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Spatial Mapping of Infectious Diseases Cases for Puskesmas Surveillance Officers in the Work Area of the Depok City Health Office

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BSTRACT

Background: *Reflecting on the previous Covid-19 pandemic obtained from the results of the situation analysis, the author concludes that the Depok City Health Office must be able to conduct data analysis spatially, thus causing a lack of information about the spread of cases based on specific places such as villages and coordinate points (GPS), this data is useful for measuring how much disease spreads in an area and can support policy making and intervention quickly and appropriately. In addition, unlucky spa data is also useful for seeing the density of vectors in an area.*
Methods: *The research method was Quasi Experimental using the One Group Pre-Test and Post-Test research design, with a sample size of 40 people. The data collection technique uses pre-test and post-test questions, spatial mapping practice exercises and data analysis and interpretation exercises. The training will be held from 19 to 20 November 2021 at the Depok City Health Office hall. The data analysis test used the Paired T-Test, because the data was not normally distributed, it was continued using Wilcoxon analysis.*
Results: *The results of the study obtained a Z value of -5.581 with an Asymp value. Sig. (2-tailed) by 0.000. Because this value is < alpha (0.05), it can be concluded that there is a significant increase in knowledge by 5.6 times after receiving training.*
Conclusion: *To improve the performance of officers in terms of spatial mapping of infectious diseases, it is expected to conduct evaluations every 3-6 months and transfer knowledge from old officers to new officers if there is a change of officers.*

INTRODUCTION

In December 2019, the world, including Indonesia, faced a global health crisis in the form of the COVID-19 pandemic caused by the coronavirus, which originated in Wuhan Province, China. Learning from the experience of handling the COVID-19 pandemic, the government and health sector communities, especially surveillance officers, should be capable of taking swift and effective preventive and responsive measures, including analyzing the spread of infectious disease cases to suppress and prevent wider transmission.

In dealing with and preventing the spread of infectious diseases, the Depok City Health Office has not yet conducted data analysis on case distribution, particularly in terms of spatial data analysis. This has led to a lack of information regarding the spread of certain infectious diseases (such as the COVID-19 pandemic in 2020). Spatial data based on locations such as sub-districts, urban villages, or geographic coordinates, and visualizations that show the position of patients and the risk of disease transmission in specific areas—especially at the smallest administrative level, such as urban villages or rural areas—can help control and reduce the spread of diseases.

Based on the above, a study is needed involving a group of surveillance officers from the Depok City Health Office and all community health centers (Puskesmas) in Depok to assess and measure the extent of COVID-19 spread in each urban village. The goal is to provide input for policies on how to respond to and prevent the spread of the disease quickly and appropriately.

The objective of this study is to assess and enhance the knowledge and skills of a group of surveillance officers regarding the concept and utilization of technology, data analysis skills, spatial mapping interpretation, planning, and spatial mapping of diseases/health problems as input for policy and intervention. The results are expected to support data-driven health policy planning and intervention within the working area of the Depok City Health Office.

METHODS

This study employed a quasi-experimental design involving a single group that received training without a comparison group. The research used a One Group Pre-Test and Post-Test design, aimed at measuring changes in a variable before and after the intervention [1]. The training was conducted on November 19–20, 2021, at the DIBALEKA Hall of the Depok City Health Office.

The population of this study consisted of health surveillance officers from all community health centers (Puskesmas) within the working area of the Depok City Health Office, totaling 38 officers, along with 2 additional officers from the Health Office itself. The entire population was used as the research sample, making a total of 40 participants.

The data collection technique involved pre-test and post-test questions. Participants were given a test at the beginning of the first training day and the same test at the end of the training. This was intended to measure the participants' knowledge level on spatial mapping before and after the training. During the training, participants engaged in practical exercises on how to use and create spatial maps using their own laptops. While participants were carrying out these practical tasks, researchers conducted assessments using direct observation and a checklist instrument, focusing on participants' skills and proficiency in spatial mapping. After the mapping tasks, participants were also given exercises in data analysis and interpretation, which were assessed in the same manner.

For statistical analysis, a Paired T-Test was used to test the difference between two means. Prior to this, a normality test was conducted. If the data were not normally distributed, the analysis proceeded with the Wilcoxon Test [2]. The presentation of numerical data results in various forms, such as the test scores from training outcomes obtained from pre-test and post-test results, descriptive statistical analysis, and normality tests in the form of graphs and tables, along with examples of practical outcomes from spatial map creation [3]. This spatial mapping training uses a visual graphic application called Tableau, which can be downloaded at https://www.tableau.com/products/desktop/download. It also incorporates SHP files to display maps at the sub-district (kelurahan) level, uses Microsoft Excel for data entry of cases per sub-district, and utilizes Google Maps to obtain coordinate points..

RESULTS

The diagram above shows the pre-test scores on the left, with the lowest score being 25.53 obtained by 15 participants, and the highest score being 52.94 obtained by 2 participants. For the post-test scores shown on the right, the lowest score was 76.47 obtained by 2 participants, and the highest score was 100 obtained by 10 participants (figure 1).

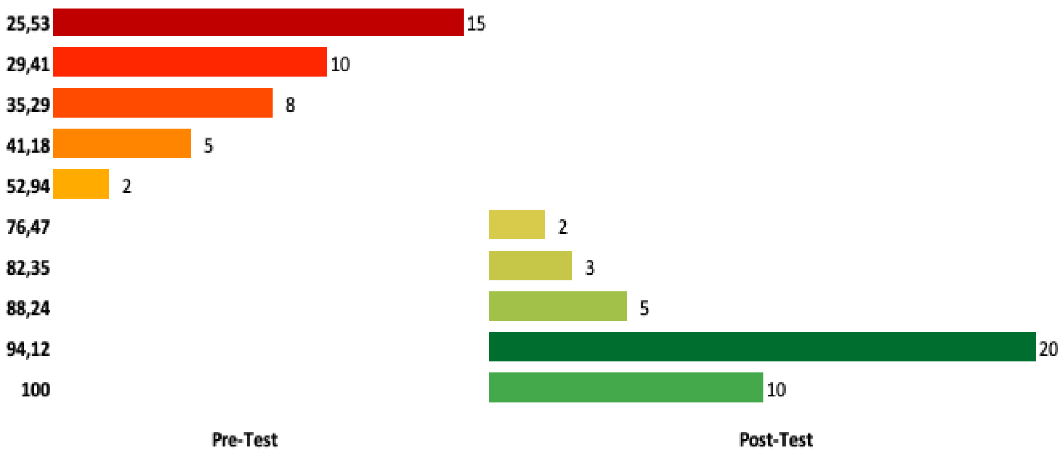

Figure 1. Pre-Test and Post-Test Scores

After processing the data, descriptive statistics were obtained, showing the minimum, maximum, mean, median, and standard deviation values. the median pre-test score of 29.41 increased significantly to 94.12 in the post-test. Similarly, the mean score increased from 30.88 in the pre-test to 93.23 in the post-test. Based on this analysis, it can be concluded that there was a knowledge increase of approximately 30% after the training (Table 1).

Table 1. Descriptive Statistics

	N	Min	Max	Median	Mean	Std.Dev
Pre	40	25.53	76.47	29.41	30.88	7.96
Post	40	52.94	100	94.12	93.23	6.18

A non-parametric test using the Wilcoxon Signed-Rank Test was then conducted to determine the difference in means for data that is not normally distributed. From the Wilcoxon test above, we obtained a Z value of -5.581 and an Asymp. Sig. (2-tailed) value of 0.000. Since the significance value is less than alpha (0.05), we can conclude that there was a statistically significant increase in knowledge, approximately 5.6 times higher, after the training (Table 2).

Table 2. Wilcoxon Signed-Rank Test

	Pre-Test Post Test Score
Z	-5.581^{b}
Asymp. Sig. (2-tailed)	0.000

The spatial maps resulting from the training were directly published on the official website for COVID-19 case reporting and visualization of the Depok City Health Office. The training utilized real data on the spread of COVID-19 cases in Depok City. The official website for the COVID-19 spread report of the Depok City Health Office can be accessed at: https://sites.google.com/view/laporanhariancovid-19kotadepok/home?authuser=0

The image below is an example of a spatial map showing the distribution of COVID-19 cases by sub-district level, created by training participants and published on the official website of the COVID-19 Task Force of Depok City in 2020 (Figure 2 and Figure 3).

Figure 2. Spatial Map of COVID-19 Case Distribution by Subdistrict as Displayed on the Official Website of the COVID-19 Task Force of Depok City in 2020.

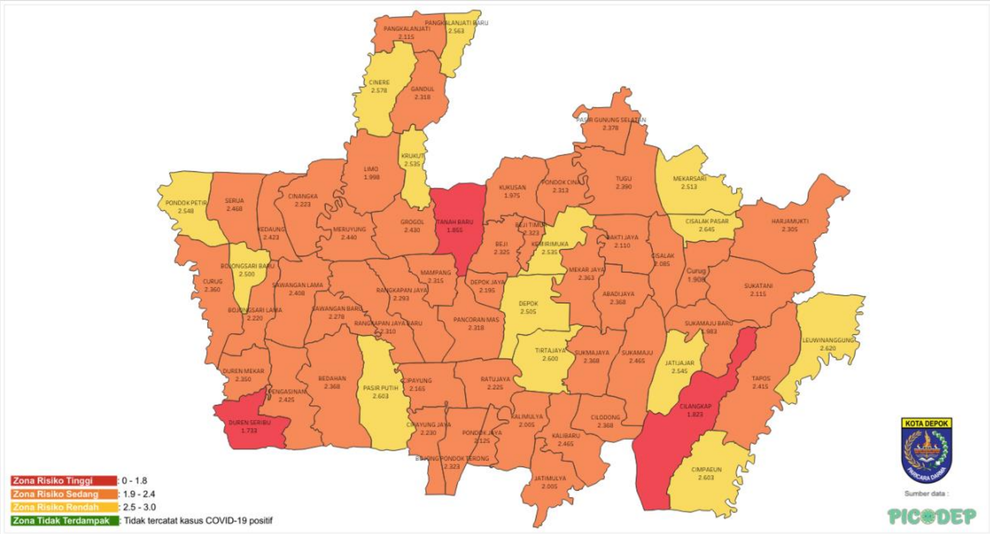

Figure 3. Spatial Map Results of COVID-19 Case Distribution by Subdistrict Level in Depok City, 2020.

The image below is an example of a spatial map illustrating the distribution of COVID-19 cases based on GPS coordinates. Areas with higher case counts are indicated in red. The map also includes a link to a website showing a video of the movement and spread of the first COVID-19 cases in Indonesia. These cases originated in Depok City and subsequently spread to various regions within Depok and beyond its borders in the year 2020 (Figure 4).

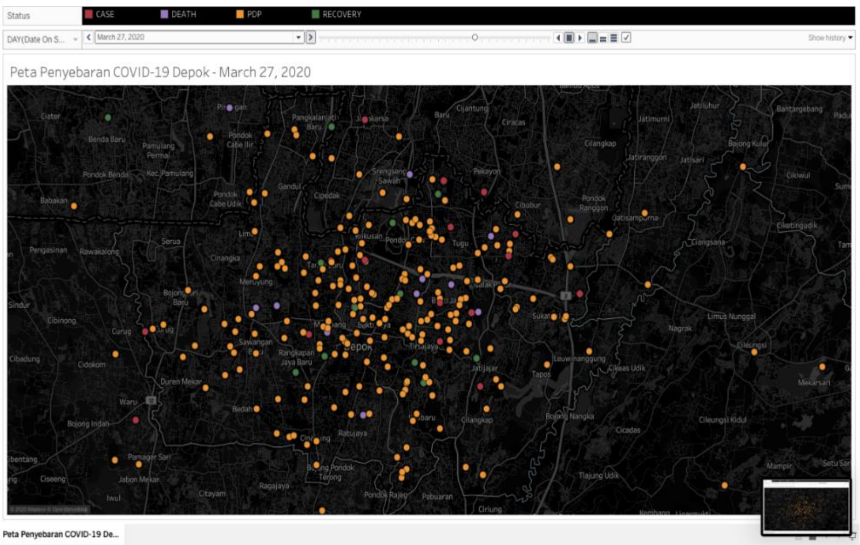

Figure 4. Spatial Map of COVID-19 Case Distribution Based on GPS Coordinates

DISCUSSION

The findings of this study align with previous research on knowledge improvement before and after training. Rahmawati and Saftarina reported a significant increase in knowledge, with pre-test scores averaging 30 and post-test scores rising to 80 among 18 *posyandu* (community health post) volunteers, showing a p-value of 0.000 [4]. Similarly, study Fatmah (found a 15-point increase in knowledge, with average pre-test scores of 64 and post-test scores of 79, demonstrating the effectiveness of training in enhancing knowledge and skills [5]. Furthermore, Study Adzkia et al. also reported a statistically significant knowledge increase after training and counseling, with a p-value of 0.005 [6].

The interval estimate of post-training knowledge was higher and broader compared to pre-training knowledge, and the distribution tended to shift upward. This is very understandable, as it was the participants' first exposure to this knowledge and information, resulting in very low pre-test scores. These pre-test scores indicate that the surveillance officers' level of knowledge is still very limited.

Research on spatial mapping, such as in the case of COVID-19, was also conducted by Ru-Jon Liao et al.. They highlighted the success of COVID-19 prevention and response strategies in the impoverished Liangshan Yi district in China, largely due to the efforts of surveillance officers who carried out epidemiological investigations, geographically mapped case distributions, and analyzed case data using spatial mapping methods. As of April 23, 2020, a total of 13 COVID-19 cases and two asymptomatic SARS-CoV-2 carriers were reported in Liangshan, across three family clusters. Among these cases, eight had a history of residing in Hubei Province (61.54%), with six linked to Wuhan. Based on this, the authorities used spatial mapping to identify areas with a high concentration of asymptomatic cases and implemented strict quarantine measures in those regions [7]. A similar study was conducted by Shahab Mohammad et al. Their spatial analysis research revealed that spatial mapping can uncover geographic patterns based on the incidence and mortality rates of infectious diseases.

A spatial mapping study of vector density was also conducted by M. Shahzad Sarfraz, who surveyed vector density in 92 villages in Phitsanulok Province, Thailand. The study collected Container Index (C.I.), House Index (H.I.), and Breteau Index (B.I.) values and applied spatial epidemiological analysis. A bivariate Pearson correlation was used to evaluate the level of interdependence between larval density and types of land use. Factor analysis was performed using Principal Component Analysis (PCA) with varimax rotation to identify variance among land use types. Furthermore, a spatial ring method was employed to visualize spatially-referenced, multivariate, and temporal data within a single informative graph. The study found that dengue indices indicated that settlements near gas stations/workshops, swamps/marshes, and rice fields appeared to be highly favorable habitats for dengue vector breeding, with a highly significant and positive correlation ($p = 0.001$) observed in May. The researcher concluded that gas stations/workshops, rice fields, swamps, and deciduous forests play a critical role in the growth of dengue fever vectors. Therefore, the spatio-temporal relationship between dengue vector larval density and land use types can help predict favorable habitats for dengue, enabling public health service managers to take proactive preventive measures against potential dengue outbreaks [8].

A spatial mapping study of vector density was also conducted by Ana Carolina in 2020, focusing on the density of *Aedes aegypti* mosquitoes. The study collected data on the House Index (H.I.), Breteau Index (B.I.), and Container Index (C.I.), and used Moran's Index for spatial analysis. The results indicated a high level of mosquito infestation, placing Campina Grande at an almost constant risk of arbovirus outbreaks and epidemics. A highly significant Moran's Index ($P < 0.001$) was observed, indicating a positive spatial dependency among neighborhoods in Campina Grande. By utilizing Moran mapping and LISA (Local Indicators of Spatial Association) mapping, the spatial autocorrelation patterns of *Ae. aegypti* infestation levels revealed hot spots that should be prioritized for preventive surveillance actions. The study concluded that spatial mapping analysis is an innovative strategy that can provide detailed information on investment locations to relevant public health authorities, enabling more efficient resource allocation—especially in the prevention of vector-borne infectious diseases [9].

Saputra explained the benefits of spatial mapping visualization in strengthening public health preparedness. It can assist in utilizing data on human mobility and disease vector movement, monitoring hospital healthcare systemssuch as spatially tracking patient surges and applying location allocation methods to determine the placement of new resources using risk-based population mapping. Health Offices and Community Health Centers (Puskesmas) can monitor and review case trends at the local level and enhance the quality of health surveillance [10]. Spatial mapping is also highly beneficial for surveillance officers at the Depok City Health Office, enabling them to create spatial maps and assist policymakers in implementing precise and cost-efficient interventions, such as during the hepatitis A outbreak in Depok City. The investigation conducted by Saputra et al in their outbreak investigation report also presented the disease distribution through spatial mapping and identified the source of the disease vector [11].

The benefits of spatial data include measuring the extent of disease spread and the distribution of vector populations in a given area. This information can support swift, accurate, and cost-effective decision-making and intervention strategies, enabling better control and reduction of the spread of infectious diseases and vector-borne illnesses.

CONCLUSION

There was increase in the knowledge of health officers after receiving spatial mapping training. The officers were able to create spatial maps of disease distribution within their respective community health center (Puskesmas) working areas. They were also capable of analyzing and interpreting data, presenting it effectively, and reporting the findings to their superiors.

RECOMMENDATIONS

Based on the conclusion above, to improve the performance of the surveillance system in mapping disease distribution, the researcher recommends the following; Conduct refresher training or on-the-job training for new staff, accompanied by experienced staff who are being transferred. The Depok City Health Office should evaluate spatial disease mapping reports every 3 to 6 months. The Depok City Health Office should provide updates on the latest information related to spatial mapping to Puskesmas officers, as well as the latest information on infectious diseases, including their spread and control measures, to help anticipate potential outbreaks within the Puskesmas working areas.

DECLARATIONS

Ethics approval

This research followed guideline of Declaration of Helsinki.

Conflict of interest.

The authors declare no conflict of interest.

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