



Research Article

# Mass Gathering and Population Movement in India: Possible Risk of Vector-Borne Diseases

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## I N F O

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## A B S T R A C T

Surveillance tools measure and help to predict the possibility of the onset of any disease including vector-borne diseases during some specific situations like mass gatherings (MGs) that are closely related to the disease epidemiology (why, what, who, where, when, and how) concerning the transmission of infectious diseases including vector-borne diseases. Some situations of mass gatherings may bring closely large and diverse population groups coming from different endemic zones/ areas leading to the transmission of communicable diseases including vector-borne diseases. Mass gatherings (MGs) may have the potential to enhance the transmission dynamics of vector-borne diseases owing to different geographical, social, and climatic factors. Usually, MGs have been thought to have enhanced risks of disease transmission. They also have the potential to increase the opportunities for other types of mechanical injuries from accidents, stampedes, alcohol use, internal group fights etc. that may result in morbidity or mortality. Besides, they are potential breeding places for the proliferation of vector species, capable of transmitting malaria, dengue, chikungunya, and JE including ticks and mites-borne diseases. It is a well-known fact there are a large number of asymptomatic cases which act as sub-clinical cases, hence, chances of local transmission through vectors during such mass gatherings can not be ruled out. There is always a need for well-structured, intensified real-time disease and vector surveillance and reporting systems in place which is essential for efficient MG planning, to ensure disease prevention and control. In the present context of the ongoing COVID pandemic, such surveillance systems have become a vital component of such events of mass gatherings and large-scale movement of people.

**Keywords:** Epidemiology, Global Health Surveillance, Mass Gathering, Asymptomatic

## Introduction

Mass gatherings in India are social and cultural events, which are commonly seen in the form of melas, festivals, games, and religious occasions. Large-scale and long-

duration mass gatherings take place in India during Kumbh melas, Simhasthameela, and national and state games. Such mass gathering events are planned well in advance giving due importance to the health of the people attending such events. They have become quite common as elections or



political rallies are held quite frequently with large-scale movement of people. Massive gatherings of people are witnessed during Durga puja, Janmashtami, and Shiv Ratri in Hindu Temples and also in Masjids while paying Ardas in main masjid areas. There are chances of food adulteration, water contamination, and drugs and alcohol-related issues in such mass gatherings on a big scale with sanitation issues related to garbage disposal and water drainage. There may be other health-related issues due to fire, accident, fight between groups, drowning, or stampede where health services of first aid to ambulance and referral services are required to be in place. A four days mela is organised at Kamakhya Temple during the Ambubachi Festival, where lakhs of devotees participate across the country. Makaravilakku, an annual festival in Kerala, is celebrated on the day of Makar Sankranti which falls in January. This festival is celebrated with great enthusiasm on a remarkable level at the Sabarimala Temple in God's Own Country, the South-Indian state of Kerala. It is estimated that approx one million believers come from all over the world to seek blessings on the auspicious day of Makaravilakku in Sabarimala. Ramdev Mela, Pushkar Mela, Khatu Shyam and International Camel festivals in Rajasthan attract lakhs of people from the country and are held for longer periods. Similarly, the Jagannath temple at Puri attracts lakhs of pilgrims from all over India.

Compared with the general population, mass gatherings (MGs) present with heightened health risks owing to increased chances of accidents and contamination including both food and water-borne diseases.<sup>1</sup> Infectious diseases are a cause of major concern amongst them,<sup>2</sup> specifically in the context of global MGs. The illnesses can arise due to pathogens native to the host state/district or due to foreign pathogens brought by the large-scale motion of participants coming from endemic areas.

A recent review<sup>3</sup> has compiled examples of infectious sickness outbreaks which have taken place in MGs everywhere in the world. Food-borne sickness outbreaks have comprised shigellosis, campylobacteriosis, and hepatitis A caused due to over-burdening of the management by a large number of visitors leading to sub-optimal food and water hygiene practices. Outbreaks of respiratory infectious diseases, e.g. influenza, measles, mumps, and meningococcal sickness, also are common. Influenza, particularly, is an instance of contamination that due to its brief incubation period, can effectuate significant morbidity and mortality at MGs.

Reports of zoonoses and vector-borne illnesses, in addition to blood-borne and sexually transmitted illnesses, all through MGs, are of low priority and are not given due attention. Regarding zoonoses, there is more probability of outbreaks in situations where humans have a possibility of

exposure to water resources (e.g. outbreaks of leptospirosis and *Escherichia coli*). Vector-borne illnesses may also pose a risk to the susceptible populace from non-endemic states/districts, and therefore measures for prevention and control should be included as a part of the action plan needed to lessen the chance of advent or transmission of VBDs where the appropriate vector might be prevalent with all congenial conditions.

### Mass Gathering Events

Mass gatherings are characterised by the concentration of humans in a selected area for a selected cause over a fixed time frame that can test the planning capability and resources of a community or nation. These gatherings may be deliberate or unplanned and recurrent or sporadic. The number of attendees can also additionally range from masses to millions. Large spiritual occasions like the Hajj Muslim pilgrimage causes the accumulation of a few million individuals in Saudi Arabia annually. Even the Kumbh Mela in India is attended by as many as forty million worshippers. Around eight million tickets were purchased by people for the London Olympic Games in 2012 and over 3 million people attended the 2014 FIFA World Cup in Brazil. Most mass gatherings are characterised by massive attendance, along with crowding. There can be bad sanitary situations at a few mass gatherings, and at others, there can be promiscuity.

It would be worth mentioning that the preparedness for public health activities during mass gathering events requires a pre-planned strategy with a timeline of the activities along with financial assistance and involvement of other sectors. There must be a risk assessment exercise before and after such events of mass gatherings for proper planning and execution. Disease and vector surveillance with continued monitoring are the key components of any such action plan with an additional focus on diagnostic and treatment facilities.

The following essential components may be taken into consideration for risk assessment during mass gathering events:

- Area coverage and expected population
- Duration of the mass gathering and density
- Prevailing geographical/ climatic conditions
- Sufficient surveillance and health facilities
- Age and gender groups
- Stationed or mobile with frequency
- Outdoor or indoor
- Data on the endemicity of VBDs from the area that people are expected to visit
- Mode of travel (road/train/air)
- Mapping of potential breeding areas

## Entomological Surveillance of Vectors influenced by Climatic Variables during Mass Gatherings

It is essential to generate data during entomological surveillance on vector biology concerning their distribution, habits, habitats, susceptibility towards insecticides and pathogens, and complexity in sub-species. Entomological surveillance can provide relevant information on the life span of the prevalent vector species playing a role in VBDs transmission. The information about where they rest, where and when they feed, and how they breed shall help to draw an action plan for the prevention and control of

VBDs in that area during the period of mass gathering. The information is to be generated pre, during and post events of any mass gathering.

Terrain particularity and seasonality along with the duration of the particular mass gathering event may provide favourable conditions facilitating the propagation of a pathogen amongst vectors and humans and thus contribute to the onset of transmission of VBDs (Table 1).

It is also important for field entomologists to identify and map the potential breeding habitats in and around the area of mass gathering events as given in Table 2.

**Table 1. Suitable Geographic and Climatic Conditions for different Vectors and their associated VBDs**

VBDs	Vectors	Terrain Features/ Ecology	Season
Malaria	<i>Anopheles culicifacies</i> <i>Anopheles stephensi</i> <i>Anopheles fluviatilis</i> <i>Anopheles dirus</i> <i>Anopheles minimus</i> <i>Anopheles sudaicus</i>	Plain and undulating Urban Forested/ riverine Hilly and dense forested Hilly and forested Coastal	Post-monsoon Post-monsoon Perennial Perennial Perennial Post-rains
Filaria	<i>Culex quinquefasciatus</i>	Drainage, ditches, sewage	Onset of summer and post-monsoon
Dengue	<i>Aedes aegypti</i>	Plains and undulating	Post-monsoon
Chikungunya	<i>Aedes aegypti</i>	Plains and undulating	Post-monsoon
Japanese encephalitis	<i>Culex vishnuigp</i>	Marshy lands and low-lying areas with high vegetation Rice fields	
Leishmaniasis: VL CL	<i>Phlebotamus argentipus</i>	Dark, damp shady places in thatched muddy houses, cracks and crevices	Post-monsoon

**Table 2. Breeding Habitats and Feeding and Resting Habits of different Vectors and their associated VBDs**

VBDs	Vectors	Breeding Habitats	Feeding and Resting Habits
Malaria	<i>Anopheles culicifacies</i> <i>Anopheles stephensi</i> <i>Anopheles fluviatilis</i> <i>Anopheles dirus</i> <i>Anopheles minimus</i>	Freshwater rain pools, ditches Overhead tanks, cement tanks, coolers, earthen pots, unused wells Riverine side pools Tree holes, water pools Tree holes, water pools Coastal pools, low-lying areas	Zoophilic and endophagic Anthropophilic and endophilic Anthropophilic and exophagic Anthropophilic and exophagic Anthropophilic and exophagic Zoophilic and exophagic Opportunistic but prefer human blood and endophagic
Filaria	<i>Culex quinquefasciatus</i>	Drainage, ditches, sewage	Zoophilic and endophagic
Dengue	<i>Aedes aegypti</i>	Plains and undulating areas	Anthropophilic and endophagic

Chikungunya	<i>Aedes aegypti</i>	Plains and undulating areas	Anthropophilic and endophagic
Japanese encephalitis	<i>Culex vishnuigp</i>	Marshy lands and low-lying areas with high vegetation Rice fields	Exophilic and exophagic
Leishmaniasis: VL CL	<i>Phlebotamus argentipus</i>	Dark, damp shady places in thatched muddy houses, cracks and crevices	Zoophilic and endophagic

The survey of such breeding habitats including larval and adult vector surveillance, before, during, and after the mass gathering events shall help the authorities in proper planning and control of vectors in those habitats. The level of insecticide resistance of the prevalent vector species is also to be closely monitored for the selection of appropriate vector control interventions in that area.

### Epidemiological Surveillance

The Centers for Disease Control and Prevention (CDC) highlights the significance of arranging epidemiological surveillance at MGs because it contributes to the well-timed detection of activities of interest to public health and the timely response of the general public health care sector.<sup>4</sup> Epidemiological surveillance relies upon making use of and improving an already present green epidemiological surveillance machine, complemented with the aid of using the provision of laboratory infrastructure. If no such infrastructure exists, the establishment of an epidemiological surveillance machine mainly for MG is desirable. To supplement the scientific laboratory surveillance structures running at some locations of MGs, the extra improvement of syndromic surveillance structures has been suggested, so one can meet the improved surveillance needs.<sup>5</sup> Syndromic surveillance is a sort of surveillance that makes use of non-traditional assets of information and gives the theoretical benefit of 'real-time' surveillance as compared with conventional surveillance structures. This function of syndromic surveillance is crucial for a well-timed reaction by the general public health care sector.<sup>6</sup> However, the added advantage of syndromic surveillance has been analysed and it still is to be justified, although it has been used as complementary surveillance in lots of MGs over the last decade. A sturdy surveillance system for the proper planning of an MG event requires choosing a technique to discover abnormalities in the surveillance records, with the use of signals that initiate a public health reaction. Issues to be taken into consideration in this system encompass the sensitivity and specificity of the evaluation algorithms, controls for seasonal and daily trends, the provision of ancient records for use as a baseline, and the choice of suitable denominators, deliberating the transient populace variations at some point during the event.<sup>7</sup>

Olympic Games (OGs) are a standard instance of MGs that contain pre-deliberate and well-prepared epidemiological surveillance. The idea of greater epidemiological surveillance in the context of OGs was considered for the first time during the 1984 Los Angeles OGs, followed by the Barcelona OGs in 1992. At the Atlanta OGs in 1996, as well as the 2000 Sydney OGs, a hospital ED syndromic surveillance system was operating along with the pre-existing surveillance systems. An ad hoc surveillance system was also installed at the venues.

At the 2004 Athens OGs, the countrywide surveillance system evolved further, introducing daily reporting from surveillance assets, inclusive of 0 reporting. Surveillance records were analysed each day and a document with the evaluation findings was forwarded to the decision-making centres. The public fitness reaction mechanism saw enhanced improvement with the development of specifically trained response teams.<sup>8</sup> In addition, a syndromic surveillance system was installed in hospital EDs, cruise ships and Olympic venues to screen public health problems.<sup>9</sup> The system was provided with the assistance of an environmental inspection system, operating on a daily basis, both outside and inside the Olympic venues.<sup>10</sup>

A deliberate and comparable surveillance enhancement for the 2012 London OGs included the introduction of a brand new ED syndromic surveillance machine and a new and advanced general practitioner (GP) out-of-hours/unscheduled care syndromic surveillance system.<sup>11,12</sup>

MGs activities provide a possibility for motivation of political will, reform in the standard of the general public fitness sector, identifying shortcomings and weaknesses, and the advent of improvements that in any other case could no longer have been contemplated.<sup>13</sup> The advantages of MG epidemiological surveillance may be ongoing, supplying a public fitness 'legacy' that may be used to serve public desires that extend much beyond a transient occasion.

The Kumbh Mela in Haridwar and Kurukshetra and Simhastha Mela in Ujjain in India have been the largest congregation of pilgrims worldwide. About 40-50 million people are expected to visit during these Melas with big mass gathering events. The vast majority of these pilgrims

come from different states including high endemic zones for communicable diseases and vector-borne diseases. It has been always a big surveillance challenge for the health personnel appointed for duty during these events. Previously there had been only a few reports, e.g., the cholera epidemics at the Mela in 1948 and as early as 1867, resulting in almost one million lives lost.<sup>14</sup> A syndromic survey conducted during the 2013 Mela, evidenced a peak in diarrhoeal diseases and symptoms of upper respiratory tract infection just after the bathing day. Among 412,703 patients who attended the outpatient departments of hospitals, respiratory infections accounted for 70% of illnesses, while diarrhoeal diseases accounted for 5%. A hospitalisation rate of 1.1% was recorded.<sup>15</sup> A disease surveillance mechanism was established during Prayagraj Kumbh in 2019 in India and it was found that the onsite surveillance imparted a public health legacy for resource-constrained settings by successfully implementing an epidemic intelligence-enabled surveillance system for early disease detection and response to monitor public health risks.<sup>16</sup> The event-based surveillance (EBS) helped identify outbreak signals based on pre-identified event triggers from the media, private health facilities, and the food safety department. Epidemic intelligence was used to analyse the data and events to detect signals, verify alerts, and initiate the response.

## Conclusion

Thus, surveillance at MGs is the key tool for understanding any disease onset with ease of access to such a huge population group coming from different states/districts belonging to different religions and geographic locations thereby congregating at a single place for the assigned dates and timings. Presently, there's no method of predicting the prevalence or transmission of a particular pathogen at any point during a MG based on the circumstance or surroundings. If a disorder emerges in any nation after a MG, there are probabilities of neighbourhood outbreaks. Pre-planned surveillance methods and public health response are important requirements for the prevention of any communicable diseases including vector-borne illnesses. The population at the mass gathering site remains at an enhanced risk of disease acquisition and/or transmission. As compared to the overall populace, the chance of disease acquisition amongst MG attendees is more because of the high population density (leading to airborne illnesses), absence of social distancing, and mixing of susceptible (e.g., unvaccinated) or immunocompromised humans with potential carriers of infections.

## Recommendations

Although, the system is always in place in the states/centres while organising such big events of mass gatherings (Kumbh Mela, Games, farmers camp, political rallies, dharna etc.) in India with all administrative arrangements

by the local authorities including health and emergency services. However, disease surveillance remains a challenge in such scenarios when the population is in large numbers, mobile and overlapping in time and space. The following recommendations are enlisted to be included in the protocol developed at the time of organising big mass gathering events.

## Preparatory Phase

Baseline data generation for the local populations to know the disease load prior to the event is to be considered most important during the preparatory phase. Risk assessment and planning are needed for screening the population to identify the points of entry i.e. road, rail or air routes. The base data would be used for comparison after the completion of event activities. Necessary logistic arrangements are to be made during the preparatory phase with some buffer stocks of diagnostics, drugs, spray equipment, and insecticides. Mapping of potential breeding areas and vector surveillance for baseline data remains a prerequisite during the preparatory phase. A central control room for all public health activities needs to be established with a proper need assessment of all requirements with records monitoring and feedback on a daily basis.

## Event Phase

This is a very crucial phase when real-time data is to be generated on daily basis. This starts from the very first day of the event and enlists all the persons who suffer from any illness or fever on reaching the venue and need to be followed up. This is the most critical period and provides an opportunity to assess compliance with disease control strategies and monitor the onset of any disease outbreaks.

## Post-event Phase

The post-event phase remains the most important as it indicates the efficacy of all actions taken for the control of communicable diseases including VBDs. The reporting and non-reporting of any disease in the local population at the event venue and the different states having the population back to their respective places in a period of 15-20 days becomes essential and have to be carefully monitored and cross notified in the respective states in case of any onset of disease outbreak. This will be critical to monitor the signs and symptoms of acquisition of any transmissible disease at the event and to study other effects of MGs on participants.

Therefore, a good public health framework is needed for an effective and stringent surveillance system, especially for organising a mass gathering event with proper planning, coordination, implementation, monitoring, and supervision.

**Conflict of Interest:** None

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