

Influenza Decline During COVID-19 Pandemic: a Global Analysis Leveraging Classification and Regression Trees

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The COVID-19 pandemic has caused a profound shock on the ecology of infectious diseases. Influenza offers a paradigmatic case. Its circulation reduced to very low levels or nearly zero after COVID-19 emergence. Since influenza and SARS-COV-2 share common transmission mechanisms, interaction between the two viruses can occur at many levels. In particular, change in human encounters due to non-pharmaceutical interventions (NPIs) against COVID-19 could have hindered influenza propagation. This complex interplay has been addressed so far by a number of studies focusing on specific countries. Here we address the problem at the global scale analyzing the FluNet influenza public repository for the periods before (2015-19) and during (2020-21) COVID-19 pandemic and leveraging machine learning. We map the space-time variation of influenza across countries. The percentage of positive tests decreased, globally, by 98.6% compared to the pre-COVID-19 period, despite surveillance remained broadly the same. The ratio of positivity rate in the pre-COVID-19 vs. the COVID-19 period was very heterogeneous across countries and seasons ranging from 6.3 to $1.4e^{-6}$. We thus used regression trees to quantify the impact of covariates such as COVID-19 incidence, strictness of NPIs, change in human mobility, demography, temperature and vulnerability of the country to infectious diseases. We found that influenza decline was mainly associated with COVID-19 incidence (positive association) and mobility, and also linked to vulnerability to infectious diseases, latitude, temperature and median age. Our study adds important elements to the understanding of the influenza circulation in the COVID-19 era and provides a basis for monitoring future influenza re-emergence.

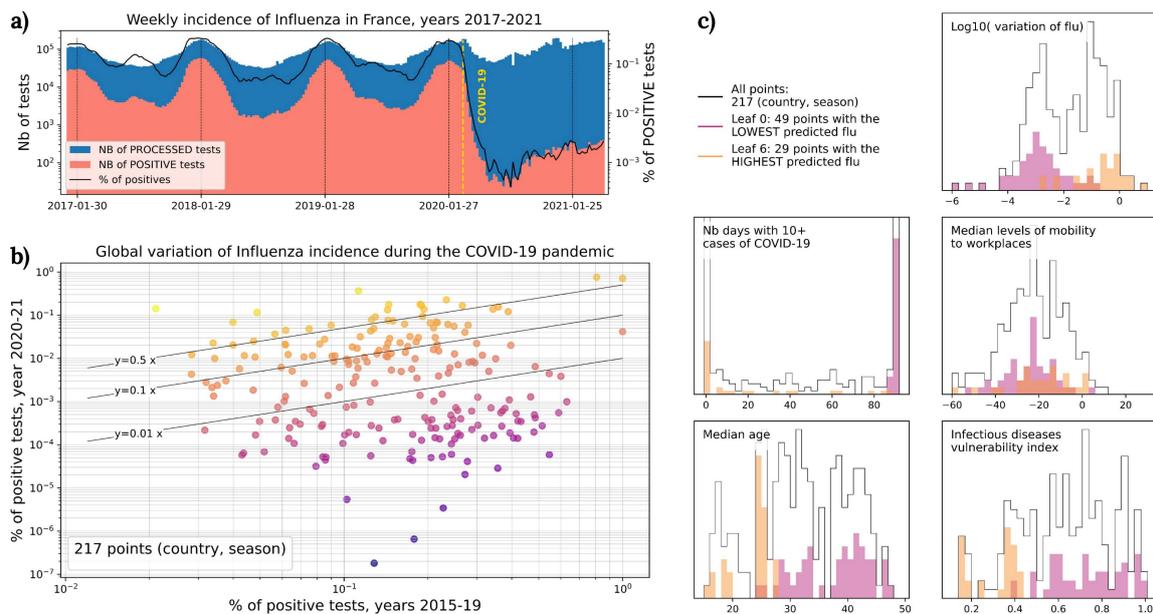


Figure 1: **a)** Weekly counts of processed and positive tests of influenza reported from 168 countries from Jan 2017 to Apr 2021. **b)** Comparison of the percentage of positive tests for the pre-COVID-19 period (2015-19) and the COVID-19 period (2020-21), considering 4 seasons and countries with at least 130 processed specimens per season. **c)** Results of the regression tree analysis. Distributions of the observed variation of influenza, daily COVID-19 cases per million inhabitants, median population age, mobility variation and temperature, for all countries/seasons and the ones with lowest and highest level of predicted influenza.