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The importance of spatial analysis in health studies

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EDITORIAL

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Spatial analysis is a technique used to derive new information and insights from spatial data. Spatial data is data that has a location reference. Location is very important for spatial analysis because the results of spatial analysis depend on the location of the object being analyzed. The ability to handle location and spatial relationships explicitly distinguishes spatial analysis from other types of analysis.[1] Historically, spatial analysis was performed manually with simple measuring tools. Today, it is conducted using advanced computers and Geographic Information System (GIS) software. Spatial analysis has applications across multiple fields, including health. Dr. John Snow, who we know as the Father of Epidemiology, in 1854 mapped the cholera outbreak in the City of London. Spatial analysis was used to determine the relationship between the location of cholera deaths and the location of drinking water pumps. Based on the results of the mapping, the main cause of cholera cases in London can be identified.

The quantitative revolution of the 1960s and 1970s spurred the development and use of spatial analysis in the health sector. In 1975 there was a diffusion of perspectives in viewing a health problem from a spatial perspective. The development continued in 1997 for a decade, publications and research increased. In 2003, National Aeronautics and Space Administration (NASA) collaborated with the Central of Disease Control (CDC) to carry out the Environmental Public Health Tracking Network (EPHTN) program to determine the relationship between the environment and malaria. Since 2007, the diffusion of spatial analysis has become increasingly widespread, with it becoming a standard tool for investigating health and disease problems.[2,3,4]

Understanding the relationship between geographic location and health outcomes is a fundamental aspect of epidemiological research. Health geography and spatial epidemiology are interdisciplinary fields of study that analyze the complex relationships between health, place and space.[5,6] Geographic information systems is one technology used to analyze how characteristics of an area affect health. Health research using spatial analysis has grown substantially and will continue to grow, as technological advances (e.g., mapping software, remote sensing, big data, mobile health applications, global positioning systems, machine learning, and artificial intelligence).[7]

Health studies using an ecological spatial approach can answer critical questions such as: Where is the disease located? What causes it to appear? What are the patterns of persistence and transmission? How can it be mitigated? An ecological spatial approach can be used in health studies for several reasons below: a disease tends to be geographically limited; spatial variation is built from physical or biological variation that supports pathogens, reservoirs, and vectors; abiotic and biotic conditions can be delineated on a map and both can be combined simultaneously.

Spatial analysis using GIS can be used for several purposes, first, for data visualization and exploration. Health data in the form of disease data or health facilities can be visualized in the form of maps. Disease incidence location maps have an important role in spatial epidemiological studies. The uses of maps in disease investigations include: identifying areas with suspected increased risk of disease, assisting in the formulation of hypotheses about disease etiology, and assessing the potential need for geographic variation in follow-up studies, preventive measures, or other forms of health resource allocation. Secondly, spatial analysis using GIS can be used for data integration. Health data can be integrated with other data such as

population data, environmental characteristics data and socio-economic data. This data integration can be done with the help of GIS through the overlay process. The results of the integration of several data will produce new data that is richer in information and can be used for health purposes.[8]

Third, spatial analysis using GIS can be used for monitoring. Monitoring of disease incidence is needed for disease control planning. Monitoring is not only carried out on disease incidence but also monitoring of physical and social environmental conditions for health planning. In general, monitoring is carried out using spatiotemporal analysis. Reporting of disease incidence, births, and deaths in Indonesia has been carried out continuously through district and city health profile reports, so that the data can be used for spatiotemporal analysis. Fourth, spatial analysis using GIS can be used for modelling and Geostatistic. Geostatistics is a spatial statistical analysis that is currently widely used in the health sector. Spatial statistics are used to determine the relationship between health problems in an area and the conditions of land, climate, biotic and social characteristics. Social characteristics include economic stability access and quality of health care, access and quality of education, the surrounding environment and built environment, and social and community context. Spatial statistics used in the health sector include exploratory and inferential spatial statistics, Moran's I statistics, local indicators of spatial analysis, and spatial regression. Models are simplifications of the real world, models in GIS include binary models, index models, process models, regression/statistical models, network models and 3-dimensional models. Spatial modeling that is widely used in the health sector includes index models used for disease risk modeling, regression models to see the relationship between disease and environmental conditions, statistical models for model prediction. Network models are used to find the best route to health facilities.

Fifth, spatial analysis using GIS can be used for spatial interaction and diffusion. Spatial interaction models can help explain the spread of disease and predict the flow of disease spread. Example: model of the spread of influenza disease through flight data between countries/regions and between travel routes. Identifying in detail the path of disease spread. And sixth, spatial analysis using GIS can be used for data sharing and web services. The government's policy on one map one police will be assisted by data sharing and web service technology. Disease maps and health facilities can be accessed by interested parties quickly. Decision-making related to handling diseases in bordering areas can also be determined together based on shared spatial data. Monitoring the spread of diseases during a pandemic in real time can be easily done using web services. Reporting disease cases using the current dashboard is not only in the form of tabular data but also in the form of distribution maps, such as during the Covid-19 pandemic. Dashboards containing spatial information on diseases are increasing, including malaria, tuberculosis, dengue fever, stunting, mental health.[9,10]

In conclusion, spatial analysis in health studies continues to evolve, with GIS becoming an increasingly standard technology for investigating health and disease issues.. The use of GIS in the health sector can help in several ways such as description of spatial patterns of disease cases, factors influencing disease distribution patterns, the relationship between disease and environmental conditions including land physics, climate, biotic and socio-economic conditions of the community, mapping of health facility locations, service coverage and analysis of the adequacy of health facilities, site selection for building health facilities.

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