ORIGINAL ARTICLE

Syndromic surveillance system during mass gathering of Panchkroshi Yatra festival, Ujjain, Madhya Pradesh, India

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Abstract

Background: The health implications surrounding a mass gathering pose significant challenges to public health officials. The use of syndromic surveillance provides an ideal method for achieving the public health goals and objectives at such events. In the absence of published reports of systematic documentation of public health preparedness in mass gatherings in the local context, we describe the public health preparedness and demonstrate the operational feasibility of a tablet-based participatory syndromic surveillance among pilgrims during the annual ritual circumambulation- *Panchkroshi Yatra*.

Methods: A real-time surveillance system was established from 2017-2019 to capture all the health consultations done at the designated points (medical camps) in the *Panchkroshi yatra* area of the city Ujjain in Madhya Pradesh. We also surveyed a subset of pilgrims in 2017 to gauge satisfaction with the public health measures such as sanitation, water, safety, food, and cleanliness.

Results: In 2019, injuries were reported in the highest proportion (16.7%; 794/4744); most numbers of fever cases (10.6%; 598/5600) were reported in 2018, while 2017 saw the highest number of patient presentations of abdominal pain (7.73%; 498/6435).

Conclusion: Public health and safety measures were satisfactory except for the need for setting up urinals along the fixed route of the circumambulation. A systematic data collection of selected symptoms among *yatris* and their surveillance through tablet could be established during the *panchkroshi yatra*, which can complement the existing surveillance for detecting early warning signals. We recommend the implementation of such tablet-based surveillance during such mass gathering events.

Keywords: Festival, Mass gathering events, Planned event, Public health preparedness, Syndromic surveillance
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1. Introduction

World Health Organization (WHO) defines mass gathering as a gathering of more than a specified number of persons at a specific location for a particular purpose for a specified period sufficient enough to strain the planning and response resources of the community, state, or nation hosting the event [1]. The concept is not tied to the size of the gathering or the number of participants on purpose because each community has a different capacity to manage large crowds [2].

The primary health risk associated with mass gatherings is the spread of communicable diseases because of increased population density and population movement. The visitors may bring in diseases that are spread to the local population and vice versa and among themselves [3].

Other health problems associated with mass gatherings include heat-related illness, drug- or alcohol-related illness, lacerations, trampling, head injury, musculoskeletal injury, and asthma exacerbation, exacerbation of existing cardiovascular

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diseases etc., Factors that affect the health of the individuals during mass gatherings are weather, crowd size, density, age, mobility of the participants, duration, and type of event [3–6].

Whether at a sporting event or a religious gathering, the hazards are the same, while the nature of the risks may differ [7,8]. Huge gatherings have the potential to result in many patients for health personnel, ambulance services, and hospitals to manage. As a result, healthcare planning is critical for all engaged healthcare providers to offer prompt on-site treatment and enough referral and transportation resources [9].

The Centers for Disease Control and Prevention (CDC) suggests that public health surveillance should be implemented at mass gatherings to facilitate early detection of outbreaks and other health-related events and enable public health officials to respond on time [9]. Public health measures for mass gatherings aim to prevent and minimize the risk of infectious disease outbreaks and to maximize the safety of participants, spectators, event staff, and residents [10].

Mass gatherings occur regularly worldwide, and syndromic surveillance provides an ideal method for achieving public health goals and objectives at such events. A different approach to the centralized surveillance is to involve population at risk to submit or share health related data [11]. In recent years, the use of digital technologies for public health has enabled the general public to participate more actively in surveillance, referred to as participatory surveillance, with the potential to contribute to public health action [12]. Such participatory syndromic surveillance gathers directly data through a variety of survey tools like mobile phone apps or simple hotlines/helplines [13]. By relying on individuals to provide data, this type of system has the potential to contribute more about disease risk and transmission patterns collectively and may enable a more rapid response to public health emergencies [14].

Panchkroshi Yatra is an annual Hindu religious ritual of circumambulation of 84 *Mahadev* (=great god). In this *yatra*, a large number of *yatris* (=devotees) walk for around 15 mile per day for six days during the daytime cover a total of 73 mile to worship the 84 *Mahadev* [15]. Majority of the reviewed published literature regarding mass gathering health in India, focuses on the public health preparedness and establishment of surveillance systems [16–21] and limited literature focus on documentation of public health preparedness at local mass gatherings [22–24]. In view of this context, we described public health preparedness measures and assessed the public satisfaction to those measures during *Panchkroshi Yatra* in Ujjain, Madhya Pradesh during 21-26 April 2017. Further, we developed tablet based participatory syndromic surveillance, field tested and implemented for consecutive three years by ICMR-National Institute of Epidemiology , Chennai and R. D Gardi Medical College,Ujjain, Madhya Pradesh. In this communication, we report the morbidity pattern of the pilgrims captured by the tablet-based participatory syndromic surveillance among the *yatra* pilgrims during 2017-19.

2. Methods

We surveyed the public health preparedness and reviewed the pilgrims' satisfaction regarding the implementation of public health measures in Ujjain during 21-26 April 2017. Public health preparedness measures were assessed by the research team under various domains such as medical camps, food, sanitation, drinking water, electricity, police and fire control using a checklist developed by the research team. Pre-event meetings were conducted with the stakeholders to assess the public health preparedness measures.

We interviewed a subset of 360 pilgrims from all those who visited designated health consultation sites in order to gauge their satisfaction with public health measures such as sanitation, water, safety, food, and cleanliness using a pre-designed questionnaire.

We established a participatory real-time surveillance system to capture information on all the health consultations done at the designated points (medical camps) in the *Panchkroshi yatra* area of the city Ujjain in Madhya Pradesh. The data were captured every year from 2017-2019 during *panchkroshi yatra* that commenced from Nagchandreashwar Mandir in Patani Bazar at Ujjain. The system was an android application with automated summary reports and an interactive dashboard for syndromic surveillance during the gathering developed by the research team. The data collection was performed using electronic forms installed on tablets that sent data via mobile internet to a database, from strategically selected places like the fixed halts set-up at the festival in Ujjain.

The surveillance system was based on participatory and voluntary reporting of selected symptoms. Data were collected from the pilgrims by designated persons using android tablets. We formed 14 teams, and each team had two members (one male and one female) who were persons with good knowledge about the festival and had experience of tablet-based surveillance in another mass gathering event [22]. The data collection team included 40 medical social workers, nursing interns and medical interns. We trained the data collection team on principles and uses of surveillance, tablet-based surveillance and road map for the yatra. Further, they were trained on informed consent process, data entry, data synchronization, retrieval, and troubleshooting.

We developed a standardized daily reporting surveillance format covering 14 health related events (Fever, Red spots/rashes, bleeding gums, cough, sore throat, diarrhoea, dysentery,

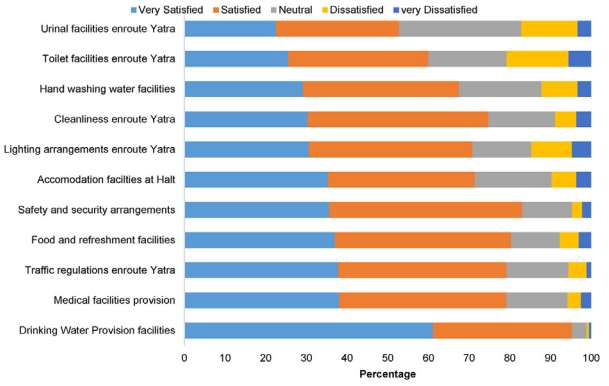

FIGURE (1). Satisfaction of the pilgrims (N = 360) regarding implementation of public health measures in Panchkroshi Yatra in 2017, Ujjain, Madhya Pradesh, India.

abdominal pain, vomiting, dehydration, difficulty in breathing, injury, redness in eyes and heat stroke). We interviewed 16,779 pilgrims at the on-site medical camps/booths during the 6 days period when the pilgrims walked through *Panchkroshi Yatra* during 2017 (n = 6,435),2018 (n = 5,600) and 2019 (n = 4,744). We did not calculate sample size for tablet based syndromic surveillance as the objective was to develop and field/pilot test the tablet based syndromic surveillance system. For each of the three years of the festival, the team decided to reach at least 5000 pilgrims to get an acceptable variation among the reported morbidities.

Data collected for pilgrim's satisfaction was entered and analyzed in Epiinfo V.7.2.5. Content analysis of the qualitative data from observation checklist and meeting minutes were done. The data exported from the tablet-based surveillance was analyzed using epi info V.7.2.5. Proportions were calculated for the categorical data. Chi-square test was used to compare the difference in proportions. The trend of the reported morbidity for the three years from 2017 to 2019 stratified by gender was assessed using chi-square for trend analysis.

Ethical Issues: Ethics approval was sought from the institute ethics committee of the R.D. Gardi Medical College, Ujjain, India (IEC no 124/2017, 04/2018, 61/2019).

3. Results

We described the pilgrims' satisfaction regarding the implementation of public health measures in *Panchkroshi Yatra* in the year 2017 (Fig. 1).

3.1. Special medical camps/booths

The local health authorities arranged medical camps to treat the *yatris* for medical ailments at the halts. Make-shift arrangements were made to accommodate inpatient admissions of *yatris* for any serious and emergency conditions. Based on a micro plan and roaster system, doctors and health staff were posted at each medical camp. However, no mobile medical units were catered to the *yatris* travelling along the pathway. Ambulance services were on standby at all the medical camps. Generally, medical personnel at the make-shift medical camps are mobilized from the existing health facilities from the neighboring areas of the city hosting the MG. They are called upon to manage both a foreseeable patient load and unexpected and catastrophic incidents at large gatherings. Due to large crowds at the medical camps, medicines were given to the *yatris* over the counter rather than by prescription from the camp medical officer. All medical camps had sufficient stocks of drugs. Pilgrims 'satisfactory survey' results showed that more than three quarters of the *yatris* were satisfied or very satisfied with the medical facilities (79%) arranged enroute by the authorities.

3.2. Food

In collaboration with the local village panchayat, the district administration had set up temporary sheds ("*pandals*") for *yatris* to rest up and prepare food at the halts. The government established ration provision stores (Public Distribution System) to supply rice, wheat, dal, and other staple foods. According to the satisfaction survey, 80% of the *yatris* were satisfied with the food and refreshments arrangements arranged by the local authorities.

3.3. Sanitation

Permanent and temporary bathrooms and toilets were installed at the halts but not necessarily enroute between the halts. Sanitation initiatives such as chlorinated road whitening, waste collection, and cleaning were observed along the route. According to the survey, over half of the *yatris* were satisfied with the urinals (53%) and toilet facilities (60%). Hand washing facilities were rated as satisfactory by 67 % of the *yatris*, and cleanliness was rated as satisfactory by nearly three-quarters of the *yatris* (74%).

3.4. Electricity

Temporary sheds built at significant intersections were well illuminated. The government ensured that the temple, halts, and important gathering spots had constant power. Around 71% of the *yatris* were satisfied with the lighting arrangements done by the authorities.

3.5. Drinking water

Safe drinking water was arranged through stationed lorries at strategic places, bore wells water, and tap water through overhead tanks. The water for bathing, cooking, cleaning, etc.,

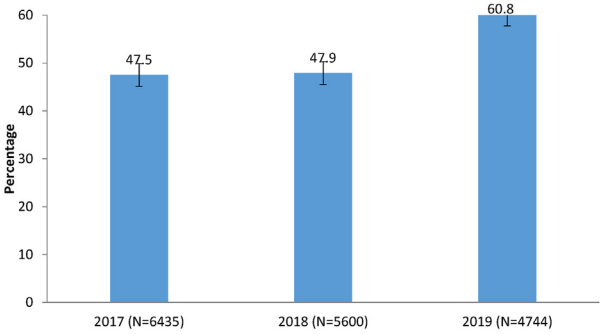

FIGURE (2). The proportion of pilgrims who attended *Panchkroshi Yatra* during 2017-2019 and used of tablet-based syndromic surveillance system to report any morbidity, Ujjain, Madhya Pradesh, India *Chi-square for trend (p value = 0.001).

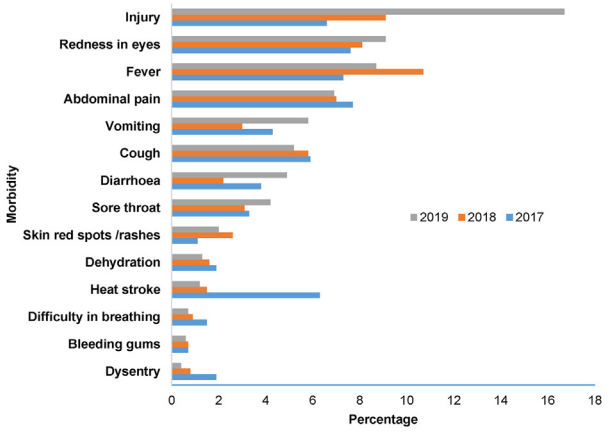

FIGURE (3). Morbidity profile of the pilgrims attended Panchkroshi Yatra and used the tablet-based syndromic surveillance during 2017(N = 6435), 2018 (N = 5600) & 2019 (N = 4744), Ujjain, Madhya Pradesh, India.

was arranged separately by the authorities through stationed lorries, water tanks installed during the *Simhasth Mela*, and overhead tanks of the villages. The district authorities made a conscious effort to provide drinking water to the *yatris* at halts and en route the *yatra*. Apart from the above provisions, the district authorities and villagers provided water through water pots, bore wells, etc. Our satisfactory study results showed that only 5% of the yatris were not satisfied with the water facilities.

3.6. Police and fire control

The police force provided crowd control, traffic control, and security patrol. The process of headcount of *yatris* was conducted by the police as well. Fire safety personnel were also on duty 24/7 at all the halts. More than three-quarters of the *yatris* were satisfied with safety (84%) and traffic regulation (79%) arrangements made by the authorities.

3.7. Syndromic surveillance

We observed increasing trend in the proportion of morbidity reported across 2017-2019. (Fig. 2). The most common presenting problems were injuries (10.3%), fever (8.8%), redness in the eyes (8.2%), abdominal pain (7.2%), and cough (5.6%). This was followed by cases of vomiting (4.3%), diarrhea (3.6%), sore throat (3.5%), and heat stroke (3.3%). In 2019 injuries were reported in the highest proportion (16.7%; 794/4744); higher frequency of fever cases (10.6%; 598/5600) were reported in 2018, while 2017 saw the highest number of patient presentations of abdominal pain (7.73%; 498/6435) (Fig. 3).

There were significant differences in the distribution of skin red spots, sore throat, dysentery, vomiting, difficulty in breathing, injuries, and heatstroke over the three years (2017 to 2019). We documented morbidity profile of the interviewed pilgrims across the study period categorized by gender (Table 1) and observed significant differences in the distribution of skin red spots, dysentery, difficulty in breathing, and heat stroke between the two genders over the three years (2017 to 2019).

4. Discussion

Our study documents the use of technology at mass gatherings through real-time surveillance towards creating baseline data for future planning and risk management.

A tablet-based surveillance of *yatris* visiting the *Panchkroshi Yatra* was successfully established for three years. It enabled us to get real-time, complete, and consistent data every day throughout the *Panchkroshi Yatra*. This is consistent with governments worldwide increasing their resources in temporary healthcare facilities and public health preparation to deal with the dangers of disease outbreaks, clinical emergencies, stampedes, and mass casualties during mass gatherings [25]. Also, on these occasions, record-keeping is frequently inconsistent and paper-based, preventing real-time data consolidation and analysis for disease monitoring or resource mobilization [16,26]. As a result, necessary health data is transmitted and analyzed with substantial delay. Therefore, investing in tab-based surveillance may make it real-time and may be deemed cost-effective [17,27].

With the real-time tablet based syndromic surveillance in place, we were able to capture the disease symptoms, which are found to be essential in view of religious mass gathering events. By this system, we have demonstrated an increasing trend in the proportion of morbidity reported across the study period. This could be attributed to the improved reporting of

TABLE 1. Comparison of the reported morbidity (N, %) by gender among the pilgrims attended and used tablet-based syndromic surveillance system during 2017-2019, Ujjain, Madhya Pradesh, India

Year	2017		2018		2019		Overall	
Morbidity	Male (N = 2840)	Female (N = 3595)	Male (N = 2399)	Female (N = 3201)	Male (N = 2273)	Female (N = 2471)	Male (N = 7512)	Female (N = 9267)
Fever	191(6.7)	279(7.8)	**309(12.9)***	**289(9)***	194(8.5)	218(8.8)	694 (9.2)	786 (8.5)
Red spots/ rashes	30(1.1)	42(1.2)	**81(3.4)***	**65(2)***	49(2.2)	46(1.9)	**160 (2.1)***	**153 (1.7)***
Bleeding gums	21(0.7)	21(0.6)	**25(1)***	**13(0.4)***	9(0.4)	20(0.8)	55 (0.7)	54 (0.6)
Cough	**191(6.7)***	**189(5.3)***	**157(6.5)***	**165(5.2)***	122(5.4)	123(5)	**470 (6.3)***	**477 (5.1)***
Sore throat	108(3.8)	106(2.9)	77(3.2)	99(3.1)	94(4.1)	107(4.3)	279 (3.7)	312 (3.4)
Diarrhoea	97(3.4)	148(4.1)	49(2)	73(2.3)	113(5)	121(4.9)	259 (3.4)	342 (3.7)
Dysentery	49(1.7)	75(2.1)	17(0.7)	25(0.8)	5(0.2)	12(0.5)	71 (0.9)	112(1.2)
Abdominal pain	**193(6.8)***	**305(8.5)***	162(6.8)	229(7.2)	156(6.9)	171(6.9)	**511 (6.8)***	**705 (7.6)***
Vomiting	**96(3.4)***	**182(5.1)***	67(2.8)	99(3.1)	129(5.7)	147(5.9)	**292 (3.9)***	**428 (4.6)***
Dehydration	47(1.7)	76(2.1)	35(1.5)	57(1.8)	28(1.2)	35(1.4)	110 (1.5)	168 (1.8)
Breathlessness	42(1.5)	54(1.6)	26(1.1)	24(0.7)	18(0.8)	17(0.7)	86 (1.2)	95 (1.0)
Injury	164(6)	245(7)	**244(10.2)***	**267(8.3)***	367(16.1)	427(17.3)	775 (10.4)	939 (10.3)
Redness in eyes	**183(6.6)***	**288(8.3)***	(8.4)	254(7.9)	206(9.1)	224(9.1)	591 (8.0)	766 (8.4)
Heat stroke	184(6.5)	223(6.2)	**50(2.1)***	**33(1)***	26(1.1)	31(1.3)	260 (3.5)	287 (3.1)

*significance = $p < 0.05$ by Chi-square.

the morbidity via the tablet based syndromic surveillance system over the years [28]. In our study, a systematic data collection of selected symptoms among *yatris* and their surveillance through tablets could be established during the panchkroshi yatra. This proves that the tablet-based surveillance can complement the existing surveillance for detecting early warning signals [29,30]. The morbidity profile of the pilgrims used the syndromic surveillance in the study may not be generalizable but with approximate sample of 5000 participants in each year, the findings are indicative enough to inform us about the burden, pattern and gender variability of the morbidity. Overall, injuries emerged as a leading cause of morbidity among the pilgrims followed by acute fever cases. A recent study reported the disease surveillance during Kumbh Mela in Prayagraj, India reported injuries as the leading morbidity in the non-communicable disease category and acute fever illnesses as a second highest morbidity in the communicable disease category [31]. We found that the symptoms like red spots/rashes and cough were higher among the males than females whereas, abdominal pain and vomiting were reported higher among females than males.

One of the major challenges we faced was data transfer and tablet battery management. But with the use of appropriate technology and planning, issues were sorted out for a smooth implementation of the surveillance system. The registration, vital monitoring, consultation, and drug distribution processes at the onsite medical camps/booths must be streamlined. There was no lab support or biomedical waste management in any of the medical camps; hence needs attention.

A satisfactory level of public health preparedness was reported by the participants. The participants' responses indicate that all public health and safety measures were satisfactory except the need for setting up urinals along the fixed route of the circumambulation. Previous findings [31] highlighted the risk of illness or injury to those visiting a mass gathering increased as compared to those who are not participating, thereby, making a case for supplementing the routine surveillance system. The medical booths/camps had adequate drug supplies and health personnel. Along the journey route, adequate sanitation measures such as chlorinated bleaching of the roads, garbage picking, and cleaning were also observed. The district authorities took conscious efforts to provide safe drinking water to *yatris* both at halts and enroute the *yatra*. Water-borne diseases remain a threat at mass gatherings, prompting for more frequent monitoring and enhanced public health interventions [16,24,32]. However, contrary to concerns of waterborne outbreaks, diarrhea was a rare presenting complaint in our study [33]. Tablet-based surveillance during the *yatra* indicated that injury was the most commonly self-reported health problem. Our study findings are consistent with previous studies [34].

4.1. Limitations

During Panchkroshi Yatra, we did not have access to the data available from other public or private health facilities. This was a major limitation of the study. One of the shortcomings of the tablet-based surveillance was that we could not directly use the information for preventive action, tracing the disease spread and its containment. Routine surveillance, including the collection of reports from medical booths/camps and their compilation for analysis to look for clusters, needs further strengthening.

5. Conclusions

Continued government commitment to engage in preparedness activities and coordination with other sectors will ensure secure mass gatherings in the future. We advocate for developing a comprehensive action plan involving key stakeholders to address public health measures well ahead of mass gatherings and collaboration with other governmental and non-governmental sectors. District health authorities can adopt tablet-based surveillance of self-reported symptoms to complement existing routine systems. The data can be used as a baseline for future planning and public health preparedness. During mass gatherings, an ad-hoc public health emergency operation center should be set up to oversee surveillance, public health measures, data compilation, and generate alerts to initiate timely action. The employment of cutting-edge digital tools for infectious disease surveillance during large-scale gatherings could save time. This calls for in-depth studies of various mass gatherings to develop evidence for context-specific solutions to address the complex health challenges that large mass gatherings pose.

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Declaration of competing interest

The authors declare that they have no conflicts of interests.

CRediT authorship contribution statement

Vishal Diwan: Conceptualization, Methodology, Supervision, Formal analysis, Resources, Project administration. **Upasana Sharma:** Writing – original draft, Formal analysis, Visualization. **Parasuraman Ganeshkumar:** Methodology, Formal analysis, Visualization. **Jeromie wesley vivian Thangaraj:** Methodology, Data curation, Validation, Formal analysis, Validation, Software, Visualization. **Sendhilkumar Muthappan:** Methodology, Data curation, Formal analysis, Validation, Software, Visualization, Writing – review & editing. **Vettrichelvan Venkatasamy:** Methodology, Formal analysis, Validation, Software, Visualization. **Vivek Parashar:** Data curation, Supervision. **Priyank Soni:** Data curation, Supervision. **Ankit Garg:** Data curation, Supervision. **Naveen Singh Pawar:** Methodology, Data curation, Supervision. **Ashish Pathak:** Methodology, Supervision, Writing – review & editing. **Manju R. Purohit:** Methodology, Supervision, Writing – review & editing. **Kalyanasundaram Madhanraj:** Formal analysis, Writing - review & editing. **Anette Hulth:** Methodology, Writing – review & editing. **Manickam Ponnaiah:** Conceptualization, Methodology, Software, Validation, Formal analysis, Supervision, Resources, Project administration, Writing – review & editing.

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Abbreviations

CDC	Centers for Disease Control and Prevention
WHO	World Health Organization
MG	Mass Gathering
ICMR	Indian Council of Medical Research

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