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Geospatial Analysis of Cervical Cancer Distribution in South Sulawesi Province

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Abstract

BACKGROUND: Cervical cancer, which is classified as a non-communicable disease, is a health problem that is of global concern at this time. Indonesia ranks second in the highest number of cervical cancer cases in the world with 36,633 cases per year. For this reason, optimization efforts are carried out to prevent the increase in the prevalence of cervical cancer patients in the province of South Sulawesi.

AIM: The purpose of this study was to determine distribution pattern, level of risk, and spatial cluster of cervical cancer in South Sulawesi Province.

METHODS: Geospatial analysis using Global Moran's I and Local Moran's I.

RESULTS: The results of the geospatial analysis of the prevalence of cervical cancer in South Sulawesi Province show that in 2016, there were two spatial hotspot clusters (H-H), one cold-spot spatial cluster (L-L), two spatial outlier clusters (H-L), and one spatial outlier cluster (L-H). In 2019, there were only two spatial hotspot clusters. Geospatial analysis of the prevalence of cervical cancer shows an increase in efforts to prevent cervical cancer from 2016 to 2019. However, there are still spatial hotspot clusters in 2019, especially in rural areas.

CONCLUSION: The efforts to prevent cervical cancer need to be optimized, especially in rural areas, in the future.

Introduction

Non-communicable disease (NCD) is one of the health problems of global concern currently. Data from the World Health Organization (WHO) in 2016 showed that of the 57 million deaths that occurred due to a disease, 41 million or nearly two-thirds of them were caused by NCD. In countries with low to middle economic level, 29% of deaths that occur in people aged <60 years are caused by NCDs [1]. One of the most common types of NCD is cervical cancer. Cervical cancer is one type of cancer that causes many deaths among women worldwide. Nearly 90% of deaths from cervical cancer occur in the developing countries [1]. According to the Global Cancer Observatory report, Indonesia ranks second in the world with the most cases of cervical cancer with 36,633 cases per year. The incidence cumulative of cervical cancer patients in Indonesia in 2020 was 17.2% [2], [3]. Risk factors for cervical cancer have been identified by several researchers and show that a higher risk of disease is related to age, human immunodeficiency virus infection, multiple term pregnancies, and smoking. In addition, it was found that geographical location is also associated with the risk of cervical cancer. Cheng (2011) investigated geographic patterns of incidence and epidemiological characteristics of cervical cancer using Poisson regression geographically and found that cervical cancer incidence rates vary spatially across the UK. Thongsak *et al*. (2016) showed that the incidence of cervical cancer in Thailand is related to location. The incidence rate of cervical cancer has spatial variation and the highest rate of incidence of cervical cancer occurs in the eastern part of North Thailand [4].

Calculation of incidence and prevalence can be used as an illustration of the level of success of the program in eradicating the disease. Incidence and prevalence data are used by health planners to measure the need for hospital care and services, assistance in planning health facilities, and workforce needs [5], [6], [7], [8], [9], [10]. Therefore, it is important to conduct a spatial analysis of the domicile of cervical cancer patients in South Sulawesi Province. The domicile location of cervical cancer patients can be an important study to assess the risk of worsening in an

effort to control risk factors. This risk of aggravation can be carried out through geographic disease mapping to see spatial incidence and to detect areas that have a high risk. Therefore, this study will analyze the risk of cervical cancer spread using spatial data of the patient's domicile. The purpose of this study was to determine distribution pattern, level of risk, and spatial cluster of cervical cancer in South Sulawesi Province.

Methods

This research was conducted in the province of South Sulawesi, Indonesia, from 2016 to 2019. The province of South Sulawesi is in the central part of Indonesia, with a population of 9 million people. The data used are women who were screened for visual inspection with acetic acid (VIA) test from Provincial Health Office of South Sulawesi in 24 districts/cities. Data processing is carried out at the Department of Public Health and Community Medicine, Faculty of Medicine, Universitas Hasanuddin.

Geospatial analysis of cervical cancer was carried out using the Univariate Global and Local Moran I methods to distinguish and map spatial clusters. The type of spatial association or cluster pattern in an observation area can be expressed as a combination of the height (H) and low (L) criteria. The HH combination represents an area that has a high observation value as well as the surrounding area. The LL combination denotes an area with low observation values equal to the surrounding observation area [11], [12]. The LH combination represents an area that has a low observation value but the surrounding area has a high observation value. The HL combination represents an area with high observation values but low observation values for the surrounding area [13]. The combination of H and L can be used to analyze the distribution pattern of cervical cancer risk. The combination of H and L can reveal the hotspot location of cervical cancer that corresponds to the level of risk in an area of observation.

Results

The VIA test was conducted on women of childbearing age in 24 districts/cities in the province of South Sulawesi from 2016 to 2019. Figure 1a and b shows the number of women taking the VIA test and the number of test participants who were positive for cervical cancer. The number of women in the VIA test tends to increase, as shown in Figure 1a. The increase in the number of VIA tests indicates that there are better habits in cervical cancer prevention efforts in 2019.

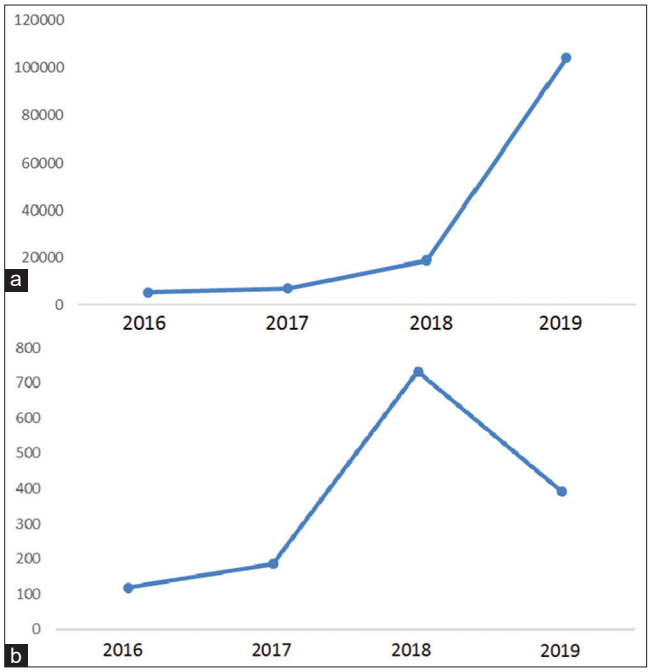

Figure 1: (a) The number of VIA tests. (b) The positive rates of VIA test

Figure 1a and b shows the number of VIA tests and the number of positive rate in the province of South Sulawesi, where a spatial analysis of the number of cervical cancer patients was carried out in 2016 and 2019. In 2016, the number of women participating in the VIA test varied widely across 24 districts/cities, ranging from 33 to 1253 women. The average number of VIA test participants who were positive for cervical cancer was seven women (minimum = 0, maximum = 24, and standard deviation = 8.24). The proportion between positive test results and the number of test takers varies by district/city. The proportion of test participants with positive VIA test results was 5.07 (minimum = 0, maximum = 66.67, and standard deviation = 13.34).

The results of the VIA test look better in 2019 compared to 2016. The number of women taking the VIA test is increasing, but the number of test participants with positive results is decreasing. In 2019, the number of participants and test results varied in each district/city. The number of VIA test takers ranged from 399 to 14,220 women. The rate of positive VIA test results was sixteen women (minimum = 0, maximum = 67, and standard deviation = 20.30). Meanwhile, the significant proportion of positive VIA tests was 0.99 (minimum = 0, maximum = 7.50, and standard deviation = 1.71).

A comparison of the number of participants in cervical cancer tests in 2016 and 2019 in each district/city of the province of South Sulawesi is shown in Figure 2. In general, the number of participants for the VIA test was relatively low in 2016. There are 22 districts/cities with low and only two districts/cities with high participation rates. However, the number of

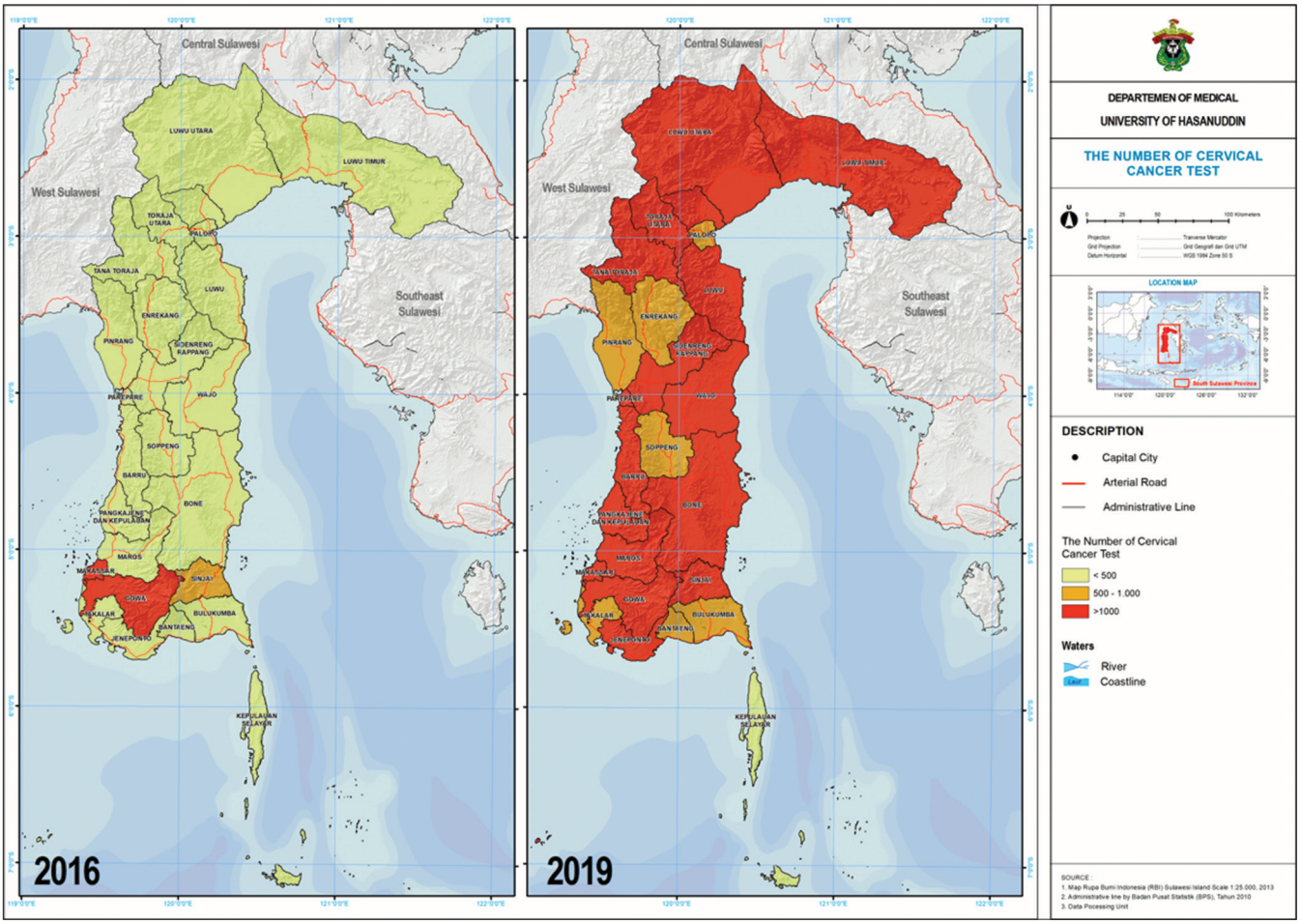

Figure 2: The number of participants in the VIA test of South Sulawesi Province in 2016 and 2019

participants in the VIA test tends to increase in 2019 in every district/city except the district/city which has a low number of participants in the VIA test in 2016 as well as in 2019.

Cervical cancer geospatial analysis

Figure 3 shows the results of the spatial cluster for the number of VIA test participants. There is a low category spatial cluster for the number of VIA test participants in 2019. Spatial cluster centers with low participation rates are located in Wajo district/city with surrounding areas such as Bone, Soppeng, Sidenreng Rappang, and Luwu district/city.

Moran's test was also carried out on the VIA test participants with positive results. This was done to see its spread in the research area in 2016 and 2019. Global Moran analysis for participants with positive cervical cancer tests showed that the spatial distribution of cervical cancer in 2016 tended to spread randomly and tended to form spatial clusters in 2019. The results of the Moran index are shown in Figure 4 as follows:

Analysis of spatial clusters and spatial outliers for cervical cancer patients in 2016 and 2019

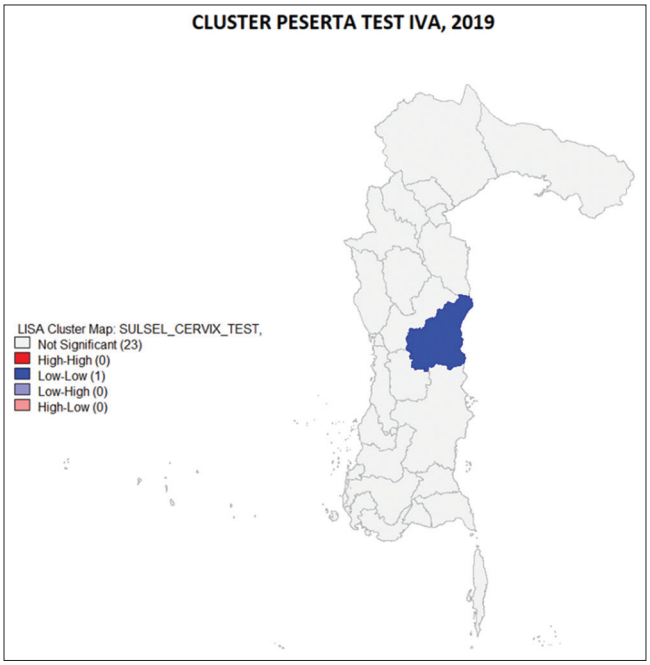

Figure 3: Spatial cluster of the number of participants in the VIA test in 2019

(Figures 5a and 5b) was carried out using the local Moran index. The results of the 2016 cluster analysis (Figure 5a) show that there are spatial clusters and

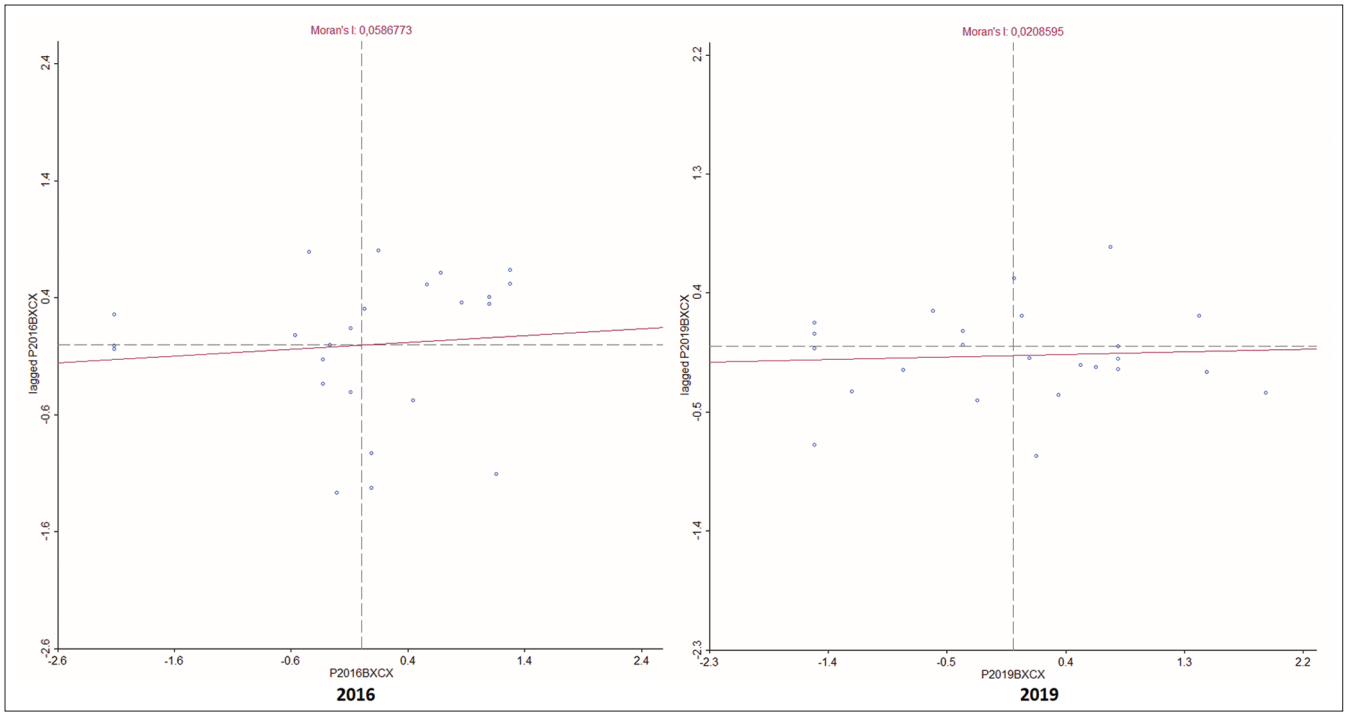

Figure 4: Global Moran's value of cervical cervix in 2016 and 2019

spatial outliers. There are two hotspot/high-high spatial clusters (red), one cold-spot/low-low spatial cluster (blue), and two low-high (purple) and high-low (orange) spatial outliers. The location of two spatial hotspot groups in Barru and Bone districts, one cold-spot spatial group in Jeneponto district (Low-Low), and two spatial outliers (high-low) located in North Luwu and Bulukumba districts, and spatial outliers (low-high) in Soppeng district.

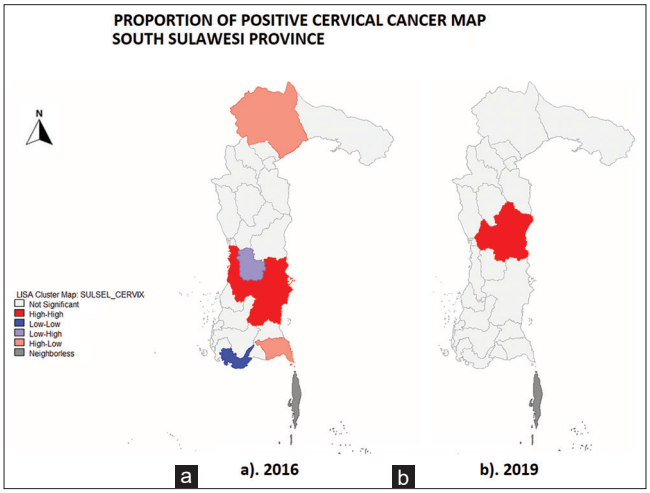

Figure 5: Spatial cluster map of proportion of positive cervical cancer at 2016 (a) and 2019 (b), in South Sulawesi Province

In 2019, there were only spatial clusters with high categories and no cold-spot or spatial outliers were found. The spatial hotspot clusters are located in two different locations, namely, in Sidenreng-Rappang Regency and Wajo Regency (Figure 5b).

Discussion

In this study, a geospatial analysis was made for cervical cancer sufferers and for the number of participants in the VIA test in 2016 and 2019 in South Sulawesi Province. In addition, an analysis of the relationship between the number of cervical cancer patients and the number of women of childbearing age was conducted. This study uses the local and global Moran indices to identify spatial clusters and spatial outliers at the district level and the Poisson regression model to assess the relationship between the number of cervical cancer sufferers and the number of women of childbearing age.

The number of participants in the VIA test in South Sulawesi Province increased from 2016 to 2019. In general, the number of participants was relatively low in 2016. The same result was found by Sumarmi *et al*. (2021) who concluded that cervical cancer screening rates are still low among rural women in Indonesia. Budkaew and Chumworathayi (2014) revealed that the low level of education and income caused obstacles in obtaining adequate data on cervical cancer [14], [15].

Various efforts have been made by the South Sulawesi provincial health authorities in districts/cities to increase the number of participants in the VIA test. Dissemination of information about the importance of early detection of cervical cancer has succeeded in increasing the number of VIA participation in 2019. Increased testing efforts can help health authorities in preventing the increase in the number of cervical

cancer sufferers. As shown in Figure 1a, the number of participants in the VIA test increased but the positive test results showed a decreasing trend. This shows that prevention efforts so far can reduce the number of cervical cancer sufferers.

Spatial cluster analysis of the number of cervical cancer patients was carried out in the province of South Sulawesi in 2016 and 2019. There were differences in spatial cluster patterns at both times. Spatial cluster patterns such as hotspot and low spatial clusters and spatial outlier patterns occurred in 2016. However, there were only spatial hotspot clusters in 2019.

All spatial patterns such as spatial hotspot clusters, cold-spot spatial clusters, and spatial outliers, in 2016, generally occurred in rural areas. Cold-spot spatial clusters occur in Jeneponto, Takalar, Gowa, and Bantaeng Regencies. This happens because prevention efforts through health promotion about the importance of avoiding cervical cancer are running effectively. Therefore, the prevention efforts that have been made so far need to be maintained. Meanwhile, spatial hotspot clusters occur in the Bone, Barru, and surrounding areas. Several efforts on the importance of preventing cervical cancer in women of childbearing age need to be continued in the region.

Nilima, 2020, also conducted a study with a similar approach by mapping cervical cancer screening. Findings in vulnerable locations need further research and better policies will encourage cancer screening among women. The study helps to adjust resource requirements. The cold-spot areas identified will contribute to the design of prevention strategies in underperforming districts compared to the overall national plan. Appropriate interventions, health promotion programs in the region, and allocation of funds for screening services will increase the percentage of screening, ensuring a reduction in cancer incidence, missed cases, and presentation of late diagnosed disease. The map presented serves as an evaluation of program progress made in addressing the issue of screening among women and provides direction for further research in locations where the percentage of continued screening is a challenge [16].

In addition, high spatial outliers were found in Bulukumba and North Luwu. Women of childbearing age who live in these areas do not have adequate information on how to prevent cervical cancer due to the geographical conditions of the two areas. The low spatial outlier pattern occurs in the district/city of Soppeng. The number of cervical cancer sufferers in the district/city of Soppeng is relatively lower than in the surrounding areas. This shows that women of childbearing age in this district/city have a relatively good understanding of developing a healthy lifestyle in an effort to prevent cervical cancer.

In 2019, there were two spatial hotspot groups located in Wajo and Sidenreng Rappang. This demands further investigation into the causes of the high rates of cervical cancer in these two areas. Compared to 2016, efforts to control cervical cancer in 2019 have shown better results. The average number of cervical cancers decreased in every district/city in 2019. This indicates an increased awareness of women of childbearing age in cervical cancer prevention.

In general, the pattern of cervical cancer in 2016 and 2019 was mainly found in rural areas. This could be due to the lack of understanding of women of childbearing age on the early prevention of cervical cancer. Therefore, efforts to prevent cervical cancer need to be optimized in rural areas in the future.

Conclusion

This study analyzes the spatial pattern of cervical cancer distribution in the province of South Sulawesi. The spread of cervical cancer formed different spatial clusters and spatial outlier patterns in 2016 and 2019. In 2016, there were hotspot and low spatial cluster patterns, as well as spatial outliers. In 2019, there is only a spatial cluster pattern of hotspots. Wajo and Sidenreng Rappang districts were identified as the center of the spatial hotspot cluster. In general, the pattern of cervical cancer in 2016 and 2019 was mainly found in rural areas. Therefore, cervical cancer prevention efforts need to be optimized in rural areas in the future.

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Ethical Clearance

Yes, from Integrated Laboratory Building, Universitas Hasanuddin.

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