Kesmas

Volume 17
Issue 3 *August*

Article 1

8-31-2022

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Recommended Citation

Eryando T . Spatial Analysis for Enhancing the Use of Health Data Availability from Different Sources to Help the Decision-Making Process. *Kesmas*. 2022; 17(3): 165-168
DOI: 10.21109/kesmas.v17i3.6196
Available at: https://scholarhub.ui.ac.id/kesmas/vol17/iss3/1

Eryando. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2022; 17 (3): 165-168
DOI: 10.21109/kesmas.v17i3.6196

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Spatial Analysis for Enhancing the Use of Health Data Availability from Different Sources to Help the Decision-Making Process

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Abstract

Spatial analysis in public health has become a common method used by researchers to understand the distribution of public health aspects related to the surrounding environment. It can also be used to analyze individual information in the form of a dot and the location or line of aggregated information in a specific area of study. Another benefit is the possibility of using different data sources to be analyzed in one statistical model analysis, as long as the identification area is sufficiently clear as a key variable. Spatial analysis can show an object's distribution on a locational map and explain the distribution type, whether random, cluster, or uniform. The statistical analysis model can also develop different risk factors for each region of the research area. A specific model sometimes explains how to treat health issues differently in a specific location and can be used as an alternative approach to dealing with an intervention plan for public health issues based on specific local phenomena.

Keywords: secondary data, spatial analysis

Spatial Analysis

Spatial analysis has been developed as a quantitative statistical geography method since 1950. Based on the statistical model for spatial data, it was then put in the mathematical model.[1] Spatial analysis procedures are quantitative techniques that apply to geographic or location analysis.[1] Spatial analysis is based on the idea that everything relates to each other: everything is related to everything else, but near things are more connected than distant things. This is the first law of geography introduced by Waldo R. Tobler in 1969.[2] Spatial analysis can be established if autocorrelation exists. Public health phenomena related to the evidence's location can be used in spatial statistics that explain the phenomenon based on a geographic aspect or location.

Spatial analysis is a common term for exhibiting a technique using locational information to understand the process of producing an observation attribute. Data gathered to investigate health aspects usually focus only on observational attributes, such as disease distribution.[3,4] However, when the coordinates of the cases are collected, the pattern can be traced back to see the additional risk factors in the spatial phenomenon.[3]

Any data or information gathered, including the geographic location, is known as spatial data and can be analyzed using spatial analysis. The data forms range from discrete to continuous. There are three types of spatial data: point, line, and area data. Point data are analyzed to generate the type of distribution of objects in a specific area, and the distribution is classified as random, scatter, or homogenous. Line data are calculated to differentiate the area's density or the length of the line features, such as roads and rivers. For instance, the road length in an area is computed to predict the level of population mobility. Spatial area data, mainly in the aggregate dataset, are related to the geographic location. These data can be treated as point data if they involve a certain number of areas in the analysis.

Spatial analysis can generate information on spatial dependency, heterogeneity, and autocorrelation to develop a statistical prediction model that considers risk factors and the distance among the areas of study. The distribution and the amount of information in each area are calculated with a spatial statistic to show not only the pattern but also the relation to the size of the area compared to a neighboring area. The distribution and dis-

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Received : August 29, 2022
Accepted : August 30, 2022
Published: August 31, 2022

tance from the neighborhoods offer the relative connectivity among areas following the object or variable calculated. For instance, the distribution of stunted under-five cases can be evaluated. The map can examine the country's highest proportion of stunting compared with neighboring areas. The results set the priority intervention areas based on the detected hotspots and risk factors.[5] It is essential to highlight studies that examine how geographic (spatial) heterogeneity is modeled and how such perspective enriches scientific inquiry into public health issues.[6]

Spatial data analysis can be easily performed, as most secondary data are collected with geographic location information. Data from population censuses, personal health records, health facilities, and schools include locations. Today, information on geographic locations can be easily collected using the Global Positioning System (GPS) installed on a smartphone. Another opportunity to use spatial analysis is to disclose the possibility of an unidentified pattern. A scatterplot map with a straightforward mathematical operation can show the data in a geographic pattern. It shows the distribution of the natural phenomenon, which likely has environmental implications in the study area.

Utilization of Spatial Analysis in Public Health

Public health is the science that studies all health issues in community. One of the essentials in improving public health development is analyzing the distribution of health indicators. The analysis includes the distribution of inputs, such as health facilities and resources, and the intervention of public health products or results. The information can be used to monitor and evaluate public health problems to help improve the performance of health development based on regional units. Information often discussed in the health sector is the distribution of health resources, as well as the incidence of illness, both communicable and non-communicable diseases, and environmental risks that contribute to public health problems. It is common knowledge that the more densely populated an area is, the more likely infectious diseases will occur in that area. Environmental factors, occupations, and the distribution of healthcare can be analyzed spatially.

Public health study questions that can be answered using spatial analysis are listed as follows:

a. What is the description or distribution of the health variable?
b. Does this condition affect neighboring locations if a location impacts a variable?
c. How do we identify the location that is the center in giving the impact of a variable?
d. Does the location element affect the variable or object of study in influencing the dependent variable?
e. How can a particular location be predicted based on the value of its neighboring location variable?

This analysis can provide insight into spatial patterns, identify disease clusters, and explain or predict the risk factor of the object of study.[1,3]

Locational health-related factors and health care are critical to consider because the location is directly related to health problems and the occurrence of the interaction between the agent, the host, and the environment. Spatial analysis can help predict how health events occur in a particular area concerning health-related aspects and health care. Spatial analysis, which considers the location or space, determines the risk factors for the occurrence of health problems and how the relationship is related to the area's characteristics. Knowing the spatial analysis results' pattern makes it easier to set the priority for interventions for health issues. In terms of infectious diseases, it is easier to control the process of disease transmission to other areas. Spatial analysis can help make decisions about mitigation or prevention actions in public health development. The uneven distribution of the population and healthcare providers leads to geographic disparity in accessibility and varying workloads for staff at hospitals and health centers. The former leads to inequality in the utilization of healthcare resources by people and, subsequently, their health outcomes; the latter affects the stress level of healthcare professionals and the quality of care that they deliver.[6]

Applications of spatial analysis in the field of public health include the following:

1. Health data visualization. Mapping makes it possible to know what is happening in each place. This information is used to understand and describe specific properties in global and local spatial distributions.
2. Environmental correlation studies can explain the relationship between health indicators and environmental exposure.
3. This study focuses on revealing or highlighting a phenomenon that shows the assumed risk around a location. The population near the source is considered exposed and compared to the unexposed population.
4. Spatial analysis can be used to detect places which are considered to have specific public health problems. This study allows us to see the prevalence or incidence of a health-related incidence in a place, concentration, cluster, central place, or pattern of certain phenomena. It shows the possibility of a causal relationship between the characteristics of the area and the observed health-related incidence.

Utilization of Secondary Data

Health care and related institutions have widely collected and published information on health and the environment. Utilizing these available data makes it possible to conduct additional analyses using spatial analysis. To explain the phenomenon of public health and the environment surrounding it, secondary data are often considered inadequate for further analysis in some developing countries, including Indonesia. As national and international institutions collect the data, issues of validity and reliability become out of the question. The data are reasonably valid and reliable, therefore they can be used optimally for additional analysis to support decision-making at the local and national levels. Big data will be more accessible because specific data on key variables do not need to be merged before performing the analysis. Hence, scattered secondary data from many sources can easily be analyzed, without mentioning the type of data collection method, as the data represent the area of interest.

However, a weakness of secondary data is that large and massive data do not have the same measurement variable that can be used as a key variable for merging the variables with other data sources for additional statistical analysis. Spatial analysis allows the combination of various existing data sources, as long as the information on the geographic location of the data is well recorded. The location of these data is a key indicator for analyzing information from different data sources. Of course, the attention must be paid to the representativeness of the data for each area location. The data allow multivariable analysis to be carried out to determine the factors which play a role in developing regional-based health problem prediction models.

Threat to Validity

Threats to validity are not related to the secondary data to be used. The data available from national and international institutions are these institutions' legal and official products. Thus, the data that an institution has collected are explicitly designed for the framework it has set and do not always fit other parties' analysis plans. The issue of validity concerns how other parties will use the available data.

It should be noted that when researchers use secondary data for further analysis, they must pay attention to the measurement variables, so that they can be synchronized with the variables built within the framework of the research concept in further analysis. Several important issues are the non-identical measurement variables in the available data. Using a substantial amount of literature, the researcher must ascertain the possibility of making existing measurement variables proximate to the variables in the conceptual framework for further analysis of secondary data.

Advantages of Spatial Analysis Modeling

In addition to using information from various data sources, spatial analysis can build statistical models that show the phenomenon of health indicators. Spatial analysis can provide an overview, such as the distribution of health care, using maps as an information tool, and the distribution of health problems in each area of study. Therefore, researchers can easily understand whether there is a relation between the distribution of health problems and the distribution of healthcare. Evaluations can be used to strengthen the equity of the distribution of healthcare among the population in each region.

In addition, spatial statistics can help develop a statistical model that differentiates models for each area of study, such as using a geographically-weighted regression model. The results can inform researchers which independent variable is built or can explain the incidence of public health problems in an area that differs from the independent variables in other regions. Hence, the typical approach, such as the intervention scenario, is not necessarily the same, although the areas are similar. This technique can help decision makers evaluate the approach that has been performed. Later, they may change the scenario according to the local specific variable that forms the local spatial statistical model.

Conclusion

Encouraging public health researchers to use spatial analysis and GPS for distribution mapping or spatial statistics is essential. Big data from many different types of data collection and models are no longer an issue. As long as they represent the area of study, they can be used and analyzed together in a spatial model. The main statistical model represents different results for each analysis area, and the model can be used for a specific approach to an intervention for a particular area.

Abbreviations

GPS: Global Positioning System.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

The author declares that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

Not applicable.

Authors' Contribution

TE contributed substantially to the conception, writing, and revising of the manuscript.

Acknowledgment

Not applicable.

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