Covid-19 in Catalonia: small area estimation of cases, hospitalization, and a causal analysis of the effect of vaccination

Pau Satorra[1]*, Cristian Tebé*[2]*, Laura Igual*[3]

[1]psatorra@idibell.cat, Biostatistic Unit, Bellvitge Biomedical Research Institute (IDIBELL)

[2]ctebe@idibell.cat, Biostatistic Unit, Bellvitge Biomedical Research Institute (IDIBELL)

[3]ligual@ub.edu, Department of Mathematics and Computer Science, Universitat de Barcelona

Objective: To assess the evolution of COVID-19 cases, hospitalization and vaccination rates in the basic health areas (ABS) of Catalonia using spatial and spatio-temporal modelling techniques, and to perform a causal analysis of the effect of vaccination.

Methods: All data were obtained from open data registries of the Government of Catalonia from March 2020 to July 2022. Primarily, Bayesian hierarchical models, with the Integrated Nested Laplace Approximation (INLA), are used to obtain reliable estimates of cases, hospitalization and vaccination rates in all basic health areas (ABS). The method to perform a casual analysis of the vaccination rates on the hospitalization rates is still to be explored.

Results: For each ABS, on a weekly basis, we obtain different estimates of cases, hospitalizations, and vaccinations: smooth cumulative incidence rates, smooth standardised incidence rates, excess risk and the probability that this excess risk is greater than zero. Furthermore, an R shiny application is under construction to present the evolution of these indicators in a fashionable way through maps and graphical representations.

Conclusions: Small area estimation methods are able to provide more reliable estimates of cases, hospitalization and vaccination rates in each of the ABS, as information about the neighbouring areas and about the past can be used to smooth the results in each area. In addition, this study provides valuable insights into the evolution of the COVID-19 pandemic over time and by small areas. Not only incident cases, but also hospitalization and vaccination rates and how they all interact. Finally, the results are presented in an interactive and user-friendly shiny web application accessible to all public.