Estimating COVID-19 Dynamics in Afghanistan

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Little reliable information on novel coronavirus (COVID-19) outbreak is available from war-torn countries, including Afghanistan. The current study estimates the pandemic features based on currently available data to forecasting future challenges of preventive strategies and emergency response using mathematical modeling. The infection fatality and recovery rates were estimated by 1.8% and 20.8%, respectively. The average growth rates of infection, death, and recovery among the Afghanistan population were estimated as 0.2, 0.2, and 0.5, respectively. Also, it was estimated that approximately 6 million people infected in the urban area, which may lead to approximately 11 thousand deaths. However, the features of the pandemic, marks that Afghanistan needs more time to pass the pandemic. Along with this, inadequate community engagement and low abiding to health advice, including social distancing, lack of personnel and testing capacities in the provinces, shortage of laboratory testing supplies, insufficient infection prevention, and control measures in health facilities in some of the provinces, limited access to and response capacities are the main challenges to fight against COVID-19. Therefore, the majority of infected cases and deaths may not be reported, and preventive strategies effectively in Afghanistan could severely be disrupted by several socio-cultural, financial, political, and administrative obstacles.

Keywords: COVID-19, growth rate, exponential distribution, estimation

INTRODUCTION

On March 11, 2020, World Health Organization (WHO) announced a novel outbreak of coronavirus in Wuhan, China, which latter named COVID-19 and subsequently spreading all around the world and convert to a severe global pandemic ever since (1). Now, the disease has established in almost all countries over the world. In Afghanistan, since 24 February 2020, which index case of COVID-19 had been confirmed, till the middle of June, 26320 infected cases and 487 deaths have been confirmed over the 34 provinces of Afghanistan officially (2).

Afghanistan has a young population structure, with approximately 38 million people live all over the country, which a significant part lives in rural areas (3, 4). Although officials have been implementing prevention programs from the beginning, disease prevention strategies face many obstacles.

Supply and access to health services are limited. As part of the measures taken to combat COVID-19 in the country, national isolation centers in capital Kabul, and regional and provincial isolation centers with approximately overall 1541 beds are currently operational in Afghanistan. Currently, a total of eight testing and health facilities centers in the regional centers, with a maximum of 2000 tests per day, provide diagnostic services. Lack of workforce in the health sector is another aspect of the problem. The proportion of health workers and physicians per 10000 individuals is 9.4 and 1.9, respectively. The access of rural area to physicians and health services are to a shortage, while 74% of the population lives in rural areas (5–7). Therefore, the burden of the pandemic may exceed the potential of the Afghanistan health system.

Using mathematical models to understand the pandemic features and transmission dynamics of outbreaks to estimate the future challenges of the crisis and making correct preventive strategies to emergency response have a long background (8). The population-based studies that consider the epidemiology of COVID-19 in Afghanistan are too limited. In the current study, we use mathematical modeling to understand the pandemic COVID-19 dynamics and current challenges in Afghanistan.

MATERIALS and METHODS

The confirmed infected cases, death cases, and recovery cases on 24 February 2020–15 June 2020, which reported daily by the Ministry of Public Health, Afghanistan, were organized in the frequency distribution table (Appendix 1).
To calculate the daily growth rate of the infection, the growth rate of the death and recovery among population following formula was applied:

\[
g = \frac{a_t - a_{t-1}}{a_{t-1}}
\]

Where: 
- \( g \) = growth rate
- \( a_t \) = present case
- \( a_{t-1} \) = previous case (lag 1)
- \( t \) = time

To calculate the linear regression in the exponential growth phase, IBM SPSS statistics 24 software was used.

The infection fatality rate and recovery rate until the middle of June was estimated based on officially reported data via the following formulas:

- The infection fatality rate = total deaths/total cases
- Recovery rate = total recovery/total number of cases
- The actual infected case number in urban areas estimated via following formula and assumptions;

**Assumptions**
- Minimally 27% of the population living in urban areas.
- Unofficial reports estimate 60% of people living in cities infected with COVID-19.
- The current population of Afghanistan is approximately 38 million based on the Worldometer elaboration of the latest United Nations data.

**Therefore**
- Actual infected case = 0.27 \( \times \) 38 million \( \times \) 0.6
- Actual death number also is estimated based on infection fatality rate obtained from official data and assumption that only 10 percent of infected persons may need hospitalization based on the Ministry of Public Health report (2):
- Actual death = actual infected case \( \times \) 0.1 \( \times \) infection fatality rate

**RESULTS**

On 24 February 2020–15 June 2020, a total of 26320 infected cases were reported from Afghanistan. The average growth rate of the pandemic among the Afghanistan population in this time was calculated as 0.2. In the same time, 487 deaths were reported officially. Therefore, the infection fatality rate until the middle of June in Afghanistan was estimated by 1.8%. The average daily death growth rate among Afghanistan cases was estimated at 0.2. Also, 5490 patients recovered during this time. The data show an overall recovery rate of 20.8%, with an average of the daily recovery growth rate of 0.5.

Based on the confirmed infected cases, distribution in time series seem exponential, as shown in Figure 1. Approximately every 10 days, the number of infected individuals is doubled. The R square index of linear regression analysis of the exponential phase was 0.75.

**DISCUSSION**

Evidence shows that the pandemic growth exponentially in Afghanistan. It is expected that the cumulative numbers of confirmed cases will highly increase during July and August. The average growth rate of infection among the Afghanistan population was calculated as 0.2. However, the infection’s daily growth rate remains approximately stable by the time, but the death and recovery growth rate highly changes (Fig. 1). Stability in the daily infection growth rate may be due to a lack of change in the daily potential of diagnostic services and limited access to health facilities. Since the maximum capacity of all diagnostic centers is approximately 2,000 tests daily and health services accessibility is highly limited, and also most of the infected persons are asymptotic official data validity must be discussed cautiously. Besides, the high differences between infected and recovered person rates can be related to inadequate treatment facilities in this country, and infected individuals stay active carriers for more time and subsequently increase the burden on the health system (Fig. 2). All of these, together with a positive death growth rate (0.2) mark, that Afghanistan needs more time to pass the pandemic.

Among the fatalities, 94% had at least one underlying disease, such as cardiovascular disease, lung disease, and diabetes. Age 40–69 includes the most fatalities. Kabul is now the most affected part of the country, followed by Hirat concerning confirmed COVID-19 cases (4, 6, 9).

There are some obstacles that contribute to making obvious restrictions for testing to detect infected cases and subsequently contact tracing, quarantine measures, case management, and even recording of death because of COVID-19.

Limited centers of testing with a limited capacity of testing, which is very difficult for suspected cases to have access to these few centers. Currently, eight laboratories, including two in Kabul, two in
much higher than this estimation. Certainly, the infection growth rate and death growing rate so obstacles, only a few percent of infected people are detected and diagnosis and treatment. During this time, security precautions are significantly increased. Therefore, because of the above-mentioned obstacles, only a few percent of infected people are detected and reported. The majority of infected cases and deaths are not reported. Certainly, the infection growth rate and death growing rate so much higher than this estimation.

Poverty is another issue; 54% of people are living under the poverty line. Poor people cannot stay in their homes (quarantine), and they have to work to earn their essential needs and food. Besides, it is not affordable to them for reaching to the diagnostic center. Security is another crucial issue that disturbs people to seek diagnosis and treatment. During this time, security precautions are significantly increased. Therefore, because of the above-mentioned obstacles, only a few percent of infected people are detected and reported. The majority of infected cases and deaths are not reported. Certainly, the infection growth rate and death growing rate so much higher than this estimation.

Conclusion
Since several socio-cultural, financial, political, and administrative factors influence pandemic dynamics, the prediction models only useful to understand the feature of epidemiology of the disease. However, the pattern may rapidly change by increasing the capacity of diagnostics services.

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| Date      | No of case | Growth rates | No of death | Death growth rate | No of recovery | Recovery growth rate |
|-----------|------------|--------------|-------------|-------------------|---------------|----------------------|
| 24.02.2020| 1          |              | 0           |                   | 0             | 0                    |
| 25.02.2020| 0          | -1           | 0           | 0                 | 0             | 0                    |
| 26.02.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 27.02.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 28.02.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 29.02.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 1.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 2.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 3.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 4.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 5.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 6.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 7.03.2020 | 3          | 0            | 0           | 0                 | 0             | 0                    |
| 8.03.2020 | 0          | -1           | 0           | 0                 | 0             | 0                    |
| 9.03.2020 | 0          | 0            | 0           | 0                 | 0             | 0                    |
| 10.03.2020| 3          | 0            | 0           | 0                 | 0             | 0                    |
| 11.03.2020| 0          | -1           | 0           | 0                 | 0             | 0                    |
| 12.03.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 13.03.2020| 5          | 0            | 0           | 0                 | 0             | 0                    |
| 14.03.2020| 4          | -0.2         | 0           | 0                 | 1             | 0                    |
| 15.03.2020| 5          | 0.25         | 0           | 0                 | 0             | -1                   |
| 16.03.2020| 5          | 0            | 0           | 0                 | 0             | 0                    |
| 17.03.2020| 1          | -0.8         | 0           | 0                 | 0             | 0                    |
| 18.03.2020| 0          | -1           | 0           | 0                 | 0             | 0                    |
| 19.03.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 20.03.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 21.03.2020| 0          | 0            | 0           | 0                 | 0             | 0                    |
| 22.03.2020| 18         | 0            | 0           | 0                 | 0             | 0                    |
| 23.03.2020| 2          | -0.888888889 | 0           | -1                | 0             | 0                    |
| 24.03.2020| 32         | 15           | 0           | 0                 | 0             | 0                    |
| 25.03.2020| 10         | -0.6875      | 1           | 0                 | 1             | 0                    |
| 26.03.2020| 10         | 0            | 0           | 1                 | 0             | -1                   |
| 27.03.2020| 16         | 0.6          | 0           | -1                | 1             | 0                    |
| 28.03.2020| 0          | 0            | 0           | 0                 | 0             | -1                   |
| 29.03.2020| 10         | 0            | 0           | 0                 | 0             | 0                    |
| 30.03.2020| 25         | 1.5          | 0           | 0                 | 2             | 0                    |
| 31.03.2020| 51         | 1.04         | 0           | 0                 | 0             | -1                   |
| 1.04.2020 | 43         | -0.156862745 | 0           | 0                 | 0             | 0                    |
| 2.04.2020 | 34         | -0.209302326 | 2           | 0                 | 0             | 0                    |
| 3.04.2020 | 26         | -0.235294118 | 0           | 0                 | 1             | 0                    |
| 4.04.2020 | 38         | 0.461538462  | 1           | 0                 | 2             | 0                    |
| 5.04.2020 | 30         | -0.210526316 | 0           | 0                 | 5             | 0                    |
| 6.04.2020 | 56         | 0.866666667  | 4           | 0                 | 1             | -0.8                 |
| 7.04.2020 | 2          | -0.964285714 | 0           | -1                | 0             | -1                   |
### Appendix 1 (cont.). Frequency distribution and growth rates of the infection, death, and recovery of COVID-19 in Afghanistan*

| Date       | No of case | Growth rates | No of death | Death growth rate | No of recovery | Recovery growth rate |
|------------|------------|--------------|-------------|-------------------|----------------|----------------------|
| 8.04.2020  | 19         | 8.5          | 3           | 0                 | 2              | 0                    |
| 9.04.2020  | 40         | 1,105263158  | 1           | -0.666666667      | 12             | 5                    |
| 10.04.2020 | 71         | 0.775        | 3           | 2                 | 0              | -1                   |
| 11.04.2020 | 52         | -0.267605634 | 0           | -1                | 0              | 0                    |
| 12.04.2020 | 58         | 0.115384615  | 3           | 0                 | 6              | 0                    |
| 13.04.2020 | 49         | -0.155172414 | 2           | -0.333333333      | 2              | -0.666666667         |
| 14.04.2020 | 70         | 0.428571429  | 2           | 0                 | 3              | 0.5                  |
| 15.04.2020 | 56         | -0.2         | 5           | 1.5               | 11             | 2.666666667          |
| 16.04.2020 | 66         | 0.178571429  | 0           | -1                | 45             | 3.090909091          |
| 17.04.2020 | 27         | -0.590909091 | 0           | 0                 | 13             | -0.711111111         |
| 18.04.2020 | 63         | 1.333333333  | 3           | 0                 | 19             | 0.461538462          |
| 19.04.2020 | 35         | -0.444444444 | 3           | 0                 | 4              | -0.789473684         |
| 20.04.2020 | 66         | 0.885714286  | 0           | -1                | 15             | 2.75                 |
| 21.04.2020 | 84         | 0.272727273  | 4           | 0                 | 16             | 0.066666667          |
| 22.04.2020 | 106        | 0.261904762  | 2           | -0.5              | 14             | -0.125               |
| 23.04.2020 | 69         | -0.349056604 | 1           | -0.5              | 8              | -0.428571429         |
| 24.04.2020 | 112        | 0.623188406  | 4           | 3                 | 18             | 1.25                 |
| 25.04.2020 | 68         | -0.392857143 | 3           | -0.25             | 18             | 0                    |
| 26.04.2020 | 172        | 1.529411765  | 7           | 1.333333333       | 1              | 0.944444444          |
| 27.04.2020 | 125        | -0.273255814 | 1           | -0.857142857      | 3              | 2                    |
| 28.04.2020 | 111        | -0.112       | 2           | 1                 | 24             | 7                    |
| 29.04.2020 | 232        | 1.09009009   | 4           | 1                 | 8              | -0.666666667         |
| 30.04.2020 | 164        | -0.293103448 | 4           | 0                 | 50             | 5.25                 |
| 1.05.2020  | 134        | -0.182926829 | 4           | 0                 | 21             | -0.58                |
| 2.05.2020  | 235        | 0.753731343  | 13          | 2.25              | 14             | -0.333333333         |
| 3.05.2020  | 190        | -0.191489362 | 5           | -0.615384615      | 52             | 2.714285714          |
| 4.05.2020  | 330        | 0.736842105  | 5           | 0                 | 24             | -0.538461538         |
| 5.05.2020  | 168        | -0.490909091 | 9           | 0.8               | 37             | 0.541666667          |
| 6.05.2020  | 171        | 0.017857143  | 2           | -0.777777778      | 10             | -0.72972973          |
| 7.05.2020  | 215        | 0.257309942  | 3           | 0.5               | 4              | -0.6                 |
| 8.05.2020  | 255        | 0.186046512  | 6           | 1                 | 30             | 6.5                  |
| 9.05.2020  | 369        | 0.447058824  | 5           | -0.166666667      | 56             | 0.866666667          |
| 10.05.2020 | 285        | -0.227642276 | 2           | -0.6              | 16             | -0.714285714         |
| 11.05.2020 | 276        | -0.031578947 | 5           | 1.5               | 36             | 1.25                 |
| 12.05.2020 | 263        | -0.047101449 | 5           | 0                 | 38             | 0.055555556          |
| 13.05.2020 | 413        | 0.570342205  | 4           | -0.2              | 43             | 0.13578947          |
| 14.05.2020 | 414        | 0.002421308  | 17          | 3.25              | 54             | 0.255813953          |
| 15.05.2020 | 349        | -0.157004831 | 15          | -0.117647059      | 33             | -0.388888889         |
| 16.05.2020 | 262        | -0.249283668 | 4           | 3                 | 26             | 3.333333333          |
| 17.05.2020 | 408        | 0.557251908  | 4           | 3                 | 26             | 3.333333333          |
| 18.05.2020 | 581        | 0.424019608  | 5           | 0.25              | 40             | 0.538461538          |
| 19.05.2020 | 492        | -0.153184165 | 9           | 0.8               | 80             | 1                    |
| 20.05.2020 | 531        | 0.079268293  | 6           | -0.333333333      | 8              | -0.9                 |
| 21.05.2020 | 540        | 0.016949153  | 8           | 0.333333333       | 55             | 5.875                 |
### Appendix 1 (cont.). Frequency distribution and growth rates of the infection, death, and recovery of COVID-19 in Afghanistan*

| Date       | No of case | Growth rates | No of death | Death growth rate | No of recovery | Recovery growth rate |
|------------|------------|--------------|-------------|-------------------|----------------|----------------------|
| 22.05.2020 | 782        | 0.448148148  | 11          | 0.375             | 47             | -0.145454545         |
| 23.05.2020 | 584        | -0.253196931 | 2           | -0.8181818        | 17             | -0.638297872         |
| 24.05.2020 | 591        | 0.011986301  | 1           | -0.5              | 22             | 0.294117647          |
| 25.05.2020 | 658        | 0.113367174  | 1           | 0                 | 31             | 0.409090909          |
| 26.05.2020 | 625        | -0.050151976 | 7           | 6                 | 10             | -0.677419355         |
| 27.05.2020 | 580        | -0.072       | 8           | 0.142857143       | 71             | 6.1                  |
| 28.05.2020 | 623        | 0.074137931  | 11          | 0.375             | 50             | -0.295774648         |
| 29.05.2020 | 866        | 0.390048154  | 3           | -0.727272727      | 44             | -0.12                |
| 30.05.2020 | 680        | -0.2147806   | 8           | 1.666666667       | 25             | -0.431818182         |
| 31.05.2020 | 545        | -0.198529412 | 8           | 0                 | 100            | 3                    |
| 1.06.2020  | 759        | 0.39266055   | 5           | -0.375            | 22             | -0.78                |
| 2.06.2020  | 758        | -0.001317523 | 24          | 3.8               | 72             | 2.272727273          |
| 3.06.2020  | 787        | 0.038258575  | 6           | -0.75             | 63             | -0.125               |
| 4.06.2020  | 915        | 0.162642948  | 9           | 0.5               | 178            | 1.825396825          |
| 5.06.2020  | 582        | -0.363934426 | 18          | 1                 | 67             | -0.62395506          |
| 6.06.2020  | 791        | 0.359106529  | 30          | 0.666666667       | 45             | -0.328358209         |
| 7.06.2020  | 575        | -0.273072061 | 12          | 0.6               | 296            | 5.577777778          |
| 8.06.2020  | 542        | -0.057391304 | 15          | 0.25              | 480            | 0.621621622          |
| 9.06.2020  | 684        | 0.26199262   | 21          | 0.4               | 324            | -0.325               |
| 10.06.2020 | 747        | 0.092105263  | 21          | 0                 | 351            | 0.083333333          |
| 11.06.2020 | 656        | -0.121820616 | 20          | -0.047619048      | 602            | 0.715099715          |
| 12.06.2020 | 556        | -0.152439024 | 5           | -0.75             | 273            | -0.546511628         |
| 13.06.2020 | 664        | 0.194244604  | 20          | 3                 | 524            | 0.919413919          |
| 14.06.2020 | 761        | 0.146084337  | 7           | -0.65             | 365            | -0.303435115         |
| 15.06.2020 | 783        | 0.02890933   | 13          | 0.857142857       | 418            | 0.145205479          |

| Total cases | Growth rate | Total death | Death growth rate | Total of recovery | Recovery growth rate |
|-------------|-------------|-------------|--------------------|--------------------|----------------------|
| 26320       | 0.246958369 | 487         | 0.209648578        | 5490               | 0.481128997          |

* Data cover the 24 February 2020–15 June 2020