The impact of non-medical interventions on temporal behaviour of COVID-19 pandemic

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Abstract

The ongoing pandemic, COVID-19, caused by the spread of respiratory SARS-CoV virus has brought the entire world to a halt. All the economic activities have greatly suffered because of this communicable disease. Governments all across the globe have been devising measures to control the spread of the ongoing epidemic by trying to keep a check on the number of daily infected cases and daily deaths and trying to minimize them by putting in tremendous amount of efforts. In this article, an analysis about the impacts of various governmental steps has been made in order to alter the temporal behaviour of the ongoing epidemic. The data considered for this work was till 17th April, 2020. This work would be of interest to the policy-makers, health professionals, drug manufacturing companies & to the common public alike and would be helpful in the formulation of subsequent mitigation strategies to fight this disease.

Introduction

COVID-19 started to spread from Wuhan district in Hubei province of China. It is caused due to acute respiratory distress following the infection by SARS-CoV-2. The spread of the virus happens by its absorption through soft tissues like mouth, eyes & nose. The disease spread very fast across the globe with high infectivity, given by the reproduction number R_0 (~ 3) [1]. To contain its spread and mitigate the fatalities caused due to COVID-19, governments worldwide have been engrossed in dousing the wildfire-like situation due to the similar spread of this disease. Social-distancing has been accepted to be the norm unless the spread of the virus flatlines [2, 3]. There have been predictions and reports that due to such social-distancing measures, the numbers of infected & deceased were contained to a great extent. In this work, country-wise temporal behaviour of the COVID-19 pandemic has been discussed

31 and to what extent the stringencies imposed by the respective governments affected the
32 flattening of the mortality curve. This work would further be of interest to policy-makers,
33 health professionals and other individuals who are involved in the mitigation of the effects
34 caused due to COVID-19.

35 *Methodology*

36 Temporal behaviour of COVID-19: The temporal behaviour of the disease was studied by
37 plotting the number of cases reported daily against the number of days elapsed since the first
38 case was reported [4]. The first case was considered when there were non-zero reported cases
39 for two consecutive forthcoming days. The plotted data was fitted using a polynomial of
40 order three (03). Such studies were conducted for the top affected countries across the globe,
41 viz, Belgium, China, France, Germany, Iran, Italy, South Korea, Spain, Switzerland, United
42 Kingdom and United States, respectively [5]. The remaining countries which were not there
43 in the list were picked up on the basis that the fitted-curve should have passed the maximum
44 point and should have started moving downwards. A representative case of Iran is shown in
45 Fig. 1, as follows.

46

47 **Fig. 1** Daily number of reported COVID-19 cases for Iran has been shown. As the red fitting
 48 curve indicates, the cases in the country have started to decline and the pandemic is past its
 49 peak.

50 A comprehensive treatise regarding the analysis that has been presented in Fig. 1 is given in
 51 *Section-A of the supplementary information*. From the fitted curves as shown, it can be
 52 deduced that the median peak-time (i.e. minimum-to-maximum daily cases) for the reported
 53 countries is 40 days.

54 Dynamic governmental stringencies in response to COVID-19: Blavatnik School of
 55 Government, University of Oxford, has devised a metric system to quantify the stringent
 56 measures imposed by governments of respective countries in response to the dynamic
 57 behaviour of COVID-19 [6]. Such governmental measures seem to be well-in-sync with the
 58 temporal behaviour of the disease in that country. A representative case of Iran is shown in
 59 Fig. 2.

60
61 **Fig. 2** Synchronous stringent measures by Iranian government with the progression of
62 COVID-19, is shown.

63 A comprehensive treatise of stringent measures of all the governments with dynamic
64 behaviour of COVID-19 is shown in *Section-B of the supplementary information*. The fitted
65 black and red curves indicate that the response from the respective governments were well-
66 timed and synchronous.

67 ***Impact of governmental stringencies on temporal dynamics of COVID-19***

68 From the analyses done using the available data [4, 6], we obtain the following pattern of
69 country-wise peak-time behaviour and the maximum values of scaled stringencies as shown
70 in Fig. 3.

71

72 **Fig. 3** Bar-chart showing the approximate peak time values for different countries with the
 73 maximum values of scaled stringencies imposed by the respective governments (inscribed
 74 within individual bars).

75 From Fig. 3 it is evident that despite having the stringency scores of 76.19 and 80.95, both
 76 China as well as South Korea got the peaks in approximately 20 days whereas the scores of
 77 85.71 & 95.24 has the peak time value of approximately 40 days (for Germany, France, Italy
 78 & Spain). Iran and U.S.A. despite having same stringency scores (76.19) have different peak
 79 times of approximately 45 days and 55 days, respectively. Thus, there does not seem a direct
 80 correlation of the peak time values with governmental stringency scores given by University
 81 of Oxford & such scores cannot be conclusively used to determine the containment of the
 82 disease, as determined by the peak time values and flatlining of the mortality curves.

83

Conclusions

84 COVID-19 has secured the attention of modelers [7, 8] and financial analysts [9] to predict its
 85 course that would help the entire world to get back on track, as fast as possible. In this article,

the temporal behaviour of COVID-19 pandemic has been discussed and it was observed that the median peak time value is 40 days (for a data set of 11 most affected countries [5]). This result seems to be in accordance with the predictions made in reference [3]. Thus if the upswing and downswing of the time-dependent behaviour of the disease is assumed to be symmetrical, it can be concluded that the disease would automatically flatline after approximately 80 days. To mitigate the effects of this pandemic, different governments have been trying to impose some restrictions on its citizens so that the spread of the disease could be contained. These moves though shown to quantitatively suppress the numbers of mortalities and further spread of the disease seem to have no correlation with the temporal behaviour of the disease. This work would be of interest to researchers and scientists working in the field of public policy making, healthcare industries, drug manufacturing companies and to the social scientists to formulate relevant strategies to sail through these difficult pandemic times.

Conflict of interests

The author declares no conflict of interest.

Author contributions

A.K. formulated the problem statement, did the analysis and wrote the manuscript.

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Supplementary Information for

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pandemic***

by

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Section –A

Determination of country-wise peak-time values [1]

Section –B

Time-dependent governmental stringencies in response to COVID-19 pandemic [1, 2]

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