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## Effectiveness of lockdown as COVID-19 intervention: official and computed cases in Nepal

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### Abstract

**Introduction:** COVID-19 was first reported on 31 December 2019 from China. It was first confirmed in Nepal on 23 January 2020. Government enforced first wave of nationwide 'lockdown' for one week on 24 March 2020 and fourth from 16 April for 12 days. This paper aims to compute effectiveness of lockdown on COVID-19 cases in Nepal.

**Method:** Doubling times were calculated using official COVID-19 records first, and then, the number of COVID-19 cases based on various doubling time scenarios starting 23 January 2020 were computed and compared with the official cases of Nepal. All the calculations were done in Microsoft Excel.

**Result:** Doubling time was 60-day between first and second case, 5-day between 2<sup>nd</sup> and 5<sup>th</sup>, 15-day between 5<sup>th</sup> and 12<sup>th</sup> and again 5-day between 12<sup>th</sup> to 30<sup>th</sup> cases. Doubling time increased to 15-day after the lockdown. Estimated doubling time was 28 days till March, 21 days till 12 April and 18 days till 17 April 2020 and it is expected to reach 15 days on 24 April 2020.

**Conclusion:** The reported COVID-19 cases doubling time was 5, 15 and 5 days in Nepal after the lockdown. The doubling time increased due to lockdown.

**Keyword:** COVID-19, doubling time, Nepal

## Introduction

A cluster of cases of pneumonia of unknown etiology was first reported from Wuhan, China to the World Health Organization (WHO) on 31 December 2019 by the Chinese authority.<sup>1</sup> The disease was termed as coronavirus disease 2019 (COVID-19)<sup>2</sup> and it was confirmed as human-to-human transmission on 22 January 2020. Wuhan city and Hubei province was put on lockdown on 23 January to break the chain of transmission.<sup>1</sup> The COVID-19 was declared a pandemic on 11 March 2020.<sup>2</sup>

In Nepal, first and second COVID-19 cases were confirmed on 23 January and 23 March 2020 respectively.<sup>3</sup> Government enforced first phase of lockdown for one week on 24 March 2020 and fourth phase from 16 April for 12 days to break the chain of transmission in Nepal.<sup>4</sup>

This paper aims to assess the effectiveness of lockdown till 17 April 2020 using doubling times of reported and estimated COVID-19 cases of Nepal.

## Method

Health Emergency Operation Center (HEOC), Ministry of Health and Population, Nepal, publishes daily situational analysis report of Reverse Transcription Polymerase Chain Reaction (RT-PCR) confirmed COVID-19 cases. This data was used to calculate doubling time of confirmed cases from 23 Jan to 17 April 2020. The what-if analysis of doubling time of COVID-19 cases in Nepal were done for various scenarios: doubling every 5, 7, 15, 18, 21 and 28 days. The simulation from 23 Jan

2020 i.e. confirmation of the first COVID-19 case of Nepal was taken as the start date. The doubling times were used to assess the effectiveness of the intervention (lockdown) in Nepal. All the calculations were done using Microsoft Excel 2013.

## Result

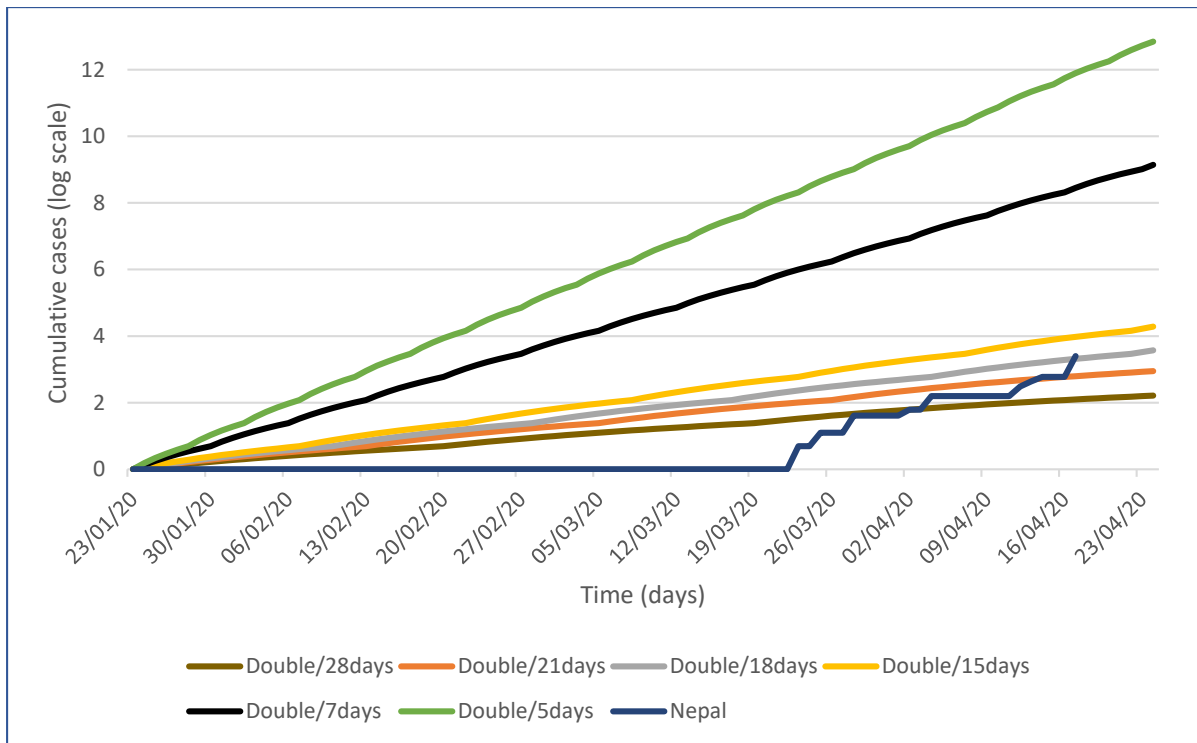
The first laboratory confirmed COVID-19 case of Nepal was reported on 23 January 2020 by WHO reference laboratory in Hong Kong using RT-PCR and second case on 23 March 2020 by Nepal Public Health Laboratory (NPHL), Kathmandu using the same method. Initially it took 60 days to double the COVID-19 cases in Nepal, and 5 days to double from 2 to 5 (increased by factor of 2.5) on 28 March 2020 even though 'lockdown' was enforced from 24 March 2020 in the country. It took 15 days (28 March – 12 April 2020) to double the COVID-19 cases from 5 to the 12 (increased by factor of 2.4) as per the HEOC situational report of 12 April 2020.<sup>5</sup>

And, only 5 days to double from 12 to 30 (increased by factor of 2.5) on 17 April. The median of doubling times between 23 January and 17 April (60, 5, 15 and 5) was 11 days with interquartile range of 19.75 days.

Estimated cases by simulation (what-if analysis) revealed that it doubled every 28-days till 28 March, every 21-days till 12 April and every 18-days till 17 April 2020, Table 1. The COVID-19 cases could have reached as high as 146,801 and 4,581 cases on 17 April 2020 if it had doubled every five and seven days respectively from the first case that was confirmed on 23 January 2020.

**Table 1. Estimated cumulative COVID-19 cases in Nepal for various doubling times (days) from 23 Jan-24 Apr 2020**

Date	Cumulative confirmed cases	Estimated doubling time days					
		5	7	15	18	21	28
23/01/2020	1	1	1	1	1	1	1
23/03/2020	2	4,096	402	16	11	7	5
28/03/2020	5	8,192	658	21	13	9	5
12/04/2020	12	73,400	2,926	43	23	14	7
17/04/2020	30	146,801	4,581	53	28	17	8
24/04/2020	48	377,485	9,362	73	36	19	9



**Figure 1. Cumulative cases by various doubling time scenarios, Nepal, up to 24 Apr 2020**

The COVID-19 cases could have reached 53 and 8 cases if it was doubled every 15 days and every 28 days on 17 April. Further, estimated cumulative cases on 24 April would have been 377485, 9362, 73 and 36 for the doubling time of 5 days, 7 days, 15 days and 18 days respectively. As 30 cumulative cases were reported on 17 April, 19 and 9 cases estimated for April 24 were unlikely.

Trend of COVID-19 cases for various doubling time scenarios showed that cases were doubling at every 28 days in the beginning but they start to come down every 21 days and every 18 days. It also showed that cumulative COVID-19 cases will double every fifteen days after 17 April 2020 (e.g. from 30 to 60 cases on May 1, 2020) if the same trend continues in Nepal. However, cases will increase exponentially from 18 April 2020 onward if the cases start to double every 7-day (60 and 120 cases on 24 April and 1 May, 2020) and every 5-day (60 and 120 cases on 22 April and 27 April, 2020), Figure 1.

### Discussion

As per the official records, doubling time of cumulative COVID-19 cases were fluctuating in Nepal.<sup>5</sup> It took 60-day to double the case from 1 to 2, which can be attributed to the extremely low rate of contact, infection and transmission of the disease as both the cases were imported in Nepal. On the other hand, it only took five days to double the case from 2 to 5 despite the enforcement of first wave of lockdown in the country from 24 March 2020 onward. The third, fourth and fifth COVID-19 cases were all imported and they were returnee Nepali from UAE, UAE and Belgium.<sup>3</sup> This could have happened as strict monitoring and testing of returnee Nepalese from abroad were not done at international and domestic airports. They were also allowed to travel freely on roads to reach their destination and roam around in neighborhood and markets within Nepal.<sup>4</sup>

However, it took 15-day to double the cases from 5 to 12 and it showed that lockdown was effective in delaying the spread of COVID-19 virus in Nepal. Sixth, seventh and eighth COVID-19 cases of Nepal were

imported from Belgium, India and India.<sup>3</sup> Therefore, Nepal decided to close all its land borders with India too.<sup>4</sup> This can also be attributed to the increased testing of the suspected cases as well as their contacts through the travel history of COVID-19 cases of Nepal.<sup>4</sup> Nonetheless, ninth case was the first local transmission of Nepal, which was confirmed on 4 April 2020 in a 34-year old woman of Kailali district, Nepal.<sup>3</sup>

The COVID-19 cases again doubled within 5-days from 12 to 30 cases on 17 April 2020 as first cluster of cases of 12 people, mostly Indian *Jamati* Muslims (nomad Muslim monks), tested positive in a single day from a mosque at Bhulke, Triyuga Municipality, Udayapur district, Province Number one, Nepal. Thus, fourth wave of lockdown was enforced from April 16, 2020 for another 12 days to stop the spread of virus in Triyuga Municipality, Udayapur district and other areas of Nepal. Another cluster of 11 COVID-19 cases were reported again from the Bhulke mosque of Triyuga Municipality, Udayapur district on 21 April 2020 suggesting a possible community level outbreak of COVID-19 case in Nepal.

The what-if analysis showed that doubling time of COVID-19 cases in Nepal was nearly 28-days till 28 March 2020. However, doubling time started to drop to every 21-days on 12 April and every 18-days on 17 April. This was not a good sign as cases would increase exponentially if the testing, contact tracing, quarantine and isolation of the confirmed COVID-19 cases were not done in Nepal.<sup>4</sup> For instance, estimated COVID-19 cases on 24 April was 377,485 for doubling time of every 5-days with possible outbreaks in many clusters. So, it will be wise to have higher doubling time to control community level transmission Nepal. Since 73 and 36 cases were estimated for doubling time of 15 and 18 days on 24 April, the doubling time of 17-day gave a fair estimate for that day (46 cases) as official cumulative cases were reported as 48 on that day in Nepal.<sup>5</sup>

The estimations of COVID-19 cases based on the various doubling time scenarios are related to the rate of infection. For instance, the rate of infection of COVID-19 cases in Nepal based on RT-PCR tests done till 24 April 2020 was 0.0051 [48/(9358 + 48)] or 0.51 percent. This infection rate was under estimated as doubling time (DT) of COVID-19 cases in Nepal with this rate would be 136 days with direct estimation [ $DT = \ln(2)/\text{rate of infection}$ ]<sup>6</sup> and 196 days with indirect estimation ( $DT = 1/\text{rate of infection}$ ).<sup>7</sup> This neither coincided with the reported nor the estimated value of doubling times of Nepal. This has happened as we have not tested COVID-19 antibodies in Nepali population to know the true rate of infection in the country. So, rate of infection must be computed indirectly using basic reproductive number and rate of recovery.<sup>7</sup>

The simulation did not consider the rate of recovery of COVID-19 cases, which was the main limitation of this study. Yet, the official report revealed that 10 persons with COVID-19 positive have already been recovered in Nepal and 38 other were undergoing treatment in various hospitals outside of Kathmandu Valley as of 24 April 2020. So, the recovery rate of COVID-19 based on official record was 0.208 i.e. 10/48. This recovery rate coincides well with the indirectly estimated recovery rate<sup>7</sup> of COVID-19 i.e. recovery rate = 1/incubation period of COVID-19 = 1/5-day = 0.20. Thus, the indirect estimation of rate of infection of COVID-19 for Nepal would be 0.48 (0.208\*2.28) with average basic reproduction number of 2.28.<sup>8</sup>

## Conclusion

The reported COVID-19 cases doubling time was 5, 15 and 5 days in Nepal after the lockdown started on 24 March 2020 whereas median doubling time was 11 days between 23 January and 17 April, 2020 suggesting effectiveness of the lockdown. The estimated COVID-19 cases doubled every 21-day from 23 January to 28 March 2020 whereas it doubled every 18-day between 23 January

and 12 April 2020. Estimated doubling time was 17 days for 24 April 2020 with 46 cases, which was close to the 48 confirmed cases on that day. A second cluster of 11 cases suggested the community level transmission (stage 3 outbreak) requiring continuation of the lockdown, contact tracing and testing.

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### Conflict of Interest

None

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None

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