The Effects of Non-Pharmaceutical Interventions on SARS-CoV-2 Transmission in Different Socioeconomic Populations in Kuwait: A Modelling Study

Fatima Khadadah^{1†}, Abdullah A. Al-Shammari^{2,3†}, Ahmad Alhashemi⁴, Dari Alhuwail^{3,5}, Bader Al-Saif^{6,7}, Saud N. Alzaid⁸, Barrak Alahmad⁹ and Isaac I. Bogoch¹

¹ Department of Medicine, University of Toronto, Toronto, Canada

² Department of Mathematics, Faculty of Sciences, Kuwait University, Khaldiya, Kuwait

³ Dasman Diabetes Institute, Dasman, Kuwait

⁴ Department of Medicine, Adan Hospital, Ministry of Health, Al-Ahmadi, Kuwait

⁵ Department of Information Science, College of Life Sciences, Kuwait University, Sabah AlSalem University City, Kuwait

⁶ Department of History, College of Arts, Kuwait University, Sabah AlSalem University City, Kuwait

⁷ Carnegie Middle East Center, Beirut, Lebanon

⁸ Department of Surgery, Faculty of Medicine, Kuwait University, Jabriya, Kuwait

⁹ Department of Environmental Health, Harvard T.H. Chan School of Public Health, Harvard University, Boston, USA

E-mail: f.khadadah@mail.utoronto.ca

Received October 28, 2020

Accepted for publication December 23, 2020

Published online September 26, 2021

† Equal contribution

Abstract

Background: Aggressive non-pharmaceutical interventions (NPIs) may reduce transmission of SARS-CoV2. The extent to which these interventions are successful in stopping the spread have not been characterized in countries with distinct socioeconomic groups. We compared the effects of a partial lockdown on disease transmission among Kuwaitis (P1) and non-Kuwaitis (P2) living in Kuwait.

Methods: We fit a metapopulation Susceptible-Exposed-Infectious-Recovered (SEIR) model to reported cases stratified by two groups to estimate the impact of a lockdown on the effective reproduction number (R_e). We estimated the basic reproduction number (R_0) for the transmission in each group and simulated the potential trajectories of an outbreak from the first recorded case of community transmission until 12 days after the lockdown. We estimated R_e values of both groups before and after the lockdown, simulated the effect of these values on epidemic curves and explored a range of cross-transmission scenarios.

Results: We estimate R_0 at 1.06 (95% CI: 1.05-1.28) for P1 and 1.83 (1.58-2.33) for P2. On March 22nd, R_e for P1 and P2 are estimated at 1.13 (1.07-1.17) and 1.38 (1.25-1.63) respectively. After the curfew had taken effect, R_e for P1 dropped modestly to 1.04 (1.02-1.06) but almost doubled for P2 to 2.47 (1.98-3.45). Our simulated epidemic trajectories show that the partial curfew measure modestly reduced and delayed the height of the peak in P1, yet significantly elevated and hastened the peak in P2. Modest cross-transmission from P2 to P1 elevated the height of the peak in P1 and brought it forward in time closer to the peak of P2.

Conclusion: Our results demonstrate that a lockdown can reduce SARS-CoV2 transmission in one subpopulation but accelerate it in another. At the population level, the consequences of lockdowns may vary across the socioeconomic spectrum. Any public health intervention needs to be sensitive to disparities within populations.