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Assessing the Effects of COVID-19 Control Strategies and Their Implementing Time through a Mathematical Model

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ABSTRACT

Social distancing, quarantining suspected individuals, isolating infected people, wearing masks and hand sanitizations were the main control strategies for COVID-19 before vaccinations are introduced. According to WHO, vaccines available for COVID-19 do not have fully immunizing ability but prevent people from getting seriously ill or dying from COVID-19. Therefore, vaccination plays an important role in reducing the death rates of COVID-19 patients. This paper aims to find the effects of the above-mentioned control strategies and their implementing time on the spread of the disease based on a mathematical model. The proposed mathematical model consists of seven subclasses (susceptible(S), Vaccinated (V), exposures (E), infectious (I), quarantined (Q), isolated (J), and recovered (R)). Next Disease spreading behavior when control strategies are implemented at different time levels are explained. Variation of the effective reproduction number when control strategies start at different time levels is interpreted Based on the proposed model the effect of vaccination on the suppression of the disease and Critical vaccination rate is determined. It is observed that in order to suppress the disease, vaccination should be done at a rate higher than the critical vaccination rate. Most affecting model parameters were determined by performing sensitivity analysis of the disease-free reproduction number. It is observed that the first three parameters as in their order of effectiveness are infectious rate, the recovery rate, and vaccination rate. It is observed that earlier implementation of control strategies is highly beneficial in controlling or suppressing the disease. The disease can be controlled more effectively by taking actions to decrease infectious rate, increase recovery and vaccination rates. Also, while implementing other control strategies, implementing the vaccination process earlier, accelerating the vaccination process to a higher rate than the critical vaccination rate, and continuing it for a sufficient period are very important in the disease control process.

Keywords: *Disease modelling, Disease control strategies, COVID-19, Critical vaccination rate*