Regular school closure & influenza epidemics: a data-driven spatial transmission model for Belgium

School closure is often considered as an option to mitigate influenza epidemics because of its potential to reduce transmission in children and then in the community. The policy is still however highly debated because of controversial evidence. Moreover, the specific mechanisms leading to mitigation are not clearly identified. We introduced a stochastic spatial age-specific metapopulation model to assess the role of holiday-associated behavioral changes and how they affect seasonal influenza dynamics. The model is applied to Belgium, parameterized with country-specific data on social mixing and travel, and calibrated to the 2008/2009 influenza season. It includes behavioral changes occurring during weekend vs. week, and holiday vs. school-term. Several experimental scenarios are explored to identify the relevant social and behavioral mechanisms.
Stochastic numerical simulations show that holidays considerably delay the peak of the season and mitigate its impact. Changes in mixing patterns are responsible for the observed effects, whereas changes in travel behavior do not alter the epidemic. Weekends are important in slowing down the season by periodically dampening transmission. Christmas holidays have the largest impact on the epidemic, however later school breaks may help in reducing the epidemic size, stressing the importance of considering the full calendar.
Changes in the way individuals establish contacts during holidays are the key ingredient explaining the mitigating effect of regular school closure. Our findings highlight the need to quantify these changes in different demographic and epidemic contexts in order to provide accurate and reliable evaluations of closure effectiveness. They also suggest strategic policies in the distribution of holiday periods to minimize the epidemic impact.

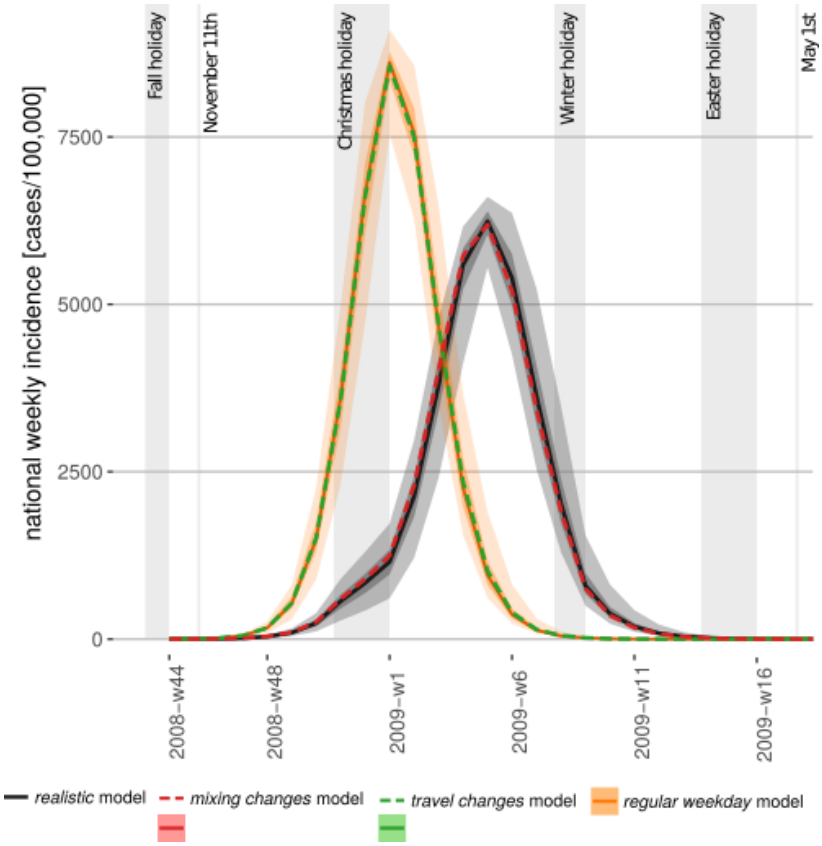

Figure 1: Simulated weekly incidence profiles for influenza in Belgium. The realistic model is compared to the travel changes model, the mixing changes model, the regular weekday model. Median curves are shown for all cases, along with 50% confidence intervals (dark shade) and 95% CI (light shade), for the realistic and regular weekday model (they are not shown for the other models for the sake of visualization).