

Use of interrupted time series design in COVID-19 data of Nepal

Saraswati Sharma¹, Shraddha Nepal¹, Shital Bhandary²

¹Masters of Public Health (MPH) Student, ²Assoc. Prof., School of Public Health, Patan Academy of Health Sciences, Lalitpur, Nepal

ABSTRACT

Introduction: Nepal was hit hard by COVID-19 pandemic and is still struggling with its implications for individuals, societies, and health systems. We applied Interrupted Time Series (ITS) analysis to see if the government's decision to end two nationwide lockdowns had an impact on the average daily new cases of COVID-19 reported in Nepal.

Method: ITS analysis on daily new cases of COVID-19 was performed for first and second nationwide lockdown on data of Nepal from data depository for 2019 Novel Coronavirus Visual Dashboard operated by Johns Hopkins University Center for Systems Science and Engineering. Impact of "ending nationwide lockdown" and possible associated factors were investigated.

Result: The impact of removing first nationwide lockdown contributed to statistically significant rise of an average difference of 899 daily new cases due to community transmission of COVID-19. During second lockdown, even after imposing lockdown, cases overwhelmed existing healthcare system due to high infectivity of new Delta variant followed by a lack of adherence to public health measures and delayed decision to impose lockdown due to economic reasons. Whereas significant decline of cases was observed with an average difference of 2970 daily new cases after ending second nationwide lockdown mostly due to vaccine acceptance.

Conclusion: First lockdown was imposed early due to uncertainty about progression of disease, curative measures and unavailability of vaccines. Ending of first lockdown was done untimely due to economic reasons and festive seasons. The unusual decline in cases after ending second lockdown could be contributed to increased vaccination in the country.

Keywords: COVID-19, interrupted time series, lockdown, policy, Nepal

CORRESPONDENCE

Ms. Saraswati Sharma, Masters of Public Health (MPH) Student, School of Public Health, Patan Academy of Health Sciences, Lalitpur, Nepal

Email: mph.saraswatisharma@pahs.edu.np

INTRODUCTION

The novel coronavirus SARS COV2 first reported in December 2019; in Wuhan, China, was declared a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, within a month of its first appearance.¹ It was declared as a Pandemic on March 11, 2020, by World Health Organization.¹ To prevent the significant loss of human life and health and, to control the virus transmission, countries worldwide adopted various mitigation measures.^{2,3} The virus transmission from human to human via droplets and aerosol resulted in the rapid spread with 219 nations reporting it as of January 22, 2021¹ due to significant gaps in advance preparedness and the implementation of response plans.⁴ Nepal confirmed its first case of COVID-19 on January 23, 2020, in a 31 years old student returning from Wuhan China, the first local transmission was confirmed on April 4, 2020, in the Kailali district and the first death occurred on May 14 of a postnatal mother of Sindhupalchowk. The country seemed to be responding preemptively to the pandemic when the country sealed its borders with India and China on March 23 and imposed a country-wide lockdown on March 24 when the country only had 2 confirmed cases of the infection⁵. The country at the beginning also enforced 2 weeks of self and home quarantine for people visiting Nepal, which was extended to 3 weeks on April 4, 2020.⁶ The promotional campaigns for "Visit Nepal 2020", "Sagarmatha Sambaad" and other international events were also halted.⁷

However, at the beginning of the COVID-19 cases in the country, the country was not sufficiently prepared to respond to the pandemic. The country sent its first case sample to Hong Kong and on 27th January 2020 rRT-PCR test began at the National Public Health Laboratory.⁶ The country had an unrealistically low incidence of the infection, though unrestricted returns of migrant workers happened through the country's porous borders with India, which can be accounted to insufficient diagnosis due to lack of testing.⁷

Randomized Control Trials (RCT), considered the gold standard to evaluate the causal effect of an intervention, it is not always possible to do RCT because of limited resources, ethical considerations, and their practicality. In such cases, quasi-experimental studies are recommended, and Interrupted Time Series is one of the strongest quasi-experimental designs to understand the effect of an intervention.⁸ An interrupted time series design involves collecting

data consistently over multiple equally spaced time points before and after the introduction of any interruption/intervention (e.g. policy, program, and product). The design helps to understand if the introduction of the interruption had any changes in the outcome of interest.⁹

We applied descriptive interrupted time series analysis on daily reported cases of COVID-19 in Nepal within the duration of 2020/1/25 to 2021/12/25. We analyzed the change in the trend of daily cases of COVID-19 reported during and post-lockdown period of both the nationwide lockdowns Nepal went through during the first wave and second wave. The findings provide ideas on the effectiveness of lockdown as a response strategy for controlling COVID-19 cases in the future too by analyzing the impact of the Nepal government's decision to end the lockdown on daily reported cases of COVID-19.

METHOD

Setting

Nepal, a country recently upgraded to a lower middle-income country from a low-income country has a total population of about 29 million with an annual growth rate of 1.8% in 2020.¹⁰ Nepal made a historic move in the form of governance as the Constitution of Nepal 2015 established the country as a federal democratic republic. The government structure changed from a unitary form of government to a federal system with three tiers of government – federal, provincial and local. The country has a federal government, seven provincial governments, and 753 local-level governments.

Data

We utilized the data on daily new cases of COVID-19 updated on the data depository for the 2019 Novel Coronavirus Visual Dashboard operated by the Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE). We extracted the data of Nepal on daily new cases within the duration of 2020/1/25 to 2021/12/25 in excel (.xlsx) format.

To analyze the fluctuations, we plotted a column chart of the daily new cases in excel. We applied descriptive interrupted time series design to the data. We examined the changes in the average number of daily new cases of COVID-19 from (24th March 2020-21st July 2020) and after (22nd July 2020- 28th April 2021) ending the first lockdown and also from (29th April 2021- 1st Sept. 2021) and after (2nd September 2021- 5th December 2021)

ending the second lockdown in the second wave. Considering lifting off lockdown as the intervention, the pre-intervention period for the first lockdown was decided as the period from the date of imposing of 1st lockdown to the day it was officially ended by the government. Post-intervention was considered as the date from a day after the liftoff of the 1st lockdown to the day before the imposition of the 2nd lockdown. For the second lockdown, the pre-intervention period was considered as the period between the day after the liftoff of 1st lockdown to the day state ended the 2nd lockdown officially. Post-intervention was considered a period between the days after the end of 2nd lockdown to the day before the Omicron variant case was 1st identified in Nepal.

RESULT

Trend Analysis of COVID-19 (25th January 2020 to 5th December 2021)

Figure 1 shows the graphical presentation of daily new cases of COVID-19 from 25th January 2020 to 5th December 2021. With the confirmation of the first COVID-19 case on January 23, 2020, Nepal started reporting daily cases in hundreds by June and July. Cases jumped to a monthly total of around 20,000 in August reaching more than 35,000 during September, and over 90,000 in October. The surged cases during this period formed the first wave of COVID-19 with a visible declination starting from November onwards. The festive season contributed to the surge in cases. Also, increasing PCR testing laboratories in the country by that time contributed to the increased reporting of cases.

The cases were less than 500 daily new cases in January 2021 that further declined during February and March with lower than 100 daily new

cases sometimes. From mid-April, the cases started to rise again following the second wave in India. The cases jumped to more than 9000 cases per day within a month showing its peak during May. From June to September 2021, there were less than 5000 cases per day that further declined to less than a thousand cases from late September onward. The fluctuation in the number of cases seen over this period of six months (April to September 2021) formed the second wave of COVID-19 in Nepal. (Figure 1)

Interrupted Time Series Analysis of COVID-19 Data

This study performed a comparison of changes in COVID-19 daily new cases before and after the government's decision to end the nationwide lockdown. During 1st lockdown, the average number of daily new cases of COVID-19 increased from 150 to 1049 in lockdown (24th March 2020- first July 2020) and post-lockdown (2nd July 2020- 28th April 2021) periods. There was an increase of 899 average daily new cases of COVID-19 during the first lockdown (Figure 2) and the mean difference of daily new cases before and after ending 1st lockdown is also statistically significant (two-tailed p-value <0.0001, obtained from unpaired t-test). During the second lockdown, this number declined to 2970 cases resulting in a difference of 3584 average daily new cases of COVID-19 during the lockdown period (29th April 2021- first Sept. 2021) and 614 average daily new cases in the post-lockdown period (2nd September 2021- 5th December 2021). (Figure 3) This difference in mean daily new cases before and after the end of the second lockdown is also found to be statistically significant as the p-value calculated with unpaired t-test is <0.0001.

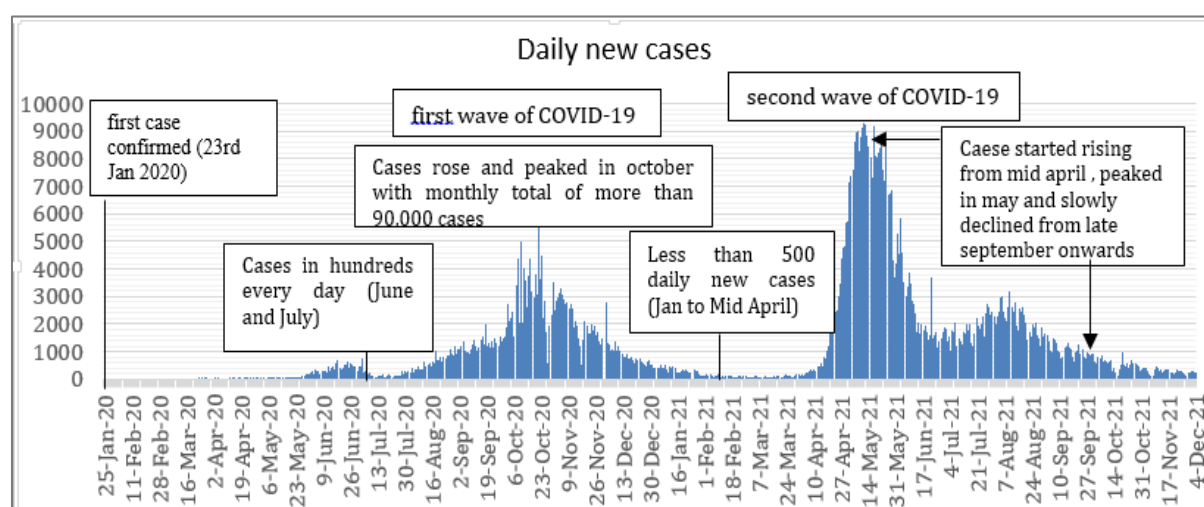


Figure 1. Trend analysis of COVID-10 cases (25th Jan 2020-5th Dec 2021)

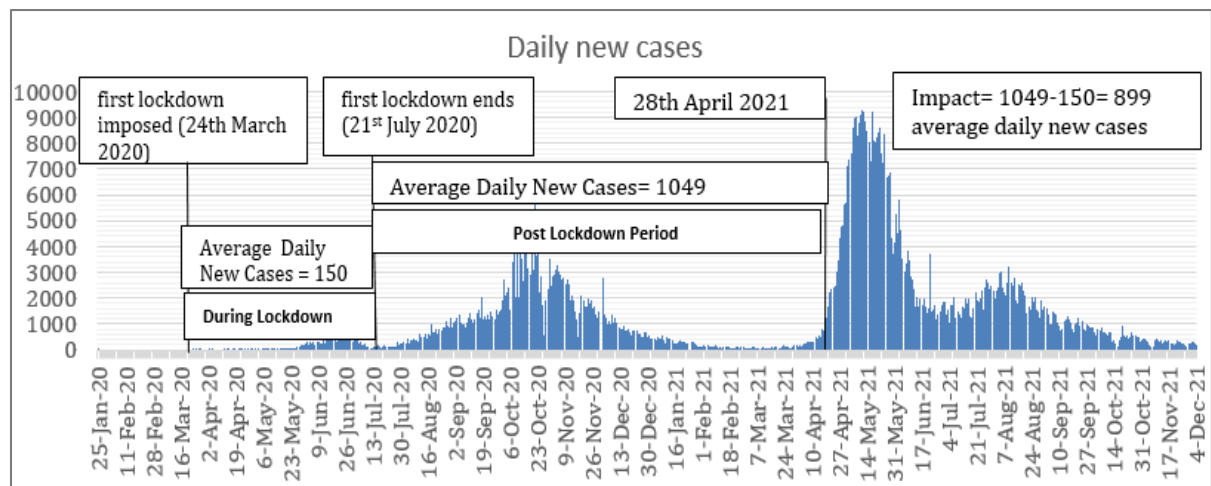


Figure 2. Interrupted time series analysis of COVID-19 daily new cases during the first lockdown

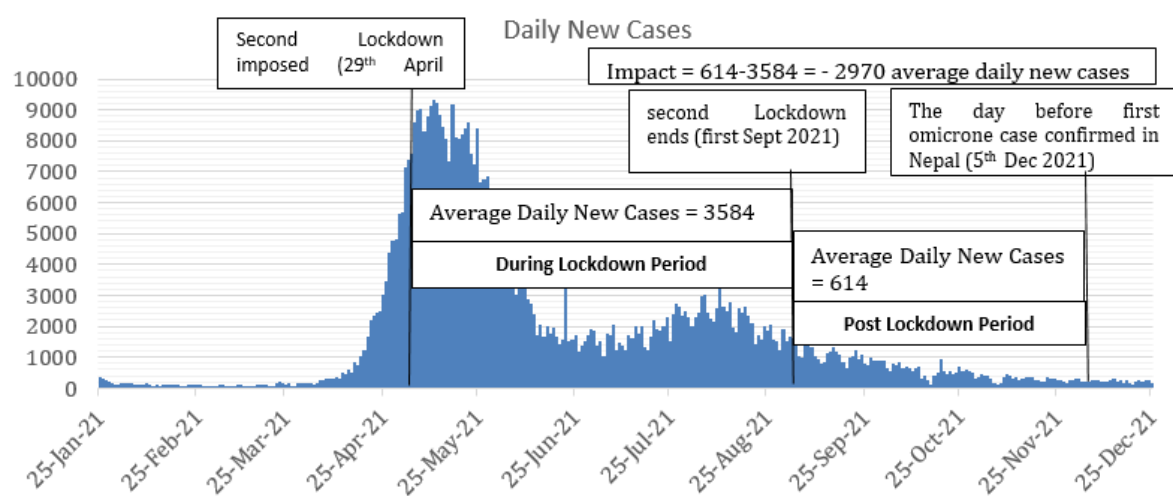


Figure 3. Interrupted time series analysis of COVID-19 daily new cases during the second lockdown

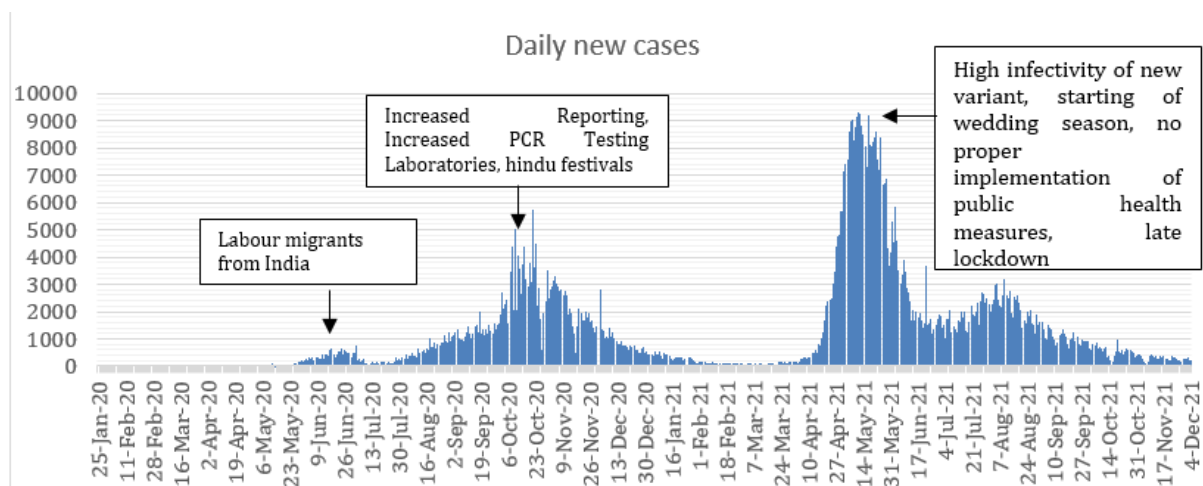


Figure 4. Probable Factors contributing to increased daily new cases during the first and second wave (Source: Verma R, 2021)

DISCUSSION

The Descriptive Interrupted Time Series Analysis (ITS) examines whether the data pattern observed post-intervention is different from that observed pre-intervention. In an ITS study, a time series of a

particular outcome of interest is used to establish an underlying trend, which is 'interrupted' by intervention at a known point in time.⁸ In this study, we examined whether the Nepal government's decision to end the nationwide

lockdown had any effect on daily new cases of COVID-19 reported in the country. We performed the analysis for both the nationwide lockdowns the country went through during the first and second waves of COVID-19. Our findings indicate that during the first lockdown, the government's decision to end the lockdown contributed to a sudden surge of COVID-19 daily new cases. It can be reflected that the government's decision to end the lockdown was possibly not appropriate at that time as the lockdown had controlled the COVID-19 transmission and the ending of the lockdown induced its abrupt increase. The findings of this study align with that of India¹¹ and China¹² both of which found that institutions of lockdown had significantly reduced the daily cases of COVID-19 and contrasts with the case of New Zealand which with early preparation and systematic management managed the COVID-19 cases to keep low without posing a longer lockdown period.¹³

The Government of Nepal decided to impose the second lockdown on 29th April 2021 which ended after four months on the first of September.¹⁴ Our finding revealed that the average daily new cases of COVID-19 reported was far less during the post-lockdown period compared to the lockdown period. This may give a false reflection that the government's decision to end the lockdown significantly reduced daily reported COVID-19 cases but the real scenario was that the second wave appeared following the emergence of a new Delta variant, in India, twice as contagious as previous variants, also the start of wedding season, the celebration of major Hindu festivals in Nepal, mass movement of people in the country, a lack of adherence to social distancing guidelines contributed to further transmission creating a devastating situation in the country that even the lockdown could not control. (Figure 4) The cases were already increasing trend from mid-April and thus it can be predicted that the official imposition of lockdown was a bit delayed as the government hesitated to impose the lockdown again due to its impact on the economy and also maybe because there were some vaccines available in the country by that time. The irony is that the second wave swept a lot of lives.¹⁵

As this review was not analytical and did not perform regression-based trend analysis of the number of daily new COVID-19 cases and is only limited to the difference calculation, the cautious use of the findings is recommended.

CONCLUSION

The decision of ending the first nationwide lockdown showed a quick surge in daily reported COVID-19 cases. A significant increment of cases after ending the first lockdown signifies that it was not an appropriate decision of the government to end the nationwide lockdown early amid community transmission. The case was different from the second lockdown during the second wave of COVID-19 as it started late after the spread of the deadly delta variant in the country. The emergence of the highly transmissible Delta variant followed by starting of the wedding season and improper implementation of public health measures played major roles in the unprecedented rise of cases even after imposing lockdown during the second wave. The daily reported cases of COVID-19 had declined significantly during the post-lockdown period after second lockdown, which could be because even the hesitant people started to get vaccinated after observing devastating deaths in India and Nepal during the second wave.

Acknowledgment

The study team highly appreciates the assistance of Ms. Kusumsheela Bhatta during the extraction of the data from the data depository of the Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE).

Conflict of Interest

None

Funding

None

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