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# Geographic Mapping and Spatial Distribution of Third Wave of COVID-19 in Jammu Division of J&K, India

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**Abstract:** ***Since the first recorded case of COVID-19, it has spread like mad forest fire all over the world. Coronavirus pandemic has been in its third wave but the ongoing pandemic is no way near over. Current epidemiological research points at the necessity for comprehensive methodologies to assess COVID-19 evolution. In the current study, we analyzed the data for 60 days during the peak of the third wave from mid December to mid February. We studied the daily incidence of the COVID-19 cases at district level in the division of Jammu, Jammu and Kashmir India. The district of Ramban, Poonch, Jammu, Reasi, Udhampur and Samba were selected as the target region of study. We utilized the data available at Government Medical College-Jammu (GMC-J) in a deep learning based technique to model the current trend of the transmission of the third wave of COVID-19. The result not only suggests high rates of incidence of COVID-19 in different districts of the target regions but shows a variation in the peaking at different regions. Thus tracing and geographic mapping of COVID-19 within the target regions would provide an important step to revisit the strategies to control the pandemic. The spatiotemporal epidemiology has been successfully utilized in case of HIV and HCV infections in Northern African countries hence, some approach might prove to be helpful in control of COVID-19 infection in Jammu division of J&K. Here in the current study, we point out the spatial distribution and geographic blueprint of the COVID-19 infection in the target study region. Every positive reported COVID-19 case was recorded and followed; geographic analysis was carried from the month of December till February 2022.***

**Keywords:** COVID-19, Jammu, Geography, 3rd wave, spatial distribution

## 1. Introduction

2019 is the year of the coronavirus (COVID-19). The pandemic has been a global narrative of sickness and mortality (Livingston and Bucher, 2020) The Novel Coronavirus or COVID-19 is an unprecedented global emergency which has lead to a large number of casualties, health crises, disruption of daily chores and economic setbacks. COVID-19 or 2019-nCoV is a highly infectious disease which is caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). This novel virus originated in Wuhan, Hubei province, China in December 2019 and has taken over the whole world in the matter of a month (Ayittey et al., 2020). The ongoing pandemic which broke out in December, 2019 in Wuhan, China is no way near over.

The major symptoms of the disease include cough, fever, breathlessness etc and may progress to acute respiratory distress syndrome (Sadiq et al., 2021). The cases have been discovered where the COVID-19 positive patients were found to be asymptomatic, which is a matter of great concern for effective identification of infected individuals. Therefore, the better understanding of the coronavirus origin and its infection biology is of prime importance to control disease spread and clinical management. Corona virus takes its name on the corona like projections emerging from the surface of the virus (Fig 1). Corona viruses are the positive sense single stranded RNA (ssRNA) viruses. These are enveloped viruses with nucleocapsid. The genome size of the coronavirus is one of the largest genomes in the RNA virus family ranging between 25-32Kb (Smits et al., 2021).

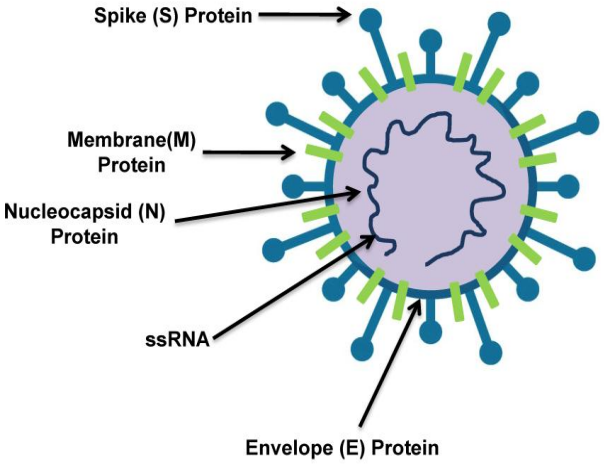


**Figure 1:** Structure of Coronavirus

Over the past two years, many variants of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been reported such as the Alpha, Beta, Gamma, Delta, and Omicron variants. The on-going pandemic has thus called upon the need of enforcement of advanced protocols in epidemiological studies to address the current situation and to prepare for the future trends of the ever evolving coronavirus.

India is the seventh largest country in the world as per the area and corresponds to the second most populated country after China which was affected by ongoing coronavirus pandemic in 2020. As the world descended into 2022, the coronavirus pandemic is no way near over. The trend of the coronavirus in India has been observed to be prolonged with a slight decline in the post-winter months. Till this date, the

country has seen the second highest figure of infected cases around 4.25 crore with over 5.07 lakh deaths (www.worldometer.com).

Jammu and Kashmir has also followed the national trend and has depicted that the high rise in daily cases during the peak with a steep decline in the number of cases in the following month (Dubey et al., 2021). Keeping in mind the constant neglect of the region in terms of political instability, socio-economical backwardness, singular topology and current available substructure may help create a pandemic epicenter in Jammu. In the current study, we studied the data for 60 days from 15 December 2021 to 15 February 2022 (during the peak of the third wave) of daily incidence of COVID-19 positive cases for a district level study In Jammu division of J&K.

The main aim of the current study is the utilization of the geographic and geo-spatial analysis of the available data to establish an understanding among locations and the distribution pattern of coronavirus. The current study establishes a research on coronavirus associated third wave in context to geography of Jammu division. The study could provide useful in understanding the geographical effects and potency of the containment of the disease. As, residential district, health authorities and administrations continue to address the coronavirus 2019 (COVID-19) pandemic, the understanding of how its impact diverges over space and across population groups is important and might generate knowledge in containment of the COVID-19 pandemic.

## 2. Materials and Methods

The present study was conducted at the COVID-19 lab at Maternal and Child care hospital (M&CH), an associated hospital to Government Medical College (GMC-J), Jammu. The Jammu division harbors a population of 53L with a density of 200/Km$^2$, spanning over an area of about 26, 293 Km$^2$. The current study set includes the date from 6 districts of Jammu division i. e. Jammu, Ramban, Poonch, Reasi, Udhampur and Samba. Figure 2 shows the map of the area under the study. Data of daily incidence cases of COVID-19 in the study region was obtained from the Covid-19 lab, M&CH hospital Gandhi Nagar, associated hospital to GMC-Jammu from 15$^{th}$ December 2021 to 15$^{th}$ February 2022.

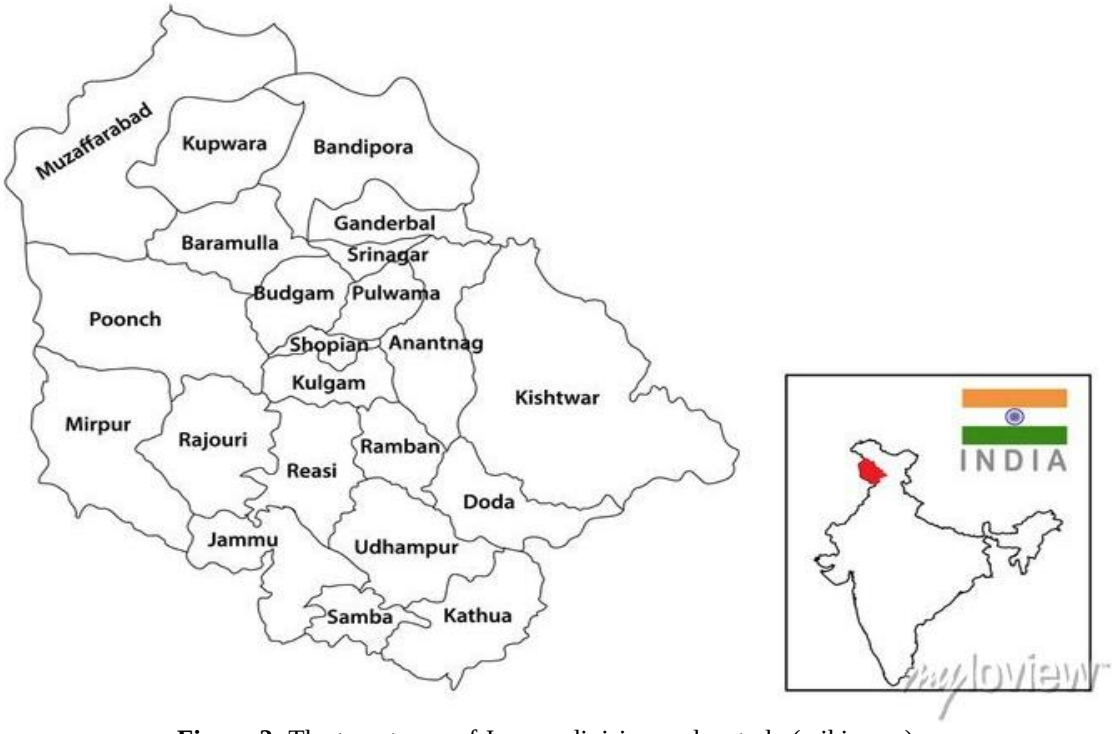


**Figure 2:** The target area of Jammu division under study (wikimaps)

Obtaining the district-wise disease intensity of COVID-19 incidence cases prove to be an essential tool for understanding the spatial pattern and intensity of COVID-19 pandemic in the target areas as it clearly illustrate the relative dominance of the COVID-19 in the area under study.

The data obtained was checked for response variables. For other variables like explanatory variables, the data transformation wasn't required. Standard deviation from the mean was calculated using SPSS software (IBM Inc., New York, USA).

Demographic data: the District-wise demographic data such as total population, density and are was obtained from the current available source, i. e., JK Statistical Digest census 2022.

## 3. Results

The distribution of the COVID-19 influence varied in the different regions during the different waves. The districts which were severely hit during the initial waves were spared during the third wave. The excess incidence pattern was seen to be varied too. The positivity was seen to be higher during the third wave whereas the excess mortality was reported to

be lesser. Spatial co-relation greatly validates the shift in the geographic hotspots to cold spots during the waves in Jammu division.

The third wave of COVID-19 infection began around 26th December 2021, approximately six months after the much fatal second wave. During the third wave, the average cases reported from Jammu division per day for testing ranged between 1000±50/ day to 1200±10/ day. Total number of cases tested during the third peak of COVID-19 infection was recorded to be 62, 051 within the designated peak period from the Jammu division with confirmed positive cases to be 6, 637 with an average positivity of 10.6%. The curve for the third wave of COVID-19 infection was found to be much steeper than that of other two waves. This steeper curve formed the characteristic of Omicron driven third wave in Jammu and Kashmir. The peak in COVID-19 positive cases was recorded to be around 19th January 2022 (Figure 3).

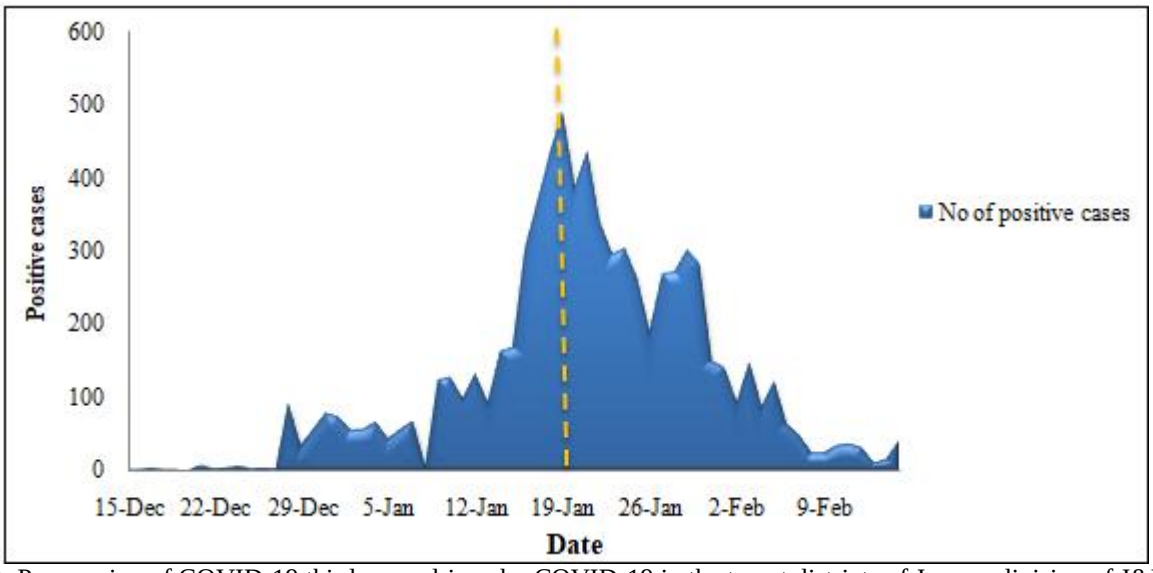


**Figure 3:** Progression of COVID-19 third wave driven by COVID-19 in the target districts of Jammu division of J&K, India at M&CH

The maximum testing was recorded from the Udhampur district of the Jammu division corresponding to about 35.6% of the total testing from Jammu division in the designated peak period, followed by Jammu district with 26.7%, Samba with 11.07%, Poonch with 10.2%, Reasi with 9.48% and Ramban with 8.6% (Table 1, Figure 4).

**Table 1:** Total samples tested per target district in Jammu division, J&K at M&CH within the designated period during the third wave of COVID-19 pandemic

| S. No | District | Total samples tested | % testing |
|---|---|---|---|
| 1 | Udhampur | 22, 116 | 35.64 |
| 2 | Jammu | 16, 587 | 26.72 |
| 3 | Samba | 6, 869 | 11.07 |
| 4 | Poonch | 6, 304 | 10.22 |
| 5 | Reasi | 5, 860 | 9.48 |
| 6 | Ramban | 5, 379 | 8.61 |

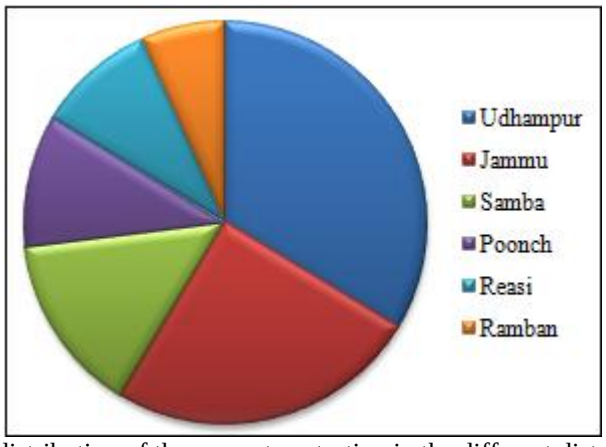


**Figure 4:** Pie chart depicting the distribution of the percentage testing in the different districts of Jammu division during the third wave of COVID-19 pandemic

On the contrary, the positivity trend showed a slight variation from the total sample tested data from different districts. Maximum positively infected COVID-19 cases were reported from Jammu district of the division with 44.9% followed by, Udhampur with 23.27%, Samba with 17.37%, Poonch with 5.72%, Ramban with 4.95% and Reasi with 3.63% (Table 2, Figure 5). The comparative of the testing and the positivity in the concerned area under the aforementioned period has been depicted in Figure 6.

**Table 2:** Total positive cases recorded per target district in Jammu division, J&K at M&CH within the designated period during the third wave of COVID-19 pandemic

| S. No | District | Total positive case recorded | % positivity |
|---|---|---|---|
| 1 | Udhampur | 1, 545 | 23.27 |
| 2 | Jammu | 2, 983 | 44.91 |
| 3 | Samba | 1, 153 | 17.37 |
| 4 | Poonch | 380 | 5.72 |
| 5 | Reasi | 241 | 3.63 |
| 6 | Ramban | 329 | 4.95 |

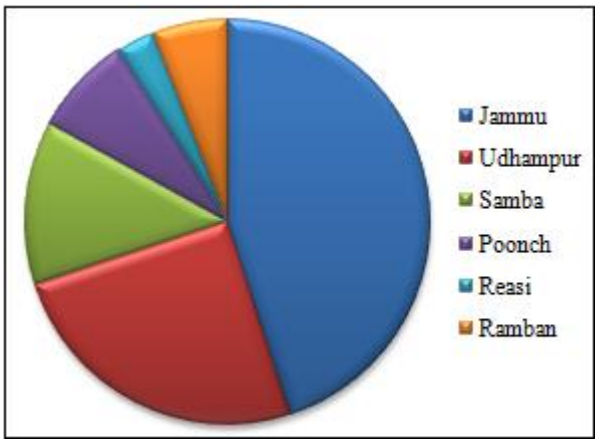


**Figure 5:** Pie chart depicting the distribution of the percentage positivity in the different districts of Jammu division under consideration during the third wave of COVID-19 pandemic

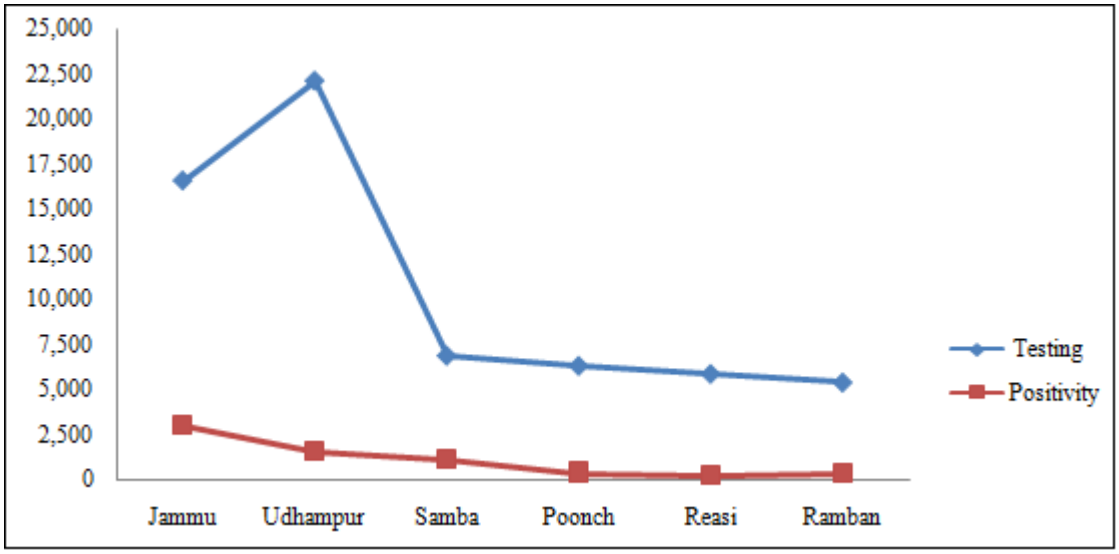


**Figure 6:** COVID-19 cases (tested cases and positive cases) recorded in the target districts of Jammu division from 15 December 2021 to 15 February 2022

## 4. Discussion

India is the second most populated country in the world and hence any shift in the dynamics of the COVID-19 progression will affect the disease progression globally (Tiwari et al., 2020). The diffusion of coronavirus across the borders has caused a huge affect on the lives of the humans (Wani et al., 2021). The current study focuses on the inter-district variations in the trends in progression of the COVID-19 in Jammu division of J&K. The onset of the third wave of the COVID-19 in Jammu division was recorded around 26th December 2021 with a steep increase in the testing and positivity. Around 19th January 2022, maximum of positive cases were recorded. After that a steep decline in the number of positive cases was seen which was quite similar to how the peak advanced in the first place. The current study represents the first district level study of COVID-19 disease progression in Jammu division of J&K. The highest

positivity percentage was recorded from Jammu division. This also corresponds to the population density of the district too making it the epicenter of the Omicron driven third wave. Even though Jammu and Kashmir recorded around 71.5% fully vaccinated population and 76.6% partially vaccinated population, the curve for omicron infection was found to be steeper as compared to the other waves where vaccination was not done. Jammu division showed 10% positivity relating to population density of the division (Jawad, 2020). Some recent studies showed that a booster dose is a must for fighting the omicron driven wave as two doses are not sufficient to tackle the viral variant (Mukherjee et al., 2022).

The threat proposed by the coronavirus pandemic in Jammu division seems to getting accelerated with the evolution of the each potential variant. It is anticipated that the world might see still multiple waves of COVID-19 pandemic, each wave with varied intensity (Fakhruddin et al., 2020). Monitoring the dynamics of COVID-19 situation presently, it will not be correct to deny that positivity and fatality percentage might surge in future with newer variants (Bohloli et al., 2022). The latency in the positivity percentage after the surge of a peak wave causing relaxation in responsive behavior resulting in lower of the barrier in the protective measures like social distancing and governmental SOPs might provide fateful against the supremely evolving coronavirus variants (Gupta et al., 2021).
The purpose of the present study was to estimate the recent hotspots and the epicenter of the omicron driven third wave in Jammu division of Jammu and Kashmir (Wani et al., 2022). In the study, it was observed that the Jammu district due to its high population density as well as the centre of the division formed the point of most infection. It is noteworthy that 71% of the population in the region has been fully vaccinated, yet the step in the curve of the positivity rate couldn't be managed (https: //www.nhm. gov. in). It also provides knowledge that the administration must uptake urgent initiatives to ascent health infrastructure especially in the hotspot districts to mitigate the burden of the future course of the pandemic.

The outcome of the present study may provide useful for the administration, policy makers and healthcare workers to grapple and contain the ongoing pandemic. This also provides a helpful insight about the epicenters of the omicron driven wave and the need to upgrade the testing facility and health care infrastructure in the affected areas for the proper management of the newer variants evolving of the coronavirus in future. The changes in the effect of population density, area and geographical variations in different regions form an interesting factor in the disease manifestation in different districts.

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