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What location tells us about the motivation of frontline medical volunteers in Ebonyi State

The reliance on the traditional heat and choropleth descriptive maps can introduce subjectivity and bias into the analysis and presentation of public health data. The decisions made by public health decision-makers therefore need more rigorous analysis. In this paper, motivation data collected from medical volunteers in Ebonyi State, southeast Nigeria, is used to illustrate how relying solely on such maps can potentially mislead public health decision-makers, causing serious implications for project planning, implementation, and cost. The paper highlights how the application of spatial statistics functions within Geographic Information Systems (GIS) can help public health managers avoid such pitfalls.

With the increasing demand for greater efficiency and effectiveness in public health interventions, the paper showcases how the use of geographic cluster and outlier analysis assisted the USAID/Nigeria's Health Workforce Management (HWM) Activity in identifying wards to conduct further investigations about motivation among frontline medical volunteers. The paper is aimed at raising awareness among public health practitioners and decision-makers about the availability of advanced GIS analytical tools. With the target audience in mind, the paper does not delve deeply into the technical details of spatial statistical analyses.

Overall, the paper emphasizes the importance of using advanced GIS analytical tools to enhance decision-making processes in public health, thereby improving the efficiency and effectiveness of interventions aimed at addressing healthcare challenges. The insights that the HWM Activity has gathered from the analysis are crucial for better identification of the areas to gather more useful perspectives to motivating medical volunteers, especially in the face of the challenges around health workforce recruitment.

Introduction

Public health practitioners have praised Ebonyi State for its remarkable performance on various maternal and child health indicators, as shown by the 2021 Multi-Indicator Cluster Survey (MICS) (Unicef, 2022). Despite facing an eight-year embargo on healthcare worker recruitment imposed by the previous administration, several Officers-in-Charge (OIC) of primary

Figure 1: Locations of respondents.

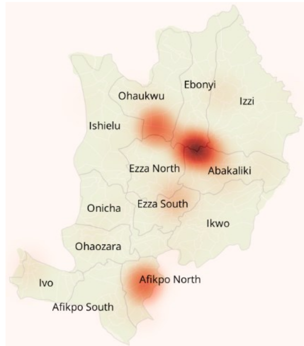

Figure 2: Classification of motivation scores using heat map

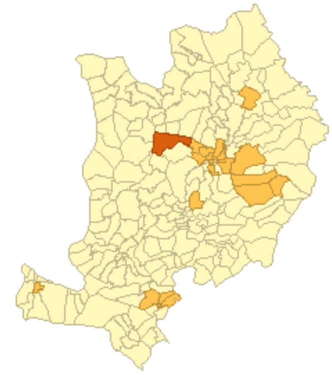

Figure 3: Classification of motivation scores using three natural breaks

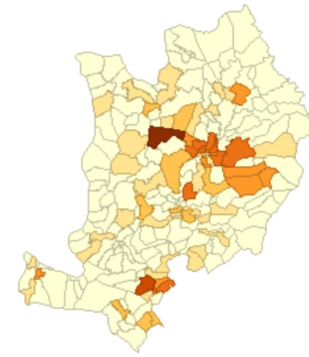

Figure 4: Classification of Motivation scores using five natural breaks

Photo Source: USAID HWM

health centers, enlisted the help of medical volunteers to fill frontline healthcare roles. The HWM Activity recognized that the medical volunteers are a health workforce stop-gap measure adopted by the OICs. It therefore sought to understand the roles that the medical volunteers played in the outstanding health outcomes that the state achieved as well as the factors that kept them motivated to serve despite receiving minimal stipends. Through spatial analytical techniques like hot and cold spot analysis and geographic cluster and outlier analysis, HWM aimed to figure out if the spatial pattern of motivation scores across the state was random or otherwise.

The paper complements the full research paper that was developed by HWM titled "Insights into the motivational factors of Ebonyi State frontline medical volunteers". By applying spatial analyses, HWM expects that the motivation scores from the study will follow Tobler's first law of geography which states that 'Everything is related to everything else, but near things are more related than distant things' (GISGeography, 2017).

The application of GIS in the analysis of public health data continues to grow. However, most of the applications have been limited to the use of choropleth, density, and heat mapping (Jones, 2023). The paper takes an entirely spatial statistics approach to better understand the underlying spatial patterns using GIS techniques. The application of the hot and cold spot technique is intended to introduce public health practitioners to the very powerful elements of spatial statistics including descriptive, inferential, and exploratory, among other types of statistics. Since spatial statistics usually involves the application of mathematical computations to understand space and spatial relationships such as pattern and shape analysis, spatial regression, statistical modeling, and prediction of spatial interaction, and more, the subjectivity of basic mapping techniques is reduced by the inbuilt spatial statistical functions.

Subjectivity of Maps

As a demonstration of the subjectivity of basic maps, Figure 1 presents an LGA and Ward map of the study areas in Ebonyi State. The dots on the map show the locations of the medical volunteers who partook in the study. From a purely visual perspective, one can begin to see patterns informed by the dots on the map. For instance, there is a concentration of respondents on the Abakaliki and Ebonyi LGA border. While this is true, it doesn't say much about the underlying attribute data as presented by the motivation scores of the individual respondents. Going beyond the presentation of the location of the respondents, we used their scores to create aggregated motivation scores for each ward. The scores were then used to create a heat map, Figure 2 and choropleth maps, Figure 3 and Figure 4.

The message conveyed in the resultant maps is significantly different from the visual perspective derived from Figure 1. They also convey three different messages and making decisions with them could be confusing and outrightly misleading. A heatmap like that presented in *Figure 2*, enables users to gain interesting insights into the spatial distribution of data and find spatial patterns based on the visual representation of geographic phenomena. Likewise, the choropleth maps presented in *Figure 3* and *Figure 4*. Making decisions on either of these maps is bound to lead to very different results. For instance, *Figure 2* presents four broad hotspots, *Figure 3* groups several wards with aggregated scores with those without respondents or scores and *Figure 4* embraces more of the wards with respondents' motivation scores. Besides, none of the maps use the motivation scores to make any meaningful interpretation of the locational relationship between the ward scores, making it very difficult to test Tobler's law of the relatedness of the wards.

Spatial Statistics

Spatial statistics work under the fundamental assumption that nearby georeferenced features show closer relatedness or association. Spatial statistical methods like "hot" and "cold" spot analysis as exemplified by the Getis-Ord Gi* method, help to find areas with statistically significant high or low values as presented in Figure 5. High values indicate a clustering of similarly high values in a specific location while low values
represent areas where the variable has values that are notably

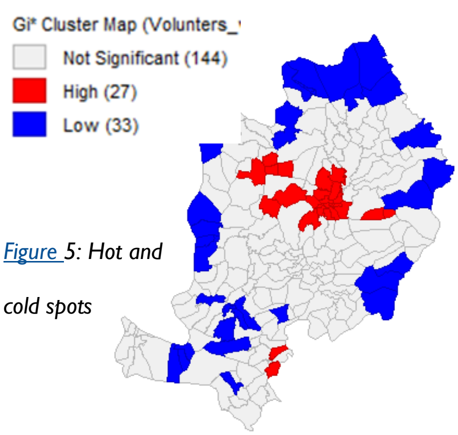

Figure 5: Hot and cold spots

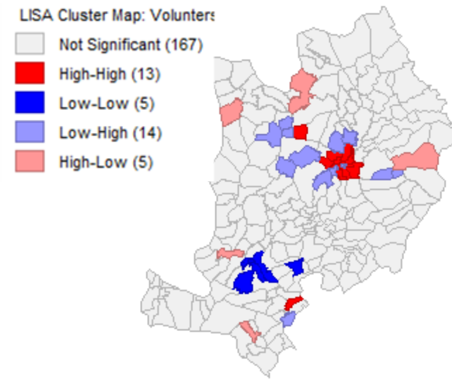

Figure 6: Clusters and outliers.

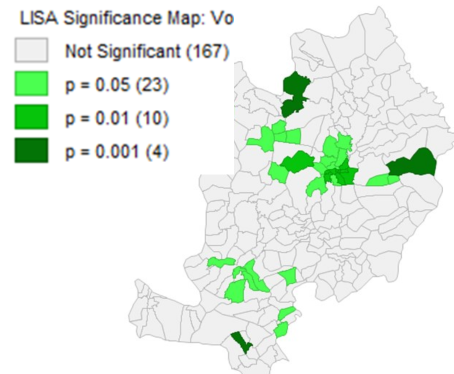

Figure 7: P-values for geographic clusters and outliers.

Photo Source: USAID HWM

lower than expected when compared to neighboring areas.

The geographic cluster and outlier analysis, utilizing the Local Indicators of Spatial Association (LISA), detect spatial clustering by assessing the degree of spatial autocorrelation at a local level within the dataset. We employed LISA statistics to calculate spatial statistics for each location, evaluating the similarity of the location's attribute value to its neighboring locations. The analyses enabled us to identify wards where similar motivation scores cluster, such as High-High (HH), where wards with high values are surrounded by other wards with high values, or Low-Low (LL), where wards with low values are surrounded by other wards with low values (see Figure 6). Of particular interest are the outliers characterized by High-Low (HL) and Low-High (LH), wherein wards with high values are surrounded by other wards with low values, or wards with low values are surrounded by wards with high values. The HL and LH wards represent areas of geographic significance because they deviate from the first law of geography. Therefore, these areas warrant our attention as we seek to gather further insights into the motivation of medical volunteers and understand the causes of deviation from Tobler's law, especially for wards that fall within the p-values of 95% and 99.9% as presented in Figure 7.

Conclusion

By applying spatial statistical methods, HWM gained valuable insights into the spatial distribution of motivation among front-line medical volunteers. We have also been able to identify political wards of concern, and we will work closely with the Ebonyi State Primary Health Development Agency to develop evidence-based strategies that will be used to support and sustain the efforts of the respective OIC for the continued provision of improved healthcare services.

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Health Workforce Management (HWM) Activity is a United States Agency for International Development (USAID)/ Nigeria task order under the Integrated Health Systems indefinite delivery, indefinite quantity contract. HWM supports the establishment of a cost-effective, well-trained, and motivated health workforce in targeted rural and remote areas of Bauchi, Sokoto, Kebbi, and Ebonyi States, as well as the Federal Capital Territory in Nigeria.

HWM strengthens the pre-service training learning environment and in-service training programs; supports the development of a robust human resources for health (HRH) information system to keep track of recruitment, deployment, retention, and continuing education; strengthens governance and management of the health workforce; and supports HRH research to improve HRH practices and retention mechanisms.

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