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Are Mass Gathering Events Hot Spot for Spreading of Infectious Diseases: The Kumbh Mela Experience

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Kumbh Mela, the largest spiritual mass gathering, witnessed around 240 million pilgrims in 2019 at Prayagraj. The huge gathering poses challenges of different kinds including easy transmission of infectious diseases. This research aims to identify the types and causes of infectious diseases and discuss the government's efforts for health and sanitation management. Secondary data from various reports have been used to support the study for which related websites, Prayagraj Mela Authority reports, peer-reviewed articles, and related literatures were studied. Qualitative and quantitative analyses have been done to find trends and have comparative studies among various Kumbh and Ardh Kumbh Melas. The study finds that there is spread of infectious diseases like Acute respiratory infections, fever, skin disease, dysentery etc. during the Kumbh Mela due to the huge population, restricted space, pressure on sanitation infrastructure, unhygienic living conditions, solid and liquid wastes generated during Mela, and pilgrims' social and religious psychologies. The number of pilgrims of the occasion has increased heavily with time. Based on the anticipated number various efforts and initiatives of the government and management such as advance disease surveillance system, HEAT map, ensuring safe drinking water, better sanitation and healthcare facilities has increased over the years to reduce its impact. Mass gathering events always draw attention to health hazards and in fact the outbreak of the COVID-19 pandemic forced to think about the organization of mass gathering events in future. The mega tent city that accommodates nearly millions of pilgrims in the river bed is significant not only for India but also for mass gathering research at the international level to draw policy and provide the opportunity to generate the evidence and document base for risk prevention, mitigation, and management planning of infectious diseases and disasters.

Keywords: Bathing, Ganga river, Pilgrimage, Public health, Religion

Introduction

Mass gatherings are events where a group of more than 1000 people assembles for a defined period. These may be spontaneous (for instance, funerals of public figures) or planned sporting events, or religious pilgrimages which attract people globally.[1] Such events include Kumbh Mela, Hajj, Olympic Games, and La Tomatina. Such congregations are important events for the host countries/states as they bring revenue in the form of tourism and strengthen international ties and domestic harmony. However, these require efficient management as such events come with potential security and public health risks. Risk to public security includes stampede, terrorist attacks, accidents, heat shocks, etc., which test the crowd management adeptness of the organizers.[2] International and domestic movements facilitate the dissemination of diseases.[3] In various mass gathering events, sexually transmitted, vector-borne, respiratory, viral, and bacterial transmission diseases have been identified.[4] During the past 5 years, epidemic-prone infectious diseases, such as Ebola virus disease, cholera, Middle East respiratory syndrome, Zika virus disease, Lassa fever, yellow fever, Rift Valley fever, COVID-19, and other zoonoses, have been on the agenda of global public health authorities.[5] In this study, we would like to analyze the Kumbh Mela, a major congregation observed in India with the influx of pilgrims, tourists, visitors, and academicians from within the country and from foreign lands. It is a three-month-long religious and spiritual mass gathering with an ancient history and rich mythology. During Kumbh Mela visitors come to the nation and region by air, road, rail, and foot from within India, making it nearly impossible to keep accurate records of their movements. Millions of people's logistical demands for water, sanitation, security, health, and transportation require careful planning and prompt action. It is a challenging responsibility to provide healthcare services to the inflow of millions of pilgrims. To understand the event better, let us know its background, significance, believes and rituals.

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History, Significance, Believes and Rituals of the Kumbh Mela

'*Kumbh*' in Sanskrit means' *pitcher'* or *'pot,'* and *'Mela'* means *'fair.'* It symbolizes divinity and knowledge. According to mythology, the *Kumbh,* or *pot of nectar,* was churned from the ocean and meant for distribution. The astrological calculations on planet placement acquire significance; determine the period of the Kumbh Mela and assign the day and time of the holy dip or unique bath. The Purna (complete) Kumbh takes place every twelve years at four sites, i.e. Prayagraj, Haridwar, Ujjain, and Nasik. The Ardh (half) Kumbh Mela is held after six years at all four locations, while the Magh Mela is held every year at Sangam, Prayagraj. Sangam is of great eminence and regards for Hindus and is formed by the confluence of the river Ganga, river Yamuna, and mystical river Saraswati. A dip in the Sangam is believed to absolve all sins and ensure *moksha* or *Mukti* or salvation, liberating the person concerned from the cycle of birth, death, and rebirth. During Kumbh Mela, rituals like community bathing in the river, rolling over the floor, mass feedings, bathing naked (by *Naga* saints), community preaching, etc., occur.[6]

The Kumbh Mela, over the centuries, attracted millions from across the world, irrespective of their faith, caste, religion, and gender.[7] Philosophers, ascetics, saints, gurus, visitors, teachers, and scholars from across India and abroad congregate here and participate in the spiritual discourses and debates.[8] *Akhadas* translates literally into a circle or core and refers to monastic schools where students of a sect were trained. There are 13 *Akhadas* divided into three categories, i.e. *Shaiva, Vaishnava, and Advait*. Each *Akhada*s have their own deity and weapon, and they take *shahi snan* (royal bath). Their procession is called *peshwai,* in which they move with their groups on an elephant, horses, flower garlands, and lavish carriages into the Mela area. This marks the beginning of the Kumbh Mela, and a large number of disciples and members of these Akhadas also participate in the processions to render their services as attendants. Only after the royal bath *(shahi snan)* by Akhadas the others people are allowed to take baths on peak days. Kalpvasis are people who stay in makeshift tents at the banks of the Sangam for a period of one month under difficult circumstances due to low temperatures during winter seasons. They do prayers, worship, yoga, *havan* (fire offerings), early morning baths in the river, listening to preaching by saints, community help etc.[9]

The Kumbh Mela 2019, the forty-nine days event started on15 January and ended on 04 March 2019 with six main bathing/ peak days, and 03 royal (Shahi) bath dates attracting to around 240 million pilgrims.[10] The extent of mass gathering during Kumbh Mela 2019 could be viewed from Fig. 1.

The Kumbh Mela can be categorically discerned from other mass gatherings on many parameters. Kumbh Mela has a long history but it is not given much consideration in scholarly debate. There are mass gathering tragedies happening all around the world but the Kumbh Mela has better track record on safety and management. While no significant human disaster occurred during the Kumbh Mela, Moreover, this has received little notice in the international media. The cause might be a major but primarily regional occurrence. This could be the reason for the lack of availability of literature on the subject. But the event's sheer size presents a serious logistical and public health issues. This provides a scope of study to explore the management and implementation of such big event from a public health viewpoint.

Materials and Methods

Secondary data from various published sources have been used in the study. Related websites, the Prayagraj Mela Authority reports, peer-reviewed articles, and other related literatures were referred for relevant information and data. Qualitative and quantitative analyses have been done. Data have been processed to find trends and have comparative studies among various Kumbh and Ardh Kumbh Melas.

We searched various databases with key words like Kumbh Mela, mass gathering and infectious disease. We explored Google scholar, Scopus, Web of Science (WoS), Science Direct, Emerald insight, Wiley Online Library, Springer Link, PubMed, ReserchGate etc. and focused only on the peer reviewed literature. Earlier Kumbh Mela reports published by Prayagraj

Fig. 1 — Pilgrims taking a holy dip at Sangam, Prayagraj, during Kumbh Mela (Source: Prayagraj Mela Authority report)

Mela Authority and reports published by various government departments studied for this research. Websites and News related to Kumbh Mela, Magh Mela and mass gatherings were used as information and data sources. After searching the databases by search terms 'mass gathering and infectious disease' 111000 articles were found, and then we applied a filter that allowed us to the true review articles related to our study topic. We found 21200 articles. The majority of these articles are related to the Hajj, Olympic and other mass gathering events. But when we searched the databases by search items 'Kumbh Mela and infectious disease'1040 articles were found, and then we applied a filter that allowed us to the true review articles related to our study topic. To do this, we eliminated the duplicated articles. We found only 120 articles. Later we excluded the articles unrelated to the central studied topic or called the exclusion for relevance. Finally 48 literature reviews were found directly related to our topic.

Results and Discussion

Pilgrims Participation during Kumbh Mela

Based on the Administrative reports submitted by the respective Mela officer of Kumbh Mela, the numbers of pilgrims participated in Kumbh Mela are plotted in Fig. 2. It shows the rapid increasing pattern of inflow of pilgrims in Kumbh Mela in last three decades. There are six main bathing days and the highest crowded event is *Mauni Amavasya*. A large number of visitors to the Kumbh Mela are old age, women and young people whose active presence greatly enhances the color, energy, and vitality of this vast gathering of humanity. Across denominations and sects, their numbers have been exponentially growing over the years.

Public Health Challenges, Risks and Concern at Kumbh Mela

The activities performed during mass gatherings may attract the infections through skin, respiration, gastro intestine etc. There is an evidence of infectious

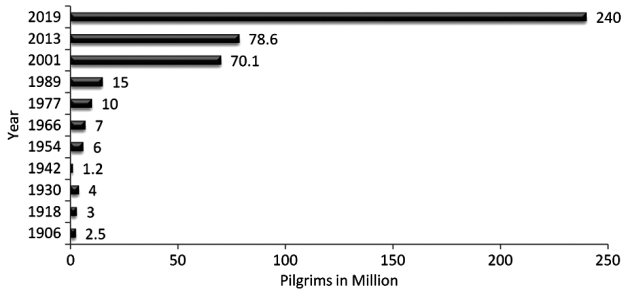

Fig. 2 — Inflow of pilgrims during Kumbh Mela

epidemics. According to an examination of breakouts during significant sporting events like the Summer and Winter Olympics, the Winter Olympics in Salt Lake City in 2002 saw 36 incidences of influenza among competitors, which was an exception. A single team was impacted by a minor gastroenteritis epidemic during the pre-race sailing competition in Brazil in 2015, which took place before the 2016 Olympics.[11] India too in the future shall be host to a number of international meets, sports events, and cultural exchange programs, and hence the planning must be done in the best possible way to avoid undesirable scenarios. The Lancet Conference on Mass Gathering Medicine in 2010 and the Jeddah Declaration on Mass Gatherings stressed the need to exchange knowledge, strategies, and collaborative approaches.[12] During 2020 Tokyo Olympic and Paralympics, a multi-institutional coordination center was established and focused on strengthening of communication, information and medical risk assessment based on daily emergency medical supply and demand balance.[13] During year 2012–2014 Hajj, respiratory tract infections, meningococcal meningitis, waterborne infections, ENT infections, influenza, pneumonia, whooping cough, and tuberculosis were most frequently observed.[14]

During Kumbh Mela 2019, acute respiratory illness, skin infections and early signals of acute diarrheal disease, vector borne disease, acute gastroenteritis and chickenpox were reported.[15] It is important to have advanced planning for public health surveillance at spiritual mass gatherings.[16] Pilgrims participation across the world is increasing in Kumbh Mela and is likely to increase in next Kumbh Mela 2025.[(17)] Risk assessment, risk preparedness and risk mitigation play a vital role during mass gatherings.[18] The pilgrims drink the water of river Ganga and Yamuna during bathing. All these activities enhance the transmission of infectious diseases. A water quality index and multivariate statistical study using samples collected from Sangam, Prayagraj was conducted in 2019. The samples tested on 17 different quality parameters demonstrated that the water became non potable and unfit for bathing. This could be concluded based on water quality index (59–132) and most probable number count (920 to greater than 1800/100 ml) among other results.[19] The earliest documented record of infectious disease at the Kumbh Mela festival was an outbreak of cholera in 1817. This led the focus on the compulsory inoculation up to the 1960s. There were sporadic epidemics during the Kumbh Mela in 1892, 1948, and in the 1960.[(20)] In

year 1906, 2.5 million pilgrims participated in the Kumbh Mela and it increased up to around 240 million in year 2019. Few reports had previously been made on cholera outbreaks at the Mela in 1948 and 1967. During Kumbh and Ardh Kumbh Mela the various infectious diseases like fever, stomach pain, dysentery, skin diseases etc. were identified. The Harvard school of public health reported a 5% incidence of diarrheal diseases during Kumbh Mela 2013.[21] During Kumbh Mela 2019, among the reported illness, 95% were the communicable diseases, such as acute respiratory illness (35%), acute fever (29%), and skin infections (13%). The diseases identified during Kumbh Mela are given below in Fig. 3.

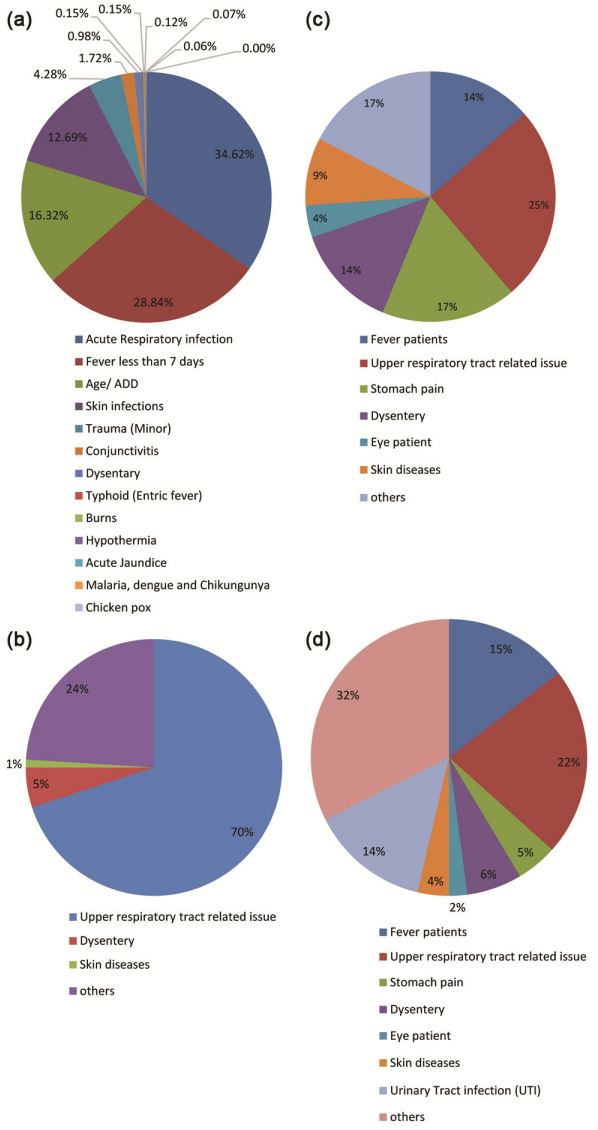

Fig. 3 — Occurrence of disease listed during Kumbh Mela: (a) Kumbh Mela 2019; (b) Kumbh Mela 2013; (c) Ardh Kumbh Mela 1995; (d) Kumbh Mela 1989

During Kumbh Mela, various religious institutions provide free cooked food and organize *Langar* (distribution of foods in mass) for all pilgrims and Kalpvasis. Although these food items are of good quality but the monitoring system of preparing foods are not properly enforced or regulated. The servings of foods are in very crude manner and not properly arranged. Sometimes they distribute food openly on the roads and sometimes it is not hygienic. All these activities attract various enteric diseases.[22] The various factors include the causes of spreading of infectious diseases. The source of transmission of infections may be varied like direct contact (handshake, hug, distribution of food in Langar, close group discussions and living in close tents/camps), through inhalation (coughing, sneezing, nose blowing and spitting), through vectors (flies, mosquito bite and contaminated food and water), through saliva and nasal mucous during open mass bathing and taking dip, through different sources (solid and liquid wastes directly to water bodies, open defecation and urination, cooking and eating in open, throwing all religious wastes directly into river, cutting hairs, washing clothes, cleaning utensils near riverside, industrial wastes and effluents to river and drainage of sewage). Various factors causing the spread of infectious diseases during mass gathering like Kumbh Mela are illustrated in Fig. 4.

Surveillance of such large gatherings is very challenging for appointed healthcare professionals. As per the medical department report, the all type of hospitals (Allopathic, Homeopathic, Ayurvedic and Unani) was established in Mela area for treating the patients. The number of patients treated by different type of hospitals is around 1.3 million during Kumbh Mela 2019. The patients treated by different type of hospitals are shown in Fig. 5.

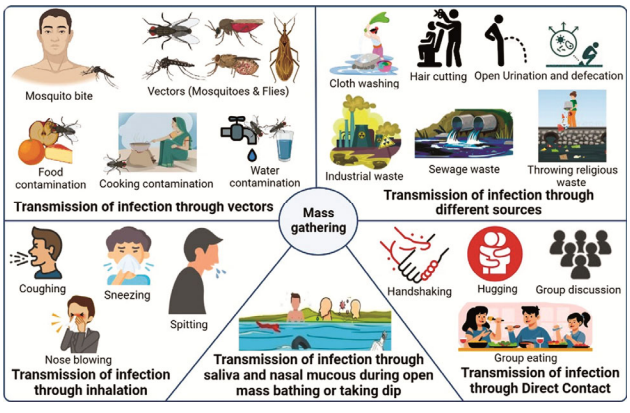

Fig. 4 — Various factors causing the spread of infectious diseases during mass gathering like Kumbh Mela

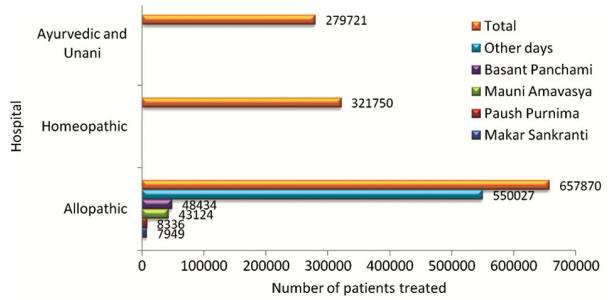

Fig. 5 — The number of patients treated by hospitals (from 15 January 2019 to 01 March 2019)

Most of the patients were related to diarrheal disease, vector borne disease, acute gastroenteritis and chickenpox. In mass gatherings, large numbers of people stay in close contact for prolonged periods. This increases the chance of contagious diseases. In the case of religious festivals, acute respiratory infections (ARI) tend to be the most frequent infectious disease spread during large gatherings. Recently a systematic analysis of 45 studies was done to identify the impact of sporting events (17 studies), religious events (15 studies), festival events (11 studies), and other gatherings (4 studies). The most common disease in the case of religious events was identified to be ARI i.e., 10/15 studies. ARI was the second most common disease in sporting events (6/16 studies). ARI was least reported in festivals and other illnesses (2/11 studies).[23] A survey was carried out during the 2013 Mela which revealed that symptoms of diarrhea and upper respiratory infection symptom peaked right after the bathing day. Respiratory infections made up 70% of illnesses among the 412,703 patients who visited hospitals' outpatient clinics, while diarrheal disease cases were 5%. An increase of 1.1% in hospitalization rate was observed.[24]

In last phase of Kumbh Mela 2019, early signals were reported of acute diarrheal disease, vector borne disease and acute gastroenteritis. Vector borne diseases (malaria and dengue fever), parasitic infections (amoebiasis, giardia infections through contaminated water and pinworm) and air borne diseases (influenza, measles, and pertussis) have the potential to spread during mass gatherings events like Kumbh Mela. Another ritual is shaving process and this done at very large scale. Aspiring sadhus undergo initiation by different Akhadas to make them *naga* sadhus. There is possibility of transmission of blood borne diseases like hepatitis B and human immunodeficiency virus (HIV). During Kumbh Mela 2021, the increasing number of pilgrims in Haridwar and subsequent rise in number of COVID-19 cases in Haridwar, Uttarakhand and India resulted into early conclusion of Kumbh Mela.[25] During Magh Mela 2021 at Prayagraj, there was also sign of increasing number of pilgrims in Prayagraj and subsequent rise in number of COVID-19 cases in Prayagraj, Uttar Pradesh and India.[26] Introduction of risk based a multitude of public health interventions can reduce transmission of SARS-CoV-2 and other Respiratory Tract Infections (RTIs).[27]

The atmospheric temperature also plays an important role in spreading the infectious disease. In warmer temperatures, vectors become infectious more quickly and can transmit virus earlier in their lives.[28] In Prayagraj, India, average temperature varies between 8.9°C (48°F) and 23.2°C (73.8°F) in month of January while in month of April average temperature varies between 22.2°C (72°F) and 39.4°C (102.9°F).[29] The relative average humidity is 76.3% in month of January while it is 42.3% in month of April. There is a remarkable average temperature and humidity difference between before and post Kumbh Mela. Warm temperatures facilitate the transmission of vector borne pathogens, and estimates of vectorial capacity usually assume an even distribution of vector bites in time, which results in a smooth increase in transmission efficiency with warming temperature.[30] The Kumbh Mela ends in the month of April when the temperature is around 40°C and it provides the favorable conditions for breeding grounds of pathogens to generate and spreading of infectious diseases.

Strategies for Overcoming Challenges and Risks in Kumbh over Years

Given the challenges that have been encountered over the time and the risks associated various preventive measures and mitigation strategies have been adopted over years. These implemented strategies are results of methodical deliberation over experience gained from the past and advancement of technology. Some of the management strategies used in the past Kumbh to limits various hazards have been enlisted below.

Overcoming Infrastructural Barriers

The preparations of Kumbh Mela start much before the first bathing day. It starts with the planning, budgeting and interdepartmental meetings. Land leveling in the river catchment area is done to raise the temporary structure. In 2019, Kumbh Mela area

was developed in around 3200 hectares and around 5,500 religious groups and organizations participated. A huge tent city springs up for the pilgrims, Kalpvasis, Akhadas, security personnel and government officials at the bank of the river. Various facilities are developed like electricity poles, developing river edges for safe bathing, roads, pontoon bridges, bus shelters, water pipes, urinals, toilets, hospitals, fair price shops, cultural activities etc. To accommodate and facilitate the huge influx of pilgrims during Kumbh Mela, the permanent and temporary infrastructures are developed in the Prayagraj city and at the river bank. The permanent structure is in form of broadening and beautification of roads, development of ROB (road over bridges) and RUB (road under bridges) etc in the city. The temporary infrastructure at the river bank is rebuilt for every year like water pipeline, electricity pole, sewage, healthcare facilities, mass public accommodation, toilets, parking lots etc.

Advance Disease Surveillance System through HEAT MAP during Kumbh Mela 2019

The first time web-enabled and hand held tablet-based field data collection on pre-defined disease/health conditions were introduced during Kumbh Mela 2019. It used Integrated Disease Surveillance Program (IDSP) module of Integrated Health Information Platform (IHIP). This platform provided the ability to analyze and review special public health surveillance data in near real-time and use it for timely public health intervention. It identified those areas which were having the high infection rates (Fig. 6).

These data were based on the patients reported in the hospitals. It generated hotspot pockets for focused and immediate intervention in those areas. This helped to reduce the spread of infectious disease in other areas.

Public Healthcare Services and Sanitation Efforts at Kumbh Mela

During Kumbh Mela 1989, 136 medical officers, 24 Pharmacist and 36 staff nurses were deployed. One 100 beds hospital was established. In the year 1966 around 20% of the budget was allocated to health whereas around 45% was allocated to health in 2013 and it increased further to 51% in 2019-20. In 2013, there was a hospital in each of the 14 zones of the Kumbh Mela and a central hospital. Additionally, there were 24 primary health centers of Ayurveda and Homeopathy. Nearly 250 medical officers along with hundreds of health workers were appointed. In 2019, the Kumbh Mela area was divided into 20 sectors for all administrative purposes and five zones for medical health purposes (Fig. 7).

The different health departments like Allopathic, Homeopathic, Ayurvedic and Unani developed health facilities. Around 367 medical officers, 476 pharmacist and 101 staff nurses were deployed. One central hospital, 40 bed trauma care facility, 150 Ambulances, 10 Motorized river Ambulances, 6 Advanced Life support ambulances, 1 Air Ambulance were deployed. Additionally, 01 hospital of 10 Bed and 14 Dispensaries of Ayurvedic and 01 hospital of 08 Bed and 15 Dispensaries of Homeopathy medical facilities were also provided for 24h a day. As well as a tertiary-level public hospital

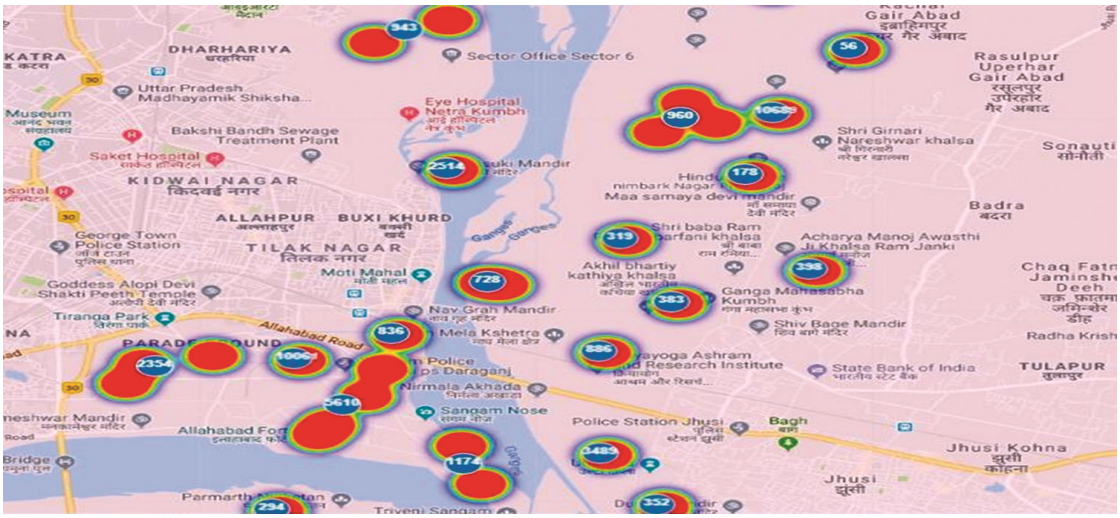

Fig. 6 — Heat map generated during Kumbh Mela 2019 (source: Medical and Health department report, Prayagraj)

Fig. 7 — Hospitals during Kumbh Mela 2019 (source: Medical and Health department report, Prayagraj)

Table 1 — Safe drinking water and drainage facilities during Kumbh and Ardh Kumbh Mela (Source: Prayagraj Mela Authority report)

Mela, Year	Tube well	Overhead Tank	Water Pipeline (Km)	Hand Pump	Stand post	Tank type stand post	Non RCC drain (Km)	RCC drain (Km)
Kumbh Mela, 1977	17	3	168.5	180	3863	80	13.5	—
Ardh Kumbh Mela, 1982	19	3	170	0	5680	79	33	8 1
Kumbh Mela, 1989	23	4	242	0	9237	73	44	12.5
Ardh Kumbh Mela, 1995	10	2	216	37	9302	65	62	9.85
Maha Kumbh Mela, 2001	28	—	345	17	15430	141	150	16.5
Ardh Kumbh Mela, 2007	38	—	458	2	18523	141	240	22
Kumbh Mela, 2013	46	—	690	81	32570	—	40	60
Kumbh Mela, 2019	87	—	1001.99	166	70863	—	113443 Cubic meter	187

RCC (Reinforced Cement Concrete)

like Sarojini Naidu, Manohar Das eye hospital, Railway hospital and three district level hospitals were upgraded with all modern facilities in Prayagraj city and beds were reserved. Mela epidemic officer was deployed.

Ensuring Safe Drinking Water

During Kumbh Mela, Government constructed water pipeline, tube well, mini tube well and hand pump to supply clean drinking water for Akhadas, Kalpvasis and tourists (Table 1).

The government gradually increased the facilities to cater the increasing pilgrims in Kumbh Melas. Even though, drinking water supply areas were identified and visible on locations but the cases of using of non-potable water were visible in some places during Kumbh Mela 2019. This was especially occurred on main bathing days when there were huge floating populations. The presence of millions of people bathing in a brief period raises the question of sanitation and diseases like cholera and dysentery. The suction of sludge from septic tanks and soak pits was performed round-the-clock during the Mela to cater to the large number of pilgrims and their usage of toilets and urinals. Moreover, the pits were treated with bleach and Malathion, an organophosphate insecticide that neutralizes the chances of fleas breeding, and thus the outbreak of epidemic. Thirty-five drains were treated by bioremediation. Five major polluting drains were treated through geotubes while 06 drains were treated by the National Environmental Engineering Research Institute (NEERI) in situ treatment methods. Ten small drains were tapped and treated with up flow filter. At Rajapur Sewage treatment plant (STP) 110 million of Liters per Day (MLD) against 60 MLD capacities was treated by the addition of bioremediation and enzymes. At Salori Sewage treatment plant (STP), 55 MLD against 43 MLD capacities was treated by the addition of bioremediation. Around 9,888 MT solid wastes were disposed during Kumbh Mela 2019. Arrangements for supply of wheat flour (2702.939 MT),

rice (2220.622 MT) and sugar (1753.875 MT) were there to make them available nutritious food at fair price. Earlier there were stances of burning of coal and wood to prepare food and it was unhygienic because of cooking in open area. Government provided LPG gases and refilling facility at fair price for the Kalpvasis and visitors. Kumbh Mela in form of mass gathering poses a complex health challenge. Although in comparison of other Kumbh and Ardh Kumbh Mela, the percentage of some infectious diseases like cholera, dengue, malaria, chickenpox, conjunctivitis etc. reduced but fever, upper respiratory tract related issues and skin infections increased. The facilities of the safe drinking water and availability of food grains at fair price helped in reducing the spread of infectious disease in Kumbh Mela 2019. The reason of skin infections may be the mass bathing and reduced water quality of the river.

Providing Better Sanitation Facilities

However, over the years, the government focused on sanitation management and awareness and healthcare facilities. To prevent open defecation in Kumbh Mela, the temporary toilets were constructed (Fig. 8). According to the reports, in the Kumbh Mela of 1989 around 321, in the Kumbh Mela 2001 around 48, and in Ardh Kumbh Mela 2007 around 38 flag areas (open defecation point) were identified where open defecation was prominent but this were reduced in succeeding Kumbh Melas. In Kumbh Mela 2019, open defecation cannot be summarily rejected. Due to proper focus on sanitation management, it was not prominently visible.[31]

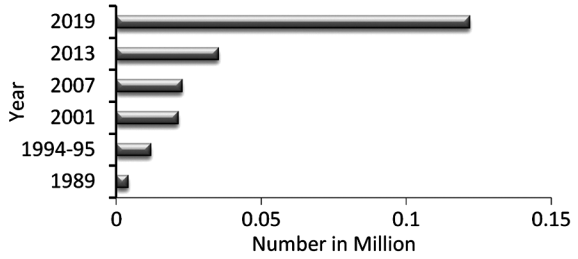

Fig. 8 — Number of temporary toilets constructed during Kumbh Mela (source: Prayagraj Mela Authority report)

Although around 1,22,500 eco-friendly temporary toilets and more than 20,000 dustbins with liner bags were deployed for sanitation management in Kumbh Mela 2019(32) but various spots of open urination and defecation found.[33] For effective monitoring to check the cleanliness of toilets, a mobile application was developed. A QR (quick response) code for each public toilet complex was assigned and more than 20000 sanitation workers were deployed and trained to monitor and give feedback through app. In many places, toilets were seen choked and dirty. Overflow of sewages, water stagnation and poor drainage of water were visible in many places. This attracted the infection of various infectious diseases through air transmission. Various diseases carried by mosquito vectors are particularly sensitive to meteorological condition.[34] There is need to develop the Climate-based early warning systems for infectious diseases.[35] During earlier Kumbh Melas, the traditional approaches were adopted for solid and liquid waste management which polluted the ground and surface water. The sanitation management efforts during Kumbh and Ardh Kumbh Mela are shown in Table 2.

Recommendations and Future Perspective

The Kumbh Mela is a tradition that finds its roots deep in the culture of the country and Hinduism. It is also an important event that attracts crowds and brings in revenue. Hence effective measures need to be put in place to shoulder the herculean problems it presents in front of the administrative and medical

Table 2 — Comparison of sanitation management efforts during Kumbh/ Ardh Kumbh Mela (Source: Prayagraj Mela Authority report)

Kumbh/ Ardh Kumbh Mela Year	Mela area (Hectare)	Number of Toilets Constructed	Flag areas where open defecation was prominent	Garbage disposal (Metric Ton MT)	Urinals constructed	Pits dug for garbage disposal
1989	1180	4180	321	—	1526	4980
1994-95	980	12024	—	—	2051	5629
2001	1200	21400	48	2000 MT per day	2020	5577
2007	1620	22770	38	—	555	3908
2013	2000	35410	—	10104.53 MT during Mela period	—	—
2019	3200	122500	No flag areas identified	200-500 MT per day	17910	Sewage treatment plant, Geo tube technique and use of ICT

ICT (information and communication technology)

fraternity and the glitch less execution of the entire event. The following recommendations could be given for organizing mass gathering events especially Kumbh Mela.

- Various mass gathering events organized across the globe can share their expertise with each other in different fields like event management, new health management initiatives and crowd management, etc. Sharing experiences and documents may help in developing guidelines, problem-specific solutions, and a unified approach to public health during mass gatherings. This can promote more research and study to find out new ways and practical approaches to manage public mass gatherings. This could help the government to make improved public policies that can be effectively implemented and executed during mass gathering events. This facilitates the paradigm shift from the response model to the prevention model.
- It should be remembered that many mass-gathering-related illnesses, such as influenza, measles, mumps, meningococcal disease, and pneumococcal disease, are vaccine-preventable. Meningitis vaccination requirements have been successful in the context of the Hajj. It is essential to check and, if necessary, update the immunization status of children for measles, mumps, and meningococcal disease.
- The disease mapping based on earlier experience may be helpful in risk mitigation. Disease diagnosis, climate-oriented disease identification, treatment, and prevention will be more target oriented if health services and its associated activities are aware of common health risks involved during spiritual mass gatherings. Disease mapping and disease surveillance systems may be generated for risk preparation. The documentation of various types of diseases during the Kumbh Mela should be done.
- Evaluation of risk factors and Capacity assessment and planning should be done before organizing the mass gathering events. The event management should assess its capacity to enforce preventive and curative measures in case of spread of pandemic. The characteristics of event should be explored whether the event has the potential to spread infections due to its activities.
- Set up of a multi-institutional coordination center with focus on strengthening of communication, information and medical risk assessment based on daily emergency medical supply and demand balance like in Tokyo Olympic and Paralympics.
- Provision should be there for effective surveillance systems to get early warning in case of outbreak.
- In the case of COVID-19 outbreak during Kumbh Mela.
  - Static thermal screening centres at the entry of event area and for checking the RTPCR report.
  - Strict compliance of wearing mask, maintain social distance and hand sanitization.
  - Static sampling centres should be established in each sector and wide publicity should be done through electronic, print and social media regarding COVID-19 protocol and preventive measures.
  - Announcement and appeal by religious leaders to follow the COVID-19 norms and restrict to themselves to come to the religious mass gathering events.
  - Dedicated healthcare facilities in case of COVID-19 positive case found.
  - Dedicated Rapid response and surveillance teams for identifying and follow up the COVID-19 positive patients.
  - Identifying to those social and religious organizations where large number of crowd stay in the Kumbh Mela so that focused attention can be given for compliance in case of spread of COVID-19 disease.
  - Restrictions on entry of old age people and children in Mela area.
  - Compulsory arrangement of COVID-19 help desk at the entry point of religious camps.
  - Making COVID-19 healthcare card for each Kalpavasi (who reside in makeshift tent during whole Kumbh Mela period) and tourist residing in different religious institutional camps in case of Kumbh Mela.
  - Identifying the capacity of each religious camp as per COVID-19 protocol and regular sanitization of each camp.
  - If large numbers of COVID-19 positive patients are found in any camp then close the camps fully and sanitize the whole area.
  - Proper arrangement of disposal of biomedical wastes like mask, sampling kit, vaccines etc.
  - Mass gatherings should be allowed only with proper social distancing and with prior permission of administration or organizers.

- Speedy vaccination for preventing COVID-19 and vaccination camps for pilgrims and tourists can be organized during Mela period.
- Strict and rigorous contact tracing of COVID-19 positive patients and their sampling.

- After the completion of mass gathering events, the following activities should be done.
- The total area should be sanitized according to COVID-19 protocol.
- Biomedical wastes should be properly disposed to contain the spread of infection.
- Those who identified COVID-19 positive, they must complete their quarantine period.
- After completion of event, an undertaking may be taken from all Kalpavasi (in case of Kumbh Mela) that they will be in self-quarantine at home for next 07 days.

Conclusions

The massive tent city in the riverbed that houses almost millions of pilgrims is significant not only for India but also for global mass collecting research to develop international policy and give the chance to produce the evidence and document foundation for risk prevention, mitigation, and management planning of infectious illnesses and disasters associated with mass gatherings. The huge variation in climatic conditions, religious beliefs, huge crowd mobility, and socio-economic profile of pilgrims make it difficult to assess the actual requirement of risk preparedness. After the completion of the Kumbh Mela, there is a challenge to containing the spread of epidemics. The mass gathering event's biggest problem is its numbers, which will increase further. Approximately 240–250 million people are predicted to attend the Kumbh Mela 2025. Out of these people, most of the pilgrims come from highly endemic zones which are more prone to vector-borne diseases and contagious diseases. The health care facilities are always under pressure. Mass gatherings have been taking place across the world and each event presents itself as a new case. It is wise and prudential to observe these cases, make minute observations and formulate dos and don'ts for future events.

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