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The Required Confronting Approaches Efficacy and Time to Control COVID-19 Outbreak in Iran

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Abstract

The ongoing devastating epidemic of coronavirus disease 2019 (COVID-19) in Iran and the evolving public health situation is very concerning. We have developed a deterministic epidemiological SEIR (Susceptible, Exposed, Infectious, Recovered) model to quantify the required time and efficacy to bring the COVID-19 outbreak under control in Iran. Our results showed that the efficacy of COVID-19 confronting strategies on Feb 29th and March 9th were at 0.5 and 0.7, respectively owing to the relative equivalence number of infected cases estimated by the model and national officially reported cases. Therefore, to control the COVID-19 outbreak in Iran we strongly recommend maintaining the effectiveness of interventions at 0.7 or more at least for the next 4 - 6 weeks. Because the COVID-19 declining statistics over the next few days or weeks do not mean the definitive control of the outbreak.

Keywords: COVID-19, Outbreak, Iran

1. Background

In December 2019, Chinese authorities reported the emergence of a cluster of severe respiratory infections of unknown etiology in Wuhan (Hubei, China). A novel strain of coronavirus was subsequently isolated from the patients' samples, namely severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and the disease it causes, COVID-19 (1). Following the rapid global epidemic, evidence showed that COVID-19 can spread rapidly through human-to-human transmission (2). In response to this ongoing public health emergency, the WHO upgraded the devastating outbreak and is closely monitoring the emergence of COVID-19 as a potential pandemic threat.

As of March 12th (11:00 GMT), 2020, there have been over 127,700 confirmed cases and 4,700 deaths associated with COVID-19 in more than 110 countries/regions, with an overall case-fatality rate (CFR) of 2.3% (3). An in-depth analysis of the available data reported by the Chinese Center for Disease Control and Prevention report indicated clear disparities in the CFR between age groups. The CFR was 8.0% in ill personal between the age of 70 and 79 years; where CFR was 14.8% in those 80 years and older (4).

During the global COVID-19 outbreak, Iran reported its first confirmed cases on 19th of February 2020 in Qom (Qom province, Iran). As of 12th of March 2020, there were 429 COVID-19 deaths in Iran with a total of around 10000 infections and there are more than 20000 suspected cases. Accordingly, Iran has the highest number of deaths outside mainland China and the highest number of infected persons in a country apart from China and Italy. These worryingly increases in the number of COVID-19 confirmed cases in Iran may suggest that there have been asymptomatic or minimally symptomatic individuals who had not been tested for COVID-19. Therefore, the evolving situation surrounding the COVID-19 outbreak in Iran is very concerning.

2. Objectives

We aimed in this study to develop a COVID-19 epidemiological model to quantify the requirement time and efficacy to control this outbreak in Iran.

3. Methods

We aimed in this study to develop a COVID-19 SEIR (Susceptible, Exposed, Infectious, Recovered) epidemic model in Iran by summarizing the effectiveness of interventions against COVID-19 in preventing people from gathering at venues and ceremonies, disinfecting public places, closing universities and schools, and ultimately contact tracing and isolating patients (two important components for controlling COVID-19 (5). To do so, we modeled COVID-19 from February 19th 2020 after reporting the first cases of disease (on February 19th 2020 in Qom province). People aged over 14 years were considered to estimate the number of susceptible individuals and then approximately adjust it for current infective and recovered cases in Iran. Other parameters were considered as follows: infection duration and exposed duration times at 3 and 2 days, case fatality rate (CFR) at %2, basic reproductive number (R0) between 3 - 3.5 (6) and then by mathematical rearrangement consider the recovery rate as (1 - CFR) * (1/disease duration) * infection number. We considered the effect of interventions in our models in two action times of February 19th and March 9th from the beginning of the outbreak based on the following mathematical logic: If, Effective contact rate (β) be β = R0/infection duration (γ) and, Force of infection0 = β * infection number/N, then, Force of infection1 = Force of infection0 * (1 - intervention efficacy). Based on the aforementioned points in the first and second action time the R0 will be declined to 1.75 and 0.9, respectively after implementation of health measures. All analysis has been done using Epimodel package version 1.7.3 in R platform.

4. Results and Discussion

We first ran our model based on Iranian reported cases of COVID-19 on February 19th. In this case we considered basic reproductive number (R0) at 3.5 (6). We assumed the efficacy of confronting strategies at %50 after the 10th day from the onset of the outbreak in Iran (the first action time). Since, we assumed that the health system was at a higher level of readiness about the 10th day after reporting the first cases of disease (on February 19th 2020 in Qom province), in this time COVID-19 had been reported from 18 provinces of the country, so that all patients individuals with suspected symptoms were supposed to be isolated and also some prevention from overcrowding was done including closing Friday prayers and mosques and closing schools and universities in all provinces across the country. Surprisingly, the estimated number of patients by our model (4923 cases) in this condition for March 6th is approximately equal to those reported in the country (4747 cases) for this day (Figure 1A). Moreover, the estimated number of deaths (205 cases) was also approximately close to the national report (124 cases). The number of exposed people was estimated at 5000 persons (Figure 1A). These results suggest that the spread of COVID-19 is expected to grow critically; thus, Iranian health professionals must take immediate action to control the outbreak to protect public health.

Next, we populated our model based on previous results, assuming the basic reproductive number has been reduced to 3 (6 days after the first action time). We proposed that the effectiveness of interventions will be increased to 0.7 in the next 3 days, on March 9th (the second action time). Given that more contacts tracing, more disinfecting of public places, more compliance with health recommendations, home isolation due to the Iranian new year holidays and legal restriction, and providing further protection measures such as masks and gloves and disinfectants for people are expected. In this case, about 4500 and 6698 new infected and exposed cases of COVID-19 were expected on March 11th (Figure 1B). Likewise, the estimated number of cases by the model (9469) was relatively equal to officially reported cases (9000) in the country on March 11th.

Iranian medical authorities should strengthen their ability to manage this unprecedented infectious disease outbreak, including stockpiling of personal protective equipment (PPE) and masks, expansion in the number of isolation beds throughout the public hospital system, public training in the correct use of PPE, formulation of appropriate platforms for multi-ministry and cross-agency coordination, and development of a strong capability to perform contact tracing quickly (7). It is also necessary to cooperate with the international health institutions, particularly the WHO, and other countries to prevent the worst impacts of this dreadful outbreak in Iran in the spirit of global health, in which those with capabilities and expertise can help others that are resource-limited.

Limitations of our study included using the deterministic models instead of the stochastic model and application of the Chinese COVID-19 outbreak parameters that may have led to the probable over or underestimation of our results. However, it is not negotiable because the model estimates were almost equal to official statistics.

Taken together, to control the COVID-19 outbreak in Iran, it is necessary to maintain the effectiveness of inter-

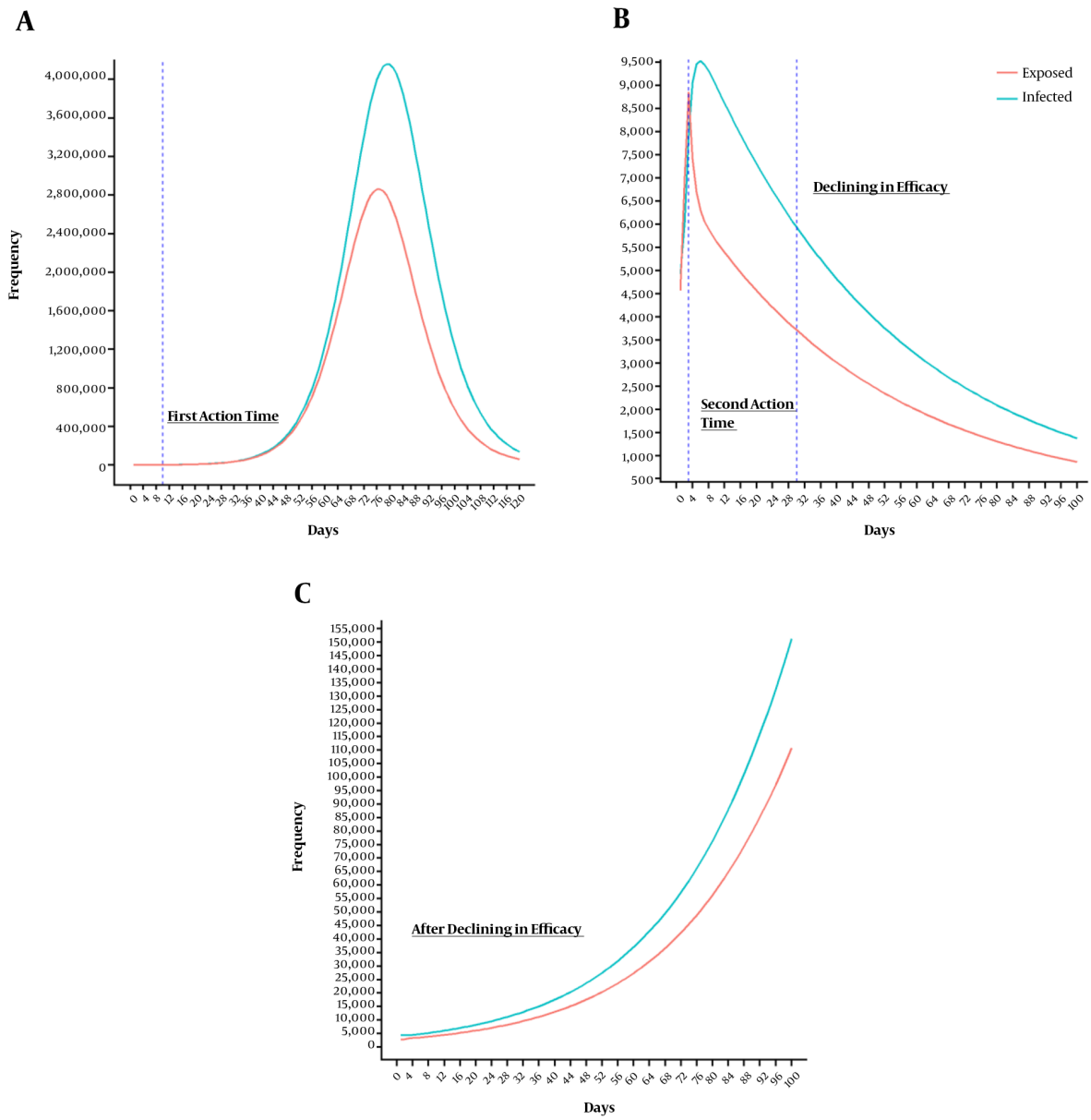

Figure 1. SEIR model of COVID-19 with different scenarios of outbreak controlling actions for the Iranian population

ventions at 0.7 or more at least for the next month and subsequently the basic reproductive number at 3 or less. Because the -19 declining COVID statistics over the next few days or weeks do not mean the definitive control of the outbreak. Therefore if we assume that about one month later the effectiveness of the interventions will be reduced by 0.6 for any reason, we will see an increasing trend in the number of infected cases (Figure 1C). Therefore, we strongly recommend maintaining the effectiveness of interventions at 0.7 or more at least for the next 4 - 6 weeks.

Footnotes

Authors' Contribution: Concept and design: Meysam Olfatifar, Mohamad Amin Pourhoseingholi, Busani Luca, Walid Al-Ali, and Hamidreza Houri. Acquisition, analysis, or interpretation of data: Meysam Olfatifar, Mohamad

Amin Pourhoseingholi, Busani Luca, Hamidreza Houri, Sajad Shojaee, Walid Al-Ali, Sara Ashtari, and Amir Vahedian. Drafting of the manuscript: Meysam Olfatifar, Mohamad Amin Pourhoseingholi, Hamidreza Houri, Busani Luca, Walid Al-Ali, Amir Vahedian, and Shabnam Shahrokh. Statistical analysis: Sajad Shojaee, Meysam Olfatifar, Mohamad Amin Pourhoseingholi, and Sara Ashtari. Administrative, technical, or material support: Hamid Asadzadeh Aghdaei, and Shabnam Shahrokh. Supervision: Mohamad Amin Pourhoseingholi, and Hamid Asadzadeh Aghdaei.

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