School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 06/09/2023

TO: Faculty and Students

FROM: Professor(s) Abba Gumel
Chair/Co-Chairs of Adel Mohammed S Alatawi
Defense for the PhD in Applied Mathematics
Committee Members
Eric Kostelich
Haiyan Wang
Sharon Crook
Steven Baer

DEFENSE ANNOUNCEMENT

Candidate: Adel Mohammed S Alatawi

Defense Date: Monday, June 26, 2023

Defense Time: 9:00 AM

Virtual Meeting Link: https://asu.zoom.us/j/8077965318 Live Attendance: WXLR 206

Title: Mathematical Assessment of the Transmission Dynamics and Control of MERS-CoV and SARS-CoV-2 in the Kingdom of Saudi Arabia

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40-minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. However, guests are invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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ABSTRACT

The Kingdom of Saudi Arabia (KSA), which hosts some of the largest mass gatherings of humans globally every year, has seen the emergence of two coronavirus pandemics, namely the 2012 middle eastern respiratory syndrome (MERS-CoV) and the 2019 SARS-CoV-2 pandemics. This dissertation contributes in providing deeper insight into the transmission dynamics and control of the two diseases in the Kingdom. A model for SARS-CoV-2 transmission dynamics, which incorporates the key features of the disease, was designed first of all. Its disease-free equilibrium was shown, using Lyapunov function theory, to be globally-asymptotically stable when the associated reproduction number is less than one. The model, which has a unique and locally-asymptotically stable endemic equilibrium (for a special case) when the reproduction threshold exceeds one, was fitted using observed data for the KSA. Global sensitivity analysis was carried out to identify the key parameters of the model that have the most influence on the disease burden in the Kingdom. The model was used to assess the population-level impacts of control and mitigation interventions. It was shown that a face mask use strategy, based on using masks of moderate to high efficacy, can lead to the elimination of the pandemic if the coverage in its usage is high enough. A model for the spread of MERS-CoV in the human and camel host populations was also designed, rigorously analysed, and fitted with data. The model was later extended to include the use of intervention measures, notably vaccination of humans and camels and the use of face mask by humans in public or when having frequent closed contacts with camels. The population-level impacts of these interventions, implemented in isolation or in combinations, were assessed. The study showed that focusing intervention resources on containing the MERS-CoV spread in the camel population would be more effective than on containing the spread in humans.