UNIVERSITÀ DI TRENTO
Dipartimento di Matematica

DOTTORATO

CYCLE 36th
ORAL DEFENCE OF THE PHD THESIS

Tuesday 5 December 2023 – at 9.30 am

Department of Mathematics
Seminar Room 1

The event will take place in presence and online through the ZOOM platform.
To get the access codes please contact the secretary office

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PhD Student in Mathematics

Modeling the spread of SARS-CoV-2 variants during the COVID-19 crisis

Abstract:
The analysis of real-world data and the development of mathematical models played a fundamental role in understanding the epidemiology of COVID-19 and informing public policies throughout the recent pandemic. This thesis presents a collection of modeling approaches and results addressing key questions that arose during the COVID-19 crisis, with a specific focus on the emergence and epidemiological features of SARS-CoV-2 variants of concern (VOC) in Italy and related public health implications. In the first chapter, conducted analyses suggest that the Alpha variant was approximately 50% more transmissible than historical lineages of SARS-CoV-2, and that this transmissibility advantage was enough to outcompete a variant associated with immune escape phenomena and circulating in central Italy in February 2021 (i.e., the Gamma variant). In the second chapter, by investigating the potential impact of new hypothetical VOCs in Italy in late 2021, modeling results highlighted that the emergence of variants associated with significant immune escape (i.e., with a rate at which vaccinated or recovered individuals from infection with pre-circulating lineages become infected being at least one-fifth that of unvaccinated individuals who never experienced SARS-CoV-2 infection) would have been able to replace pre-circulating lineages in a couple of weeks. Strict restrictions would have been required to prevent a new large epidemic wave. In the third chapter, the analysis of genomic and epidemiological data associated with the expansion of the Omicron variant over the Italian territory revealed that this variant was able to become dominant at the national level in less than a month, increasing the net reproduction number from 1.15 to 1.83. Despite the marked growth advantage of Omicron compared to the previously circulating Delta variant, a moderate impact on the number of severe cases was observed, likely due to the high proportion of vaccinated individuals in the country by the end of 2021. In the fourth chapter, the estimation of the intrinsic generation time of the Omicron variant (mean: 6.84 days) was found to be similar to that of previous lineages. Such estimates have been key to define adequate isolation, quarantine, surveillance, and contact tracing protocols in 2022. The prevention of SARS-CoV-2 transmission in educational settings represented a key challenge during the pandemic, due to the large proportion of asymptomatic carriers in young individuals. The last chapter presented in this thesis shows that, when the Alpha variant was circulating in Italy, almost half of positive students and school personnel ascertained during in-person education were likely infected by school contacts. The mean number of secondary cases caused at schools was found to be 0.33, with high heterogeneity in the chance of onward transmission. Provided estimates suggest that the timely identification of cases combined with reactive quarantine policies had the potential of reducing SARS-CoV-2 transmission in schools by at least 30%

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