Geospatial Analysis of Covid-19 Spread and Control Measures in India

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Abstract

COVID-19 Coronavirus, which has gained worldwide attention since its discovery in 2019 and subsequent spread throughout China, is now among the most infectious illnesses in the world. Most people infected with COVID-19 should only have mild to moderate respiratory symptoms, and they should get well on their own. People with preexisting conditions or who are elderly are at an increased risk of developing major diseases including cancer, heart disease, diabetes, or severe respiratory illness. The COVID-19 pandemic has been officially proclaimed by the World Health Organisation (WHO). Samples of individuals, mostly contacts of previously confirmed patients, have shown a high level of COVID-19 positivity in India, reaching the highest number of cases since the epidemic began earlier this month, as of April 11, 2020. The Indian government's Ministry of Health and Family Welfare reported a total of 7364 confirmed cases, 633 of which were treated or released, and 240 of which were fatal. The project aims to use GIS software to examine the geographical distribution and trends of COVID-19. Neither specific antibiotics nor treatments for COVID-19 exist at this time. Treatment efficacy is also being evaluated in a number of active clinical trials. A thorough understanding of the present COVID-19 virus, the illness it causes, and its ongoing transmission is essential for optimal protection and slow transmission. Consequently, in order to address issues like the propagation of the COVID-19 virus, it is crucial to monitor active links using GIS spatial analysis.

INTRODUCTION

A group of pneumonia cases, triggered by recently discovered β-coronavirus, happened in Wuhan, China, in December 2019. This coronavirus was at first called the 2019 novel coronavirus (2019-nCoV) by WHO on 12 January 2020. WHO officially referred to as coronavirus disease 2019 (COVID-19) and Coronavirus Study Group (CSG) of the International Committee suggested that the current coronavirus be named SARS-CoV-2, both issued on 11 February 2020. The Chinese researchers quickly isolated SARS-CoV-2 from the patient within such a short timeframe on 7 January 2020 and issued the SARS-CoV-2 genome sequence (Lu et al., 2020). Since 1 March 2020, a total of 79,968 cases of COVID-19 have been reported in China, including 2873 deaths (WHO, 2020). The results of the study stated that the basic replication number (R0) of SARS-CoV-2 was approximately 2.2 (Riou et al., 2020) or more (range from 1.4 to 6.5) (Liu et al., 2020) and that the pneumonia clusters (Chan et al., 2020) add to the scientific evidence of a continuous increase in human-to-human transmission of the

COVID-19 epidemic. SARS-CoV-2 is a β-coronavirus enclosed with an un-segmented positive-sensing RNA virus (subgenus arbecovirus, orthocoronavirinae subfamily) (Zhu et al., 2020). Coronaviruses (CoVs) were separated into four genera, with α-/β-/γ-/δ-CoVs. α- and β-CoV are capable of infecting animals, whereas γ- and δ-CoV appear to infect animals. Earlier, six CoVs were indeed well-known as living organism-sensitive viruses, including α-CoVs HCoV-229E, HCoV-OC43, HCoV-NL63, and β-CoVs HCoV-HKU1 and with minimal pathogenicity, triggering mild breathing problems analogous to common colds. The other two recognized β-CoVs, SARS-CoV and MERS-CoV, resulted in serious and possibly fatal respiratory infections (Yin and Wunderink, 2018). It has been discovered that the SARS-CoV-2 gene sequence tends to be 96.2% similar to the CoV RaTG13 bat, even though it shares the SARS-CoV, 79.5% identity. Based on the results of virus genetic sequences and genetic analysis, bats are suspected to be a normal host of virus provenance, and SARS-CoV-2 could be transferred from bats to human beings through unidentified intermediate contestants.

It is now clear that SARS-CoV-2 might use angiotensin-converting enzyme 2 (ACE2), a receptor called SARS-CoV (Zhou et al., 2020), to spread the disease. The first outbreak of unidentified acute respiratory infections occurred in Wuhan, China, on 12 December 2019, possibly linked to the seafood market. Numerous research has proposed that the bat might be a potential pool of SARS-CoV-2 (Giovanetti et al., 2020; Paraskevis et al., 2020). Moreover, there is no current evidence that the source of SARS-CoV-2 originated in the seafood market. Somehow, bats are natural pollutants of a wide range of CoVs, such as SARS-CoV-like and MERS-CoV-like viruses (Hampton, 2005; Banerjee et al., 2019; Li et al., 2005). Not only on the genome of the virus, but COVID-19 has also been investigated throughout the genome of Bat CoV RaTG13 and reveals 96.2% of the aggregate genome sequence identity (Zhou et al., 2020), proposing that CoV bat and human SARS-CoV-2 may discuss a certain ancestor, even though bats were not commercially available in the above seafood market (Wu et al., 2020). In addition, the orientation of carbohydrate sequences and phylogenetic analysis (Liu et al., 2020) has also shown that closely related receptor residues have been identified in several species, offering additional possibilities for appropriate optimal hosts, such as pangolins and snack foods.

Human-to-human transmitter, SARS-CoV-2 emanates primarily around families, along with friends and relatives who have been in direct contact with patients. It should be noted (Guan et al., 2020) that 31.3% of patients have recently travelled to Wuhan and 72.3% of patients have been able to contact Wuhan among several non-Wuhan patients. Transmission around healthcare professionals was recorded in 3.8% of COVID-19 patients received by the National Health Commission of China on 14 February 2020. On the other hand, the transmission of SARS-CoV and MERS- CoV has been shown to arise primarily through nosocomial propagation. Health workers illnesses in 33-42% of SARS cases and distribution around patients (62-79%) have become the most prevalent pathway of disease in MERS-CoV cases (Chowell et al., 2015; Kang et al., 2017). Physical contact with optimal host animals or the use of animals has already been assumed to be the main route of propagation of SARS-CoV-2. Moreover, the sources and transmission routines of SARS-CoV-2 remain a mystery. Recent research on epidemiology, pathogenesis and clinical features of COVID-19 and ongoing treatment and scientific advances in the fight against the novel coronavirus epidemic (Guo et al. 2020), which has the potential to cause toxic encephalopathy. Geographic Information Systems (GIS) and spatial mapping are emerging global health tools, but the degree to which they have been implemented in India for COVID-19 research is unclear. To inform researchers and program developers, this mapping review presents the scope and depth of the GIS and Spatial Analysis Studies conducted by COVID-19 in India. In particular, GIS and spatial analysis can be essential tools for knowledge, prevention, and treatment of diseases. For example, GIS technology can be used as a visualization help to map the geographical distribution of the disease, the potential risk factors and the resources available for treatment and prevention. In relation to the spatial analysis of certain information, it is possible to evaluate the risks of disease, trends in outbreaks over time and space, and hotspots of infection (Lyseen et al., 2014; Kandwal et al., 2009). Similar to each other, such methods may relate to the design, planning, and distribution of international health resources for treatment and prevention facilities and may help mitigate the impact of interference. The aim of this research is to analyze the spatial distribution of COVID-19 and its trend to predict the spread of diseases with the help of GIS software.

DATA AND METHODS

This research surveyed published, peer-reviewed articles on COVID-19 in India that dealt with geographic information systems (GIS) and spatial evaluation. concerns pertaining to COVID-1, with the exception of the prevalence of COVID-19, cardiovascular diseases caused by COVID-19, health disorders associated with COVID-19, and resources for preventing the spread of COVID-19. This collection includes research articles written by authors located in India and beyond. For the purposes of this analysis, spatial analysis approaches and GIS were defined vaguely; for example, research papers that used any specialised GIS software or explicitly implemented spatial analysis techniques were included (Kawo and Shankar, 2018; Shankar and Kawo, 2019; Balamurugan et al., 2020). This research relies on data collected by the Indian government's health department, which breaks out the number of COVID-19 cases by state from February to April 11th. This study uses a geographic information system (GIS) to show the spread of illness and uses Kriging and Inverse Distance Weighted (IDW) interpolation methods to predict daily patient volume.

One of the best-known methods of interpolation is Inverse Distance Weighted (IDW). It calculates the projected zone of the surrounding locations and uses that information to forecast values for any unknown destination (Childs, 2004). The key points of departure are two conclusions: first, that the unknown value of a point has an effect on the point of close control, not the range. Secondly, the effect size is proportional to the inverse of the distance between the two places. In order to conduct the analysis, the following equation was used (Huang et al., 2011; Bartier et al., 1996).

the weighting function that regulates the control point's importance, and Zp, the interpolated value of the unknown point With a range of 20–30, Zi is the value recorded at control point i, which stands for the closest neighbourhood of the interpolated point; n is the nearest inside the time-consuming neighbourhood of the control points, where p is a weighting absolute value that may be any positive real number and is always 1 in inverse distance weighting; the interpolated point is denoted by "dip" (Guan and Wu, 2008).

STUDY AREA

India is a country in South Asia. Its northern boundary is formed by the world's tallest mountain range. To the south and centre of the Bay of Bengal and the Arabian Sea, between Pakistan and Burma, lies India. With a total size of 3287590 km2, the geographic coordinates are between 8°4' N and 37° 6' N latitude and 68° 7' E and 97° 25' E longitude. New Delhi is the nation's capital, while Mumbai, Kolkata, and Delhi are among the most populous cities in India. India ranks as the world's seventh-largest nation. At one billion, India is the most densely populated country in the world, second only in terms of population density to China (Figure 1 and Table 1). Though it occupies only under a third of the United States' landmass, its population is more than three times that of the United States. According to the population map in figure 1 and table 1, the most populated state in India is Uttar Pradesh, while the least populous state in India is Sikkim. When it comes to democracies, India is by far the largest. Despite its large iron and steel sector and supply of manufactured products, the country is mostly an agricultural nation.

RESULTS AND DISCUSSIONS

Current Status

There have been more than 7,364 instances of novel coronavirus, also known as COVID-19, in India as of April 11, 2020 (Table 2). This table displays the confirmed cases of COVID-19 in India, broken down by state. It seems like every single student returning from Wuhan, China, is one of the initial three instances recorded by India in Kerala. March saw a rise in the global case count, driven mostly by individuals with travel histories to the afflicted regions. Worldwide, there has been an increase in the number of reported cases. The number of confirmed cases reached 50 on March 10th. In Saudi Arabia, a 76-year-old man became the first person to survive the virus on March 12th. By 15th, over 100 were infected; by 24th, 500 were infected; by 30th, 1,117 were infected; and by 11th, 7,364 were infected (Table 2). Between March 30, 2020, and April 11, 2020, the overall count of newly confirmed cases increased at a fast pace. The states of Maharashtra, Delhi, and Tamil Nadu have the highest number of coronavirus cases. Table 2 shows the mortality and discharge (cured) rates as of April 11th. Out of the total number of cases, 110 were in Maharashtra, 33 in Madhya Pradesh, 19 in Gujarat, and 13 in Delhi; 188 in Kerala and 44 in Tamil Nadu were cured.

COVID-19 Geographical Distribution

The use of Inverse Distance Weighted (IDW) interpolation in this study establishes unequivocally that nearby items are more comparable than further away ones. Each unknown site's value is estimated by IDW using the prediction site's computed values (cases). The predicted value is more affected by the values that are determined close to the forecast site, rather than those that are decided farther away. IDW operates on the premise that there is a time-decreasing local impact at every measured site. The IDW method finds the mean for non-sampled areas by averaging the values of neighbouring weighted points. Weights were given for the IDW power coefficient and were proportional to the distance from the sampled points to the non-sampled site.

Expectation of the Pattern of Transmission of COVID-19

In order to forecast the spread of illness in India, we have achieved interpolation using IDW. Across the nation, this map displays the number of patients as well as the expanded illness zone. From 0 to 150, 151 to 250, 251 to 350, 351 to 450, 451 to 700, 701 to 1000, and > 1000 are the seven classifications of COVID-19 disorders according to IDW, as shown in Figure 2. Because of demographic and environmental variables that could influence patient distribution, these groups run the danger of revealing the disease's geographical spread in connection to various states. Daily observational analysis reports the largest number of patients returning on board, including family, acquaintances, and relatives in close contact with incubation carriers.

The COVID-19 virus may soon infect a large number of people in India. In the next two months, the states of Maharashtra and Tamil Nadu are expected to have over a thousand instances of COVID-19, according to the IDW map used for this study. The country's biggest metropolis, Maharashtra, is located near the stock market and financial hub of Mumbai. There has been a daily rise in the highest spread of infectious illness, COVID-19.

It is necessary to increase the prevalence in these states; for example, in Delhi, Gujarat, Telangana, Uttar Pradesh (city), and Rajasthan (city), the distributions range from 451 to 1000. In these states, you may see a spread ratio in the moderate range: The states of Karnataka, Kerala, Andhra Pradesh, and Madhya Pradesh may see an increase in cases in the future, with estimates ranging from 251 to 450. Odisha, Manipur, Haryana, Jammu & Kashmir, Bihar, Chhattisgarh, Chandigarh, and Mizoram have the lowest range of 0 to 250 for patients in the centre of the country.

the COVID-19 death prediction distribution and Figure 4 for the cured prediction distribution in India. In terms of fatalities, the region around Maharashtra is the most hazardous, followed by Madhya Pradesh and Gujarat, which are fairly dangerous. The other states have a risk rating of less than 20. Healing is more prevalent in the regions bordering Maharashtra, Kerala, and southern Tamil Nadu; moderately prevalent in the regions bordering Telangana, Karnataka, Uttar Pradesh, Ladakh, and Gujarat; and less prevalent in the central region of Tamil Nadu and the other states. People may become sick from each other very fast. Nonetheless, geographical and spatial variables affect the exposure behaviour of diseases in different ways.

In order to aid the government in its monitoring and prediction of the spread of viruses over both local and broad regions, this study may provide useful information. The World Health Organisation (WHO) has declared the Novel Coronavirus Disease (COVID-19) outbreak a pandemic and has urged nations to respond quickly in order to save lives by diagnosing the virus, identifying its sources, and preventing its further spread. Here, the Indian government will take every safety measure to make sure the country is ready to deal with the COVID-19 epidemic when it arrives.

CONCLUSIONS

In this research, we looked at the geographical distribution pattern of illnesses in India. Future assessments of environmental elements responsible for the immediate danger of illness may be informed by GIS-based spatial approaches, which provide a viewpoint on simplifying and evaluating the outbreak status of COVID-19 pathogens in specific places. Government surveillance and the prediction of the virus's spread over small and big regions may benefit greatly from analysis of geographical distribution patterns. Hence, this paper used an IDW method-based GIS spatial distribution to find possible disease risk assessments in India. Additionally, the apparent conditioning factor weight and the IDW analysis of the spatial interpolation layers were generated. The suggested technique was shown to be strong and successful in identifying and forecasting the potential for disease risk assessment in India, according to the validation findings. The linked authorities may be able to use this research's findings to conduct a thorough evaluation of the virus's transmission and environmental control measures in the study region. Not only does this approach rule out the possibility of using predictive mapping to identify acceptable zones across the country, but it also lets you show how uncertain the forecast is, which could be useful for other countries with similar distance and density issues.

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