Original Article

COVID-19 Infection Control Parameters in Iran: An Epidemiological Modeling

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Received: 07 February, 2021; Accepted: 06 April, 2021

Abstract

Background: We aimed to evaluate Iran's current COVID-19 infection, emphasizing the number of infection detection and the disease's reproductive number in its high peak in November and after the lockdown in December.

Materials and Methods: Using the Johns Hopkins Bloomberg School of Public Health Contact Tracing Evaluation and Strategic Support Application, we used the average weekly new cases and average case mortality in November and December 2020. The average case isolation and identification time (25%, Four days) and the average case contact within the household and community were entered into the application. We examined Two modeling systems with 50% and 70% case isolation for the November period as alternative scenarios for the current infection control rate.

Results: Our modeling showed only 11% and 30% of the infections were detected in November and December. The disease's reproductive number is similar to the natural reproductive number of the disease (2-3) in November. The two models used to increase the rate of case isolation to 50% and 70% did not significantly change the reproductive number.

Conclusion: The priority in Iran for COVID-19 infection control should be a dramatic increase in the number of testing to achieve the correct number of case detection and fulfill the contact tracing criteria to reduce the disease spread.

Keywords: Basic Reproduction Number, COVID-19, Quarantine, Contact Tracing, COVID-19 Testing

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Please cite this article as: Eftekharian K, Eftekhar Ardebili H, Eftekharian S, Eftekharian A. COVID-19 Infection Control Parameters in Iran: An Epidemiological Modeling. Novel Biomed. 2021;9(3):118-22.

Introduction

The response of public health systems to the COVID-19 pandemic has been significantly different between countries. As a result, case numbers, mortality rates, and epidemiological characteristics of the disease are different. The common ways to control the epidemic in the countries have been massive testing, patient and contact tracing to minimize the disease spread to healthy individuals. However, many successful nations in contact tracing, especially Southeast Asian countries, had to experience minimal lockdown periods to control the infection wave[1,2].

In Iran, the information from the number of new cases and case mortality has been provided daily by the ministry of health and education. The ministry also provides reports on the reproductive number and the projection of the disease. Upon writing this paper, eleven reports have been generated that did not concord with the disease epidemiological behavior during the pandemic and could not project the country's waves until now[3].

In this study, we intend to use the official numbers provided by the ministry and the new tool developed by Johns Hopkins University to examine the accuracy of the ministry's calculations and find the most effective measure needed to control the epidemic in the country by using the modeling tool provided by the application[4]. Furthermore, to compare these measures with other nations with a successful COVID-19 epidemic control strategy.

Since national lockdown was put into practice in the middle of data gathering on Nov 21, 2020, we compared the country's situation before the lockdown and two weeks afterward when the restrictive measures' impact had begun. The reason for choosing this period is the fast-changing characteristics of the disease and the impacts of new measures which change the infection control parameters fast in a short period.

Methods

As stated by the ministry of health and medical education of Iran, the number of testing was on average 40000 daily[5], which we used to estimate the average positive testing in the four weeks of Oct 25 until Nov 21, 2020, and two weeks after the national lockdown Dec 4 until Dec 31.

Data provided by the ministry of health and medical education of Iran[5] was submitted to the Johns Hopkins Bloomberg School of Public Health Contact Tracing Evaluation and Strategic Support Application (ConTESSA)[4].

The average weekly new cases in the previous four weeks from Oct 25 until Nov 21, 2020 (on average 69650.5 new cases weekly) and the average weekly case fatality in the past two weeks from Oct 9 until Nov 21, 2020 (on average 3250.15 deaths weekly) were inserted to the application.

The average weekly new cases in the previous Four weeks from Dec 4 until Dec 31, 2020 (on average 63359.4 new cases weekly) and the average weekly case fatality in the past Two weeks from Oct 9 until Nov 21, 2020 (on average 1064 deaths weekly) inserted to ConTESSA.

Up to this date, no studies are estimating the infection fatality rate (IFR) in Iran to the best of our knowledge. As suggested by the ConTESSA application, we selected a similar IFR relative to Iran's average year of life, which is 31.1 years according to the National Statistical Center of Iran[6]. At the research time, China had the closest number (37 years)[7], and the suggested IFR would be 0.5%. According to Iran's minister of health statement in March 2019, only 25% of the new cases of COVID - 19 adhered to self-isolation[8], and the recent announcement by the head of the COVID - 19 task force showed that only 20% of the new cases adhered to isolation according to mobile data tracking[9]. As a result, we used 25% case isolation in our modeling.

As to our knowledge, there are no data available showing the average time between the onset of symptoms and having a test performed in Iran. We used the number of two days, the number in countries with a higher number of testing populations[10]. According to the IRNA news agency, the official government news agency, the PCR test results are ready within 48 hours[11], and we used this number, which is the shortest possible time to have the answers in hand. We presumed immediate self-isolation after the test results are ready.

According to the National Statistical Center of Iran, Iran's family size is 3.3 persons[12]. As a result, the number of household contacts was 2.3 in our modeling. We inserted the same percentage and time for self-quarantine within the household for self-isolation (25% and Four days, respectively). Comparing with other countries, we used at least 10% less self-quarantine percentage and the same time duration for community contacts of the case (15% and Four days, respectively). Considering current society's background factors, we decided to use two different scenarios to see the effectiveness of self-isolation and self-quarantine increase. We used the modeling tool to predict 50 and 70 percent isolation and its impact on disease control in the November period, while lockdown results showed a dramatic change in isolation and case contact in the later period.

Results

The application calculated the amount of detected infection in the November period as 11% and the December period as 30% by adding the number of new weekly cases and deaths and insertion of the possible IFR in Iran.

After entering the percentage of self-isolation and self-quarantine into the application, using the time needed for testing and the time interval for self-isolation/quarantine, the application calculated the disease's reproductive number in the population.

The reproduction number in the November period was as the Basic Reproduction Number (R_0) of the disease (2-3 in the literature[13], taken as 2.5 in modeling). After changing the self-isolation percentage by 50% (Figure. 1) and 70%, the reproduction number did not decrease and remained the same natural number. The reproduction number was not subject to estimation in the December interval because there was no data on the impact of lockdown on self-isolation, quarantine, and the disease spread.

Discussion

Our estimations show a low number of case detection (11%). Due to the low number of testing in the country, the possibility for case detection remains low. The World Health Organization has suggested a maximum of Five percent positive in testing for a controlled infection[14] because of the daily testing numbers (approximately 40000 tests daily) and an average of 24.8% positive tests from Oct 25 until Nov 21, 2020. However, this period shows an approximate fivefold higher positive result.

Due to the lockdown in the December period, the country experienced a significant decrease in the number of new cases (6291.1 average lower number of

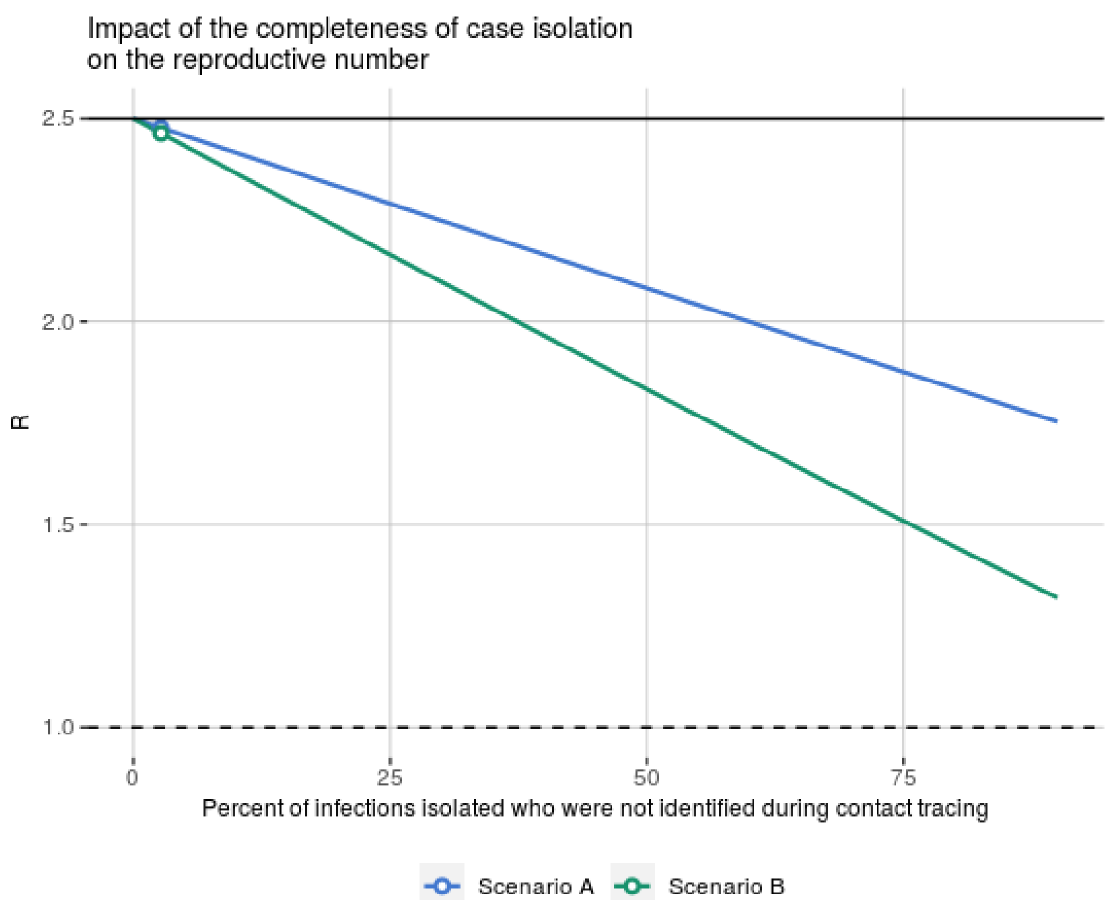

Figure 1. Scenario A at the current self-isolation rate, scenario B at 50% self-isolation rate in November. Impact of completeness of case isolation, as the percent of cases not identified during contact tracing and isolated, on the reproductive number, assuming that infections are isolated on average four days after symptom onset in Scenario A. The filled circles represent the reproductive number for Scenarios A and B, described above.

new cases weekly and more than 60 percent in deaths). Also, infection detection rose from 11% to 30%, which is remarkable on all fronts. However, the downside is the substantial economic impact of national lockdown on the economy and the impossibility of continuing this infection control long run.

As a result, we believe the number of testing is insufficient to track enough cases to isolate and control the infection. Our estimations are in clear contrast with the health ministry's latest report (Nov 9) on the reproduction number, estimated to be 1.06[3]. This number cannot justify the rise in the number of new cases and deaths in the upcoming days.

Unique to its kind, a paper founded by the Iranian Ministry of Health, based on 8902 individuals in 17 cities from Apr 17 till Jun 2, 2020, showed a 20.0% seroprevalence in the high-risk population[15]. While at the time, only 0.6% of the population were tested positive in the country[16].

Dighe and colleagues[1], in their article on COVID-19 control in South Korea, showed the significant impact of the high number of testing, social distancing, and targeted local lockdowns in COVID-19 number reduction in South Korea. Individual case contact tracing played a minor proportion of the measures as discussed. However, this control agrees with the high number of testing in the country-1049 tests per million- in contrast to Iran- 482 tests per million[17]. As a result, the contributing factor in infection control would be case identification and case tracing in the first place.

Furthermore, the comparison of South Korea's reproduction number (as a country with focusing mainly on massive testing) with China's (as the one with enormous lockdown and testing together) in the same period is considered as another proof for the success of the non-lockdown approach vs. other combined methods[10].

In reviewing other Asian countries with high population density and high elderly population per capita, such as Japan[2], we can infer that although mass testing was not the priority in COVID-19 control, other strategies such as Retrospective Monitoring (focusing on closest dependent of the patient) with a digital application, educating the society with new awareness program, and promoting social distancing helped to keep the reproduction number below number 1.

In the Middle East, the Kingdom of Saudi imposed various measures as early as possible to control the COVID-19 rate, such as border control, different social distancing levels based on population and local factors, and usage of digital health applications for medical needs. The final measure that significantly helped maintain the reproduction number was massive testing before detecting 500 active cases in April[18].

Besides the negative social impact of the lockdown, which is beyond this research's scope, its effect on the economy is worth mentioning. According to the world bank, governments' lockdown action led to the global Gross Domestic Product reduction in 2020 of about 5.2%[19].

The lockdown impact has had a significant impact on reducing the number of cases and deaths. Still, considering the economic impact, a lockdown is not a long-enduring measure, as the ministry announced it would remove the limitations on Jan 4, 2021[20].

It is worth mentioning the need for more long-term studies to examine the Iranian COVID–19 testing model's efficacy for further studies. A shortcoming of our study is the lack of firsthand data and its dependence on the data provided from the official bodies without independently examining the data's accuracy.

Conclusion

The authors believe that the low number of testing in Iran has resulted in a low number of infection detection, restrictive self-isolation. Self-quarantine measures would not be sufficient because of the low impact of these measures on reproduction number reduction and infection control. Although the infection and death rate significantly improved, national lockdown cannot be the plan for an extended period due to its social and economic impacts. We suggest the efforts to be more devoted to increasing the number of tests rather than patient tracking because it does show significant priority in our modeling.

Acknowledgment

None.

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