



Research Article

Tracking and time series scenario of coronavirus: Nepal case

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Abstract: The pandemic COVID-19 caused by novel coronavirus (SARS-CoV-2) is a highly infectious disease that has created an unprecedented global challenge affecting all the countries including Nepal. In Nepal, the first case of COVID-19 was reported on 24 January, 2020. The number of case increased to 1,798 by June 1, 2020. Most of these cases were recorded in the lowland Tarai districts of the country indicating that the major transmission slipped from the border between Nepal and India. Thousands of Nepali people go to India for work every year. This year, they returned en-masse to Nepal after India declared lockdown. However, the first case of COVID-19 was detected in a student who had returned from China and a few initial cases were from people who had returned from Europe via Middle East using international flights. As of June 1, 2020, the coronavirus has spread to 61 districts (out of 77) of Nepal as those home returning people, mostly the migrant workers made their destinations by roads using public vehicles. Reports are mounting that the infected cases are increasing in the rural mountains gradually. This study aims to prepare time series tracking map of the infection in Nepal. It is based on a total of 71,903 PCR tests that were conducted till June 1, 2020. There is a strong correlation between PCR tests and the identified case; however, the number of tests is much limited to develop a decision support scenario.

Keywords: Covid-19, international border, migrant workers, PCR, pathway

सारांश: नयाँ प्रकारको कोरोनाभईरस (सार्स-कोभिड-२) का कारण उत्पन्न कोभिड-१९ महाव्याधी एक अत्यन्त छिटो फैलिने सरुवा रोग हो जुन अभूतपूर्व रूपले विश्वव्यापी चुनौती बन्न पुगेको छ र नेपाल यसबाट अछुतो छैन। नेपालमा कोभिड-१९ को पहिलो केस २०२० जनवरी २४ मा भएको प्रतिवेदित छ, जून १ सम्म यसबाट संक्रमितको संख्या १,७९८ पुगेको छ। धेरैजसो यी केसहरु भारतसित सिमाना जोडिएका तराईका जिल्लाहरुमा भेटिएका छन्। हरेक वर्ष, हजारौं नेपालीहरु कामको खोजिमा भारत जाने गर्दछन्, कोभिड-१९ महाव्याधिको अवस्थामा भारत सरकारले लकडाउनको घोषणा गरेपछि ती हुलमूलमा नेपाल फर्किएका छन्। यद्यपी, यस रोगबाट संक्रमित पहिलो केस चीनको वुहानबाट फर्किएका युवा थिए र प्रारंभका अन्य केसहरु पनि युरोपबाट मध्यपूर्व हुँदै अन्तरराष्ट्रिय हवाई उडानबाट फर्किएका यात्रुहरुमा पहिचान भएको थियो। भारत लगायत अन्य देशहरुबाट स्वदेश फर्किएका नेपालीहरु जब स्थलमार्ग र सार्वजनिक यातायातको प्रयोग गरी आ(आफ्नो गृहजिल्ला पुग्नथाले जून १ पुग्दा, कोभिड-१९ बाट संक्रमितहरु देशका ७७ मध्ये ६१ जिल्लामा भेटिए। क्रमशः पहाडका दूर्गम जिल्लाहरुमा पनि संक्रमितहरु बढ्दै गएको प्रतिवेदन आउन थालेका छन्। यस अध्ययनको मुख्य उद्देश्य नेपालमा कोभिड-१९ संक्रमणको समय-श्रृङ्खलाको नक्साङ्कन गर्नु रहेको छ। यसको तथ्याङ्क आधार जून १, २०२० सम्म गरिएका कूल ७१,९०३ पीसीआर नमूना परिक्षणहरु हुन्। पीसीआर परिक्षण र पहिचान गरिएका केसहरुबीच बलियो सह(संबन्ध देखिन्छ, तथापी निर्णयात्मक परिदृश्यको लागि भने परिक्षणको संख्या र दायरा अभि बढाउनु पर्ने देखिन्छ।

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1. Background

In the past two decades, people of the world were facing health challenges from two coronavirus causing SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome), which have taken over 1,600 human lives combined in several countries (Cheng et al., 2007; Chan et al., 2015; Gralinski and Baric, 2015). A new coronavirus causing second type of SARS was detected on December 31, 2019 in Wuhan, China. The World Health Organization (WHO) named the disease COVID-19 and the new coronavirus as SARS-CoV-2. The COVID-19 is a highly contagious disease and has created the biggest global crisis after World War II impacting human health, economic and even the environment (Neupane, 2020). Recognizing the severity of the disease transmitting across the continents, the WHO declared this disease a pandemic on March 11, 2020.

It is estimated that the novel coronavirus has infected over six million people and nearly 377,000 people have died due to this disease by June 1, 2020 (WHO, 2020). The persistent drumbeat of positive tests and reported deaths in other countries due to COVID-19 has created widespread concern in Nepal. Nepal reported the first case on January 23, 2020 and by June 1, 2020 there were 1,798 people infected by COVID-19. This is based on tests of 71,903 by PCR (Polymerase Chain Reaction) and 113,757 by RDT (Rapid Detection Technique) till the date (MoHP, 2020). In such grave circumstances, it is very important to track the pathways, and predict the future infection that can support for prevention of the disease and aid in the health care service preparation. This study aims to assess pathways, timeline of spreading and time series scenario of COVID-19 in Nepal. Particularly, this study aimed at understanding the transmission media of COVID-19, finding out the spreading trend of COVID-19, and developing the time scenario of spreading of COVID-19 in Nepal.

2. Materials and Methods

We collected the number of COVID-19 cases in Nepal between January 23, 2020 and June 1, 2020 from the official portal of the Ministry of Health and Population, Government of Nepal (<http://covid-19mohp.gov.np>). Detailed information of infected people, such as their age, gender, location, travel history and means of transmission, and status of hospitals and their testing facilities, and quarantine centers were compiled. Additionally, daily PCR tests and number of infected people were recorded during the study period. These data were analyzed using STATA software (stata.com) to generate the regression model and scatter diagram. The Arc GIS

software (ArcGIS ver. 10.2) was used to prepare transmission pathways map.

3. Results

3.1. Transmission media of COVID-19 spread

A total of 1,798 COVID-19 cases were recorded between January 23 and June 1, 2020 in Nepal. The first case in Nepal was reported in a 32-year old person returning from Wuhan, China. At the first stage, 20 cases were reported in Nepal on those people who travelled via air from China (1) France (1), Belgium (1), United Kingdom (2), Bahrain (1), Qatar (2) and United Arab Emirates (1) and remaining 11 infected people who travelled to Nepal via road from India (Figure 1).

The Government restricted all the international flights to Nepal on March 22, 2020, banned long distance domestic vehicle movement from March 23, 2020 except domestic flights, restricted people coming out of their houses, halted all the private and public sectors services except emergency situation from March 24, 2020.

Similarly, the Government initiated some precautionary measures and notified all the migrants to stay in quarantine either in government facilities or in their own home. These migrants, however, travelled to their home districts either by road or by domestic flights. On March 25, 2020, more than 300 Nepali, who were in New Delhi, Uttar Pradesh, Bihar and other places in India, entered to Banke and Kailali districts in Tarai of Nepal via road without medical check-up. In addition, more cases were reported between March 23 and June 1, 2020 in Nepal.

3.2. Spreading trend of COVID-19 cases

The results show that COVID-19 cases are spreading rapidly in Nepal, since the first case was reported on January 24, 2020 in Kathmandu. The spreading of COVID-19 reached to 61 districts (Kailali, Kanchanpur, Banke, Kapilvastu, Rupendehi, Chitwan, Baglung, Parsa, Bara, Rautahat, Udayapur, Bhojpur, Jhapa, Sarlahi, Kathmandu, Dailekh, Dhanusha, Surkhet, Saptari, Dang, Salyan, Siraha, Mahottori, Jumla, Kalikot, Achham, Bardia, Syangja, Nawalparasi East, Nawalparasi West, Dhankuta, Morang, Baitadi, Makawanpur, Bhaktapur, Gulmi, Palpa, Parbat, Arghakhanchi, Dhading, Bajura, Lalitpur, Nuwakot, Rukum East, Sunsari, Sankhuwasabha, Bhajhang, Dadeldhura, Darchula, Dolakha, Doti, Kavrepalanchok, Khotang, Lamjung, Myagdi, Pyuthan, Ramechhap, Sindhuli, Sindhupalchok, Solukhumbu and Tanahun) by June 1, 2020 (Figure 2). The cases severely hit all districts of Tarai region and almost all districts of mid-hill except Ilam,

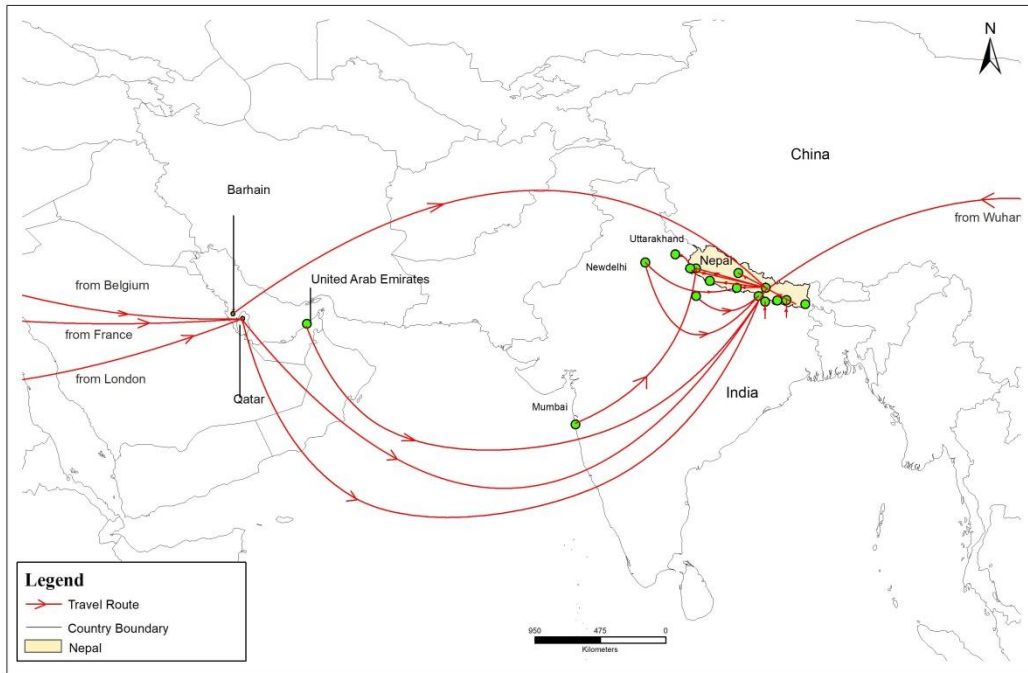


Figure 1. Pathways of COVID-19 in Nepal

Panchthar, Rukum West, Jajarkot, Rolpa, (305), Banke (213) Sarlahi (133), Jhapa (112), Parsa (107) and so on. Based on gender, about 93 percent cases were recorded on male and 7 percent on female (Figure 4). The COVID-19 was increasing on daily basis. From the data of COVID-19 cases of Nepal it showed that the male individuals were more infected than female individuals (Figure 4).

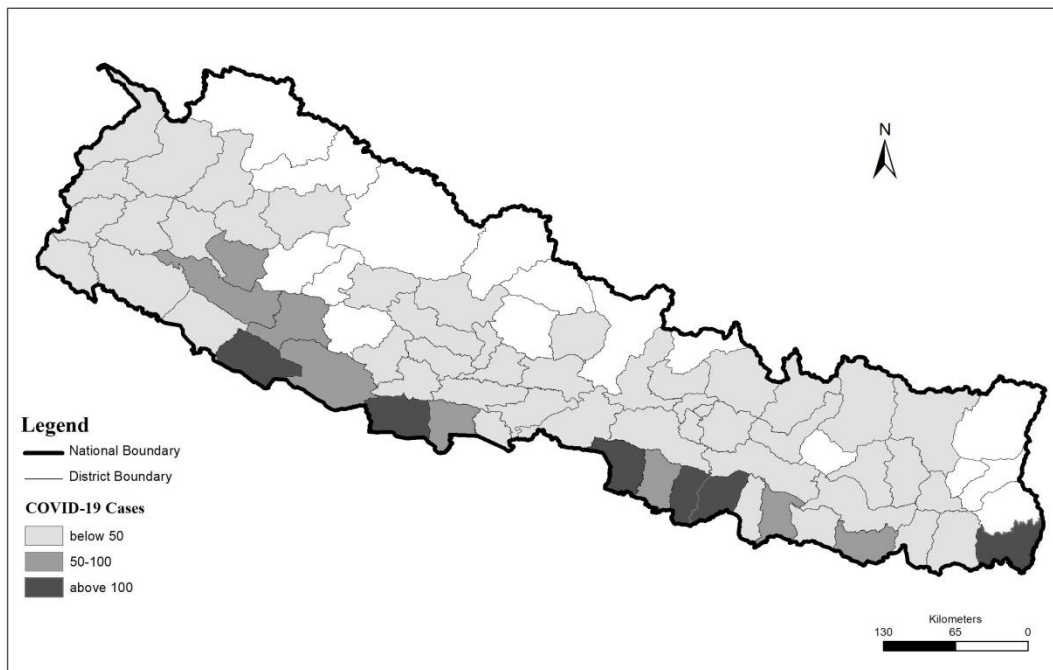


Figure 2. COVID-19 cases by district

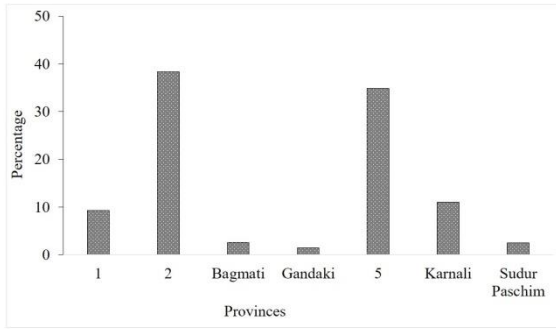


Figure 3. Status of COVID-19 infection by provinces of Nepal

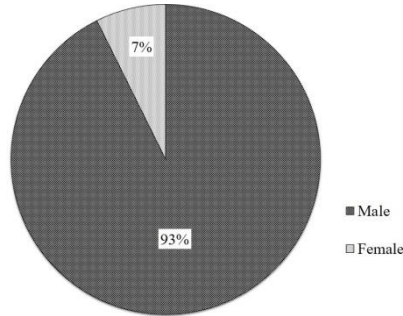


Figure 4. Status of COVID-19 infected people by gender

Out of 1,798 infected COVID-19 cases, 24 percent were below 20 years, 62 percent were in 20-40 age groups, 13 percent were in 40-60 age group and 2 percent were above 60 years old (Figure 5). A total of 25 hospitals with 21 laboratory facilities were available for treatment of COVID-19 patients in Nepal.

3.3. Time scenario of COVID-19 spreading

The data showed that a total of 71,903 PCR tests were performed with an average of 1,099 PCR tests per day from March 27 to June 1, 2020. However, the number of tests per day ranged from the lowest 42 per day to the highest 3,494 per day. On June 1, 2020, the highest number of COVID-19 cases in a day so far ($n = 226$) was recorded. Similarly, a total of 113,757 RDT tests were conducted in an average of 2,230 tests per day during the period.

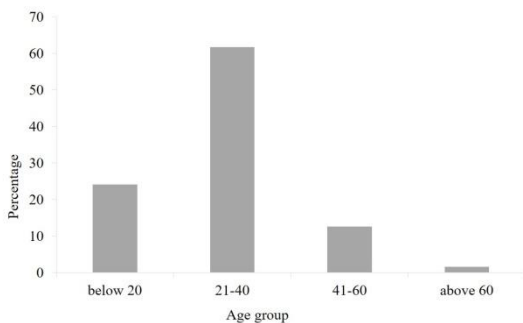


Figure 5. Status of COVID-19 cases by age group

The linear regression conducted between PCR and COVID-19 cases showed that there was high correlation ($r = 0.949$) between PCR test performed and COVID-19 cases identified (Figure 6).

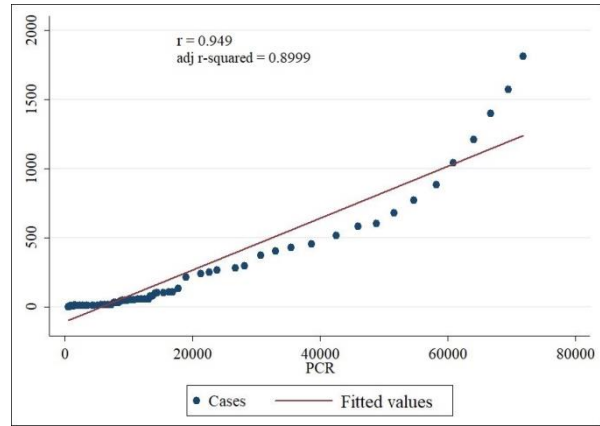


Figure 6. Comparative analysis of PCR tests and COVID-19 cases in Nepal

The linear regression between PCR tests and infection identified followed the equation of $Y = 0.0187821x - 107.7512$, with an adjusted r squared of 0.9 (Figure 6). This result showed that every 5,795 PCR tested, one person was detected with COVID-19 in Nepal. The scatter diagram (Figure 6) showed that there were same trend between PCR tests and infection of COVID-19 in Nepal. Further, time series analysis showed that how COVID-19 cases reached in higher number (Figure 7).

4. Discussion

The current trend shows that there will be a linear trend continued in next few weeks. Despite of imposing strict lockdown by the Government, there has been an increasing trend of COVID-19 in Nepal. The COVID-19 in Nepal was transformed from foreign countries through immigrants, majority from India.

As Nepal has open border with India in the south, the neighboring provinces (Province 2 and Province 5) have higher number of COVID-19 cases. On March 12, 2020, the Government of Nepal requested all travelers coming from 118 countries to stay in self-quarantine for 14 days. This step helped to prevent in transferring COVID-19 in community. However, it spread in the Tarai and mid-hill (Udayapur, Bhojpur, Kathmandu and Baglung districts); fortunately there is no case report from

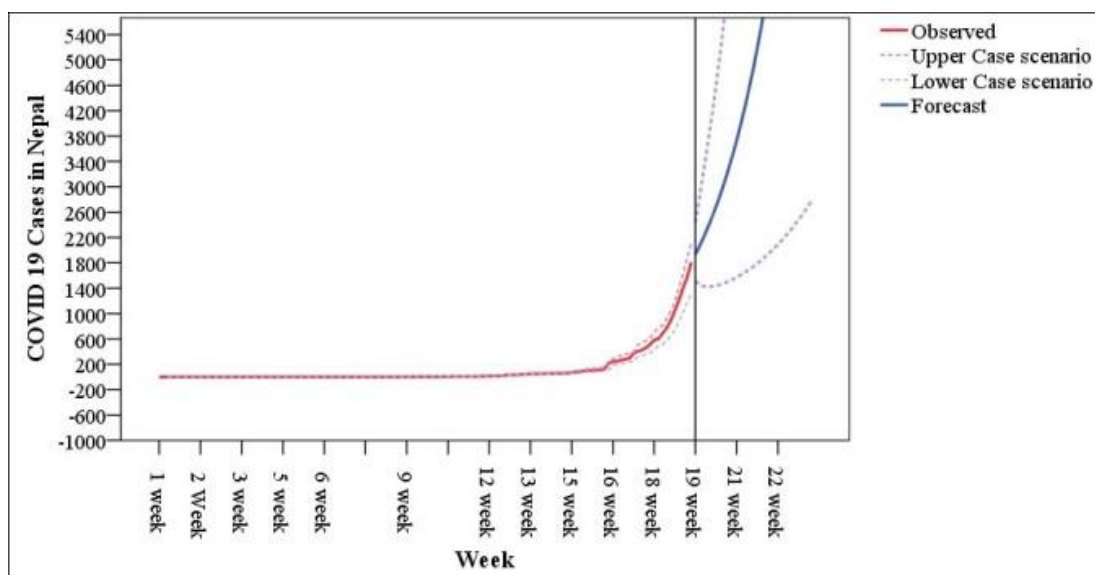


Figure 7: Time Series scenario of COVID-19 cases

High Mountain till date. A study by Arias-Reyes et al (2020) explained the decrease of COVID-19 prevalence in the populations living in high mountains at altitude of above 3,000m.

Despite the fact of having more health risk in female population in Nepal (Dhimal, 2015), COVID-19 affected more to male people in Nepal. This could be due to a greater number of male engagements in outdoor activities that gave them higher exposure to the contagious disease. In a report, ILO (2014), has concluded that the overseas employment is heavily male dominated with about 90 percent of all permits. Many Nepali people have been marooned in foreign land, after the lockdown was enacted on March 24, 2020. Many migrant workers suffered indirectly as they lost their jobs. Many of them are trying to enter from Nepal-India international border, which is nearly 1,750 km and open. Despite the warnings, some desperate citizen are taking illegal routes while some young and brave adventured crossing the turbulent cold waters of Mahakali in the western border of Nepal.

The PCR test carried out so far is low. With 25 hospitals and laboratory facility available in Nepal for COVID-19, Nepal lacks not only the health infrastructure, but also is in severe crunch of PCR kits. Unfortunately, the Ministry of Health and Population, which is taking over all charge of tests, is not heeding the available facilities in the academia and research laboratories, many of which are not in the scene at present (Neupane et al., 2020). Due to the limited number of PCR tests, it becomes difficult to test the large number of migrants travelling from

India to Nepal freely without any precautions and tests. In order to reduce the spread of transmission, the Government should surplus the availability of testing kits. As the high number of PCR tests are conducted, there is high chance of COVID-19 cases be diagnosed. The lacking of PCR tests also deter developing reliable scenario and make trend analysis, which, however, is a precursor to prepare plan and make evidence-based decisions. Current measures adopted to combat COVID-19 that include physical distancing, lockdown would help to reduce the infection rate significantly (Pandey et al. 2020). However, laboratory expansion and empowering lab technician for sampling efficiently and fast detection of disease would enable to combat the pandemic.

5. Conclusion

Data-driven measures are required to prevent the spread of COVID-19. The prohibition of immigrants' movement could halt COVID-19 and prevent spreading disease but many migrant workers from India are entering using illegal routes. The tracking records show that this has resulted to a spike in COVID-19 cases. Were these bonafide citizens allowed to enter through formal channel and the maximum number of PCR conducted, not only the health of these vulnerable people saved but also prevented spreading the disease in their communities. Though the strict measures of lockdown bring difficulties to day-to-day life, it gives the Government time to prepare in tackling the impending impacts of the pandemic. PCR tests have shown a positive correlation with COVID-19 cases. Improvement of the facilities to increase the tests and strengthening the health infrastructure to treat

the COVID-19 victims is the need of the time.

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Conflict of Interest

There is no conflict of interest among authors

Author Contribution

P.M.S. drafting manuscript and GIS mapping, R.T. drafting manuscript and data analysis, D.N. data analysis and editing, K.A. editing and structuring the manuscript, D.R.B. editing and structuring the manuscript.

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