



# The Statistical Analysis to Find Correlation Between Mass Gathering Event and COVID-19 Pandemic Outbreak: The Prayagraj Magh Mela 2021 Experience

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**Abstract** Magh mela, a smaller form of Kumbh mela, organize every year in Prayagraj. With the emergence of novel corona virus, there is worldwide discussion to find out the effective way to organize or cancel the mass gathering events. The present study assesses the challenges in organization of mass gathering events like Magh mela held at Prayagraj, India in 2021. The correlation between increased cases of COVID-19 and Magh mela-2021 has been highlighted through statistical analysis and growth curves using the available data. The study finds that there is a correlation between the Magh mela-2021 mass gathering event and increased rate of COVID-19 infections. After the Magh mela 2021, the average daily increase in the COVID-19 cases started to increase. It was found 4.25%, 6.28% and 2.73% in India, Uttar Pradesh and Prayagraj, respectively.

**Keywords** Correlation · Kumbh mela · Mass gathering · COVID-19 · Infection · India

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This study shows the correlation between mass gathering public events and COVID-19 infections. This study helps to identify the impact of mass gathering events on increased rate of COVID-19 infections. This will be relevant for the next Kumbh mela 2025 during policy making and planning.

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## 1 Introduction

It is believed that the Kumbh Mela originated in times immemorial and is attested in the Hindu mythology about *Samudra manthan* (churning of the ocean) found in the Vedic texts [1]. The festival is attended by millions of people irrespective of caste, creed or gender. In 1906, the pilgrim's participation was around 2.5 million, and it reached to around 240 million in Kumbh Mela-2019 at Prayagraj [2]. The Kumbh Mela is one of the largest and magnificent religious gatherings on earth and inscribed as an intangible cultural heritage of humanity by UNESCO. It is more than a pilgrimage. The Kumbh mela provides a broad perspective of the entire range of varied thoughts and practices of the Hindu way of life. It is a celebration of an ancient tradition where a dip in the holy river water is given prime importance. This riverside festival and the city that springs up around them are attended by million. The pilgrims participate in religious discourse available there. They listen the preaching of saints and do *Kalpavas* (living simple life during Kumbh/Magh mela period in camps). Every year Magh mela at Prayagraj also attracts millions of pilgrims in form of mass gathering. In Hinduism, the concept of Tirth (pilgrimage) grew from the Vedic reverence of rivers in the hymn. It is believed that the religious rites conducted at *Tirth* will inevitably yield spiritual benefits. Tirth in Hinduism is a transcendental or deepest quest of all human beings in form of self-actualization and in that sense it is regarded as being at the apex of our hierarchy of needs. This is the reason the *Kalpvasis* do not want to break their continuity of *Kalpavas*. In Kumbh mela-2013, there was at least 10 times more revenue generation on capital investment (both permanent and temporary) [3] but during Kumbh mela-2019 it was expected to grow worth 1,200,000 Million rupees against

the government expenditure of 42,000 million rupees. Approximately 60,000 million jobs were projected for generation in general including 25,000 million alone in hospitality (tour operators, guides, airlines, hotels, local transport, emergency and ancillary support system etc.). Around 8500 million jobs were expected from medical and ecotourism [4]. The Kumbh and Magh mela have the potential to boost the local economy. Due to the lock down measures in 2020, the socioeconomic conditions of middle class in developing countries, especially in India affected badly. India's GDP shrank 7.3% in 2020–21[5]. During the Kumbh-2019, 240 million pilgrims participated in which 1.03 million foreign tourists were included while 78.6 million pilgrims participated during Kumbh Mela-2013 including 0.35 million foreign tourists. It was the highest footfall in the history of mela in fact it was more than the annual footfall of tourists Uttar Pradesh had between year 2014 and 2017. As per official figures made of the Uttar Pradesh Tourism Department, year 2014 witnessed a total of 187.1 million tourists in the state. They included 184.2 million Indians and 2.9 million foreigners, while in year 2015, 209.6 million tourists, including 206.5 million Indians and 3.1 million foreigners, visited the state. Furthermore, official records of the department revealed that in 2016, 216.7 million tourists visited different parts of the state. They included 213.5 million Indians and 3.2 million foreign visitors. In 2017, a total of 237.5 million tourists visited the state. They included 233.9 million Indians and 3.78 million foreigners. However, in 2018, a total of 288.8 million tourists, including 285 million Indians and 3.8 million foreigners, visited Uttar Pradesh [6]. The Kumbh mela 2021 was organized from 14 January 2021 to 29 April 2021 at Haridwar and was attended by around 10–20 million people between 1 April 2021 and 30 April 2021[7].

## 2 Materials and Methods

Major databases such as ResearchGate, PubMed, Crossref, ScienceDirect, Google scholar were explored with the keywords 'Kumbh mela', 'Magh mela', 'mass gathering', 'religious gathering', 'COVID-19', 'infectious diseases', 'infection', 'pilgrims' and 'sanitation' for this study. The recent and earlier reports of Prayagraj Mela Authority were also studied. Only peer reviewed articles were considered for gathering information. Various online portals like World Health Organization (WHO), IHME (Institute for Health Metrics and Evaluation) and government web portals were browsed to gather relevant information.

The Magh mela-2021 can be categorised into three phases i.e. before starting of event (from 01 November 2020 to 15 January 2021), during event (15

January 2021–1 March 2021) and after the event (1 March 2021–30 April 2021).

## 3 Results

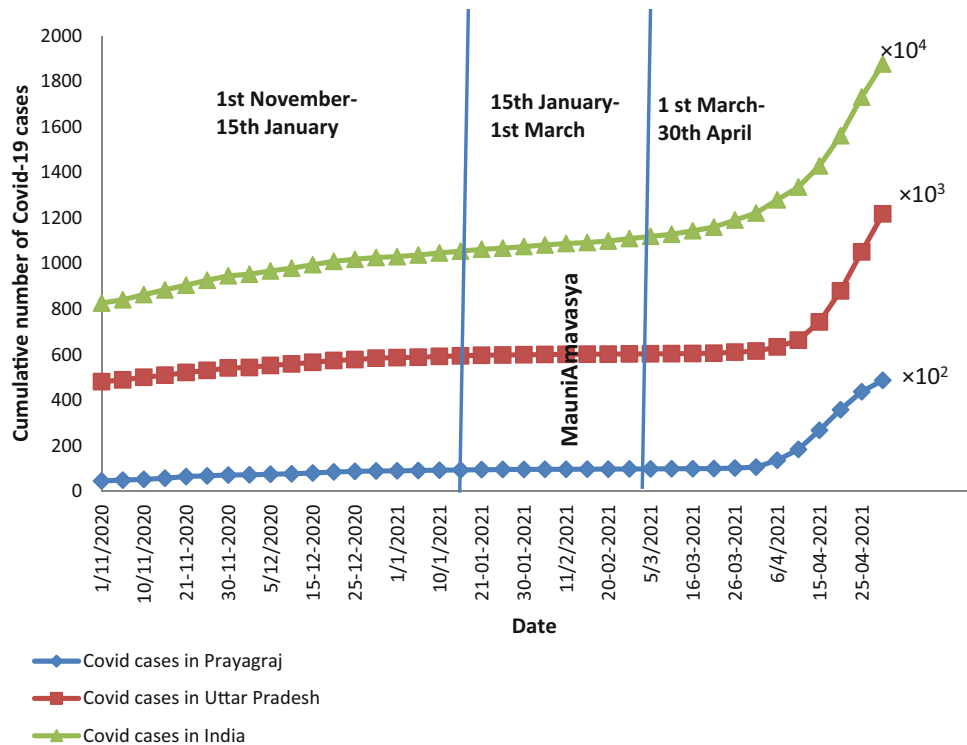
### 3.1 COVID-19 Cases During Magh Mela-2021

The number of COVID-19 cases (from 01 November 2020 to 30 April 2021) in India [8], Uttar Pradesh [9] and Prayagraj [10] is represented in Fig. 1. The figure is divided into three phases. The cases in Prayagraj are calculated from 1 October 2020. The 47 day event of Magh mela 2021 was commenced on 14 January and concluded on 1 March. Magh mela is a mass gathering event but in smaller scale than Kumbh mela. The preparation for Magh mela starts in November. Before starting of Magh mela, the average daily increase in the number of cases was found to be 1.44%, 1.34% and 0.95% in India, Uttar Pradesh and Prayagraj, respectively. During the Magh mela, the average daily increase in the cases slightly decreased everywhere i.e. 0.65%, 0.20% and 0.10% in India, Uttar Pradesh and Prayagraj, respectively. During Magh mela 2021, there were six main bathing days. Mauni Amavasya, one of the peaks bathing days, which occurred on 11 February, was highest crowded event. Three million pilgrims took dip in the Sangam. After the Magh mela, the average daily increase in the COVID-19 cases started to increase. It was found to be 4.25%, 6.28% and 2.73% in India, Uttar Pradesh and Prayagraj, respectively. The steep rise in the number of COVID-19 cases in Prayagraj coincided with the greater number of people that came to Prayagraj during Mauni Amavasya. The analysis of the average daily increase shows that the cases increased remarkably after the completion of Magh mela when the pilgrims moved to their destinations. During the Magh mela the average daily increase was not higher because there was little movement from mela to other cities.

### 3.2 Correlation Analysis

There may be possibility of some interrelation between the rise of the daily average increase in the COVID-19 cases in Prayagraj with the daily average increase in the COVID-19 cases in Uttar Pradesh, India. This study tried to find out this interrelation through correlation analysis. Various correlation plots were prepared to analyse the correlation between the daily cases of COVID-19. For correlation analysis, the two phases are considered i.e. during Magh mela (15 January–01 March) and after Magh mela (01 March–30 April). The resulting coefficient of correlation ( $r^2$ ) was found to be greater than 0.96 for the first phase and 0.98 for the second phase for Prayagraj-Uttar Pradesh. It

**Fig. 1** Cumulative number of COVID-19 cases reported in Prayagraj, Uttar Pradesh and India

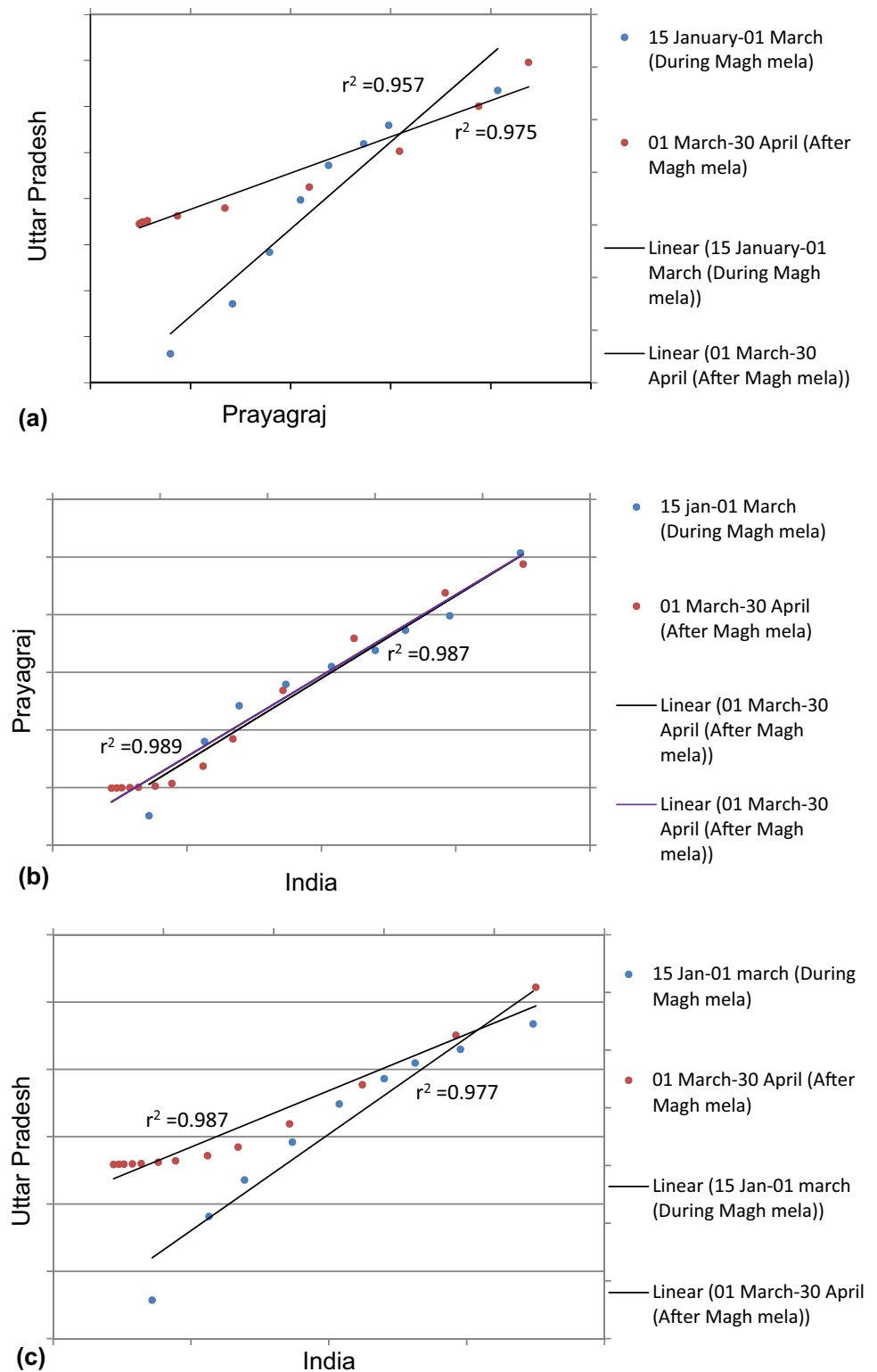


was greater than the 0.98 for India-Prayagraj and India-Uttar Pradesh for both phases. The resulting coefficient of correlation for the first phase for Prayagraj-Uttar Pradesh is comparatively less than the second phase. The reason behind for this may be the less movement from mela to the outside areas. The increase in number of COVID-19 cases in Prayagraj was strongly correlated with the increasing cases in Uttar Pradesh after the completion of Magh mela phase. The coefficient of correlation between Prayagraj-India, and Uttar Pradesh-India were found higher in the second phase in comparison to the first phase (Fig. 2a, b, c). The correlation suggests that after completion of the Magh mela pilgrims returning to their destinations in different parts of the country might have caused the increase in COVID-19 cases in Uttar Pradesh and India. The coefficient of correlation between Uttar Pradesh-India and Prayagraj-India was found higher than that of Prayagraj-Uttar Pradesh. It suggests that some other sources or activities in Uttar Pradesh and India contributed to increase the cases. The local bodies' elections were held in month of April in Uttar Pradesh which may be one of the reasons also [11]. During local bodies' election, there were huge interactions among the people. In month of April, the COVID-19 cases were highest in India and Prayagraj. In addition, in all the correlation plots, the highest coefficient of correlation was found between Prayagraj-Uttar Pradesh, Prayagraj-India and Uttar Pradesh-India during the second phase i.e. after completion of the Magh mela.

#### 4 Discussion and Conclusion

The finding suggests that the non-following of the COVID-19 protocol during Magh mela-2021 had a huge impact on the total number of cases reported in Prayagraj. Kumbh Mela-2021 at Haridwar had also impact on the surge of the COVID-19 cases in Uttarakhand and India [12]. The impact of local bodies' election during month of April 2021 can also be further assessed because there were huge violations of COVID-19 guidelines [13]. In Jan 2021 and Feb 2021, 620 and 222 COVID-19 positive cases were found in Prayagraj, respectively, but it increased rapidly in March (798 COVID-19 positive cases) and April 2021 (39,236 COVID-19 positive cases). The mass gathering at Magh mela 2021 in Uttar Pradesh helped in spreading the COVID-19 infections in Uttar Pradesh. The incoming floating populations in Magh mela 2021, especially on weekends were violated the COVID-19 norms and no plans were made, especially for them to restrict in mela areas. The families of the *Kalpvasis* were the regular visitors in mela area for short term and they spread the infections from mela area to city area. The First and second dose of vaccination in India has been given for 89,63,91,162 and 64,16,17,038 people, respectively, and in Uttar Pradesh it is 13,72,83,506 and 8,09,39,371, respectively [14]. Although the Vaccination situation is improving in India but the mass gathering event may become a hazard due to lack of emergency health services in remote rural areas. During Magh mela, various activities are performed like sitting

**Fig. 2** Correlation of cumulative number of COVID-19 cases between **a** Uttar Pradesh and Prayagraj **b** Prayagraj and India and **c** Uttar Pradesh and India



together to organize worship, community preaching and bathing in Sangam area, etc. causes close interaction among the pilgrims. Common toilets, limited space in camps and little impact of sanitization due to open area also makes the probability of spreading of infectious

diseases. Due to globalization and opening of international borders for tourism purposes promoted the international movements largely. The various mass gathering events like Kumbh mela, Hajj and Olympic, etc. which attracts the people of every corner of the world put pressure on the

organizing country to implement COVID-19 guidelines. The communicable and non-communicable diseases claimed life's and caused injury to the pilgrims and tourists [15]. Risk assessment and planning should be done keeping into the consideration of the severity of pandemic and huge crowd [16]. The mass gathering events can be cancelled delayed or organized with limitations [17] [18]. Due to the accumulation of pilgrims from different parts of country restricts the scope of proper and effective contact tracing in case of spreading of COVID-19 infections [19]. These mass gathering events promote local economy like small business, service sectors, local vendors, etc. So the rigorous study should be done before cancellation of such mass gathering events. In case of Magh mela, we may organize only with the *Kalpvasis* and restricting the floating populations. The interpretation through a correlation amongst the rise of COVID-19 cases and Magh mela-2021 in Prayagraj was directly dependent on the availability of limited secondary data. Hence, in future a real time or primary data analysis should be attempted to support the findings of study.

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**Declarations**

**Conflict of interest** The authors declare that they have no conflicts of interest.

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