Geospatial Analysis of COVID-19 Vaccination: A Local Electoral Area Analysis in Ireland

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Background

The COVID-19 pandemic has demonstrated the important role vaccination plays in managing an infectious disease outbreak globally. There are several factors that might affect vaccination uptake, like vaccine center accessibility, urban-rural differences, and demographic variables. However, the influence of spatial determinants has not been widely done and this has potential to aid public health policy making during healthcare emergencies.[1]

Objectives of Project

- We aim to explore the spatial and demographic patterns associated with COVID-19 vaccination rates in Local Electoral Areas (LEAs) in Ireland.
- Examine differences in vaccination rates across LEAs over time, with a focus on potential variations between urban and rural areas.
- Evaluate accessibility to vaccination centres, including initial vaccination centres (preliminary vaccine dose centres), GPs, and pharmacies.
- Investigate potential associations between demographic characteristics in LEAs and vaccination rates.
- Assess the applicability of non-linear logistic growth models to describe trends in vaccination uptake over time.
- Identify and describe spatial and demographic disparities in vaccination rates, if present.

Data Sources

Data on centers offering COVID-19 vaccines are of three types:

1.Initial Vaccination Centers for COVID-19[2] 2.GPs[3] 3.Pharmacies[4]

They were **scarped** using **rvest** in **R** and **selenium** on **python (for dynamic webpages)**. They were all **geocoded** to obtain longitudes and latitudes using **Google Maps API**

LEA vaccination rates are in table **CDC47 in CSO website**[5]

LEA Boundary files were taken from **OSI**[6]

LEA Boundary files were linked to the CDC47 dataset by processing the LEA names to be same on both files and then using **merge** function on R to combine them on the LEA names.

Early Results

Figure 1, and Figure 2represent an exploratory analysis of Primary Vaccination Rates, with the former highlighting rates by LEA and the latter depicting trends over time on a monthly basis. Additionally, Figure 2provides a more detailed breakdown, distinguishing vaccination rates between urban and rural areas for each month.

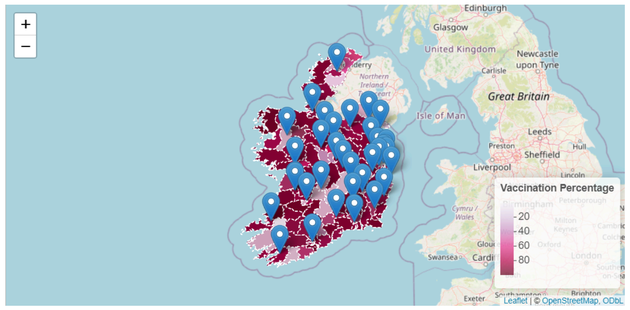

Figure 1: LEA wise Primary Vaccination Rates

The centroids of the LEAs were calculated and the distance of these centroids to the initial vaccination centers were calculated using sf and geodist packages The Geodesic method which gives highly accurate pairwise distance between two coordinates based on the WGS84 ellipsoid was used. The below Figure 3 depicts the distance of the LEAs to all the initial vaccination centers.

Figure 2: Primary Vaccination Course Completion Over Time

Figure 3: Distance to Vaccination Center

Next Project Steps

Geospatial Analysis: Inspect and extract variables that can be used to demonstrate accessibility to the vaccination centers. It can be done using routing APIs (e.g., Google Maps API, OpenStreetMap) to estimate travel times by car, public transport, or walking.

Additionally, spatial clustering can be carried out to identify areas with high or low accessibility

Demographic Analysis: Identify and extract local area level demographic summaries and transform compositional demographic variables by log-ratio transformations for modelling.

Model Development: Implement mixed-effects models like generalized linear mixed models or Bayesian linear mixed models to analyze which might best describe the vaccination uptake rates[7] [8]

In the presence of spatial autocorrelation, spatial regression models can also be analysed.

Determine the best fit model to data.

Feedback and Refinement: Review intermediate results and refine analysis as needed

GitHub

The code and datasets for this project can be viewed at our GitHub repository here: https://github.com/Siva-1247/HDS_Project_2425_SN.git

References

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