the city of Medan had become red zones exposed to COVID-19. The distribution map, which has been the main information for the community, only provides information on which sub-districts have a high rate of COVID-19 cases without knowing what is the comparison and the cause of a sub-district strict in the city of Medan having a high rate of COVID-19 positive cases. Therefore, the latest handling and solutions are needed that aim to determine the distribution of which sub-districts have the highest relative risk of being exposed to the COVID-19 virus. So that later the government can make policies so that the number of victims affected by this infectious disease can be controlled and tends to decrease.

By utilizing information from the data obtained in this study, the approach used is a spatial and non-spatial approach. SMR (Standardized Mortality/Morbity Ratio) model is a non-spatial model and CAR (Bayesian Conditional Autoregressive) is a spatial model. SMR is used in epidemiological studies to observe locations where the number of positive cases of COVID-19 is higher than the expected value and to describe the information contained in spatial data so that it can provide information about the geographic distribution of a disease, while CAR is a disease mapping technique that models the relative risk. by taking into account the smoothing of the relative risk estimates and incorporating spatial information to reduce errors.

2. RESEARCH METHODE

Relative Risk Analysis

Relative risk analysis is a comparison between two events or a comparison between the exposed group and theunexposed group (Santosa, 2007). In this study, the types of risk, the consequences that can occur, the severity, the frequency of an event, how to prevent it or an action plan to deal with these risks are discussed in detail andrecorded as completely as possible. The most common relative risk measures used in disease mapping are the Standardized Morbility Ratio (SMR) and Bayesian Conditional Autoregressive (CAR). The parameter values used in this study are as follows:

i. If $\theta = 1$, then the risk in an area is equal to the risk in the population
ii. If $\theta < 1$, then the risk in an area is less than the risk in the population
iii. If $\theta > 1$, then the risk in an area is greater than the risk in the population

Spatial and Non-Spatial Approaches

Spatial approach is an analysis of spatial data that contains location information indicating the location where the data is located. The spatial data to be analyzed can be in the form of geographic location information, such as the latitude and longitude of each region and the borders between regions. Thus, the spatial approach is usually presented in the form of thematic maps. While the non-spatial approach is an approach that describes theinformation contained in spatial data (Basic, 2010). Non-spatial data is tabular data that is mutually integrated with existing spatial data in the form of non-spatial data generally in the form of sentences or tables. Mathematically to find the value of relative risk using Direct Standardization and Indirect Standardization. Direct Standardization is a method of finding the relative risk value in a disease. Based on the variables and parameters used in this study, the researchers used Direct Standardization. Standardized Morbility Ratio (SMR) is a direct standardization model in determining relative risk. SMR as a spatial model is used for direct estimation of a research case. However, in disease mapping, the small sample size or the number of disease cases is a problem that is often faced due to the very small area. So that the direct estimation of the Standardized Morbility Ratio (SMR) becomes unreliable, Bayesian Conditional Autoregressive (CAR) is a development of the Poisson-Gamma model, one of the alternatives used.

3. RESULT AND ANALYSIS

Given its nature that causes and causes large losses, infectious diseases become a priority. COVID-19 spreads suddenly and attacks all groups of people. This epidemic has spread throughout the world, including Indonesia. If COVID-19 is increasing day by day, this indicates that the number of people infected with COVID-19 and their deaths are relatively high in a short time. Therefore, it is necessary to analyze the relative risk of the spread of the COVID-19 virus in the city of Medan using the Standardized Morbility Ratio (SMR) and Bayesian Conditional Autoregressive (CAR) models to see which sub-districts in the city of Medan have a high risk and pay special attention to the area. the area so that treatment or assistance can be carried out more quickly and on target as an effort to prevent the number of cases from increasing.

Analysis result of this study can be describe below.

1. Small area estimation is a statistical technique to estimate the parameters of a subpopulation with a small sample size. This estimation technique is an alternative to increase the effectiveness of the sample size and reduce error. The following is a manual calculation of the direct estimator and the errorvalue of the small area estimator.
   a. Calculating the value of the direct estimator of each sub-district in a small area estimate with the formula : $\frac{y_i}{n_i}$
   b. Calculate the error value of each sub-district in small area estimation using the formula : $\varepsilon_i = N_i \left(\sum_{i=1}^{m} y_i / \sum^{m} n_i\right)$

Table 3.1 Calculation Results of Small Area Estimation with Manual

Kecamatan	Banyak penduduk	Terkonfirmasi positif COVID-19	Langsung	
			Penduga	Galat
Medan Tuntungan	88624	3087	0,034833	3087
Medan Johor	137367	3751	0,027306	2668,920827
Medan Amplas	130926	2071	0,015818	3420,567757
Medan Denai	148438	2672	0,018001	3022,171591
Medan Area	100262	2265	0,022591	3410,569352
Medan Kota	75231	2491	0,033111	2409,255812
Medan Maimun	41139	1112	0,027030	1801,521366
Medan Polonia	57682	1000	0,017336	970,0981622

Medan Baru	41149	1661	0,040366	1423,583903
Medan Selayang	111052	3740	0,033678	1037,189489
Medan Sunggal	117535	3138	0,026698	2832,637032
Medan Helvetia	155437	3709	0,023862	2990,810086
Medan Petisah	64075	2190	0,034179	4037,020733
Medan Barat	73536	1728	0,023499	1637,931667
Medan Timur	113045	2770	0,024504	1893,038199
Medan Perjuangan	96991	1938	0,019981	2865,742308
Medan Tembung	139249	2412	0,017321	2404,26045
Medan Deli	190971	1307	0,006844	3201,524055
Medan Labuhan	122192	1036	0,008478	4263,520875
Medan Marelan	175382	1342	0,007652	2577,638715
Medan Belawan	99611	502	0,005040	3577,602978

2. Perform data distribution test calculations, The data obtained were tested for Poisson distribution because the basis of the Standardized Mortality Ratio (SMR) is that the data is assumed to have a Poisson distribution. the calculation process is carried out with Ri368.
   Diperssion test of count data :

   21 data points

   Mean : 2186.762

   Variance : 919644.8

   Probability of being drawn from poisson distribution: 0

   Based on the results of the data distribution test using the Dispersion Test, it was found that the *p-value*was 0.00 and the decision obtained was reject H_0. Therefore, the conclusion obtained is that the data onthe number of confirmed cases of COVID-19 per sub-district in Medan City has a Poisson distribution.

3. Calculation of Relative Risk Using the SMR Model. The Standardized Mortlity Ratio (SMR) model is a simple estimator of the relative risk of a disease spreading, hereinafter referred to as a direct estimatorin a small area estimate. SMR is defined as: $\check{\theta}_i = \frac{N_i}{}$
   With e_i defined as $e_i = n_i \left(\sum_{i=1}^{m} y_i / \sum_{i}^{m} n_i\right)$

Table 3.2 Relative Risk Calculation Results and Mean Squared Error ValueCAR

Kecamatan	Resiko Relatif	Mean SquaredError
Medan Tuntungan	1,0000000	0,001213307
Medan Johor	0,7207582	0,001435325
Medan Amplas	0,5480078	0,000833173
Medan Denai	0,6354522	0,000802448
Medan Area	1,1507371	0,0003854
Medan Kota	1,9945031	0,000275603
Medan Maimun	2,6625724	0,000103062
Medan Polonia	1,1877072	0,000213059
Medan Baru	3,4624710	0,000135909
Medan Selayang	1,0551537	0,00101873
Medan Sunggal	0,8040466	0,001102577
Medan Helvetia	0,5759089	0,001716711
Medan Petisah	1,9239972	0,000315575
Medan Barat	1,1313048	0,000431448
Medan Timur	0,7822770	0,000981151
Medan Perjuangan	0,7523429	0,000705364
Medan Tembung	0,4745710	0,001332195
Medan Deli	0,1485237	0,002123365
Medan Labuhan	0,3012886	0,000791897

Based on the manual calculation of the relative risk of the Standardized Morbility Ratio model with RStudio, it can be concluded that from the data of this study there is no significant difference, thereforeit is assumed that the relative risk value of the direct estimator of SMR by manual method and with RStudio in a sub-district has a Poisson distribution. The relative risk estimation obtained based on modeling from the Poisson regression shows that the small area and the high chance of being positive for COVID-19 make the population in that area more susceptible to the COVID-19 virus compared to people living in larger areas and with higher density. few and the results of the calculation of the low chance of COVID-19 transmission.

4. Calculation of Relative Risk Using the CAR Model. After direct estimation on the SMR model, to determine the small area estimator used Bayesian Conditional Autoregressive (CAR) estimator method with Poisson-Gamma model using RStudio software.

Table 3.3 Relative Risk Calculation Results and Mean Squared Error Value CAR models with RStudio

Kecamatan	Nilai Duga Parameter	PendugaCAR	Mean Squared Error Jackknife
Medan Tuntungan	2,9916	1,7293	0,00000181
Medan Johor	1,8384	1,3557	0,0001396
Medan Amplas	0,6170	0,7853	0.0000368
Medan Denai	0,7990	0,8937	0,00000102
Medan Area	1,2585	1,1216	0,00000526
Medan Kota	2,7034	1,6439	0,0070069
Medan Maimun	1,8025	1,3420	0,00000305
Medan Polonia	0,7416	0,8607	0,0001099
Medan Baru	4,0186	2,0040	0.00000152
Medan Selayang	2,7964	1,6720	0,00000391
Medan Sunggal	1,7575	1,3255	0,00000194
Medan Helvetia	1,4038	1,1847	0.00030378
Medan Petisah	2,8807	1,6969	0,0000459
Medan Barat	1,3618	1,1666	0,00000178
Medan Timur	1,4805	1,2165	0,0001018
Medan Perjuangan	0,9846	0,9920	0,00020082
Medan Tembung	0,7398	0,8600	0,0000676

It can be seen that the sub-district that has the highest relative risk is Medan Baru District with the value and relative risk value of the CAR estimator of 2.0040. Similar to the analysis of the SMR model, this is because this sub-district has a small area and the opportunity value for the positive risk of COVID-19 is high but not the highest. In addition, the direct estimator value is high, when compared to the CAR model, Medan Baru District is also a sub-district with the highest estimated parameter value.

Spatial Bayesian Conditional Autoregressive Modeling, Modeling the number of confirmed cases of the COVID-19 virus uses case number data and involves population size data as a comparison. In this modeling, a useful method is used to draw high and low risks to the average value so that there is smoothing on the relative risk, but by considering the spatial information obtained from the analysis process. Bayesian Conditional Autoregressive estimates can be mapped into five classes (quantiles).

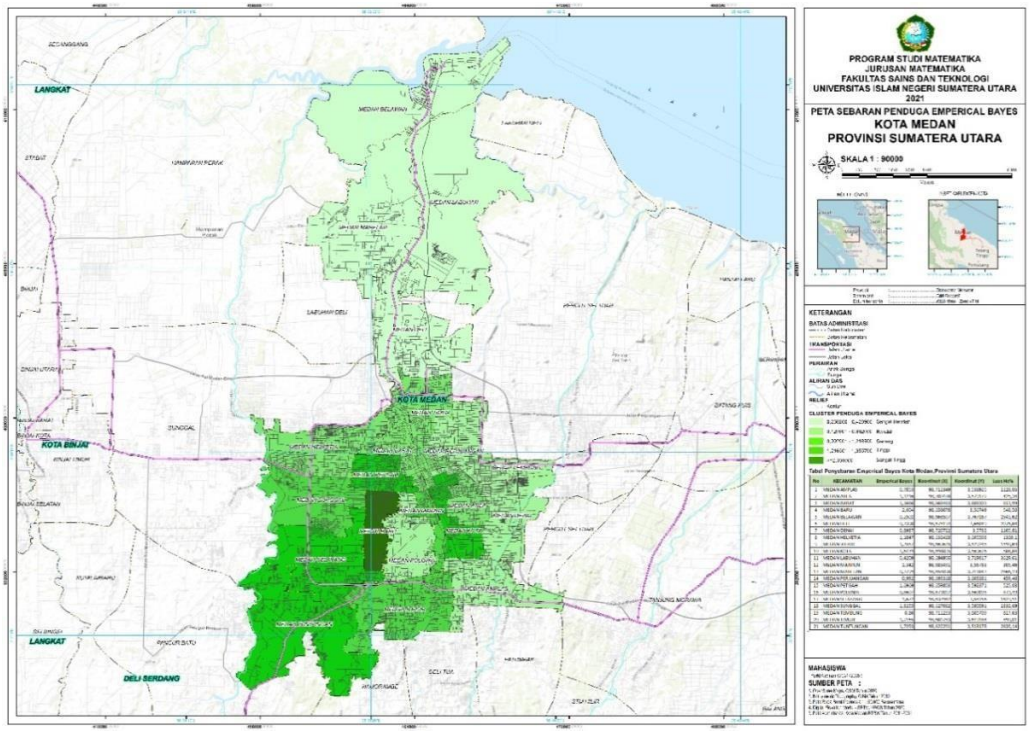

Figure 2 Spatial Bayesian Conditional Autoregressive Relative Risk Estimation Map

4. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that in this study the Medan Baru sub-district has the highest risk level of contracting the COVID-19 virus by using the Standardized Morbility Ratio model, the relative risk value level is 3.4624710. When compared with Bayesian Conditional Autoregressive from 21 sub-districts, the results of the analysis using CAR also show that Medan Baru sub-district has the highest risk with a relative risk value of 2.0040.

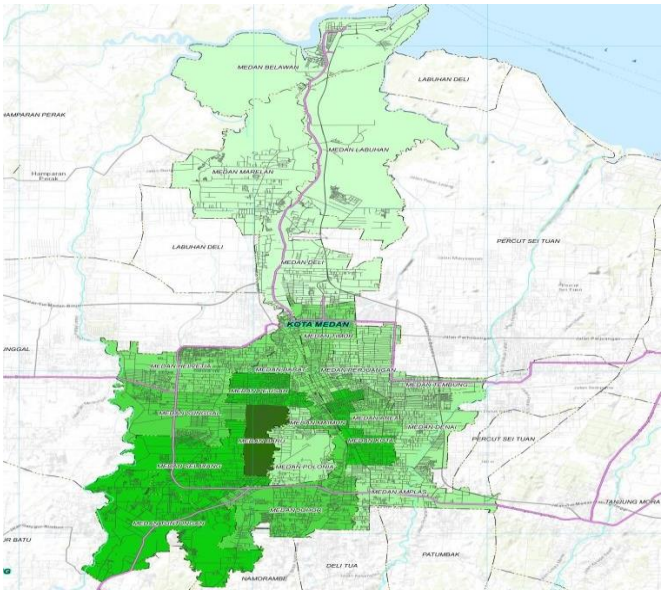

Figure 3 Spatial Bayesian Conditional Autoregressive Relative Risk Estimation Map

The distribution of the map in dark green is the area with the highest relative risk of the 21 sub-districts in the city of Medan. Furthermore, it is also proven that based on the Mean Squared Error criteria, the estimation of the relative risk of the Bayesian Conditional Autoregressive (CAR) model gives better estimation results than the direct estimation of the Standardized Morbility Ratio (SMR).

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