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Research paper

Mathematical model for understanding the relationship between diabetes and novel coronavirus

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ABSTRACT

A new model is proposed to explore interactions between diabetes and novel coronavirus. The model accounted for both the omicron variant and variants varying from omicron. The model investigated compartments such as hospitalization, diabetes, co-infection, omicron variant, and quarantine. Additionally, the impact of different vaccination doses is assessed. Sensitivity analysis is carried out to determine disease prevalence and control options, emphasizing the significance of knowing epidemics and their characteristics. The model is validated using actual data from Japan. The parameters are fitted with the help of "Least Square Curve Fitting" method to describe the dynamic behavior of the proposed model. Simulation results and theoretical findings demonstrate the dynamic behavior of novel coronavirus and diabetes mellitus (DM). Biological illustrations that illustrate impact of model parameters are evaluated. Furthermore, effect of vaccine efficacy and vaccination rates for the vaccine's first, second, and booster doses is conducted. The impact of various preventive measures, such as hospitalization rate, quarantine or self-isolation rate, vaccine dose-1, dose-2, and booster dose, is considered for diabetic individuals in contact with symptomatic or asymptomatic COVID-19 infectious people in the proposed model. The findings demonstrate the significance of vaccine doses on people with diabetes and individuals infectious with omicron variant. The proposed work helps with subsequent prevention efforts and the design of a vaccination policy to mitigate the effect of the novel coronavirus.

1. Introduction

The number of confirmed cases reported by the World Health Organization (WHO) until July 25, 2024, has moved to 775.7 million, whereas the number of deaths has shot to around 7.054 million (World Health Organization (2024)). The novel coronavirus pandemic and the increase in diabetes mellitus (DM) individuals are of utmost concern worldwide (Liu et al. (2022)). Around 11.3% of the United States population is coping with DM (CDC NDSS (2020)). For individuals undergoing treatment for novel coronavirus, DM is the most common comorbidity (Muniyappa and Gubbi (2020)). Increasing indications have entrenched the connection between DM and raised risk of severity of COVID-19 infection and death (Muniyappa and Gubbi (2020); Barron et al., 2020; McGurnaghan et al., 2021; Rawshani et al., 2021). People with type 2 DM had 1.4 times more tendency to hospital and intensive care unit (ICU) admittance. Additionally, they had a 1.5-fold increased risk of mortality (Rawshani et al. (2021)). Due to the epidemic, interruptions in medical care, being at home, and lagging in the clinical process have led to a decline in the testing process and an increase in the online consultation and medication by persons with diabetes (Patel et al. (2021)). Thus, an increase in uncontrolled glycemic and incidents of diabetic ketoacidosis have been reported (Czeisler et al. (2021)).

Like other viruses, coronavirus also evolves with time. Most modifications have little to no impact on the virus's properties. Nonetheless, a few of these modifications might impact the virus's properties, including how quickly it propagates and the intensity and severity of the illness it causes (Özköse et al. (2022)). The novel coronavirus's omicron variant (B.1.1.529) was initially found in South Africa at the end of November

Abbreviations: COVID-19, Coronavirus Disease 2019; ICU, Intensive Care Unit; DM, Diabetes Mellitus; OV, Omicron Variant; DFE, Disease Free Equilibrium; EE, Endemic Equilibrium; CFR, Case fatality rate.

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