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Localized Spatial Clustering of HIV Infections in a Widely Disseminated Rural South African Epidemic

INTRODUCTION

Geographical Information Science is multi-faceted, and is becoming more prevalent in the field of health and medicine, under the term Health Geography. Here, we explore an example of such. Being a globally known epicentre for the occurrence and spread of HIV, South Africa expresses a need for greater HIV research and prevention. In that regard, this paper by Tanser *et al.* (2009) attempts to identify areas greatest in need of intervention and create geographical prioritization by analyzing the varying levels of HIV infection within the study area of KwaZulu-Natal, rural South Africa. Using the two spatial analytical techniques of Gaussian kernel and Kulldorff spatial scan statistic, clusters of HIV infections were discovered, revealing micro-graphical patterns of the disease spread.

METHODOLOGY

Located within Kwazulu-Natal, the study area was confined to the Hlabisa sub-district, covering roughly 438 km^2, containing a homogenous population of 87,000 (Tanser *et al.*, 2009). 12,221 HIV cases were taken from annual population based surveillance data from the Africa Centre Demographic Information System (ACDIS), through consensual HIV tests. These cases, along with their respective homesteads, were then geo-referenced with an accuracy of <2m, in order to preserve participant privacy.

The Guassian kernel analysis was used to create a geographical spread of the HIV cases, which showed variation across the area (Tanser *et al.*, 2009). This analysis allowed local variations in the data to be detected, while eliminating random noise and freeing the data from any geographical confinement. This was created by superimposing the HIV cases on a 30mx30m grid study area, then allowing the Guassian kernel analysis, with a 3km radius (found to be the distance within which HIV prevalence was spatially dependent), to pass over this grid, calculating prevalence estimates for each cell neighbourhood. The generated prevalence estimate for each cell was then overlain on a new map

with the same geo-reference. Together, these estimates were then smoothed to generate a contour map, ready for cluster detection.

Cluster detection allowed the identification of clusters of high and low infection areas. Tanser *et al.* (2009) used a Kulldorff spatial scan statistic, via the SaTScan spatial cluster dectection programme, to avoid multiple testing, and to provide the statistical significance (P-value of <0.05 generated from a Monte Carlo test) and location of each cluster. Kulldorff analysis used a circular window to run through the study area, changing its radius to a maximum of 3km (to compliment the Gaussian analysis), and using a likelihood ratio test statistic, to verify whether the number of HIV cases within the cluster was greater than expected, given the null hypothesis that the HIV cases were spatially random. The cluster with the greatest likelihood was the "most likely" cluster, indicating they did not occur by chance. The clusters were then categorized by education, employment level, household wealth, marriage, and migrants per household, via data from the Africa Centre's household socio-economic survey.

CONCLUSION

Tanser *et al.* (2009) mentions that the results of the Gaussian and the Kulldorff analyses agree with each other. The Gaussian analysis detected spatial heterogeneity of the HIV cases, and discovered the highest prevalence (>35%) occurred within homesteads near the National Road, and decreased significantly away from the road, with the rural areas having the least prevalence. The Kulldorff analysis identified 3 clusters that had high and excess numbers (high risk) of HIV cases (Relative Risk =1.34-1.62), and these were found near the National Road, where there is the highest population density, and were characterized by higher employment, education, wealth, and lower levels of migrants and marriage. The clusters of lower risk were found in more rural areas with lower population density. These results show that because the spread and severity of HIV varies across the region due to social, economic, and geographical aspects associated with the locations of high risk and high prevalence areas, targeted invention would be more successful than generalized intervention.

Overall, we give this paper a rating of 10 due to it's concise and understandable use of the GIS techniques. The authors properly articulated their steps, and provided rationale as to why each spatial

analysis technique was chosen and the results produced. Additionally, the results of this analysis furthers the overarching research surrounding HIV, and can definitely be widely implemented.

References

Tanser, F., *et al.* (2009). Localized spatial clustering of HIV infections in a widely disseminated rural South African epidemic. *International Journal of Epidemiology, 38*(4), pp. 1008-1016.