Evaluating the Effect of Macro-Level Health Policies on Novel Coronavirus (COVID-19) Epidemic Control in Iran

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Abstract- This study aimed to evaluate the effect of macro-level health policies on COVID-19 outbreak control in Iran. This was a descriptive-analytical study of the applied time series performed on April 19, 2020. The effect of four macro-health interventions, including reducing overcrowding, social distancing, limitation of high-risk economic activities, and active case detection, was examined. The Vector auto-regression (VAR) was used to investigate the effect of the interventions. The augmented Dickey-Fuller test (ADF) was used to ensure the time stability of the time series and the existence of a unit-root. To analyzing data and estimation VAR models, STATA software was used. P of less than 0.1 was considered significant. The increase in the number of cases with two days' lag had a positive and significant effect on increasing the number of new cases of the COVID-19 (C=0.176, P=0.097). Adopting an overcrowding reduction policy with both 2-day lags (c=0.095, P=0.066) and 4-day lags (c=0.314, P=0.000) had a negative and significant effect on increasing the number of new cases of the COVID-19. Our study showed that overcrowding reduction and new COVID-19 case detection could play an effective role in controlling the epidemic of COVID-19 in Iran. It seems that the best advice is to stay home and use strategies to identify more patients.
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Introduction

In December 2019, pneumonia associated with the novel coronavirus disease 2019 (COVID-19) emerged in Wuhan, Hubei Province, China (1). It is highly contagious and has quickly spread to many other parts of China and some other countries within one month since the first report emerged (2). In February 2020, the World Health Organization (WHO) declared the Coronavirus (COVID-19) outbreak a pandemic (3). On 30 January 2020, the WHO declared COVID-19 as the sixth public health emergency of international concern (4). COVID-19 can damage and involve multiple organs, such as renal involvement and acute respiratory distress syndrome (ARDS) in adults or children (5-8). The COVID-19 pandemic places unprecedented pressure on societies and healthcare systems around the world; that

is why the exact drug aimed to target novel coronavirus was not found yet on 4 May 2020 (8,9). This first pandemic of the 21st century demands internationally unified, cogent, and collective actions by individuals, communities, commercial bodies, institutional systems, and all governments in mitigating its escalating impact (10). Meanwhile, the role of governments is very important for the implementation of political and social interventions, and of course, the societal and political response to a major outbreak like COVID-19 is highly dynamic, changing often rapidly with increasing case numbers (11). All kinds of preventive interventions have been a priority for governments in this disease, while COVID-19 is lethal and involves many organs such as kidneys and lungs without any specific drug (12-16).

The main public health preventive advice focuses on hand hygiene and social distancing. The latter is

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impossible to enforce at mass gatherings (17). During the 2019-2020 coronavirus pandemic, the WHO suggested the reference to "physical" as an alternative to "social," in keeping with the notion that it is a physical distance which prevents transmission; people can remain socially connected via technology (18,19).

To slow down the spread of infectious diseases and avoid overburdening healthcare systems, particularly during a pandemic, several social distancing measures are used, including the closing of schools and workplaces, isolation, quarantine, restricting movement of people and the cancellation of mass gatherings (20). It should be noted that clinical display of the COVID-19 can play an important role in the management of COVID-19 (21). In COVID-19, which also has a high rate of spread, restricting large communities with the help of one type of social distance, and taking other measures to help reduce disease transmission, especially in a country like Iran, is essential. The coronavirus disease has had a high transmission rate in Iran compared with its neighboring countries including Bahrain, Iraq, Kuwait, Oman, Afghanistan, and Pakistan (22).

Since the beginning of the COVID-19 in Iran, various policies and measures have been taken to control this epidemic. These interventions can be divided into four main areas: overcrowding reduction, social distancing, limited economic risk activities, and disease detection. On 7 April, the intensification of the social distancing policy had led to fewer new cases in recent days. The President of Iran again asked people "to stay at home" and obey guidelines (23). The Islamic Republic News Agency reported that "low-risk" business activities restarted in most of the country on 11 April, except for in Tehran, where they would restart on April 18. President of Iran said, "Easing restrictions does not mean ignoring health protocols... Social distancing and other health protocols should be respected seriously by people (24).

Currently, compared to the peak time of COVID-19 in Iran, more than 50% of hospitalizations and about 70% of deaths due to COVID-19 have decreased (25). An examination of official statistics shows that the number of new cases of this disease has decreased since March 30, 2020 (Figure 1).
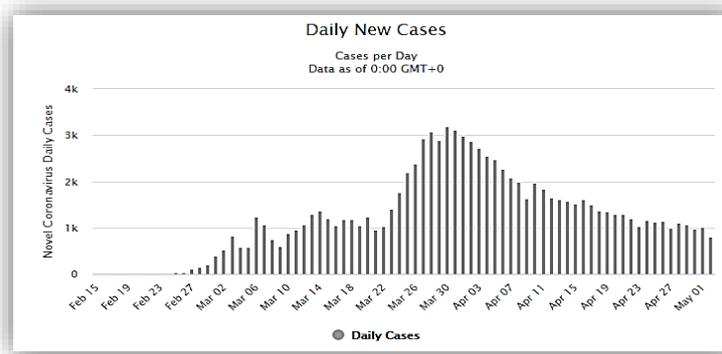

Figure 1. Number of new cases of COVID-19 (taken from https://www.worldometers.info/coronavirus/country/iran/)

The main question of the present study is: Which of the above interventions has had a greater impact on this reduction and has played a more prominent and significant role in controlling the growth of the COVID-19 epidemic? Therefore, this study was conducted to evaluate the effect of macro-level health policies on COVID-19 epidemic control in Iran.

Materials and Methods

The present study was a descriptive-analytical study of the applied time series analysis that was performed on April 19, 2020. In this study, the effect of four macro-health interventions, including overcrowding reduction, social distancing, limitation of high-risk economic activities, and active case finding on reducing the number of cases of COVID 19, was examined (Figure 2).

The dependent variable of the study was the change in the number of definite cases of COVID-19, which was collected as a 59-day time series (from 20 February 2020 to April 20, 2020) from the WHO statistics. Also, the independent variables of the study included overcrowding reduction, social distancing, and

limitation of high-risk economic activities and active case finding, which independently assessed the impact of each intervention as dummy variables.

To show the effect of the presence or absence of each of these interventions, the exact time of implementation was collected as a 59-day time series from the Iranian Daily report of COVID-19 epidemiology.

The Vector auto-regression (VAR) was used to investigate the effect of the above interventions. Using this model allows the researcher to examine the effect of each intervention with time lag on the growth of the number of COVID-19. This is because the effect of implementing a health policy on reducing new cases is expected to be delayed due to the incubation period of the disease. Due to the volume of data, it was possible to use a maximum of 4 days' lag, and therefore the effect of each policy was investigated with an interval of 2 days (L2) and 4 days (L4).

The use of the VAR model also allowed the researcher to examine the effect of previous values of dependent variable (increase/decrease of new cases at previous days) on the next values of the dependent variable (increase/decrease in next days). This feature of the VAR model is completely consistent with the contagious nature of the virus. The augmented Dickey-Fuller test (ADF) was used to ensure the time stability of the time series and the existence of a unit- root. A two-sided α of less than 0.10 was considered statistically significant. To analyzing data and estimation VAR models, STATA software was used.
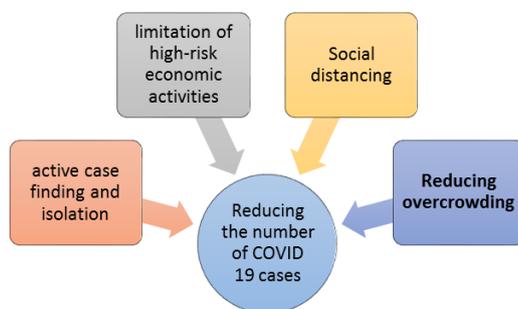
Figure 2. Four macro-health interventions used in Iran to control COVID-19

Results

The results of the Generalized Dickey-Fuller unit root test on the time series showed changes in the number of new COVID-19 cases, which have acceptable stability for time series analysis (*P*=0.0008) (Table 1).

The findings of the VAR model to analyze the effect of health interventions on changes in the number of COVID-19 cases are presented in Table 2.

The results of regression analysis showed that the increase in the number of cases with two days' lag had a positive and significant effect (*P*<0.1) on increasing the number of new cases of the COVID-19 (C=0.176, 95%CI: -0.031 to 0.384, *P*=0.097) which can be due to the contagious nature of the virus. But over a longer period of 4 days, the incidence of the COVID-19 had a small effect on the number of new cases of the COVID-19 (C= -0.043, 95%CI: -0.091 to 0.004, *P*=0.078), which could be due to the closing of the epidemic curve to the peak.

Adopting overcrowding reduction policies with both 2-day lags (c= -0.197, 95%CI: -0.091 to 0.006, *P*=0.066) and 4-day lags (c= 0.314, *P*< 0.001) had a negative and significant effect on increasing the number of new cases of the COVID-19. It can be argued that the policy of overcrowding reduction (including closing schools, colleges, conferences, and group activities) will be effective in the long term and will increase its effectiveness over time. Adoption of social distancing policy with 2 and 4 days' lag, respectively, had a decreasing and increasing effect on the growth of cases of the COVID-19, which had a statistically significant effect with four days' lag (c=0.097, 95%CI: -0.004 to 0.198, *P*=0.060). This suggests that adopting a policy of social distancing could have the opposite effect. Although restricted economic activity with 2-day and 4-day lags (*P*=0.033 and *P*=0.006, respectively) had a significant effect on disease growth.

Adopting screening / active case finding policy with 2 days and 4 days' lag had a significant increase (c=0.116, 95%CI: 0.010 to 0.222, *P*=0.031) and a decrease (c= -0.189, 95%CI: -0.256 to -0.121, *P*<0.001),

respectively, on the growth of cases of the COVID-19. This can be due to the fact that with the onset of the active case finding, the number of identified cases

increases in the short term, but in the long term, it reduces the number of latent cases of the disease and brings the epidemic curve faster being close to its peak.

Table 1. Generalized Dickey-Fuller test results

Variables	Statistics	Critical value			P
		1%	5%	10%	
Growth of Covid-19 Total Cases	-4.145	-3.569	-2.924	-2.597	<0.005
Decrease Population Density	-2.432	-2.395	-1.673	-1.297	0.009
Social Distancing	-3.169	-2.395	-1.673	-1.297	0.001
Economical Limitation	0.000	-2.617	-1.950	-1.610	NA
Screening	-1.903	-2.395	-1.673	-1.297	0.031

Table 2. The effect of health interventions on changes in the number of COVID-19

Variable	Impact with lag for two days			Impact with lag for four days		
	Coefficient	P	(%; 95% confidence interval)	Coefficient	P	(%; 95% confidence interval)
Growth of covid-19	0.176	*P*< 0.05	(-0.031 to 0.38)	-0.043	*P*< 0.05	(-0.091 to 0.004)
overcrowding reduction	-0.095	*P*< 0.05	(-0. 19 to 0.006)	-0.314	*P*< 0.05	(-0.39 to -0.23)
Social distancing	-0.046	*P*>0.05	(-0.13 to 0.038)	0.097	*P*< 0.05	(-0.004 to 0.19)
limitation of high risk economic activities	0.033-	*P*<0.1	(-0.098 to 0.03)	-0.006	*P*<0.1	(-0.06 to 0.05)
Active case finding/ Screening	0.116	*P*< 0.05	(0.01 to 0.2)	-0.189	*P*< 0.05	(-0.25 to -0.012)
Vector Auto Regression Model Statistics	AIC = -76.36804 HQIC = -75.59179 SBIC = -74.3607			Sample (adjusted): 5-59 Log likelihood = 2155.121 FPE = 4.82e-40		

Discussion

Since the WHO unveiled the novel coronavirus as a pandemic, most governments have taken unprecedented steps to promote social isolation. Closing schools, banning traffic in public, canceling sports competitions, and advising on unnecessary trips are all helpful in smoothing out the novel coronavirus outbreak curve and balancing it to prevent the fast progression, especially in the metropolis (26-28).

In the present study, we decided to evaluate the effect of macro-health policies caused by COVID-9 on the population of Iran using a time series model with a time interval of 2 and 4 days from March 21, 2017, to April 19, 2011. These policies include overcrowding reduction, social distancing, limiting high-risk economic activities, and active case finding/screening in countries simultaneously (or sometimes individually). With the spread of the COVID-19 and the involvement of almost everyone in the community, most researchers sought to predict the peak time of the virus in each region.

In a recent study by Moghaddami *et al.*, (27) on the population of Iran, using an exponential smoothing model, the peak time of COVID-19 was predicted in early April. The result was confirmed in our study, without considering the interventions and by examining

the cases in the past few days, with a 4-day longer interval. Also, in another study by Zahiri (28) *et al.*, using the SIR model, the peak of the disease in Iran was predicted in late March.

After adopting and implementing health policies resulting from the development of COVID-19, in order to influence the policies used, the researchers conducted studies on this issue almost all over the world. A study by Barkur *et al.*, found that Indians had successfully fought the COVID-19 and that the people of the country were largely in favor of the government to announce a policy of reducing social traffic (29).

Likewise, our study showed that the policy of overcrowding reduction, both in the short and long term, has led to the control of epidemic growth.

The current study showed that social distancing, although in the short term, leads to a decrease in the incidence of the disease but in the long term, leads to an increase in new cases. Therefore, this intervention does not seem consistent with the situation of Iran. In other countries, this is not confirmed.

In this regard, Singh and Adhikari (30) used an age-structured model and Bayesian method to evaluate the progress of the COVID-19 epidemic in India. They found that in the absence of a vaccine, large-scale social distancing as the most effective method reduced

mortality and morbidity, albeit in structured age. In addition, according to the WHO, social and physical distancing measures by stopping the COVID-19 transmission chain help to slow the spread of the virus and prevent new cases of the disease (31).

In another study, Greenstone and Nigam (32), using a simulation model in the United States, estimated that 1.7 million people would be saved from March to October 2020 with the implementation of the social distancing plan. According to the results, an American household will receive a sum of $ 60,000 for this rescue due to the social distancing plan.

Another simulation study using the age-structured model on the population of the United States predicted that the evolutionary course of COVID-19 would lead to severe social distancing measures for the whole year or even 18 months (until the vaccine was discovered) to reduce the number of patients. On the other hand, the economic value of these measures for 12 to 18 months, as well as the great economic burden of losing working time (or even life) due to COVID-19, necessitates an urgent economic analysis in this country (33).

Although, according to our findings in Iran, limiting high-risk economic activities reduces the number of patients (but not significantly), the need to implement this plan for such a long period of time (12 to 18 months) in the United States is taking away our economic comparison. However, some countries have defeated the COVID-19 without serious actions. After some time, South Korea, instead of staying at home and social distancing, tried to organize a large-scale test for people with COVID-19.

Simultaneously, extensive efforts have been made to isolate patients and quarantine their communication (34), the policy that has been effective in Iran and in the long term will control the epidemic of COVID-19.

Numerous studies have been performed on the population of Iran to predict the number of patients in the following days using different models such as an autoregressive integrated moving average (ARIMA) model and also Poisson Autoregressive Model (35-37). Simulation model predicts the number of cases and the number of deaths in the next days. However, fewer studies have evaluated the effect of macro-health interventions on controlling COVID-19 outbreak in Iran.

The effect of long-term and short-term health interventions varies in terms of its intensity and direction. Some long-term health interventions are more effective than short-term ones, and their effectiveness increases over time. Adopting the right policies to control the epidemic requires accurate identification of

the extent and direction of the impact of each of these policies. Our study showed that the best advice is to stay home, overcrowding reduction and use strategies to identify more patients.

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