The impact of vaccination on the spread of varicella in Hungary

CHALLENGES: Health, demographic change and wellbeing

PRODUCTIVE SECTOR: Public Health Care

PROBLEM DESCRIPTION

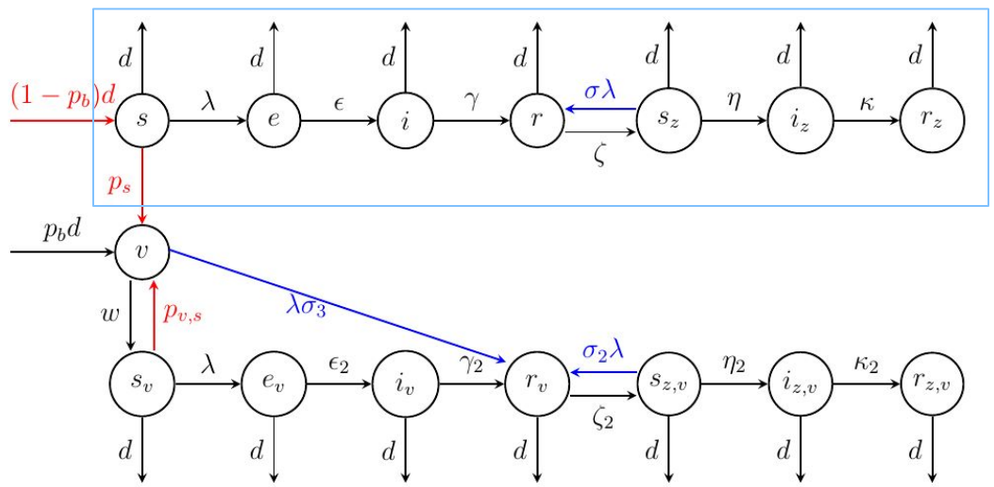
Varicella Zoster Virus (VZV) causes chickenpox typically in children, and herpes zoster in adults (reactivation of the latent virus). A vaccine can effectively prevent infections. In Hungary, varicella vaccination into the mandatory schedule incorporated in 2019.

CHALLENGES AND GOALS

- Build new models and incorporate vaccination strategies into them according to the Hungarian specialties including seasonality.
- Parameter estimation and sensitivity analysis
- The study of basic reproduction number and its dependence on underreporting
- The impact of vaccination on the incidence of varicella and zoster in Hungary
- The effect of various vaccination strategies.

MATHEMATICAL AND COMPUTATIONAL METHODS

We study the known dynamic transmission population-based models of Varicella-Zoster virus and implement them according to the specialties in Hungary. Concerning the simple models (see the figure), we fit the system parameters to the Hungarian incidence, and do parameter sensitivity analysis. Reported data show that Varicella shows high seasonality related to the academic year. This phenomenon is also built into our models. We investigate the dependence of the basic reproduction number on system parameters and the underreporting ratio what may be different in in countries according to the reporting system. We study the effect of vaccination scenarios in in the developed model variations.



$$\lambda = \beta(i + \nu\, i_z + \rho i_v + \nu i_{z,v})$$

Our basic transmission model with vaccination.
Upper part (framed) is the model with no vaccination used in parameter estimations.
λ: force of infection, proportional to the contacts of susceptible and infectious individuals.

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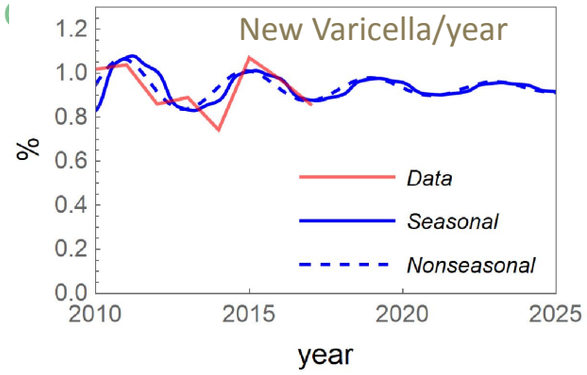
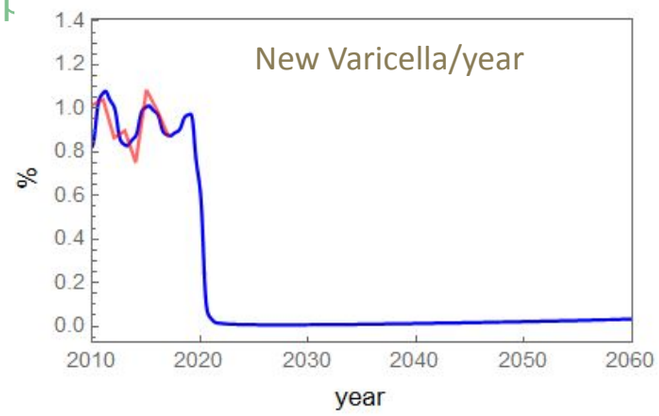
Results and Benefits

We have developed simple dynamic models (also including seasonality) for the spread of Varicella in Hungary. We have fitted our models to the available data. Sensitivity analysis was done to select the most sensitive parameters. Our models detect the 3-6 years long periodicity in infections. May be unexpected that basic reproduction number highly depends on the underreporting ratio, what may explain the differences between countries. We found that models without age-structure can describe the general phenomena. Age-structured hybrid models will be applicable to practical problems and



Incidence data and prediction by different models



Complete toddle and appropriate adult vaccination immunity waning: 20 years

The research group has the mathematical-computational methodology and tools to study large age-structured hybrid models in epidemiology. Modelling the vaccination against Varicella may support the decision making in public health administration.

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