



# Exploring spatial distribution pattern of COVID-19 incidence in Telangana state, India

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Received: 17 September 2021 / Revised: 5 March 2022 / Accepted: 7 March 2022 / Published online: 1 April 2022  
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**Abstract** The outbreak of coronavirus (COVID-19) disease is essentially considered as a severe global public health disaster and the biggest challenge that the people have met since the Second World War. The main aim of present study is to comprehend the frequency trends of total confirmed cases, currently active cases, total recovery cases, deceased rate, and their distribution pattern in the mainland of Telangana, India. As demonstrated in this study, during the first lockdown, the slopes of the confirmed cases, active cases, and mortality cases were kept increasing. In the middle of the potential second-term lockdown, the daily active incidence trend was progressively declined while the growth of the recovery rate was steadily increased. Results describe that the strict implementation of the lockdown procedure has tremendously built confidence in order to flattering the COVID-19 epidemic curve. Moreover, spatial distribution of confirmed cases of COVID-19 indicates that higher cases were recorded in Hyderabad and its surrounding areas of the investigated region. The outcome of this study will assuredly be helpful for executing certain precautionary measures and definite health policies to regulate the spread of COVID-19 in Telangana, India.

**Keywords** COVID-19 · Spatial distribution · Lockdown effect · Telangana · India

## 1 Introduction

In the month of December 2019, the first case of pneumonia of unknown aetiology was discovered from the city of Wuhan, Hubei province in China [1]. After a few weeks, this new disease was officially assigned a name “coronavirus disease—2019” (COVID-19) by the World Health Organization [2]. In other words, the International Committee on Taxonomy of Viruses (ICTV) also named the virus as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2).

India is the second-most populous country in the world, and its contribution accounts for about 17.7% of the world population. As of now (8th May, 2020), a total of 11, 91, 946 peoples have been tested, of which 59,712 COVID-19 incident cases have been confirmed and 1,985 cases have reported deaths across India, and these figures are progressively increasing every day [4]. As we are aware of that the end of January, 2020, the first COVID-19 case was found in a patient with severe pneumonia in Kerala, India. Since then, the deadly virus (COVID-19) has quickly been spreading to the maximum states of India. As a result, Maharashtra (19,063), Gujarat (7403), Delhi (6318), Tamil Nadu (6009), Rajasthan (3579), Madhya Pradesh (3341), Uttar Pradesh (3214), Andhra Pradesh (1887), Punjab (1731), West Bengal (1678) and Telangana (1132) continues to remain worst-hit states in India due to the COVID-19 pandemic [4]. In addition, Jammu and Kashmir, Karnataka, Haryana, Bihar, and Kerala are also battling to contain outbreaks of the virus where more than 500

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of COVID-19 cases were confirmed [4]. This seems to have remained an endemic scenario in India.

Geographic information system (GIS) is broadly used to examine the spatial distribution trend of infectious diseases and tracking the COVID-19 pandemic across the Globe [5–9]. Consequently, the GIS dashboard is extensively used around the world that basically provides real-time/live data information and also the spatial distribution of COVID-19, including the various factor such as confirmed cases, active cases, recovered/rehabilitation patients, and also deceased cases [10]. The application of GIS has been used to estimate the outbreak of COVID-19, for instance, Mollalo et al. [7] implemented GIS-based spatial modeling of COVID-19 in the United States. Zhou et al. [9] utilized GIS spatial distribution and big data analysis to recognize the most vulnerable COVID-19 zones in China. In a study, Kamel Boulos and Geraghty [6] used geographical tracking and mapping COVID-19 epidemic scenarios around the world. However, in the present study, we aimed to assess the trend of COVID-19 pandemic in the district-wise classification and also comprehensively understand the spatial distribution of COVID-19 confirmed cases, currently active cases, total recovery cases, deceased rate during the March and May 8th, 2020, in Telangana state, India. To our best knowledge, the outcome of the present study can provide significant information for policymakers for targeted interventions.

## 2 Materials and methods

For this study, we basically collected the (COVID-19) coronavirus disease daily data including confirmed cases, active cases, recovered/rehabilitation patients, and also deceased cases between March 14th (when the first case of COVID-19 was identified in Telangana state, India) and April 8th 2020 from a repository publicly available and official website of the Ministry of Health and Family Welfare, Government of India [4]. More specifically, district-wise counts of COVID-19 infected cases data across the continental Telangana state were retrieved from central and state government official websites [11]. The spatial distribution pattern of COVID-19 was generated with the help of spatial analyst modules in ArcGIS 10.2 and other graphs were prepared using Grapher 12 software.

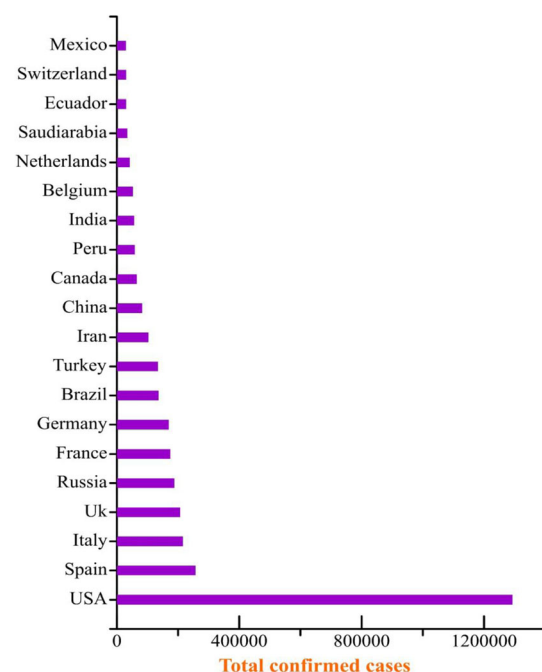
## 3 Results and discussion

As we know, the coronavirus is one of the contagious diseases that has widely been spreading throughout the world and currently has been reached at a higher number of countries (i.e., 200 countries). Globally, as of 8th May

2020, COVID-19 has affected more than 3.75 million people and caused about 259,474 deaths [2]. The countries that the US, Italy and Spain are most severely affected in the globe. Outstandingly, Fig. 1 provides the top 20 countries which are majorly suffering by the deadly virus (COVID-19) and India is one of them [2, 3].

### 3.1 Current status of coronavirus in the Telangana state, India

During the COVID-19 pandemic, the first positive case of coronavirus cases (COVID-19) in the Indian state of Telangana was reported in early March 2020. Subsequently, the virus spread to all most all districts in Telangana state, India. Currently, a total of 1132 coronavirus cases and 29 deaths were reported as of 8th May 2020 in Telangana, according to data released by the Ministry of Health and Family Welfare, Government of India. However, Table 1 presents the district-wise classification of population, density of population (per Km<sup>2</sup>), occupied area (Km<sup>2</sup>), and number of COVID-19 confirmed cases and percentage of COVID-19 cases are listed in Table 1. It is apparent that there is a moderate connection correlation between the density of population and confirmed COVID-19 positives cases in the Telangana state, suggesting the densely populated zones have a greater chance to spread the coronavirus from person to person (Table 1). Figure 2 reveals that the estimated trend slopes for COVID-19 confirmed total cases data, daily recovered cases, date wise



**Fig. 1** Number of coronavirus (COVID-19) cases worldwide (top 20 countries) as of May 8, 2020

**Table 1** Distribution of population, the density of population (per Km<sup>2</sup>), occupied area (Km<sup>2</sup>), and number of COVID-19 confirmed cases and percentage of COVID-19 cases in Telangana state, India

Name of the district	Area (Km <sup>2</sup> )	Population	Density (per Km <sup>2</sup> )	Confirmed cases	Percentage of confirmed case
Adilabad (AB)	4153	708,972	171	21	1.86
Badradri Kothagudem (BK)	7483	1,069,261	143	4	0.35
Hyderabad (HYD)	217	3,943,323	18,172	624	55.12
Jagitial (JL)	2419	985,417	407	4	0.35
Janagoan (JN)	2188	566,376	259	3	0.27
Jayashankar Bhulapally (JB)	6175	711,434	115	3	0.27
Jogulamba Gadwal (JG)	2928	609,990	208	45	3.98
Kamareddy (KR)	3652	972,625	266	12	1.06
Karimnagar (KN)	2128	1,005,711	473	19	1.68
Khammam (KM)	4361	1,401,639	321	8	0.71
Komaram Bheem (KB)	4878	515,812	106	7	0.62
Mahabubabad (MB)	2877	774,549	269	1	0.09
Mahabubnagar (MN)	5285	1,486,777	281	11	0.97
Mancherial (MC)	4016	807,037	201	1	0.09
Medak (MK)	2786	767,428	275	5	0.44
Medchal Malkajgiri (MM)	1084	2,440,073	2251	22	1.99
Mulugu (MU)	3881	294,671	124	2	0.18
Nagarkurnool (NK)	6545	893,308	142	2	0.18
Narayanpet (NP)	2336	566,874	243	1	0.09
Nalgonda (NLG)	7122	1,618,416	227	17	1.5
Nirmal (NL)	3845	709,418	185	20	1.77
Nizamabad (NB)	4288	1,571,022	366	61	5.39
Peddapalli (PP)	2236	795,332	356	2	0.18
Rajanna Sircilla (RS)	2019	552,037	273	3	0.27
Ranga Reddy (RR)	5031	2,446,265	486	36	3.18
Sangareddy (SR)	4403	1,527,628	347	7	0.62
Siddipet (SD)	3632	1,012,065	279	1	0.09
Suryapet (SP)	3607	1,099,560	305	83	7.33
Vikarabad (VB)	3386	927,140	274	37	3.27
Wanaparty (WP)	2152	577,758	268	0	0
Warangal rural (WR)	2152	718,537	330	0	0
Warangal urban (WU)	2175	1,080,858	826	27	2.39
Yadadri Bhuvanagiri (YB)	1309	739,448	239	0	0

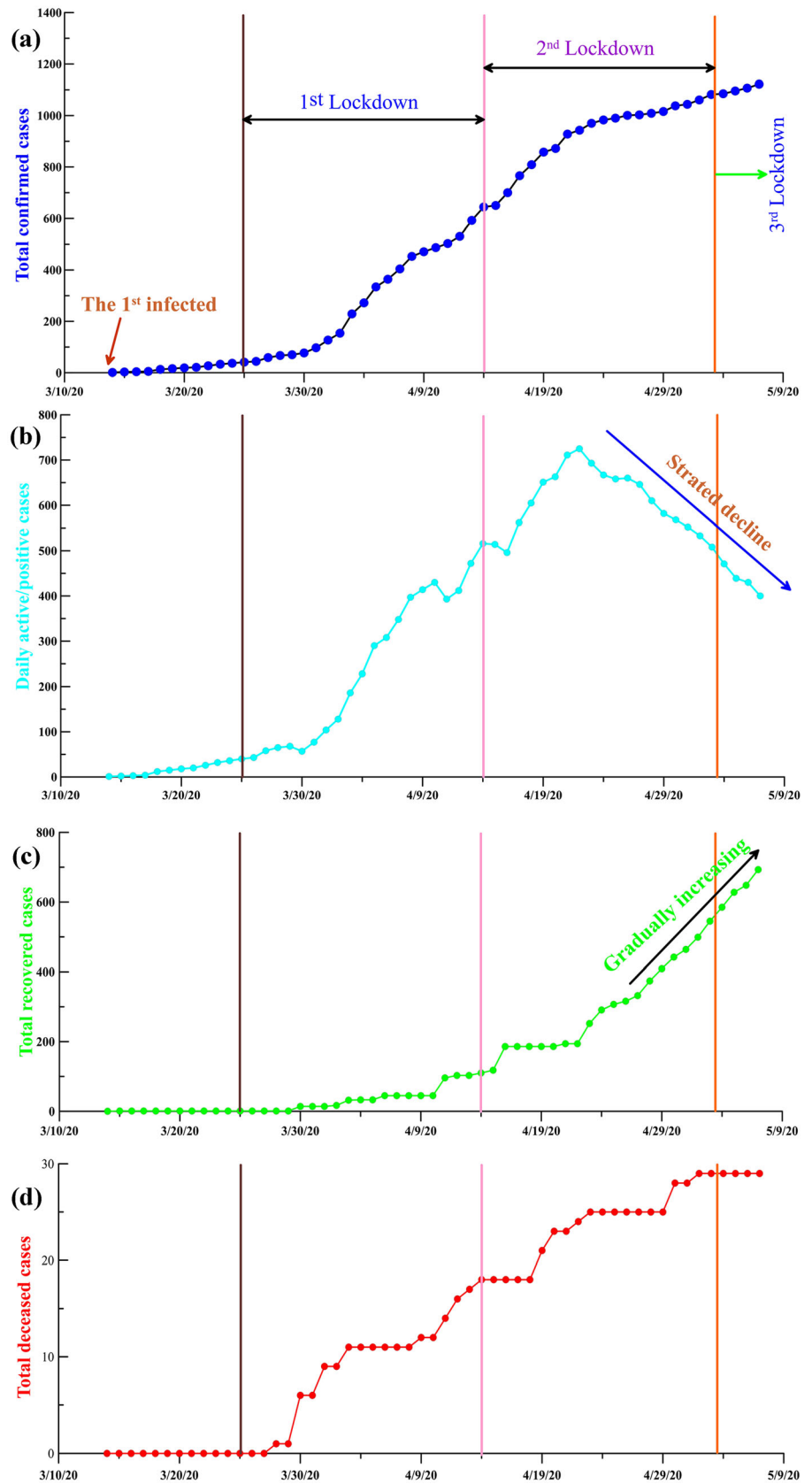
active cases and daily deceased cases in Telangana since March 14th, 2020. Especially, the curve of the daily active cases has started declining significantly from the peak at the end of April (on 28th April 2020). Simultaneously, the growth of recovery rate (discharged patients) among COVID-19 positive patients in the Telangana state continued to increasing since early April 2020 (Fig. 2). By 8th May 2020, the cumulative growth of rehabilitation/recovered frequency reached at 64.22% (Fig. 2), which has obviously indicated that the hospitalized patients (COVID-19 patients) were unambiguously received the better medical treatment in the continental Telangana state. In other words, the outbreak situation is significantly under

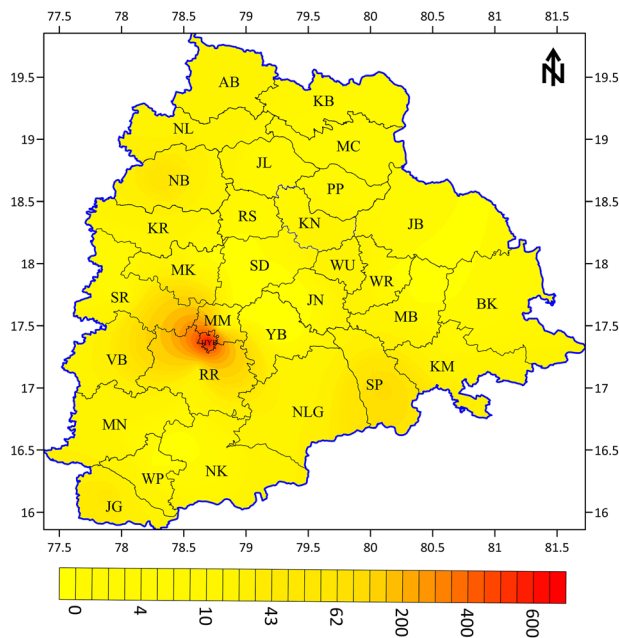
initial control in all districts of Telangana in India. However, when compared to Indian states of Maharashtra (mortality rate-731), Gujarat (mortality rate-449), and Madhya Pradesh (mortality rate-200), the mortality growth frequency in Telangana is quite low (Fig. 2). Overall, the cumulative mortality rate in Telangana is reached at 29 due to the COVID-19 pandemic (Fig. 2) [11].

### 3.2 Distribution of COVID-19

The spatial distribution of COVID-19 is depicted in Fig. 3, and district wise cumulative confirmed COVID-19 cases is also shown in Fig. 4. It is observed from Figs. 2 and 4 that

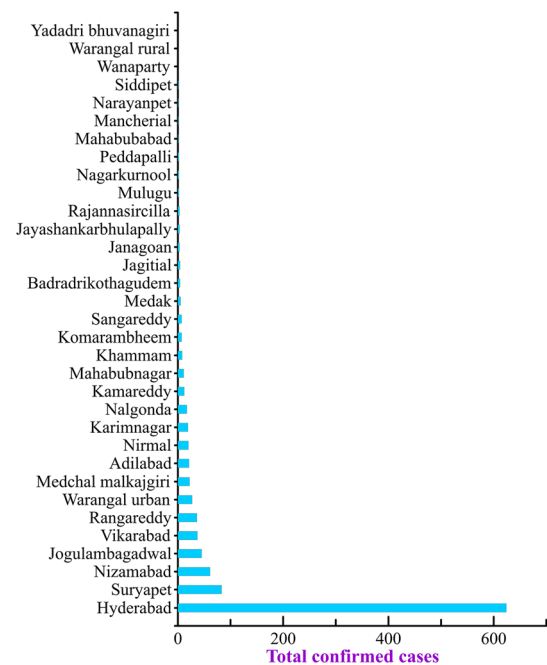
**Fig. 2** The overview of the COVID-19 scenario in the Telangana state, India. **a** A total number of confirmed cases (Total confirmed cases = daily active cases + total recovered cases + total deceased cases), **b** daily active cases, **c** totally recovered cases, and **d** total deceased cases





**Fig. 3** Spatial distribution of confirmed cases of COVID-19 in Telangana state, India [where Adilabad (AB), Badradri Kothagudem (BK), Hyderabad (HYD), Jagitial (JL), Janagoan (JN), Jayashankar Bhulapally (JB), Jogulamba Gadwal (JG), Kamareddy (KR), Karimnagar (KN), Khammam (KM), Komaram Bheem (KB), Mahabubabad (MB), Mahabubnagar (MN), Mancherial (MC), Medak (MK), Medchal Malkajgiri (MM), Mulugu (MU), Nagarkurnool (NK), Narayanpet (NP), Nalgonda (NLG), Nirmal (NL), Nizamabad (NB), Peddapalli (PP), Rajanna Sircilla (RS), Rangareddy (RR), Sangareddy (SR), Siddipet (SD), Suryapet (SP), Vikarabad (VB), Wanaparty (WP), Warangal rural (WR), Warangal urban (WU), Yadadri bhuvanagiri (YB)]

the order of highly affected to coronavirus (COVID-19) risk districts in Telangana state are as follows: Hyderabad (624) > Suryapet (83) > Nizamabad (61) > Jogulamba-gadwal (45) > Vikarabad (37) > Rangareddy (36) > Warangal Urban (27) > Medchal-Malkajgiri (22) > Adilabad (21) > Nirmal (20) > Karimnagar (19) > Nalgonda (17) > Kamareddy (12) > Mahabubnagar (11). Remarkably, as yet there are three districts namely Wanaparthi, Warangal Rural, and Yadadri-Bhuvanagiri that have not reported a single coronavirus case since the COVID-19 epidemic [11]. In other words, these three districts are identified as coronavirus free zones. It is interesting to know that more than 55% of COVID-19 confirmed cases were only reported in the metropolitan city of Hyderabad. According to official census data [12], Hyderabad city is resident to 3,943,323 people and 18,172 residents living per square kilometer, and it is the capital and largest city of the Indian state of Telangana. Currently, Hyderabad city is an epicenter for the spread of infectious COVID-19 diseases [11]. Therefore, explicitly speaking, more precautionary measures should be implemented in



**Fig. 4** District wise classification of coronavirus (COVID-19) confirmed cases in Telangana as of May 8, 2020

this megacity in order to mitigate the prevalence of the COVID-19 epidemic.

### 3.3 Lockdown effect on the spread of COVID-19

As we all know, the World Health Organization (WHO) has authoritatively declared the (COVID-19) coronavirus outbreak as a global pandemic [2]. Thus, the Government of India has implemented its first 21-days nationwide “Lockdown/Janata Curfew” to reduce the impact of the COVID-19 infection cycle. And it extended further from 15<sup>th</sup> April to 3<sup>rd</sup> May, 2020 (Second-term lockdown period), and now we are in the third lockdown period, it was started on 4<sup>th</sup> May and continues upto 17<sup>th</sup> May, 2020, with strict implementation to maintain the social distancing is the only way to break the cycle of COVID-19 infection which is declared by Government of India. However, during the three lockdown period, the obtained total confirmed cases, recovery cases, current active cases, and deceased data were clearly depicted Fig. 2, in order to comprehend the progress of prevention measures in Telangana state, India. It is apparently observed that the first and middle of the second lockdown period the daily active/positive cases are gradually increasing and reached at a peak level of 646 cases on 27<sup>th</sup> April, 2020 (Fig. 2). Daily active/positive cases were gradually started declining on 28<sup>th</sup> April 2020, while recovery cases were significantly increased could be due to the inclusion of critical medical treatment for diminishing the COVID-19 positive cases



(Fig. 2). Due to strict lockdown, no single coronavirus positive case was reported in 22 districts in the last 15 days which were namely, Medak, Mahabubnagar, Mahbubabad, Mancherla, Mulugu, Kamareddy, Rajanna-Sircilla, Karimnagar, Sangareddy, Nagarkurnool, Narayanpet, Sid-dipet, Jayashankar-Bhupalapally, Vikarabad, Nalgonda, Khammam, Nizamabad, Adilabad, Bhadradi-Koth-agudem, Komaram Bheem, Suryapet, and Peddapally. These results explicitly show the positive signs that declining the active cases trend slope after the mid-term of second restrictive lockdown in Telangana, and also the third lockdown is still ongoing with an aim of flattening the coronavirus epidemic curve.

#### 4 Conclusions

The current study has been conducted to comprehensively understanding of the distribution trend of COVID-19 in Telangana state, India. The results divulge that the crowded city of Hyderabad was the most vulnerable/contaminated zone with the higher number of coronavirus (COVID-19) cases. Interestingly, only three districts i.e. Wanaparty (WP), Warangal rural (WR), and Yadadri Bhuvanagiri (YB) have recorded no positive coronavirus cases (COVID-19) in Telangana state. Therefore, it is found that spread of coronavirus (COVID-19) is not uniform across the Telangana state, India. The strict implementation of lockdown and public health control measures might greatly be helpful in controlling the COVID-19 epidemic scenario in Telangana state, India. Moreover, the outcome to this study may be able to support the decision makers and policy-makers to implement the suitable prevention methods to arrest the further spread of COVID-19 in Telangana State, India.

**Acknowledgements** We would like to express our genuine and greatest gratitude to the medical professionals and all those who fighting the COVID-19 epidemic in India and also World. The authors are grateful to Editor-in-Chief and anonymous reviewers for their suggestions and critical comments which helped us to improve the quality of this manuscript significantly.

**Author contribution** Writing original draft preparation, conceptualization, and writing—review and editing: NA; software: RM; investigation, supervision: HQ. All authors read and approved the final manuscript.

**Funding** No funding has been received for this work.

**Data availability** The data utilized in this study has been acquired from freely available sources.

#### Declarations

**Conflict of interest** The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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