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Perspective

Risk of COVID19 Infection: Spatiotemporal Modeling

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ABOUT THE STUDY

The lack of knowledge about the virus's behaviour history, uncertainty about how it spreads in predictions of new waves, and inability to distinguish it, over space and time, from other viruses that present similar symptoms are some of the critical factors that have most influenced approaches to characterising the risk of infection by the SARS-CoV-2 virus (e.g., seasonal influenza). The ability to distinguish the space-time behaviour of the infection risk given the socioeconomic factors in each region, such as the concentration of risk groups in urban areas and the existence of retirement homes, is one of the most important challenges facing health authorities after approximately six months of gathering data and knowledge on the risk of infection.

A key consideration for the management of medical resources is the ability to distinguish the incidence of COVID-19 from other less dangerous viruses that exhibit the same symptoms. This is made possible by the spatiotemporal characterization of the risk of COVID-19. It will also aid in the identification of second waves by region and increase the possibility of doing so. In order to address those problems, it is necessary to lower the problem's dimension when incorporating six months' worth of daily infection rate data from a broad collection of localities.

We suggest using historical data to characterise the local spatiotemporal behaviour of infection risk and categorising the local spatiotemporal patterns of the time series to enable regional management of fresh waves. To simulate the spatiotemporal evolution of infection risk by COVID-19 in mainland Portugal, we combined functional data analysis with geostatistical modelling. The Portuguese Directorate-General for Health's daily infection data by municipality are used to create a time series of infections since the outbreak's start in Portugal.

To model local infection risk using COVID-19 temporal series, we created and applied an approach based on FPCA and geostatistics. It was also possible to obtain very detailed maps of the risk of COVID-19 infection at any time step in addition to being able to recognise various temporal trends. By modelling time and location simultaneously, it is possible to reconstruct the entire history of the epidemic and examine the relationship between socioeconomic factors and the efficacy of health policies, such as the effects of local, regional, or national mitigation and prevention measures.

Next, a description of the FPCA used to model the development of the cumulative infection time series for each municipality follows. Then, using stochastic sequential simulation at a high resolution, we map the crucial PCs at the national level. Using the created maps, it is possible to retrieve the cumulative infection rate curves locally at the resolution of the simulation grid.

It's a good idea to analyse what effect changes in mobility will have on outbreak rebound potential at a localised geographic scale before lifting the lockdown, and to keep track of changes in daily/weekly mobility patterns. Finally, geographic locations with a large concentration of senior people, particularly elderly people living in poverty, are at a much higher risk of COVID-19-related death, hence better monitoring and case follow-up should be assured in these more susceptible areas.

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