DEVELOPMENT AND VALIDATION OF A RISK ASSESSMENT TOOL FOR MASS GATHERING EVENTS OF INDIA

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Ph.D. THESIS

2021

THE SREE CHITRA TIRUNAL INSTITUTE
FOR
MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram

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FOR MASS GATHERING EVENTS OF INDIA

A THESIS PRESENTED BY

DR.UPASANA

TO
THE SREE CHITRA TIRUNAL INSTITUTE FOR
MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF
DOCTOR OF PHILOSOPHY

2021

DECLARATION BY THE STUDENT

I, Dr. Upasana, here by certify that I had personally carried out the work depicted in the thesis entitled, "Development and Validation of a Risk Assessment Tool for Mass Gathering Events of India."

No part of the thesis has been submitted for the award of any other degree or diploma prior to this date.

30/09/2021

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Signature

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Of

SREE CHITRA TIRUNAL INSTITUTE
FOR MEDICAL SCIENCES AND TECHNOLOGY
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----------30-09-2021

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ACKNOWLEDGMENTS

This thesis was carried out at the Achutha Menon Centre for Health Science Studies (AMCHSS) of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), an Institution of National Importance under the Department of Science and Technology, Govt. of India. It was funded by the Indian Council of Medical Research (ICMR), New Delhi, the apex body in India, for the formulation, coordination, and promotion of biomedical research (Ref: No. 3/1/3/JRF/2014/HRD/46).

Undertaking this Ph.D. has been a truly life-changing experience for me, and it would not have been possible without the support and guidance that I received from many people.

I am profoundly grateful for the brilliant guidance and motivation from my mentor Dr. Sankara Sarma, Professor & Head, AMCHSS, SCTIMST.His valuable advice, support, and encouragement helped me shape this thesis into its present form. He helped me in various capacities, as a guide, dean of academic affairs, and department head.

My doctoral advisory committee members were Dr.BR Desikachari, Dr. Manoj Murhekar, and Dr.Ramakrisnan Rao. I gratefully acknowledge the scientific advice and timely support they have provided in carrying out this research work.

Dr.BR Desikachari, Senior Public Health Consultant, Formerly with Department of Public Health and Preventive Medicine, Government of Tamil Nadu, Chennai, India, for his insightful comments, constructive criticisms, and critical evaluation at different stages of the research.

He has guided and encouraged me to persevere over the years and has immensely contributed to this thesis. Thank you for guiding me, often with infinite patience, through the complexities of scientific writing.

Dr. Manoj Murhekar, Scientist G & Director, ICMR-National Institute of Epidemiology, Chennai, for his unrelenting support and kind encouragement during my study.

Dr. R Ramakrisnan, formerly Scientist G, ICMR-National Institute of Epidemiology, Chennai, for his time, patience, insight, and valuable feedback on my work at every step of my study.

A huge thank you to Dr.Sanjay Mehendale, formerly Additional Director General, ICMR, New Delhi, and Dr.P.Manickam, Scientist-E & Head, Division of Online Courses ICMR-National Institute of Epidemiology, for their valuable guidance & support during the initial stages of my research work. I thank them for introducing me to this emerging new area of mass gathering research.

I sincerely acknowledge the ICMR-NIE Institutional Ethics Committee for providing feedback, suggestions, and ethical clearance for the research study. I have infinitely benefitted from the intellectual interactions with scientists, teachers, and colleagues at ICMR-NIE.

I extend my gratitude to the Director, Dean, Registrar, and Deputy-registrar of SCTIMST for their kind encouragement during my study. I am incredibly grateful to registrar Dr. Santhosh Kumar B & all the staff members of the Division of Academic Affairs, AMCHSS, for helping me tiding through the administrative challenges that I faced during my doctoral journey.

I would also like to express my special gratitude and thanks to the Directorate of Public Health and Preventive Medicine, Govt. of Tamil Nadu & Deputy Director of Health Services Thiruvannamalai, Govt. of Tamil Nadu for supporting me in the completion of this endeavor.

I will forever be thankful to my former research advisor, Dr.Amarjeet Singh, Professor & Head Department of Community Medicine and School of Public Health, PGIMER, Chandigarh. He was and continues to be my most incredible role model as a scientist, mentor, and educator.

I am highly indebted to all the study participants for their kind cooperation. I am grateful to all stakeholders involved in this study for their valuable insights and contribution. I acknowledge my friends and colleagues who facilitated me during fieldwork and the entire study.

A solid support system is critical for surviving doctoral research. With a deep sense of reverence, I acknowledge my gratitude towards my family members for being solid pillars of support. A heartfelt thank you to my parents for always believing in me and encouraging me to follow my dreams. And finally, I have to thank my husband, Dr. Madhan, who has been by my side throughout this PhD. I know I could always go to him for any research-related advice and opinions. He has been patient and supportive of me and has been instrumental in instilling confidence in me.

Many thanks and appreciations go to the wonderful friends who have willingly helped me out with their abilities. Some special words of gratitude go to those who have always been a significant source of support when things would get a bit discouraging.

The last word goes for Mozzo, our adorable doggo, who has been the sunshine of our lives for the past few years and has always provided me with the extra love and warmth when I've needed it the most.

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LIST OF ABBREVIATIONS

AHA	All-Hazards Approach
API	Application Program Interface
ARI	Acute respiratory Infection
BCE/CE	Common Era
BSN	Body Sensor Network
CCTV	Closed-circuit Television
CDC	Centres for Disease Control and Prevention
CGS	Center for Global Surgery
CI	Confidence Interval
CSS	Cascading Style Sheets
CVI	Content Validity Index
DAC	Doctoral Advisory Committee
DDHS	Deputy Director of Health Services
DM	Diabetes Mellitus
DPH	Directorate of Public Health
EMS	Emergency Medical Services
EURO	European Championship
FEMA	Federal Emergency Management Agency
FIFA	Federation Internationale de Football Association
GCSE	General Certificate of Secondary Education
HBV	Hepatitis B Virus
HCPs	Health Care Professionals
HHV	Human Herpes Virus
HIRA	Hazard Identification and Risk Assessment
HIV	Human Immunodeficiency Virus
HPV	Human Papilloma Virus

HROs	High-Reliability Organizations
HT	Hypertension
HTLV	Human T-Lymphotropic Virus
HTML	Hyper Text Markup Language
I-CVI	Individual Item Content Validity Index
IEC	Institutional Ethics Committee
IHDs	Ischemic Heart Diseases
IHR	International Health Regulations
INR	Indian Rupee
iOS	iPhone Operating System
IQR	Interquartile Range
KIIs	Key Informant Interviews
KMs	Kilometres
LGBT	Lesbian, Gay, Bisexual, and Transgender
LPG	Liquified Petroleum Gas
MARS	Mobile Application Rating Scale
MEDLINE	MEDical Literature Analysis and Retrieval System OnLINE
MEM	Major Emergency Management
MG	Mass Gathering
MGI	McKinsey Global Institute
MGRAT	Mass Gathering Risk Assessment Tool
MHOs	Municipal Health Officers
NCDs	Non-Communicable Diseases
NDMA	National Disaster Management Authority
NWCPHP	Northwest Center for Public Health Practice
OR	Odds Ratio
OS	Operating System
PD	Police Department
PHP	Public Health Preparedness

PWA	Progressive Web Application
RA	Risk Assessment
ReactJS	React Java Script
RFID	Radio Frequency Identification
RTI	Road Traffic Incident
RTs	Rescue Teams
S-CVI	Scale Content Validity Index
SD	Standard Deviation
STI	Sexually Transmitted Infection
STREET	Swedish Tool for Risk/Resource Estimation at EvenTs
TB	Tuberculosis
UEFA	Union of European Football Associations
UI	User Interface
VIPs	Very Important Visits
WHO	World Health Organization
WSN	Wireless Sensor Network

SYNOPSIS

According to the World Health Organization (WHO), a mass-gathering event (MG) is a gathering of persons that is usually defined as “the congregation of more than a specified number of people at a specific location for a specific purpose (a social function, a large public event, a sports competition) for a defined period”. Mass gathering events can be of two types- Spontaneous and Planned. The planned mass gatherings can either be recurrent or a one-off event. Recurrent events can either happen at a consistent location like the Hajj or locations may vary as in the Olympics or Football world cup. Whilst one-off events comprise mostly of celebrations, funerals of famous personalities and royal weddings, etc.

During a MG event, a huge influx of people occurs impetuously at a particular site for a fixed duration. This influx ushers an increase in crowd density posing an array of challenges. The resolution of which forms the basis of this study. The challenges include transmission of communicable diseases, environmental health issues, mass causalities that may occur due to stampedes and challenges associated with emergency preparedness. These MGs not only pose health risks to the visitors but also affect the local population of the place hosting the event. Thus, the entire health care system and related services such as water and sanitation services are put under a serious strain. Risk assessment (RA) plays a major role in enabling planners and authorities to identify, evaluate and prioritize the risks which are related to MGs and find a way to mitigate them.

An extensive literature review on models and frameworks outlining the risk assessment in the case of MG was done. Some of the significant models which we reviewed include the Arbon

Model, Hartmann's Stratification scoring model, Maurer's formula, and STREET tool while the frameworks that were reviewed were the HIRA approach, all-hazards approach, and Pan/Parapan Am games approach (a modified version of HIRA approach). The current planning tools concerning MGs are based on the availability of historic data specific to a particular event. There is a lack of validation of the available models and tools directed towards risk assessment MG scenarios. Some tools have only been tested on simulation case studies. Different governments employ different strategies for MG related preparedness. A staggering revelation that came forth during the literature review was the emphasis on emergency medical preparedness in comparison to public health preparedness. To the best of our knowledge till date; there are no recognized religious MG specific risk assessment tools or mobile apps. Lack of documented systematic process of risk assessment in published literature in India was also identified. This is a massive irony as India accounts for the largest number of religious MG events in the world. 9 of 23 pilgrimage places in the world that record more than half a million visitors annually are in India. Even the internationally developed risk assessment standards provide only a generic framework for risk assessment and management. The Mass Gathering Risk Assessment Tool (MGRAT tool) developed as a part of this study is based on the WHO all hazards approach, a principle framework of disaster planners for decades. This MGRAT RA tool bridges the earlier mentioned gaps becoming the first RA tool specific for religious MGs. With this background we conducted this study with the following objectives : (1) To develop a risk assessment tool (RA tool) to assess the public health and environmental risks associated with religious MG events of Tamil Nadu (2) To develop a mobile application (app) based on the developed RA tool (3) To test the feasibility of the mobile app-based risk assessment tool in a selected religious MG event of

Tamil Nadu (4) To assess public perceptions of public health and environmental risks associated with the selected religious MG event of Tamil Nadu.

In the first objective, qualitative research methods comprising of two main components- Extensive review of the literature and Key Informant Interviews (KII) were deployed to elicit the domains, items, factors, and risks to be included in the proposed risk assessment (RA) tool. A review of the literature was carried out using Pubmed and Google scholar with specific keywords pertaining to MGs. We included original and review articles describing real-world MG events, health risks, and disasters related to MG published since 1998 in the English language. All findings were tabulated in the form of a table which included pertinent details such as the name of the Author, Place, Name of the event and its type, article type, summary of finding, and remarks. A total of 61 studies from the year 2003 up to 2019 with the most number of articles in the year 2015 were reviewed out of which 33 solely attributed to religious MGs. For the Key Informant interviews (KIIs), 15 study participants with experience in planning and managing MGs from health and related departments were purposively selected by following principle of redundancy through existing contacts and networks to secure representation from all groups of interest and relevance. Interviews were conducted using a semi-structured interview schedule. An inductive approach was applied and thematic analysis was done to evaluate the transcripts manually. Out of the median total work experience of 14 years, they had a median experience of 8 years working in the field of MG alone. As a result of KIIs, 4 domains/themes pertaining to the event, participant, environmental and medical characteristics along with 17 items/subthemes emerged. A final draft tool was developed based on both the literature review and KIIs consisting of 7 domains, 23 items, and 48 health risks.

Face and content validity of the tool was evaluated by circulating the draft tool among 6 subject experts (four experts from the Department of public health & preventive medicine and two academicians/research consultants); who were selected by convenient sampling. Using a self-administered content validity questionnaire, they were asked to assess the relevance & representation of each item generated on a four-point Likert scale. Out of the 23 items, 18 items were agreed upon as 'Relevant' by all the six experts. The 'Item-Content Validity Index (I-CVI)' of 'Solid waste management' (item no 14) was 0.17. I-CVI of items 'Participant origin (item no 7) 'and 'Psychosocial behaviour of participants (item no 9) 'was 0.67; 'Area involved (item no 4)' and 'Fire safety (item no 20)' were 0.83. These items were retained in the tool with minor modifications and 'Solid waste management' (item no 14) was merged with the item 'Sanitary and hygiene facilities'. Agreement proportion expressed as Scale level Content Validity Index (S-CVI), calculated by averaging method (S-CVI/Ave =average of all I-CVI) was calculated to be 0.92 indicating excellent content validity. Interrater agreement among six raters was assessed using Fleiss kappa with a value of 0.522 indicating moderate agreement which was statistically significant. After this evaluation, 7 domains were retained, 22 out of 23 items were accepted, solid waste management was merged with sanitary & hygiene facilities and 48 health risks were included in the modified tool.

The second objective was to develop a mobile application (app) based on the developed RA tool. An adequate number of team meetings/discussions were held with the software professional. After reviewing the initial draft versions of the app, anomalies were reported to the app developer and the final draft of the mobile app MGRAT was developed in English language which consists of two parts: Part 1 includes Risk identification and categorization and Part 2 includes Risk Characterization (Assessment and Ranking). MGRAT web app is a device

responsive Progressive Web Application (PWA i.e it runs on multiple platforms regardless of OS or device as long as the browser is compatible and is developed with a configuration-driven model. The app along with the data is hosted in the worldwide served Google's Firebase Cloud platform.

The third objective was test the feasibility of the mobile app and this was carried out at the 'Karthigai Deepam' Festival held in Thiruvannamalai district of Tamil Nadu. It is one of the 123 government notified festivals of Tamil Nadu for undertaking public health measures. For this, a cross-sectional survey was carried out on selective public health preparedness team members (N=49) who were involved in the planning and management of the MG were termed as "App Users". They were briefed about MGRAT app with practical demonstration, following which the app link was shared and they were asked to use it in the context of the Deepam festival. Their feedback about the content and feasibility of the tool revealed that most users (67.3%) reported the items in the app to be quite relevant. Items were reported to be simple and understandable by 57.1% of the users. The most valid feedback was that majority of the users (96%) found the application of the tool to be feasible. The feedback of MGRAT app using Modified version of Mobile Application Rating Scale (MARS) (an app quality rating tool) was obtained in alignment with app quality indicators like engagement, functionality, information, and aesthetics. About 69.4 % of the users described the app to be well targeted with negligible issues. 46.9 % of users described the app to be moderately interesting and 46.9 % described it as intuitive whereas 51 % felt that the response of the app was perfect with no technical bugs. Majority (63.3%) of them rated the app with a 4-star rating. The interrater reliability of the MGRAT app was assessed by measuring the agreement between users in risk prediction and ranking using fleiss kappa(0.311) indicating a fair agreement between all users which was consistent at the subgroup level as well.

The fourth objective of the study was accomplished by conducting a cross-sectional survey at the MG of Karthigai Deepam festival, Thiruvannamalai, among 400 pilgrims consisting of 200 residents (persons living in the host town i.e. Thiruvannamalai for a minimum of one year) and 200 visitors (outsiders attending the MG of Deepam festival). Due to absence of sampling frame, purposive quota sampling was used wherein multiple points in the event area were selected and at each point participants were selected randomly during different time points to achieve a representative sample.

About 69% participants did not perceive increased health risks concerning *Annadhanam*, even though food poisoning outbreaks have been commonly reported at the places of worship. The same scenario prevailed with drinking water, safety, and sanitation facilities as well. The majority (83.6%) of them found the MG site to be stampede prone reflecting the point of published literature. Majority of the participants did not perceive increased health risks due to the animal sacrifice/slaughtering (60.7%), head shaving (70.3%) and ear piercing (69.3%) during Deepam festival. Overall, infectious diseases were perceived as the priority health risks by majority of the participants (91.3%). The same was reflected in the output generated by users of the MGRAT app as well. We analyzed the difference in perceptions of health risks associated with MG event by different socio-demographic factors. Residential status appeared to be a significant predictor of health risk perceptions among the participants (Adjusted OR= 1.525; 95% CI of adjusted OR=1.004, 2.316; p=0.048).

Our study highlights that the MG health service delivery system should be magnified towards non-communicable diseases. Culturally relevant health promotion activities should be included in MG planning & management. Our study led to the development of a RA tool which consists of features pertinent to planned religious MGs of Indian Context conceptualized by a unique

model called, “The MGRAT conceptual model” which comprises of three domains of the Arbon’s conceptual model in addition to a “System Preparedness domain” that emerged from our study.

Our tool is feasible, valid, and reliable which could be replicated across various religious MGs in the country. Generalization of the validity and utility of the MGRAT app in a diverse setting like India should be done with caution. There is a need to test this novel app for its validity and reliability in multiple religious MG events in order to assert robustness of this app. The MGRAT app is a promising tool to aid public health managers in conducting RA in MG settings which could serve as a baseline framework for the systemization of the risk assessment process with huge potential for further evolvement. It could further serve as a prototype based on which other MG related applications could be developed like risk communication app.

INTRODUCTION

CHAPTER I

INTRODUCTION

Traditionally, a mass gathering (MG) events have been defined as a group of more than 1,000 persons assembled at a particular location for a specific purpose and for a defined period (Memish et al.2012). This definition considers only the crowd size, which is just one of the descriptive factors of mass gatherings (MGs). From a health perspective, MGs have been defined as the events where people assemble in huge numbers in a defined area, resulting in restricted access to emergency care, thereby leading to a delayed medical care response to the patients. (Yezli &Alotaibi, 2016) However, the World Health Organization (WHO) takes into account the entirety of all factors. It defines MG as "the congregation of more than a specified number of people at a specific location for a specific purpose (a social function, a large public event, a sports competition) for a defined time causing strain in planning and response resources of a state, community, or nation." (WHO 2015)

Mass gatherings may be classified into spontaneous and planned gathering.

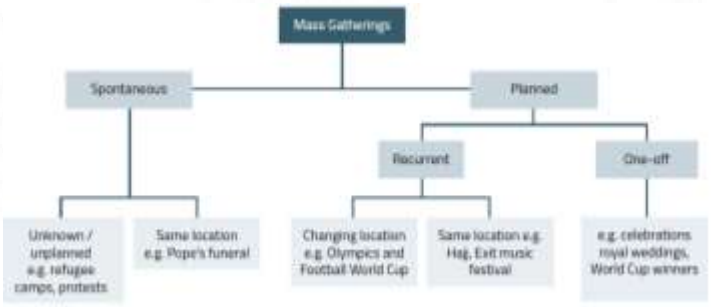

Figure 1: Types of Mass Gathering ; Source : Public Health for Mass Gatherings: Key Considerations (WHO 2015)

Planned MGs occur regularly in various locations, such as the Olympic Games or the FIFA World Cup, and some in the same venue, such as the Hajj or Wimbledon. Spontaneous gatherings are usually unplanned, such as protests, refugee camps, or the ones occurring at a consistent location (such as Pope's funeral).

All MGs are associated with unique and daunting health and environmental risks that warrant a comprehensive understanding of the event. (WHO 2013)They have significant public health implications, including stampedes, crush injures, burns due to fires, exposure to extreme weather, infectious diseases, water, sanitation, hygiene-related illness, and epidemic outbreaks. (Soomaroo & Murray 2012; Friedman et al.2017; Koçak et al.2018; Nakamura et al.2018). MGs afflict behavioural change in the population due to the surge in demand for routine services and public health emergencies. Owing to these factors, MGs have gained importance among the medical fraternity. (Al-Tawfiq & Memish 2016). Mass gatherings of people can pose major public health challenges to the population and can profoundly affect routine health services. (Memish et al 2019)

The aggrandized risk of transmission of contagious diseases resulting from close contact of a huge number of participants for an extended time is a major concern for mass gatherings. (Memish et al.2019). The temporal and spatial concentration of individuals, together with the particular socio-economic characteristics of MG participants, contributes to development of certain characteristics which increase the efficacy and vulnerability of the population to spread of infectious diseases such as Acute respiratory

infections (ARI) which creates a dual challenge of control and prevention of the disease at MGs. (Abubakar et al.2012) ARIs are most prevalent in religious gatherings with overcrowded conditions, where people tend to be in close proximity.

Disease surveillance carried out in India in 2019 involving 120 million people during the Kumbh Mela revealed that 95% of the identified diseases were communicable diseases such as acute respiratory disease (35%), acute fever (28%), and skin infections (18%) among the identified diseases (Aggrawal et al.2020). Another study in India on the MG of Sabarimala pilgrimage showed that the most common health events recorded were the respiratory tract (38.5%) and gastrointestinal diseases (21.5%) (Nayar et al.2020). Gastrointestinal disease risk during MGs is considered high because of potential contamination of water and food. (Cariappa et al.2015). There is a risk of impending introduction or reintroduction of pathogens to host countries via appropriate vector, requiring adequate control measures to prevent subsequent transmission and potential endemicity. (WHO 2008)

There are two primary concerns associated with MGs are in the aspect of the transmission of infectious. The first concern is that MGs consist of crowds with exceptionally high density. (Hu et al.2013) This may lead to an exaggerated spread of illness, far greater than in normal circumstances due to increased contact. This is reaffirmed by the outbreak of infectious diseases during MGs held in the past. (Blyth et al.2010; Santibanez et al.2014; Hoang and Gautret, 2018).

The inter-mixing of the local and visiting population is the second cause of concern. The transmission of disease can either occur from the visiting population to the people of the host city or vice versa. The subsequent travel may lead to the spread of the disease among their contacts across a diverse geographical area. (Lindahl & Grace 2015)

Secondary aspects of challenges associated with large MGs are concerned with the need for new services, the strain on the infrastructure, and changes in behaviors. (Al-Tawfiq &Memish 2014) To cater to the increased need for water and sanitation services, public health preparedness can be easily neglected. (WHO 2015)The established network of distribution of food has to be aided by temporary facilities to meet the increasing food demands in MGs. This often leads to the practice of poor hygiene. (Bajaj & Dudeja 2019)The first noted implications of infectious diseases at MGs, which resulted from the person-to-person transmission, were food-borne diseases. (Abubakar et al.2012)

MGs also put a substantial burden on the local governments to address the demand created by surplus needs such as transport, temporary accommodation, solid waste management, vector control activities, crowd control, additional power supply, and public safety.

Due to various causes, such as high crowd densities, physical and psychological issues of humans, and crowd control problems, etc., human stampedes can occur at mass gatherings, leading to injuries and fatalities. (Alaska et al.2017) The overall high fatality rate resulting from human stampedes is one of the most feared tragedies among MGs. (Hsieh et al 2009) Religious gatherings, in particular, have been reported to shown an

increased propensity for human stampedes in developing countries. (Hsieh et al.2009)The scope of mass gathering activities, including religious events, outdoor festivals, and pilgrim visits, varies not just for providing medical services but also for emergency preparation for all forms of possible weather and environmental health hazards. (Soomaroo & Murray 2012)

MGs attract large crowds comprised of youth, children, middle-aged, and older people to vulnerable locations like valleys, hill tops, or river banks. MGs are usually held in the same places inspite of consistent reporting of hazards at a particular venue resulting in recurring stampedes at the same place over different intervals of time. Therefore, the primary responsibility in ensuring safety of a MG event is dependent on the organizers. Effective planning is mandated at an administrative level for inter-departmental coordination.

Celebrations and festivals form the basis of the religious and cultural diversity of India. India ranks second in the world's population. Therefore, it has a wide array of religious heritage where many festivals are celebrated grandly. They are celebrated at all levels of the country (state, regional and national). Large crowds of disparate physical and behavioral characteristics are attracted to religious mass gatherings.

Religious gatherings in India are marked by special rituals such as fire walking, tonsuring ceremony, animal sacrifice for a spiritual purpose, chariot pulling, immersing of idols in water bodies, etc. A study conducted in India revealed the impact of mass bathing, which is performed as a special ritual as part of religious mass gathering,

indicating significant increase in organic water pollution (Bhatnagar &Sangwan 2009). Such events sometimes end up causing damage to human beings and property as well. There have been incidents where MGs have led to different health risks and disasters at fairs and festivals in India. (Burkle and Hsu 2011; Sridhar et al.2015; Joseph et al.2016)

MGs during religious festivals have commonly been the center of crowd disasters. (Castro et al.2014). Emergency preparedness in terms of safety during MG is a major challenge in India. The composition of unique rituals and physical involvement during religious gatherings creates a higher vulnerability to human stampedes and other health risks. A study on crowd disasters in India showed that79% of human stampedes in India have been related to venues of religious gatherings. (Illiyas et al.2013;)Around 936 deaths and 540 injured causalities were reported in a study conducted a ten-year analysis of public health safety in 27 traditional MG events of India. (Sanyal& Madan 2011)

To deal with the health threats associated with MGs, there is a need for proper planning and management of MG event. This demands extensive investment, capacity building, organizational modification and plans for dealing with potential threats. One of the main reasons for the development of health risks related to MGs is the lack of risk management strategies. According to the World health organisation, to achieve risk reduction measures, health risk and aggravating factors must be identified to accomplish a comprehensive risk assessment.

The underpinning principle of the risk assessment is to ask what could happen and how likely it would happen. (Ferrier&Haque 2003; Hadjichristodoulouet al.2005; McCloskey et al.2014) According to the World health organization (2015), risk assessment (RA) is an essential component of MG preparedness. The process of RA aids in prioritizing the planning activities. It mainly includes ongoing evaluation of the existing public health system and the health care system where the MG event is expected to occur. MGs can introduce new public health risks or increase the burden of existing health risks. (Milsten et al.2002) RA can indicate both what and how much intervention is required for the community to cope with the public health risks associated with the MGs. (WHO 2012).

However, the challenge is that each MG has specific characteristics, giving rise to specific public health issues. As a result, the tools and frameworks deployed for conducting risk assessments in different MG events across the globe vary in their methodology and scope. (WHO 2008; WHO 2015).Developing countries like India don't have systematic tools for RA in MG planning and management. So, there is a need to develop a regions specific RA tool for systematically planning MG events to reduce the health risks associated with MG events. In recent years, there has been increased interest in mobile health care apps by health care professionals (HCPs). Therefore, in this digital era, in the absence of any mobile app related to mass gatherings, developing an MG risk assessment tool in the mobile health care app format seemed very much appropriate.

1.1Rationale of the study

India hosts several mass gatherings; some are recognized for public health response, yet a systematic risk assessment approach is not available in the published literature. This is a massive irony as largest numbers of religious MG events in the world are held in India. Nine of the twenty-three pilgrimage places globally that record more than half a million visitors annually are in India. (Aggrawal et al.2020)Although the public health system of India manages most religious MG events adeptly, the RA process is either based on the previous MGs or is done by reviewing the existing disease surveillance data. MG health and medicine is still in its infancy in India and other developing countries where such huge congregations regularly occur. (Kesavan 2018)

To the best of our knowledge, there are no recognized religious MG-specific risk assessment tools or mobile apps available. Even the internationally developed risk assessment standards provide only a generic framework for risk assessment and management. (ISO 31000: 2009)

The Mass Gathering Risk Assessment Tool (MGRAT tool) developed as a part of this study is based on WHO all-hazards approach, which has been a principle framework of disaster planners for decades. Risk assessment via this approach aims to include all types of threats, irrespective of their origination. Basically, it helps to gauge the risks associated with all threats without demarcation on a single framework and generate a balanced overview with a standard plan for hazard mitigation and preparedness. This

MGRAT RA tool attempts to bridge the earlier mentioned gaps, becoming the first RA tool specific for religious MGs.

1.2The study: aim and specific objectives

The overall aim of the study was to develop and validate a risk assessment tool for mass gathering events of India

The specific objectives are-

- To develop a risk assessment tool (RA tool) to assess the public health and environmental risks associated with religious mass-gathering (MG)events of Tamil Nadu
- To develop a mobile application (app) based on the developed RA tool
- To test the feasibility of the mobile app-based risk assessment tool in a selected religious MG event of Tamil Nadu
- To assess public perceptions of public health and environmental risks associated with the selected religious MG event of Tamil Nadu

1.3The chapters: what will follow?

Chapter II Review of literature focuses on the identification of health and environmental risks associated with Mass Gatherings. We reviewed the models and frameworks outlining the risk assessment in case of Mass gathering. Some of the significant models which we reviewed include Arbon Model, Hartmanns Stratification scoring model, Maurers formula and street tool while the frameworks which were included were HIRA

approach and all-hazards approach. Finally, were viewed existing risk assessment policy and programmes.

Chapter III illustrates research materials and methods, consisting of four subsections-extensive literature review and key informant interviews, development of the mobile app, cross-sectional surveys for feasibility testing of the app, and assessment of public perceptions.All the subsections focus on designs, methods, population, sample, tools, ethical consideration, data collection, and data analysis.

Chapter IV comprises the findings of all the objectives i.e. extensive literature review and key informant interviews, development of mobile app, cross-sectional surveys for feasibility testing of the app and assessment of public perceptions.

Chapter V includes discussion of findings, limitations, and areas for further research.

Chapter VI highlights major findings of the studies, conclusions and implications of the findings for policy and decision making.

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

2.1History of Religious Mass Gatherings

Throughout the planet, belief systems pirouette around pilgrimage, a cardinal factor responsible for mass gatherings. Humankind has been on a constant quest for spiritual enlightenment to be a homoviator, defined as a central figure common to the reality of many civilizations and cultures. (Memish et al.2012) In the conventional sense, pilgrimage is an inner journey that manifests as a dynamic phenomenon of immanence and transcendence in exterior space.

According to the Hellenic civilization, Delphi, the birthplace of Pythia the Oracle, has been a pilgrimage subject in history's annals. (Hervieu-Leger 2003)

Since ancient times, tribal groups such as the Lunda of central Africa, the Shona of southwest Africa, and the Huichol people of western Mexico have continued this pilgrimage culture. (Turner &Turner1997)

For centuries, humans have engaged in group actions to assemble in crowds. The evidence for a mass gathering can be dated back to 2500 years BCE when Stonehenge was constructed in the British Isles. (‘History of Stonehenge’, n.d.) The emergence of world religions gave prominence to institutionalized pilgrimage. Each faith invites pilgrimages according to their beliefs and folktales to a fastidious geographical place.

2.2Religion and beliefs

Hinduism thought to be the ancient surviving faith of the world, dates to 5000 BCE. After Christianity and Islam, it is the third-largest religion globally, consisting of about 13 percent of its population. One of the invigorated traditions has been a pilgrimage, according to the Hindu religion. In India, the numbers of Hindu sanctuaries and the pilgrimage tradition have become Bunyanesque, alchemizing India into a massive sacred space organized into a system of pilgrimage centers and their boondocks.

According to Tristhalisetu which is one of the most revered texts on pilgrimage and sacred places in Sanskrit from the late sixteenth century, Prayaga (Allahabad), Kashi (Varanasi), and Gaya form the three cornerstones of creating a bridge to the soul. The first two are found on the Ganga River, and Gaya lies on a Ganga tributary (Singh, 2006).

Allahabad is one of India's antediluvian cities with a tradition of grandeur that stretches from the Vedic period to the movement of Indian freedom. In the company of King Harsavardhana, the Chinese Buddhist pilgrim Hsuan-Tsang reported a visit to Allahabad in 643 CE and identified a tradition of Magha Mela; an annual auspicious astrological constellation lasting about a month (coinciding with January-February) during which bathers acquire spiritual benefits by bathing in the Triveni or Sangam, the confluence of the Ganga, the Yamuna, and the invisible Saraswati rivers. (Maclean 2008)

Varanasi has been accepted and eulogized as the holiest city in Hinduism. With the advent of the 13th century, spatially manifested sacred sites, shrines, and several

pilgrimage circuits developed in Varanasi until the modern period in which India was made a microcosm by the re-establishment of important pan-Indian holy sites. Pilgrimage trips to particular shrines or holy places are recommended depending on the seasons and months, culminating in mass meetings. (Singh 1997)The religious idea of considering Varanasi as the abode of Lord Shiva, one of Hinduism's principal deities, is the first dominant pilgrims' experience. (Singh 2004)

The city of Gaya is another sacred city of the Hindus, asserting continuity of the tradition of pilgrimage since the eighth century C. E. The folktale of Gaya comes from Gayasura, the demon king who pleased the Gods with his stern belief. He was thus blessed that the spirit of all deities would live in his body. Through the strength bestowed from deep meditation, resulting in the creation of a powerful and sacred location. (Singh 2006)

Since the 4th century, Christian pilgrimages to the Holy Land have been documented. Christianity, including the modern period, has a complicated tradition of pilgrimages through the ages. From 10 centuries, the literature on The Hajj, the great pilgrimage of Islam has existed. (Wolfe 1998)

Buddhism calls for a pilgrimage to Nepal, the birthplace of Siddhartha Gautama, the Buddhist founder who later became known as "the Lord Buddha, "who lived during the 5th century B. C. (Editors, n.d.)It was reported that over 75,00 0 people had gathered in Kathmandu, Nepal's capital, to recite Lord Buddha's messages, known as Dhhamapad. (Nepal mass prayers 2018)

The Jewish tradition annotates that in Jerusalem, all creation began. Jerusalem remains an important place of pilgrimage for Jewish people in this milieu. Until the demolishment of the Second Temple of Jerusalem in 70 C. E. and the Bar Kokhba revolt, it was considered the Jewish people's responsibility to visit Jerusalem three times a year, to coincide with three main Jewish festivals, Pesach, Shavuot, and Sukkot. As the focal point of their faith, many of them still visit Jerusalem and pray with their face towards it when they as a mark of its significance. (‘Jerusalem - Pilgrimage - GCSE Religious Studies Revision’, 2013)

2.3Religious events involving mass gatherings

Celebration of a mythological event in the life of a deity, an auspicious astrological period or a significant day, attracts gigantesque number of pilgrims from all over the world. The pope hosts the World Youth Day Mass celebrations once in two years which is attended by millions of catholic people from around the world. The first event was held in 1985 under the leadership of late Pope John Paul II.Events of this kind are galactic. In the Philippines, the closing mass of World Youth Day celebrations attracted 5 million and 6 million participants in 1995 and2015, respectively. (Al Jazeera 2017)

Around 5 million people gather for a perennial Christian pilgrimage to Lourdes (France), which is based on a widespread observance rooted for centuries. This pilgrimage which started in 1858, has turned this small town with a population of just 15,000, to the second most visited city in France. This influx has turned Lourdes into the third most important pilgrimage site after the Holy Land and Rome. (Lillie 2005)

Almost 8 million Catholics in Asia gather in the Christian Procession on a single day to commemorate the Feast of the Black Nazarene. A wooden statue of Jesus Christ was named The Black Nazarene which was crowned with thorns in life size form which Spanish missionaries are thought to have carried from Mexico on a galleon to Manila in 1606. Fire pulverized the galleon after taking it to the Philippines, and the remaining burnt statue was called the Black Nazarene. Devotees gather around the holy symbol for the 20-h procession, which supporters believe delivers miracles. (Ahmed &Memish 2019)

However, the world's biggest MG occurs in India. The Kumbh Mela, a major Hindu pilgrimage, is conducted annually over twelve-year periods, in four different Indian cities at different locations along the river Ganges-Allahabad, Nasik, Ujjain, and Hardwar. A holy dip in the Ganges is considered as rite of purification which is thought to halt the cycle of reincarnation. As a result, more than 120 million Hindus embrace the act of mass bathing on the banks of major rivers which include the Ganges and the Yamuna, on six days of paramount significance. (Sridhar et al.2015b) The Kumbh mela, which is celebrated once in every three years is considered to be the largest human gathering which attracts million of Hindu and Non- Hindu pilgrims from across the Globe. It is held for a 3-month period, where worshippers gather at each venue. In total, festivals would last for 55 days. The Allahabad Kumbh Mela in 2007 which stretched across a time frame of 45 days witnessed the participation of 70 million pilgrims on the festival's most auspicious day. These mass meetings surpass Hajj, the pinnacle of worship focused on Mecca by Islam. (Cariappa et al.2015)

Around the world, there are around 1·6 billion Muslims composed mainly of believers whose responsibility is to attend Hajj in their lifetimes at least once making it the world's largest recurring mass gathering event which is attended by around 2·5 million annually. (Alqahtani et al.2016)

Of all the mass gatherings, Hajj has been widely studied and researched to create a vast body of literature providing guidance of scientific inquiry into the modern mass gathering. The last visit of the Prophet Mohammed to Mecca is celebrated as the Hajj comprising of a number of religious rituals which extend for a week's duration. His last sermon sealed the basic foundation of Islamic belief's culminating into the final verses of Quran laying the foundation for Islamic pilgrimage which is practiced till date. Modern Hajj, true to the final Hajj of the Prophet Mohammed, combines the footsteps of the Prophet Abraham centuries before the beginning of Islam . (Ahmed &Memish 2019)

In the Indian context, the pilgrimage to Sabarimala pilgrimage is a recurrent MG attended by around 25 million pilgrims from all over the Globe annually. Sabarimala is situated within the Periyar tiger reserve forest above sea level at 4133 ft. It is situated in the mountain ranges of Pathanamthitta district, Kerala, India, surrounded by 18 hills and thick forests lined along the Western Ghats. The temple is only open for a month continually every year and a few days for other months. (Nayar et al.2020)

There are various places in Tamil Nadu, India, where religious mass gatherings occur. Each gathering in Tamil Nadu at a particular geographical location pays reverence to a specific deity or belief about the place/deity. In Tamil Nadu, pilgrimage centers are

divided into ‘Places of Perennial Pilgrimage’ and ‘Periodic Fairs and Festivals. ’ (Department of Public Health and Preventive Medicine 1928) Places of Perennial Pilgrimage are those which, apart from the occurrence of a holy day, hold some unique religious sanctity of their own and attract pious people in considerable numbers throughout the year. In contrast, fairs and festival centres are those where pilgrims gather in numbers only on one or more special occasions during the year when attraction may be either religious or secular or both. In periodic fairs and festivals, it is only at the time of actual fairs and festivals that the venue becomes significant and calls for specific steps in the field of public health. Tamil Nadu is one of the states with the best outcome indicators for public health in the country and one of the very few states with a dedicated public health system. (Parthasarathi & Sinha 2016)

Public health has its dedicated Directorate in the State Health Department, in place since 1922. (Das Gupta et al.2009) The public health service system of Tamil Nadu is highly empowered because a Public Health Act is in place, which gives the statutory basis to the Public Health Directorate for policy preparation and implementation of public health programs. (Department of Public Health and Preventive Medicine 1928) In Tamil Nadu, the Code of Public Health (Part III Fairs and Festivals and Epidemics) The Tamil Nadu Public Health Act governs the planning and management of MG activities and the Tamil Nadu Public Health Act. Around 123 fairs & festivals are listed in this document as ‘Notified Festivals’ in the Public Health Initiatives Gazette of the festival Region. (Department of Public Health and Preventive Medicine 1928)

The notable religious mass gatherings of Tamil Nadu are mentioned below:

(i) The Mahamakham at Kumbakonam.

(ii) The Godavari Pushkaram.

(iii) The Kistna Pushkaram.

(iv) The Chitrai festival at Madura.

(v) The Brahmotsavam festival at Conjeevaram.

(vi) The Krithigai festival at Tiruvannamalai.

(vii) The Brahmotsavam festival at Tirumalai (Tiruppati.)

(viii) The Kalyanam festival at Antarvedi.

(ix) The Panguni Uttaram festival at Palni.

(x) The Vaikunta Ekadasi festival at Srirangam.

(xi) The Velankanni Car Festival

(xii) Karthigai Deepam

2.4Risk Assessment

Life on an everyday basis comprises of lows such as the risk of loss.”Riscare "originated from a phrase that says, "Nothing ventured, nothing gained, "thus forming the root word for the term “Risk.” This origin of the word lays the premise for the terminology of Risk on the whole.

“The potential to lose something of value in a situation involving danger is termed as 'Risk'.” (Thompson 2019) Terminologies related to danger to the public and extent of harm has been associated with the description of "Risk."

Infectious diseases tend to get amplified during international MGs, causing the spread of infections during travel (Abubakar et al.2012) from the country hosting the event. Health security across the Globe is threatened due to such events, creating challenges of surveillance of transmission to relatively new geographical settings and vulnerable populations. (Johansson et al.*2*012)

Risk in part is viewed as something which is constructed socially. Qualitative interaction between society and uncertainty is based on varied culture, religion, education, and innumerable characteristics. These complex interactions often form the basis of Emergency preparedness. (Thompson 2019)

To reduce vulnerability and ensuing mortality in emergency situations, effective planning becomes pivotal in terms of Emergency Preparedness concerning MGs. Thus, analysis of Mass Gathering can provide a means of understanding the impact of various vital elements on safety and health outcomes. (Marino et al.*2*016)

Planning for mass gatherings entails essential measures such as creating provision for medical services in terms of non-infectious diseases, control of infectious diseases, and other public health risks. The risks include:

- The capacity surge accommodation by health systems

- Challenges pertaining to established health interventions in the community
- Non-endemic diseases risks which are introduced and transmitted during and after MG events
- Problems with communication of risks to participants from diverse culture attending the MGs
- Security Risks during Mass Gatherings

Priorities are set with the aid of risk assessment in the phases of preparedness, response, recovery, mitigation, and prevention. Emergency management programs of host countries through proper risk assessment can focus on allocation of resources, and planning appropriately. Risk Measurement entails inclusion of both measurable and objective factors. As some subjective measurements like psychological trauma are challenging to measure, measurement of risk is determined by transparent values and assumptions. (Thompson 2019)

MGs are impacted by factors such as huge crowd size, extreme weather conditions, the psychological and emotional states of the participants which could culminate into potential hazards increasing the vulnerability of organizers. (Hutton et al.2010)

Public health management during MGs aims to prevent or minimize the risk of injury or ill health and maximize the safety of the public. Planning for such risks can help mitigate such risks through the implementation of risk assessment, which helps in the identification of potential public health risks and forms a basis for the guidance of

surveillance, response mechanisms, control measures, and future planning efforts. (Vandijk et al.2017)

Risk assessment of MGs can be -Strategic or event-based risk assessments .While the identification of hazard, the likelihood and impact form the basis of strategic risk assessment, event-based risk assessment employs enhanced surveillance along with an outbreak alert and response mechanism which could quickly detect, respond and communicate information related to diseases and health events amongst participants and support timely implementation of infection-control activities. (WHO 2015)

2.5Risk Assessment Process

2.5.1. What Is Risk Assessment?

According to the World health organization (2012), risk assessment (RA) is a systematic process conducted for assessing, gathering, and documenting information to assign a risk level. (WHO 2012) RA forms the foundation for the preparedness and response activities for dealing with the foreseeable and unforeseeable health risks. (WHO 2012)

Risk assessment formulates an important component of the risk management cycle. The process of RA includes - hazard assessment, exposure assessment, context assessment. This is followed by risk characterization. After this, risks are ranked based on the likelihood of the risk occurring and its consequence. Based on the risk rank, control activities are planned. (WHO 2012)

The level of risk is determined by various factors such as social, environmental, economic, and political conditions in the area hosting the MG event. Local health services and the expertise of the risk assessment team also impact the process of risk assessment. (WHO 2012; WHO 2015).

2.5.2. The Risk Assessment - Undertaking

Risk assessment with the hazard, the exposure to the hazard, and the context in which the event is occurs (Figure 2)is undertaken to determine the level of risk.

Figure 2.Components of Risk Assessment [Source : ('WHO_HSE_GAR_ARO_2012.1_eng. pdf', n.d. b)]

Each of the three components are assessed separately and overlap of information is required for assessment of each domain.

2.5.3. Assessment of Hazard

The identification of a hazard caused in the event and their associated adverse health effects form the basis of Hazard Assessment. Chemical, biological, physical, and radio nuclear hazards are some of the identified public health hazards.

The Hazard assessment process includes identifying the hazard related to the event, reviewing key information of the identified hazard, and ranking of potential hazards.

2.5.4. Exposure Assessment

Identifying and defining the exposures to hazards that occur or are likely to occur in the population is exposure assessment. The output of the exposure assessment is an estimate of the magnitude of people who are likely or known to have been exposed to hazards and their susceptibility

2.5.5. Context Assessment

To gather information of the environment and geographical area of the place where MG event is going to take place is called Context assessment.

2.5.6Risk Characterization

Risk characterization is undertaken after the hazard, exposure, and context assessments. A risk level is assigned to each of the risk. A risk matrix is a tool used for risk characterization, wherein the product of the likelihood and consequences of the potential risks gives the risk level. The knowledge and expert opinion of the team members

involved in the risk assessment process is also detrimental to risk characterization. (NWCPHP n.d.; WHO 2015)

2.6 Health Risks in Mass Gathering

Religious mass gatherings entail risk to participants' health due to many factors that may include extreme weather conditions, unpredictable acts of nature, trauma, accidents, and most importantly, transmission of infectious diseases. (Ahmed et al.2006; Abd El Ghany et al.2017; Khan et al.2017; Zumla et al.2017)

The abrupt influx of persons from diverse areas, countries, and continents leads to an increased concentration of people in close proximity creating an infection susceptible atmosphere. At the end of MG, the mass efflux of infected people causes dispersion of infectious agents over a massive ecosystem, augmented by extensive travel. (Kok et al.2012)

2.6.1. Communicable diseases at MGs

The aggrandized risk of transmission of contagious diseases resulting from close contact of a huge number of participants for an extended time is a major concern for mass gatherings. (Memish et al.2019). Mass gathering events that bring together pharaonic numbers of individuals strain the resources of community planning and response. The temporal and spatial concentration of individuals, together with the particular socio-economic characteristics of MG participants, contributes to the development of specific characteristics that increase the population's efficacy and vulnerability to the spread of

infectious diseases, which creates a dual challenge of control and prevention of the disease at MGs. (Abubakar et al.2012).

The extent of transmission of infectious diseases is decided by the endemic diseases of the host nation, the endemic diseases of the visitors' home country, and how populations mix. (Tabatabaei &Metanat 2015; Hoang and Gautret, 2018)

During the rapid spread of infection allied with foreign travel, amplification of the above factors occurs in dissemination to the home population. The galloping spread of infectious diseases can result from air travel. (Mangili& Gendreau, 2005).

This massive movement of participants results in the merging of susceptible and infected populations, thereby escalating the risk of transmission of infection and drug-resistant organisms. The type of MG is also a major determinant of the type of infection. (Zumla et al.2017)

Acute respiratory infections (ARI) are most prevalent in religious gatherings with overcrowded conditions, where people tend to be in close proximity. The amount of shared air and length of contact are the main factors determining the extent of transmission. Transmission dynamics are defined by the infectious agent, the incubation time, the mode of transmission, the droplets, or the air. (Abubakar et al.2012).

Influenza leads to the majority of the ARI, causing increased morbidity and mortality. In July 2008, there was a report of an outbreak of Influenza during the World Youth Day in Sydney, pointing to the history of the ARI outbreak at MGs. This epidemic was not limited to just a single influenza strain. The oseltamivir-resistant strains were also

included. Crowded accommodation and low vaccination rates had exacerbated the spread of Influenza. (Blyth et al.2010).

A modelling study indicates that occurrence of MGs before ten days of an influenza epidemic peak would actually result in 10 percent relative increase in peak prevalence and the total attack rate which would worsen the disease outcome in the effected population (Shi et al.2010).

A recent systematic analysis of 45 studies examining the effect of sports (n=17), religious (n=15), festivals (n=11), and other (n=4) meetings stated that ARI was the most common infectious disease (Karami et al.2019). A cross-sectional analysis of international MGs using data from a global travel-related morbidity surveillance network reported 296 ill passengers, mainly religious (243 cases, 82.1%) but also cultural (e.g., music, dance, carnival) (19 cases; 6.4%), World Scout Jamboree (17 cases; 5.7%), major sporting events (13 cases; 4.4%), and large conferences (13 cases; 4.4%). A study by Gautret et al (2009) showed that ARI was the most commonly identified diagnosis (236 cases, 77.9 percent) out of the 303 diagnoses reported by 260 cases.

About four hundred fifty-two patients were hospitalized during the 2009 and 2010 Hajj seasons; 49.3 percent of them had respiratory diseases, and 27.2 percent had serious illnesses related to pneumonia. (Mandourah et al.2012). In the 2013 Hajj, 38 patients with severe bilateral pneumonia were hospitalized with a mortality rate of 36.8%. About 22 were reported as being infected with bacterial pathogens, the most common of which

were Haemophilus influenzae and Streptococcus pneumoniae. Another 16 individuals had a known viral infection, the most common being Influenza A virus and human coronaviruses 229E and OC43. (Memish, Almasri, et al.2014). Approximately 50.4 percent of all the recorded outpatient diagnoses were ARI in a specific analysis of Indian pilgrims attending Hajj between 2014-2016. It was also recognized as the most prevalent diagnosis. (Khan et al.2018).

Disease surveillance carried out in India in 2019 involving 120 million people during the Kumbh Mela revealed that 95% of the identified diseases were communicable diseases such as acute respiratory disease (35%), acute fever (28%), and skin infections (18%) among the identified diseases (Aggrawal, Dikid, S. K. Jain, et al.2020).

Another study in India on the MG of Sabarimala pilgrimage showed that the most common health events recorded were the respiratory tract (38.5%) and gastrointestinal diseases (21.5%) (Nayar et al.2020).

Tuberculosis remains one of the most common causes of death from an infectious disease worldwide. The participants of Hajj and other religious mass gatherings hail from tuberculosis (TB)-high endemic countries which has an annual incidence in 150/100000 population. TB is a disease that slowly progresses, and development of symptoms such as cough for months is common for individuals before active pulmonary TB is diagnosed. Thus, when people are in close contact with others having pulmonary TB and go on to attend MGs, the risk of transmission is high. (Petersen et al.2020). Large MG events like Kumbh Mela serve as tuberculosis transmission opportunity.

Measles is a viral infection that has the potential for spreading rapidly among non-immune individuals, particularly infants, resulting in serious illness. Due to the decrease in vaccine coverage in many nations, the virus had re-emerged at the global level. Outbreaks of measles have been reported in MGs. (Santibanez et al.2014; Hoang and Gautret, 2018). The most significant was the outbreak in the unvaccinated population at a congregation in the United States in 2005. (Kennedy& Gust 2008)

It can be a mammoth task to monitor the dissemination of respiratory infections during MGs. As the available therapies for viral respiratory infections are minimal, pre event vaccination, adequate surveillance for the detection of the disease, and vaccination of persons previously reported as not immunized are considered in the methods for the prevention of these infections. (Haworth et al.*2*013; Zumla et al.*2*018)

Infectious diseases have the potential for rapid spread on a large-scale during water-borne and food-borne disease outbreaks. (David and Roy, 2016; Portes et al.2016; Hoang& Gautret 2018)

The first noted implications of infectious diseases at MGs, which resulted from the person-to-person transmission, were food-borne diseases. (Abubakar et al.2012) Around 58% of 5918 people seen at 15 health care facilities were affected by communicable diseases, including 26 percent gastrointestinal diseases and 21 percent RTIs, during the 2010 anniversary of the death (Urs) of Baba Farid, an annual MG in Pakpattan, Pakistan (Hassan et al.*2*013) In 2013, during the Hajj, 23.3 percent of pilgrims from Marseille, France, had diarrhea, for which Escherichia coli was the major pathogen isolated by

PCR from pilgrims. Enteropathogenic E. coli, enteroaggregative E. coli, and Shiga-like toxin-producing E. coli were acquired by 29.9%, 10.2%, and 6.5% pilgrims, respectively (D *et al.*,2018). A review on diarrhea at the Hajj published in 2015 showed a prevalence of diarrhea ranging from 1.1 to 23.3% in 14 cohort studies, including 262,999 pilgrims from various countries between 2002 and 2013. (Gautret et al.2015)

During Kumbh Mela in 2013, out of the 412, 703 patients who were consulted at hospitals, diarrheal diseases accounted for 5% of consultations. Gastrointestinal disease risk, including cholera, is considered high because of the potential contamination of water and food. (Cariappa et al.2015). Moulay Abdellah Amghar Moussem, an 8-day annual gathering in Morocco, documented an increase in the incidence of gastrointestinal diseases from 11 to 14% between 2009 and 2010 (Youbiet al.2013).

The infection of travelers by an appropriate vector can cause the outbreak of vector-borne diseases even in non-endemic countries. Local healthcare personnel may not recognize a disease that has been eliminated from their country. To protect susceptible participants from non-endemic countries against vector-borne diseases such as malaria, dengue, west nile encephalitis, and yellow fever, these risks must be considered when planning MGs. (Johansson et al.2012; Khan et al.2012)

A survey in 2015 was carried out in Senegal in one of the largest Muslim pilgrimages, the Grand Magal of Touba, which has its unique characteristics. As most pilgrims travel along with their families ranging from young children to old parents, it is characterized by various age groups. The setting is also in a tropical environment. The survey was

conducted among ill pilgrims consulting health care facilities during the pilgrimage, which revealed a high rate of RTIs (5.2%), malaria and febrile systemic illnesses (4.9%), and diarrheal diseases (4.5%). It also showed that the overall hospitalization rate comprised of 14.5% confirmed malaria cases (Sokhna et al.2017). There is a risk of impending introduction or reintroduction of pathogens to host countries via appropriate vector, requiring adequate control measures to prevent subsequent transmission and potential endemicity. (WHO 2008)

Mass gatherings lead to large migrations of the transient population who seek different interests such as work and leisure. People from other parts of the world can carry infectious diseases for the host country or be in contact with uncommon infections from their birthplaces. Sexually transmitted infections (STI's) caused by viruses such as HIV, HBV, HHV, HTLV, and HPV spread in the world with different prevalence and stand out as the main causes of morbidity, especially in women. (Lima et al.2016) During mass events, travelers may have random and unprotected sex, exposing themselves to STI's. (Hall et al.2015) Prevention of STI becomes primordial during these types of events to minimize transmission.

2.6.2. Non-Communicable diseases and other Health risks at MGs

Due to various causes, such as high crowd densities, physical and psychological issues of humans and crowd control problems, etc., human stampedes can occur at mass meetings, leading to injuries and fatalities. (Alaska et al.2017) The widespread high

fatality rate resulting from human stampedes deems it one of the most feared tragedies among MGs.

In a study conducted by Hsieh et al (2009) to analyze epidemiological characteristics associated with increased mortality, 215 human stampedes were reported from 1980 to 2007; thus drawing attention to the importance of crowd management in MGs. Stampedes took place mostly during religious meetings and also during sporting, artistic, and political gatherings. Multiple studies have equated high mortality rates with outdoor gathering events. (Burkle and Hsu, 2011; Steffen et al.,2012; Illiyas et al.,2013; Alaska et al.,2017)

Religious gatherings, in particular, have been reported to show an increased propensity for human stampedes in developing countries. (Hsieh et al.2009)

The scope of mass gathering activities, including religious events, outdoor festivals, and pilgrim visits, varies not just for providing medical services but also for emergency preparation for all forms of possible weather and environmental health hazards. (Soomaroo & Murray 2012)

A study by Massod et al (2007) found that 92 pilgrims reported to a referral hospital with mental health issues in the first two weeks of Hajj (Masood et al.2007). These mental health issues may stem from the fact that the Hajj pilgrimage apart, from being physiologically exhausting due to increased physical activity, dry weather, scorching heat, mountainous terrain, sleep deprivation, overcrowding, and elderly pilgrims with chronic medical illnesses, is also psychologically stressful due to the fear of getting lost

in a foreign land, different culture, language barriers and an environment which is spiritually demanding (Portes et al.2016). According to a research study, heat-related illness and dehydration are among the most common causes of patient presentations during MG events. (Soomaroo and Murray, 2012).

While the effects of a deliberate act of bioterrorism will be of utmost significance, the likelihood of such an incident ranks low among the many other health threats at an MG. The potentially disastrous implications of such actions mean that they should not be overlooked and must be included in planning; however, they should not be permitted to control the mass gatherings because of all the other public health aspects and the number of other risks that are statistically more likely to occur. (WHO 2015)

Environmental conditions and weather, including warm, cold temperatures, and pollution, can contribute to life-threatening illnesses such as hypothermia, heatstroke, trauma, and dyspnoea. (Allen et al.2006; Soomaroo & Murray 2012)

A review by Baird et al. on the effect of warm weather during MGs showed a positive correlation between high temperatures and the frequency of patient presentation, thereby proposing a simplified algorithm for predicting patient volume at these gatherings (Baird et al.2010).

The most common medical emergency among the pilgrims during the Hajj has been heat stroke, characterized by hyperpyrexia, anhydrosis, and disturbances of the central nervous system, thereby reflecting similar health outcomes when exposed to warm temperatures. (Abdelmoety et al.2018)Another study from Mecca revealed a major

disaster resulting from soaring heat at the venue resulting in 1000 deaths from heatstroke. Around 1800 people had to seek emergency treatment for heat exhaustion. (Noweir et al.2008)

Based on these findings, it is indicated that warm weather is a crucial environmental determinant responsible for increased health risks. Advanced climate models have been developed to predict hot days with extreme temperatures deeming this finding critical.

Cold temperatures can also lead to health problems. This was evident in a study conducted in Denver during the Papal visit; where pilgrims were subjected to hike 14 miles at a high altitude, which resulted in a sudden drop in temperature from 29°Cto 13°C, leading to a huge increase of the number of pilgrims requiring medical care among the total of 50000 0 attendees (Paul, 1993).

A study conducted by Bhatnagar et. al. revealed the impact of mass bathing, which is performed as a special ritual as part of a religious mass gathering held in Brahmsarovar, at Kurukshetra in India, where one of the sacred water tanks was studied during new moon day, which is called as Amavasya in India, in terms of biological and physicochemical characteristics. Results have revealed a significant (Bhatnagar &Sangwan 2009) increase in organic water pollution.

Minor traumatic injury and medical complaints are the main contributors to morbidity and mortality requiring onsite emergency medical. A prospective study conducted by Al-Harti et. al for 15 days in the emergency department during the Hajj revealed that the number of trauma cases who attended the emergency department was 713 patients out of

which 248 patients were admitted in different surgical departments, together with the intensive-care unit. Sixty-five percent of the patients reported minor trauma. Sixty percent were involved in road traffic accidents and limb fractures accounted for 53% of total trauma admissions. It is of point to note that two patients died in the first 48 hours (Al-Harthi & Al-Harbi, 2001).

During the Hajj MG, high rates of mortality and morbidity from non-communicable diseases (NCDs) like diabetes mellitus (DM), cardiovascular diseases, and asthma were reported (Madani et al 2006). Walking long distances, changes in daily activities and poor adherence to diet and medications could negatively impact NCD control, particularly hypertension (HT), DM, and ischemic heart diseases (IHDs) (Yousufet al.1995). The incidence of severe acute cardiovascular events is more than doubled during MGs for people exposed to intense stress (Memish et al.2019).

2.7. Mass Gathering Risk Assessment Frameworks and Models

Previous studies have provided an in-depth understanding of the effects of pre-event preparation and allocation of resources on patient presentations at mass gatherings. (Milsten et al.2002; Arbon, 2007; Zeitz et al.2009).A study by Milsten et al, 2007 offered a review of literature on MGs pertaining to essential variables that could lead to understanding these events. (Milsten et al.2007).

Mass-gathering literature suggests that several characteristics such as duration of the event, the temperature, crowd characteristics, alcohol availability, and event geography can impact and affect the choices made while preparing for allocation of health-related

services. These features aid public health planners in understanding the operations of MGs. It has greatly augmented our understanding of individual gatherings, thereby contributing to the subsequent delivery of better health-related services. However, it is suggested that more basic concerns of the essence of the relationship between the wellbeing of the crowd and characteristics of mass gatherings should be considered like:

(1) Which frameworks or models can enable understanding of MGs and help us to make better provision of services at various MGs?

(2) Principles and effects that contribute to mass gatherings?

2.8. Existing Conceptual Models & Frameworks

Conceptual frameworks provide a source of increasing our knowledge related to MGs. The establishment of an MG conceptual model can encompass the main characteristics of an MG event and thereby provide a framework for the linkage and organization of such characteristics.

A conceptual model serves as a comprehensive system and contributes in the enhancement of knowledge about the phenomenon of MGs instead of considering it just as an occurrence having unique characteristics. It is necessary to consider this perspective as, at present, magnanimous work makes it possible to comprehend a single event but hinders applicability to new or different events. Similarly, the existing body of knowledge, which lacks theoretical improvement and sufficient analysis, does not provide an understanding of non-traditional MGs, which include railway networks,

airports, and shopping malls, where the impending design may cause hindrance to emergency medical services.

The International Health Regulations (IHR), is an international legal instrument binding on all WHO member states, whose purpose is to assist the international community in preventing and addressing public health risks, which may cross borders and threaten populations around the world. (WHO 2005)The fact that any public health event is notified in a timely and open manner is an essential aspect of ensuring global security. It has long been known that MGs provide the ideal conditions for the transmission of various diseases. Therefore, specific monitoring measures are essential to facilitate a healthy development of these activities and the health of the community involved in MGs and those regions that host them (Al-Tawfiq & Memish, 2014).

2.8.1. Arbon's Conceptual Model

Arbon, Bridgewater, and Smith created a model for forecasting the presentations of patients at MG events based on a comprehensive review of work related to health at major events for 12-months. The predictive model of Arbon et al. uses predicted crowd size and event profiles to forecast medical work. (Arbon 2004)

According to this model, the key characteristics of mass-gathering events were clubbed as :

(1) Biomedical - Understanding the influence of biomedical factors on the various types and number of patients at MGs

(2) Psychosocial –Consideration of the emotional and psychological influences associated with MGs

(3) Environmental – Factors that include environmental changes like the weather and terrain in a mass gathering

Measurement in terms of injuries and illness can be derived from the interaction of different domains and the subsequent effects produced. A response based on these interactions aids in the formation of a response strategy related to health catering to the unique needs of each MG.

It outlined the strength between MG health domains as mentioned in Figure (3) :

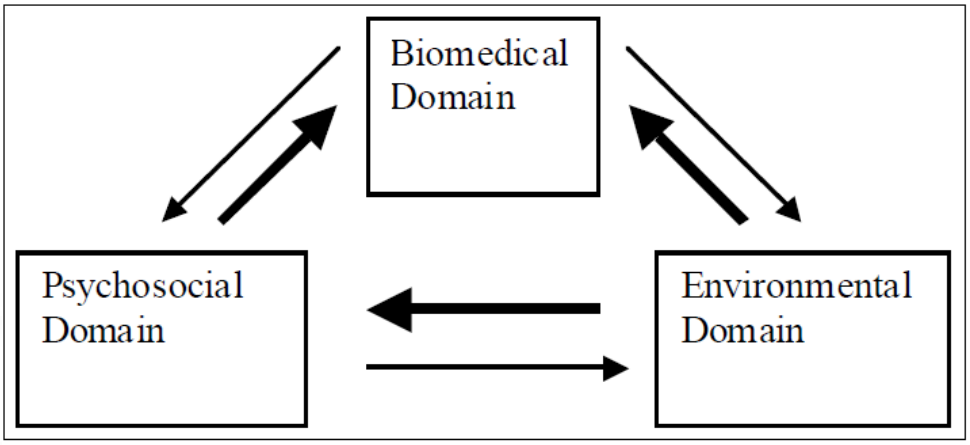

Figure.3 A relationship model of domains for mass gathering health (Relative strength of influence indicated by weights of arrows)

For example, the environmental domain features, like crowd density, greatly influence crowd mood and behavior under the Psychosocial Domain. In contrast, it has a strong propensity for causing trauma under the biomedical domain. This is evident when taken

a scenario of a huge crowd having limited access to a MG (Environmental Domain) tends to be extremely frustrated (Psychosocial Domain) with an inclination to become violent. The combination of these factors escalates the event of injuries and illness (Biomedical Domain).

A study by Zeitz et al. reported that the Arbon approach is beneficial for events with no or minimal knowledge on prior medical work, e.g., one-time, special events. It makes a prediction based on a combination of information obtained from a variety of events. This prediction has proven reliable over the entire event but is limited in its ability to predict inter-day variability. (Zeitz et al.2005)

2.8.2. Zeitz Model

Zeitz et al. undertook a longitudinal study to review the predictors of patient presentations at an annual agricultural and horticultural show (Royal Adelaide Show) leading to the development of a risk assessment model in South Australia in 2002. (Km et al.2002)

Detailed patient records of the show were maintained since 1995. Various factors like size of the crowd, number of patients, ambulances were taken into account in this review of data taken from the period of 1996 until 2001. The data of these seven years indicated several factors which could predict the medical workload for that particular event.

A study by Hartman et al. reported that according to The Zeitz Model, the volume of medical work can be forecasted based on examination of historical data for a specific event. (Hartman et al.2009)

2.8.3. Hartman's Stratification Scoring Model

The Arbon and Zeitz models are based on the availability of historical data (Km et al.2002). When the data are not readily available or reliable, it may be useful to categorize events based on proven variables affecting patient volume to classify mass gathering events. Weather, number of people, demographics and intentions, and presence of alcohol are some of the established variables that influence the number and type of medical needs.

As per Hartman's model, it is hypothesized that events can be categorized as "major," "intermediate," or "minor," based on the likelihood of emergency medical needs regarding these variables, and resources can be accordingly allocated (Hartman et al.2009). For the development of this model, an examination of records for 55 events was carried out. These events were representative of an array of sizes and circumstances under which gatherings take place. They were also representative of events for which the special events team provided staffing.

Only events for which appropriate records could be obtained were included. Each event was analyzed based on expected weather, attendance, presence of alcohol, age demographic, and crowd intentions. In each category, individual events were given a score of 0 to 2 according to their impact. Events with a score greater than "5" or with

scores of "2" in 2 categories were classified as "major." Those events with scores greater than "3" but less than or equal to "5" or with a score of "2" in one of the categories were classified as "intermediate.” Gatherings with scores less than or equal to "3" were labelled "minor."

Each of these events was then examined to determine how many total patient contacts occurred and how many of these were of the full or limited variety.

- Full contacts required full evaluations, which were defined as a full patient assessment by an advanced life support provider, nurse, or physician.
- Minor contacts required limited evaluations, which were defined as those that consisted of minimal interventions such as basic wound care.

The major limitation of this tool was the inability to identify each of the predictive factors. (Hartman et al.2009).

2.8.4. Street Tool

Estimating risks and resources needed during an event forms a prerequisite for creating common leadership areas, staff pools, and registering with triage areas and inter-organizational incident management groups. Such an organizational model plays a vital role in Sweden where the rescue teams (RT), police department (PD) and emergency medical services (EMS) play an equal role, STREET tool was developed with the aim to enhance collaboration between R. T.,P. D., and EMS before and during an event. A tool adjusted to Swedish context based on the modified version of the British "Purple Guide"

was proposed to manage mass gatherings (Berner et al.2015), predictive, collaborative, generalized, and easily manageable. The predictive tool "STREET" (Swedish Tool for Risk/Resource Estimation at EvenTs) consists of 35 items grouped into six dimensions to fit different types of events and to suit High-Reliability Organizations (HROs) as well as organizers. The response options range was presented as actual factors, e.g., temperature or distance to a hospital, on a three-degree scale of none, moderate, and high. This assessment tool gives a common understanding of all risks before an event and aid in preventing disastrous consequences of identified risks by mutual planning and resource estimation. In an simulation environment, STREET is reliable and valid, which could be used as a basis for HRO collaboration. But, the challenges of creating measurable values from simulated cases refer to the lack of reliability. A study on real events was suggested to provide higher reliability. (Berner et al.2015)

2.8.5. UEFA Euro 2012 Risk Assessment Tool

In view of disaster preparedness for EURO 2012, a European Football Championship organized by the Union of European Football Associations (UEFA; Switzerland), based on the recommendations of the multidisciplinary committee, a risk assessment tool based on a template by Dublin's Major Emergency Management Group was developed ((EPAn.d.) and preliminary risk assessment data derived from 2010 WHO Europe's evaluation led to the establishment of a detailed list of hazard categories and its subtypes. Based on four important factors: Environment, Economy, Potential effect on population and Community, the classification of the level of consequences or the

impending impact, from "minor" to "catastrophic" was carried out, and the impact was predicted based on available historical literature and consensus of the multidisciplinary group. The historical frequencies and national intelligence also aided in predicting the likelihood or probability of the event, ranging from "extremely unlikely" to "very likely."

A holistic view from the previous evidence, available measures, identified likelihood, impacts, and shortcomings led to the development of important phases in the planning continuum in line with disaster preparedness, which included Prevention, Response, Mitigation, and recovery built upon the detailed risk assessment. The findings were collated into a simple table-based tool with specific instructions on utilization to organize the hazards with their respective risk assessments visually. Further, a detailed risk assessment was proposed for hazards that were likely to arise and/or with significant consequences, along with specific plans for prevention and mitigation. This led to the development of the UEFA EURO 2012 risk assessment tool was developed. (Wong et al.2015)

This tool is simple and led to the development of an organized approach to the risk assessment process and has been applied successfully to the single setting in the city of Donetsk in the UEFA Euro 2012, which needs to be validated further in additional settings. Furthermore, no quantitative data were available regarding the actual implementation of the recommendations. Also, the scales used to categorize the impact and likelihood of each hazard present their limitations. The scales were developed to

assess disasters in general and not specifically for disasters in the context of Mass Gathering Events. These scales require modifications in the future, as even a hazard deemed as "likely" to occur (or occurring annually) remains unlikely to occur during a 3-week event, and the potential impact of a disaster may be exponentially higher in the aggregated population at a Mass Gathering Event.

2.8.6. Maurer's Formula

For estimation of the hazard potential of large events, Maurer's formula was developed. This formula aids in the identification of the number of medical staff needed, taking into account the number of visitors (points-based system), the type of the event and the special circumstances, such as attendance of very important people or violent groups. (Potin et al 2007)

2.8.7. Hazard Identification and Risk Assessment (HIRA)

The Ontario Hazard Identification and Risk Assessment (HIRA) Guidelines are published every five years. HIRA follows the risk assessment, which is based on exposure, hazards, capacity, vulnerability, and resilience. The purpose of which is to assess the potential risk of hazards with the capacity to cause a disaster. (van Dijk et al.2017)

Likelihood and Consequence are the critical factors used for the evaluation of risk by this method. (Ferrier& Haque 2003)

Likelihood

It refers to the understanding of the chances of occurrence of a hazard.100% likelihood of a hazard poses a "certain" threat, while a hazard with zero likelihood doesn't pose a threat.

Consequence

Interaction of exposure, vulnerability, and capacity in a community is called Consequence.

Number values can be given for likelihood and Consequence, which can be used to derive an overall score for risk using an equation.

For the creation of a ranking of hazards using this method, the following equation is used:

Risk = Likelihood X Consequence

Such equations are only useful for well-defined problems but not well suited to ill-defined or complex systems, which is a major limitation of this method.

2.8.8. All Hazards Approach

The World Health Organization defines all-hazards disaster preparedness as "an integrated approach to emergency preparedness planning that focuses on capacities and capabilities that are critical to preparedness for a full spectrum of emergencies or disasters. (WHO 2015)

In 1996, the U. S. Federal Emergency Management Agency (FEMA n.d) published the 'Guide for All-Hazard Emergency Operation Planning which had a more general view of hazards. The All-Hazard Approach focuses on shared response elements across emergencies.

An all-hazards approach was touted as an integrated approach to emergency preparedness planning critical to preparedness for a full spectrum of disasters and emergencies, including internal emergencies and a man-made emergency (or both) or natural disaster, which focussed on capacities and capabilities. Therefore, all-hazards planning do not address every possible threat specifically but ensures that hospital and all other providers and suppliers have the capacity for addressal of a broad range of related emergencies. (WHO 2007)

The All-Hazards Approach (AHA) has been the principal framework of disaster planners globally. The AHA has been criticized for its artificial attempt to consolidate dramatically different scenarios under the same disaster planning umbrella. (Bodas et al.2020)

2.9Use of Digital Technologies in Risk Assessment and Preparedness

Digital and electronic technologies are used in various ways in health care, including inpatient assessment and monitoring, social support, patient education, and research, with mobile technology forming an important component of this growing trend (Blake 2008). The increase in smartphone penetration and internet service deployment has

provided unprecedented opportunities for developing mobile health-based applications. This, in turn, has revolutionized the collection, assessment, and dissemination of healthcare information. (Ajuwon 2015; Slattery 2008)Mobile health (mHealth) technologies have the potential to transform healthcare delivery: their ubiquity and low marginal costs make them highly scalable and potentially cost-effective. (Kazi et al 2016)

The availability of open-source, customizable software, inexpensive mobile technologies, and cloud-based analytics provides an unprecedented capacity to rapidly collect and analyze large amounts of data in real-time. In addition to data curation, digital platforms can aid the implementation of clinical decision support systems and the dissemination of important public health information (Steinhubl 2013). The use of smart phones and their apps (downloadable programs designed to run on the smart phone operating system) in health care has been demonstrated in a research context (Rosser & Eccleston, 2011).

The transmission and exchange of medical knowledge and data through telemedicine involving the use of electronic resources was credited with aiding to avert a possible cholera epidemic at the Mass Gathering of Kumbh Mela in 2001 (Ayyagari et al.2003) Researchers have also used novel technologies like geo-location of pilgrims visiting hospitals during Kumbh Mela (Mapping the Kumbh Mela, n.d.)

An innovative technology that uses wireless sensor networks (WSN) and body sensor networks (BSN) technologies to locate critically ill pilgrims has been proposed in a

study (Boudhir& Elbrak, 2013). Environmental and physical conditions are sensed, and communication with one another occurs through many nodes, which is termed WSN. Through BSN, it is possible to monitor the biometrics of an individual by the use of on-body sensors. This BSN is the unique modified version of WSN. In combination, they can locate ill pilgrims and help the response team reach them within a stipulated time.

Another study described radio frequency identification (RFID) technology to create a system to track pilgrims. It is also bundled with a smart phone app, through which the location data can not only be used for tracking the pilgrims but also call for an ambulance in case of emergencies. (Mohandes 2010)

Detection of acute disease outbreaks at an early stage was carried out using the Healthy Cup, a participatory surveillance app during the Fédération Internationale deFootball Association (FIFA) World Cup 2014. This app was developed by a partnership between the Skoll Global Threats Fund, the Secretariat of Health Surveillance (Brazil's Ministry of Health), and the Epitrack eHealth system. (Leal Neto et al.2017) For usage on mobile devices, an open-source platform was used by the app. This platform supports both iOS and Android operating systems developed as a hybrid app on Android, iOS-based mobile, or a Web app that could be accessed via any Internet browser. PhoneGap (built with JavaScript, HTML5, and CSS) was used to develop the iOS native and Web apps. The app was designed in the native language for easy understanding. Various external interface capabilities were used by web and mobile apps for specific purposes like defining the location of nearby pharmacies or hospitals is carried out through the use of Application Program Interface (API) Google Places while Google Maps API is used for

navigation to points of interest by the user (‘Google API Console’, n.d.).

It is to be highlighted that few governments do not possess dedicated teams for examination and interpretation of data generated through risk surveillance. Hence, designing an intuitive platform that generates visual data and provides ease of interpretation overcoming the need for dedicated workforce would be beneficial for settings like mass gatherings as well.

2.10 CONCLUSION

Every mass gathering event has its separate risks and health hazards. The literature on the risks and adverse health effects of any mass gathering event is limited, with learning points very difficult to extrapolate. However, from the detailed analysis of previous MG events and available frameworks/tools for risk assessment, our review provided the following learning points that can be applied for planning and managing MG events in the future:

- The current planning tools are mostly based on the availability of event-specific historical data
- Non-validation of available risk assessment (RA) models and tools
- Focus is mainly directed towards medical care and medical resource estimation based on risk assessment
- The paucity of documented real-time testing of RA tools
- Disparate government strategies for preparedness for MGs

- Emphasis on medical preparedness and disaster management in comparison to public health preparedness

One of the important issues of MGs is public health risks, as they threaten the health of the participants and the health of the community as a whole. The first step in managing health risks is identifying health risks (Tavan et al.2020). Thus, for the purpose of planning for a MG, historical data from similar events can provide valuable information to planning officials. Interaction of various factors leads to uncertainty disrupting the process of planning for MGs. In order to streamline the process of planning and management, understanding of these factors is vital (A. M. Milsten et al.2002).

Although there is no general consensus upon the models or tools for risk assessment and preparedness at large MG events, predictive models with inadequate scientific support have been proposed, limiting implementation on a wide scale. There is a need to develop practical models and tools supported by higher levels of evidence to underpin the development of prevention and response strategies that are effective and suitable for application across the various types and contexts of mass gatherings. Especially a Risk Assessment tool targeted towards religious mass gathering does not exist at present. With this background, we conducted this study with the following objectives:

The study aim and specific objectives

The study aimed to develop a risk assessment tool for religious mass gathering events in Indian setting.

The specific objectives were-

Objective 1: To develop a risk assessment tool to assess public health and environmental risks associated with religious mass gathering events of Tamil Nadu

Objective 2: To develop a mobile application (app) based on the developed risk assessment tool

Objective 3: To test the feasibility of the developed mobile app-based risk assessment tool in a selected religious mass gathering event in Tamil Nadu

Objective 4: To assess public perceptions regarding public health and environmental risks associated with the selected religious mass gathering event of Tamil Nadu

The flow of this research study (Figure 4) is summarised below:

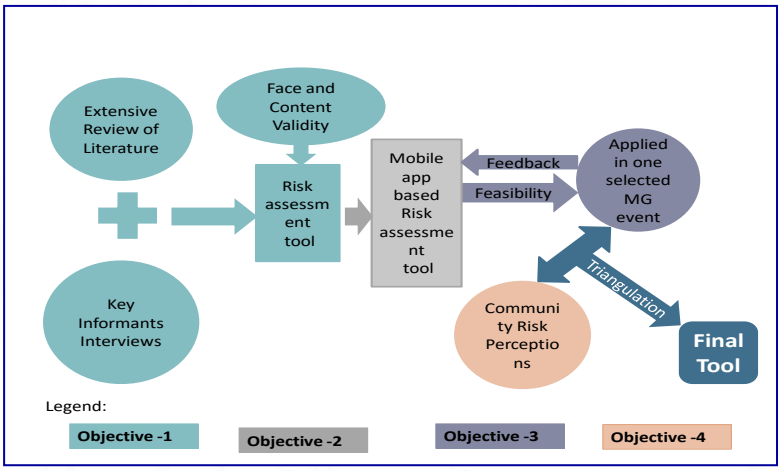

Figure 4: Flowchart of the Research Study

METHODOLOGY

Chapter-3

METHODOLOGY

We deployed mixed methods with quantitative and qualitative components to carry out the research study. We conducted the study in four stages in different settings. We have described the methodology of each stage under relevant objectives.

3.1*Development of Risk Assessment tool (Objective 1)*

3.1.1 Study type

Study Design: We deployed qualitative research methods to achieve the first objective of the study. We conducted key informant (KI) interviews &an extensive literature review to identify the domains, items, factors, and risks included in the proposed risk assessment (RA) tool for religious mass gathering events in the Indian setting.

Review of Literature: We conducted an extensive literature review to identify the risks associated with the MGs, theoretical basis for RA, and available RA tools for MG events, frameworks, and other guidance documents for MG. The purpose of conducting a review of the literature was to identify the risks associated with the MGs reported in the previous studies and to get a brief understanding of the existing risk assessment tools for mass gathering events, frameworks & guidance documents for MGs so that the proposed tool could be built on the existing guidelines. We reviewed the literature using Pubmed and Google scholar using specific keywords about mass gatherings.

We used the keywords as simple search terms in different combinations. We used Boolean operation “AND” to combine search words between 1 and 2 and “OR” within 1 or 2.

Search terms included:

1. Mass gathering, mass gathering event, mass gathering medicine, mass gathering health, religious mass gathering event, planned event, event, religious event, crowd, crowd event, gathering, , event.
2. Risks, health risks, environmental risks, diseases, communicable diseases, non-communicable diseases, infectious diseases, non-infectious diseases, injuries, accidents, stampedes, drowning, fire accidents, fire injuries, casualty, deaths, morbidity, mortality, incidents, health incidents, health issues, health problems.

Inclusion Criteria:

- Articles published since 1998 (20 years)
- Published in the English language
- Original research articles describing real-world MG events
- Articles/reports on casualty/disaster occurred in MG events
- Articles describing any risks/health-related events associated with MG events
- Systematic reviews about risks associated with MG events
- Review articles about risks associated with MG events
- Government reports related to MG events

Exclusion criteria:

- Research articles published in a language other than English
- Research articles published before the year1998
- Discussion papers/commentary
- Letter to the editor

All findings were tabulated in a data extraction tool prepared to extract information such as author name, study design, name of MG, MG type, place of MG, and other relevant details from the selected articles. We also recorded the summary of findings. (Annexure A-1)

Key informant interviews: We conducted KI interviews to draw relevant domains and items from their real-time experience for the proposed risk assessment (RA) tool.

3.1.2 Study Setting for Key Informant Interviews

We selected Tamil Nadu, a state in India's southern part, also known as the land of temples, as the study site. It celebrates fairs and festivals around the year in all districts with a diverse number of pilgrims. In Tamil Nadu, pilgrimage centres are divided into 'Places of Perennial Pilgrimage' and 'Periodic Fairs and Festivals. ' (Director of Public Health Madras 1928) Tamil Nadu is one of the states with the best outcome indicators for public health in the country and one of the very few states with a dedicated public health system. (Parthasarathi &Sinha 2016) Public health has its dedicated Directorate in the State Health Department, in place since 1922. (Das Gupta et al.2009) Under the Health Secretary, the division has three main directorates hierarchically on an equivalent

balance: the Directorates of Public Health, Medical Services, and Medical Education. At the district level, The Deputy Director of Health Services (DDHS) is responsible for the health service delivery. DDHS focuses on preventive and primary health care and is responsible for providing all forms of services to the Directorate of Public Health (DPH). All the staff at the district and block levels are supervised by DDHS. It also administers rural health, including all employees of primary health centres and sub-centres. However, Municipal Health Officers (MHOs) operate public health services nominated in large municipalities by the Directorate of Public Health. A team of Sanitary Inspectors typically assists mHOs.

Study Population

We conducted interviews with a total of fifteen key informants from different departments.(Table 1).We followed the principle of redundancy, and interviews were carried out till we attained saturation of information. We conducted face to face interviews with the representatives of the Department of public health and preventive medicine, Department of Medical and Rural health services, Department of Police, Department of revenue and disaster management, Department of fire and rescue services, Department of animal husbandry, community leaders from religious organizations with experience in planning and management of MG event (at least one MG event) in the state of Tamil Nadu. We also interviewed academics and researchers with expertise in MG research.

Table 1: Key informant interview participants profile (N=15)

S. No	Designation/Department	n (%)
1	Health Officers	3 (20)
2	District Epidemiologists	2 (13)
3	Temple authorities	2 (13)
4	Police personnel	2 (13)
5	Veterinary doctor	1 (7)
6	Fire safety officer	1 (7)
7	Public health researcher	2 (13)
8	Disaster Management officers	1 (7)
9	Revenue officer	1 (7)
10	Entomologists	2 (13)

3.1.3 Sample size

We interviewed a total of fifteen key informants from different departments. We followed the principle of redundancy and continued the interviews till we attained saturation of information.

3.1.4 Sample selection procedure

We selected the study participants by purposive sampling. We identified them through existing contacts and networks to secure representation from all groups of interest and relevance.

3.1.5 Study tool:

We used a semi-structured interview schedule to guide the key informant interviews. We prepared the interview schedule after early literature reading and multiple brainstorming sessions. (Annexure A-2)

3.1.5.1 Data Collection

We identified the key Informants with experience in planning and managing MG events in Tamil Nadu. In every case, participants were contacted directly by telephone or personally to seek their participation. We provided them with the participant information sheet and had any of their questions answered and obtained signatures on informed consent.

We carried the study through one-on-one interviews of all the participants except for two with whom we conducted telephonic interviews. Interviews were audio-recorded via a digital device, with data transcribed immediately after data collection. The time taken for conducting each interview was between 40 to 60 minutes. We used a semi-structured interview schedule to guide the interviews. We used the open-ended questions developed based on the information gathered through the literature review to generate the data. We conducted a pilot exploratory interview with a senior public health researcher to ensure that the proposed interview questions were clear, appropriate, and would elicit information about the study. After this pilot, we made adjustments to the questions. Interviews were performed individually and based on participants' willingness in terms of time and site. Firstly, interview questions began with the general questions based on the participants' core area of expertise and the

central questions of the research. Probing was done to encourage the interviewees to describe their experiences completely. Examples of questions asked of participants included: “Briefly describe your role/experience in planning and management of MG event? According to you, what are the health and environmental risks associated with MG events during & after the event? What is your opinion regarding the preparedness of our health system in tackling the risks mentioned by you? Strengths & weaknesses you observed in the present system of MG management?”

3.1.6 Data preparation and management

Key informant interviews were audio-recorded, transcribed, translated (if in local language), de-identified, and verified. We conducted all the interviews in the English language except two, which were conducted in the local language (Tamil). Tamil translation was done by a trained researcher who was back-translated and cross-checked by another researcher not involved in the study. Subsequently, the transcripts were obtained and analyzed. Transcript data were managed using word processing software. Transcripts were labeled to identify participant quotes according to the core department.

3.1.7 Data Analysis

The data consisted of the participants’ statements recorded during the interviews. Using an inductive approach, we conducted thematic analysis method to evaluate the transcripts. (Thomas & Harden 2008)We analyzed the data manually. The steps were: first, read the interview transcripts repeatedly; second, coded/categorized essential pieces of information to answer the research question; third, searched for themes to arrange the information into sub-themes and themes; fourth, reviewed themes/analyzed

matches between the themes and categories; peer reviewed for quality control of coding. Fifth, defined and named themes to find general information from each theme followed by write-up. (Braun &Clarke 2006)

3.1.8 Quality assurance

We used the trustworthiness criteria recommended by Lincoln and Guba to establish rigor. We used several measures (transferability, credibility, dependability, and conformability) to enhance this study's rigor. (Lincoln & Guba 1985) Data analysis included collecting thick, rich descriptions of participants' experiences, enabling identification of recurrent patterning to enhance dependability and trustworthiness. Rigor was increased further by independent coding and interpretation of the raw transcript data; interviews were re-coded by another researcher to check for the reproducibility of emergent codes and finalized via consensus decision. Member (study participants) and expert (supervisor) checking were applied for achieving the criteria of credibility and dependency. In member checking, we asked the study participants about possible misunderstandings and participants concurred with the proposed results. For expert checking, we discussed the emerging concepts with the supervisor to ensure themes were understandable. No significant changes to the analysis arose from this debriefing. We obtained conformability and transferability of data by a comprehensive explanation of the study process to the participants. Besides, we tried to discard the potential biases through peer evaluation before interviews. Accordingly, the research scholar played the role of a participant, and colleagues performed the interview. Feedback from colleagues helped recognize and manage potential biases.

To summarize, the review of the literature and key informants' interviews led us to identify various public health and environmental risks about MG events. We categorized the identified risks under broad domains and sub-domains or items. As a result, the risk assessment tool, in its initial form, was developed.

3.1.8.1 Validation of the risk assessment tool

Validity refers to how truly a tool measures what it is purported to measure. (Michael et al.1996) We analyzed the validity in various ways to assure the strength of the tool to conduct a risk assessment in religious MGs.

Face and Content Validity

To assess the tool's face validity, the draft tool was administered to six experts with experience in planning and managing religious MGs. We requested them to evaluate the tool & give their comments about the domains, items, relevant responses, and overall presentation of the tool. We collected written as well as verbal comments on the tool as their feedback. Face validity is regarded as a subjective assessment of the scale, so we also considered the participants' subjective ideas throughout the data analysis.

For assuring the content validity, we circulated the draft of the tool among six experts who were selected by convenient sampling for review (four experts from the Department of public health & preventive medicine and two academicians/research consultants)

Using a self-administered content validity questionnaire, we requested the six experts to assess the relevance & representation of each item generated on a four-point Likert scale as 1 = not relevant, 2 =somewhat relevant, 3 =quite relevant, and 4 = highly relevant to

avoid having a neutral and ambivalent midpoint (Annexure A-3). We requested them to assess the tool on various parameters. This included questions like whether all the items referred to relevant aspects of the construct to be measured, whether all the items together comprehensively reflected the construct, whether all the items were relevant for the setting where it was going to be applied, whether the tool was simple and understandable. We modified the draft, considering the experts' written and oral feedback after the face and content validation process. The final version's content was further assessed by the thesis supervisor and one of the DAC members.

3.1.9 Data analysis:

We used multiple statistical measures of content validity like the content validity index (CVI) and Fleiss Kappa to report agreement among the experts. We analyzed the data collected through content validity questionnaires from experts' statistical software Epiinfo 7.1.5.2 version. We calculated descriptive statistics like agreement proportions between the experts. We calculated S-CVI (Scale Content Validity Index), the inter-rater agreement index (agreement proportion), and the Kappa agreement coefficient. The content validity index (CVI) is the most widely used in quantitative evaluation (Polit & Beck 2006)because it is simple for calculation, easy to understand, and provides information about each item, which can be used to modify or delete instrument items. There are two kinds of CVI: content validity of individual items (I-CVI) and content validity of the overall scale (S-CVI). Fleiss Kappa value was calculated to measure the agreement between the experts after adjusting for their chance agreement. The interpretation of an agreement or association measure according to Landis and Koch is

as follows; < 0.00 indicate poor agreement, 0.00–0.20 indicate slight agreement, 0.21–0.40 indicate fair agreement, 0.41–0.60 indicate moderate agreement, 0.61–0.80 indicate substantial agreement, and 0.81–1.00 indicate almost perfect agreement. (Landis & Koch1977)

After content validation, we adapted the newly developed paper-based risk assessment (RA) tool was into a web-based application called MGRAT app (Mass Gathering Risk Assessment Tool)

3.2 Development of MGRAT web app (Objective 2)

An interdisciplinary team comprising of the primary researcher, public health expert, and software professional were formed, and an adequate number of team meetings/discussions were done. We developed a mobile web application based on the risk assessment tool.

This mobile web application is called the "Mass Gathering Risk Assessment Tool (MGRAT)." Mass Gathering Risk Assessment Tool (MGRAT) is a mobile web application-based tool that predicts a list of 'event-specific' health and environmental risks associated with religious mass gathering events based on the user's inputs regarding various factors enlisted in this web-based application. It is also embedded with formulas that calculate the rank for each risk predicted for an event. The tool allows the user to observe the list of risks and rank each risk associated with religious mass gathering events.

3.2.1 The development process of the MGRAT app

Software/coding details:

MGRAT tool has been developed as a device responsive Progressive Web Application (PWA). We chose this method over any other platform-specific (iOS, Android, web) apps because of the following advantages of PWA:

1. A web application can be used on all platforms that have an internet browser.
2. A device-sized responsive web application can be accessed from devices with various forms- factors (smart phones, tablets, desktop computers, etc.) and different layouts (portrait, landscape).
3. There is no requirement for app installation or app updates, which significantly reduces the initial hurdle of user on boarding and gets the user right into the app immediately.
4. A single app for all platforms eliminates the need to write, maintain, and deploy separate apps (Write-Once-Run-Everywhere).
5. A PWA's nature allows the user to automatically install the website as a lightweight app on the users' platform when the users visit the website. The app never downloads itself again (except for updates), thereby enabling the app to load instantly. This is greatly useful for fringe areas where network bandwidth (Wifi or Cellular) is insufficient.

6. When updates are made to the app, it is immediately uploaded to the website. This prevents the overhead servicing or support of various versions of apps on other platforms.

Tech Stack

We developed the MGRAT app using ReactJS ('React – A JavaScript library for building user interfaces', n.d.) a web app development framework using Javascript, HTML, and CSS languages. It uses the Material UI framework for the UI components.('Material-UI: A popular React UI framework'n.d.) The app and the required configuration and data are hosted in Google's Firebase Cloud platform, which is served worldwide.

Language: The mobile web-based mobile app MGRAT was developed in the English language.

Target Audience*:* Public Health Preparedness team involved in the planning and managing MG events are the intended audience for the app MGRAT.

The mobile web application is based on the developed RA assessment tool. The intended audiences for the MGRAT are the public health managers who were involved in the preparedness activities of the MGs. It is intended to be used before the MG event, i.e., at the pre-event stage, by the public health preparedness team to assess the potential risks that could have been posed by the forthcoming event

Compatible Operating System*:* MGRAT was developed as a web-based mobile application. Mobile Web applications are the applications designed for mobile devices that require only a web browser to be installed on the device. Web browsers and web

technology is utilized to perform tasks over the internet. MGRAT runs on multiple platforms regardless of OS or device as long as the browser is compatible. Web-based apps are one of the universal cross-platform solutions available today. A mobile-based web app's advantage is that all users have access to the same version, eliminating compatibility issues. By updating the server application, all users can access the updated version.

Additionally, the data that is entered into a mobile web app is processed and saved remotely. This allows access to the same data from multiple devices, rather than transferring files between computer systems. The user data is stored in the cloud on a powerful server. It is also very cost-effective as it reduces both the server and end-user costs as there are less support and maintenance required at both ends.

3.3 Feasibility study (Objective 3)

This part of the research study's objective was to assess the feasibility of the MGRAT app in a religious MG event and assess the inter-rater reliability of the MGRAT app.

3.3.1 Study Design

We conducted a descriptive cross-sectional survey among the Public health preparedness (PHP) team members of the Department of Public Health and Preventive Medicine involved in the Deepam festival, Thiruvannamalai 2018. We conducted the study to test the feasibility of the developed mobile app-based risk assessment tool (MGRAT) in the religious mass gathering (MG) event of Tamil Nadu.

3.3.2 Study setting

Thiruvannamalai Temple Town is one of India's oldest heritage sites and a stronghold of Saiva worship. The district is surrounded by the district of Kanchipuram in the East, the district of Villupuram in the South, Dharmapuri and Krishnagiri's districts in the West, and the district of Vellore in the North. It is divided into 3 Revenue Divisions, namely, Thiruvannamalai, Arni, and Cheyyar. It is the administrative headquarters of Thiruvannamalai District. The town is governed by a special grade municipality covering 13,64 km2 (5,27 sq mi) and a population of 145,278 inhabitants. It is located at 12°N 79.05°E with an average elevation of 200 meters (660 ft). Situated to the east of Eastern Ghats, Thiruvannamalai's topography is almost plain, sloping from west to east. Throughout the year, it encounters hot and dry conditions (Census of India 2011). According to the 2011 census, Thiruvannamalai consists of 72,351 males and 72,332 females. The sex ratio is 1,000 and the child sex ratio stands at 960 whereas the average literacy rate is 81.64% (Census of India 2011). The figure (Figure.5) below indicates the area where the study was conducted.

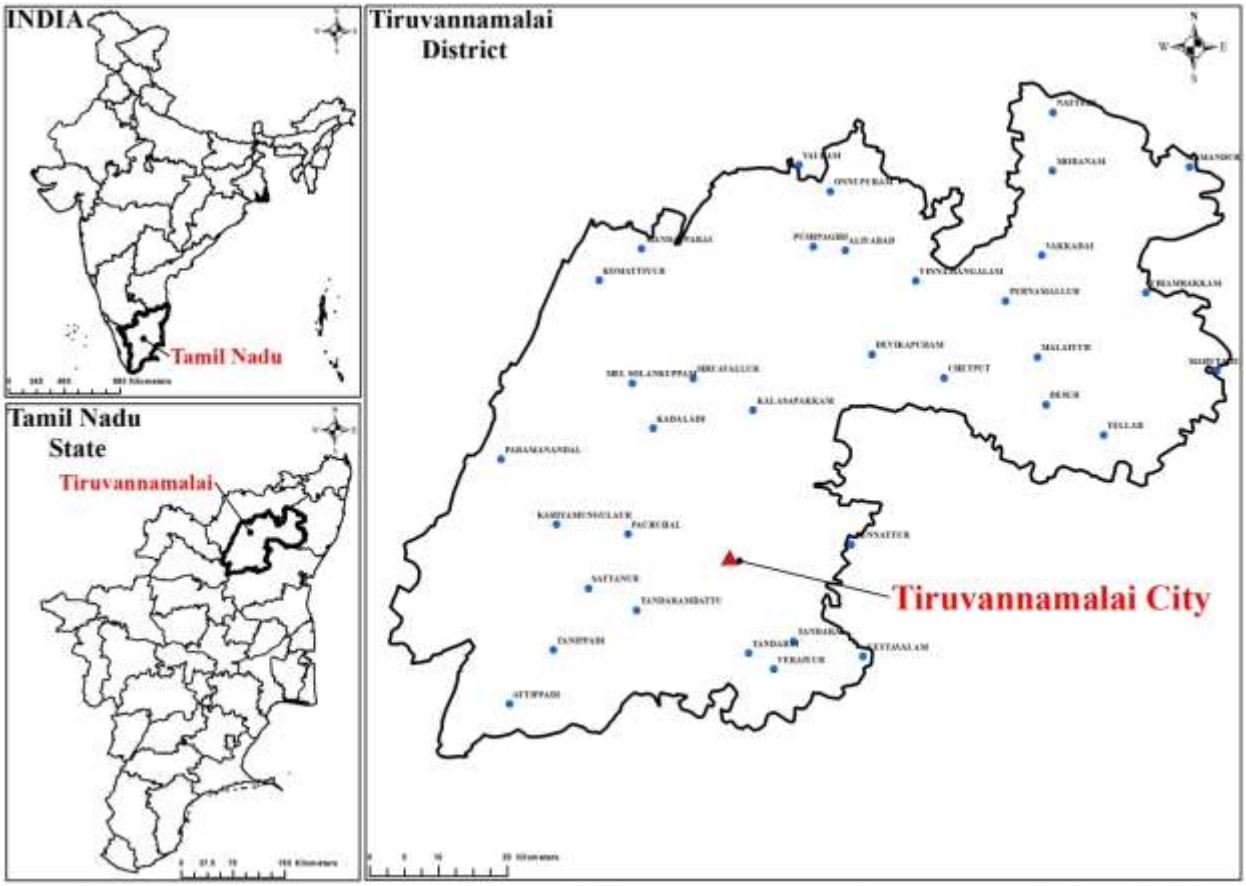

Figure 5.Map of India locating the study setting: Thiruvannamalai district, Tamil Nadu, India

During the Tamil month of Karthigai, the most important Annamalaiyar temple Deepam festival is observed between November and December, ending with Karthigai Deepam's celebration. It is a religious MG of perennial nature where large crowds than usual foregather in a seasonal festival. It is one of the 123 ‘notified festivals’ enlisted by the government of Tamil Nadu. This MG was selected to test the feasibility of the MGRAT app as per the researcher's convenience. It was a ten-day festival that lasted from 14th to 23rd November 2018. It began with the hoisting of the holy flag in Arunachaleswarar

Temple situated at Thiruvannamalai. The procession of deities was held every day during the festival. The Car festival was conducted on the 7th day. On the tenth day, the MahaDeepam was lit atop the 2668 feet high Thiruvannamalai hill.

3.3.3 Study Population

The cross-sectional survey was carried out among Public health preparedness (PHP) team members of the Department of Public Health and Preventive Medicine involved in the Deepam festival 2018. The team had 52 members performing various roles in public health preparedness. For the study purpose, we categorized the PHP team members into high, middle, and grass-root level based upon their role in public health preparedness for this religious MG event.

- High level members included medical officers with managerial role i.e block medical officers, district training team medical officer, epidemiologist, deputy director of health services, program officers; assistant program officer and other officers included designated officer, district entomologist, municipal health officer, and veterinary officer.
- Mid-level members included the duty medical officers who were involved in discharging their duties at the medical camps organized during the festival.
- Grass root level members included sanitary inspectors who worked under the supervision of municipal health officer.

3.3.4 Sample size and sample selection procedure

We used the universe survey (census) method (Research Population - The Focus Group of a Scientific Query, n.d.). We included all the 52 PHP team members involved in the Deepam festival. We circulated the MGRAT app among all of them. After repeated reminders and telephonic contacts, 49 members completed the risk assessment process of the Deepam festival using the MGRAT app.

3.3.5 Data collection tools

Data were collected using two tools : (i) The mobile application was evaluated using a modified version of the Mobile Application Rating Scale (MARS) for mobile applications. It is a self-administering mHealth app (the scale can be modified to measure the quality of non-health-related apps) quality rating tool that provides a multidimensional measure of the app quality indicators of engagement, functionality, aesthetics, and information quality as well as app subjective quality. It has been used to provide a checklist for designing and developing new high-quality health apps (Stoyanov et al.2016). Each MARS item uses a 5-point scale (1-Inadequate, 2-Poor, 3-Acceptable, 4-Good, 5-Excellent); descriptors for the rating anchors were written for each item. (Annexure A-4) A self-administered feedback questionnaire was used to collect the app users' feedback on the parameters like relevance, comprehensiveness, simplicity, and feasibility of using the app on five points Likert scale ranging from 1 (Not relevant) to 5 (Highly relevant). (Annexure A-5)

3.3.6 Data Collection:

We sought prior permission from the public health and preventive medicine department Chennai, Tamil Nadu, for data collection. A pre-event meeting with the PHP team members at the Deputy Director of Health Services (DDHS) office Thiruvannamalai. We explained about research objectives and requested their participation in the study. Participation in the study was voluntary. The study participants could withdraw from the study at any point, including the right to answer partially or not to answer the questions. After a detailed briefing of the MGRAT app, we demonstrated the app to the study participants. PHP members who could not attend the meeting were contacted, and the demonstration of the app was given to them in person.

We shared the MGRAT app link requested to download & use the mobile app in the context of the Deepam festival, Thiruvannamalai. Thus, PHP team members (49 out of 52) used the MGRAT app in the context of the Deepam festival to assess the risks associated with the MG event of Deepam festival, 2018. We also asked them to evaluate the MGRAT app in the technical sense and give feedback about the relevance, comprehensiveness, simplicity, and feasibility of the MGRAT app. We shared the links of google forms for the Modified version of Mobile Application Rating Scale (MARS), i.e.,app quality rating tool & feedback questionnaire. In addition to this, paper-based versions of the MARS and feedback questionnaire were distributed for the participants' convenience.

3.3.7 Data Analysis

We used descriptive statistics, median, and proportions to express the ordinal data collected from the PHP team members using the modified version of the Mobile Application Rating Scale (MARS) and a self-administered feedback questionnaire. All the 49 PHP team members assessed the same event (Deepam festival, 2018) using the MGRAT app. We analyzed the output of MGRAT from all the 49 PHP team members and assessed the inter-rater reliability of the MGRAT app. We used the Fleiss kappa inter-rater agreement. Inter-rater reliability or inter-rater agreement is the degree of agreement among raters after adjusting for the chance agreement. Kappa value of 0.50 or above indicates moderate inter-rater agreement.

3.4 Community survey (Objective 4)

3.4.1 Study design

We conducted a cross-sectional study among the pilgrims attending the mass gathering of Deepam festival to assess their perceptions of public health and environmental risks associated with the religious mass gathering of Deepam festival held at Thiruvannamalai district of Tamil Nadu.

3.4.2 Study setting

We carried out a cross-sectional survey among the pilgrims attending the Deepam festival held at Thiruvannamalai district of Tamil Nadu 2018. It was a ten-day festival that lasted from 14th to 23rd November 2018. It began with the hoisting of the holy flag in Arunachaleswarar Temple situated at Thiruvannamalai. The procession of deities was

held every day during the festival. The Car festival was conducted on the 7th day. On the tenth day, the Maha Deepam was lit atop the 2668 feet high Thiruvannamalai hill. From the 7th day onwards, a high influx of pilgrims is expected and tends to reach its peak during the 10th day (Maha Deepam day).

Study Population

The study population consisted of adult pilgrims (residents and visitors). Residents included adult pilgrims who had been residing in Thiruvannamalai at least for the past one year. Visitors included any adult pilgrims who were visiting Deepam festival at Thiruvannamalai from places outside the host town.

3.4.3 Sample size

Assuming that 50% of people attending an MG event positively perceived risks, with the relative precision of 10% and confidence interval of 95%, the required sample size was calculated to be 384 (OpenEpi). With the assumption that5% of the study participants will be non-responders, 400 participants were surveyed for the study. Four hundred included 200 resident pilgrims and 200 visitor pilgrims.

3.4.4 Sample selection procedure

We used purposive quota sampling. Data were collected during the 9th and 10th day of the festival. We selected around ten high-yielding points in the event area (event area here refers to the streets encircling the Arunachaleswarar temple called *'MadaVeedhi'* and the path surrounding the holy hill (*'Girivala path'* – a 16-kilo meter path where pilgrims revolve the sacred hill). At each point, participants were selected randomly

during different periods in a day (9 AM - 12 noon, 2 PM - 4 PM, and 6 PM -8 PM) to achieve a sample size of 400 (200 resident pilgrims and 200 visitor pilgrims).

3.4.5 Data collection

We used a pre-designed & pre-tested semi-structured questionnaire (in English language and translated into local language, i.e., Tamil) (Annexure A-6) to collect data to assess the risks perceived by the pilgrims attending MG of Deepam. We collected data with the assistance of ten nursing volunteers who were identified from the same locality. We conducted half a day training session in data collection for the ten nursing volunteers.

3.4.6 Study variables

We collected details on socio-demographic characteristics, perceived risks of accommodation (only for visitors), respondents' perception regarding the roadside eateries at the event site, annadhanam site (free food distribution places) and *prasadam* provided at the event site, drinking water arrangement at the event site, sanitation arrangement, regarding the medical care facilities available at the site, transportation facilities, crowd management, solid waste management, and safety arrangements and overall risk perception related to the MG event. We captured the details regarding the variables as mentioned above, indicated under different sections of the pre-designed questionnaire. At the end of each section, we asked the respondents an open-ended question to list the perceived health risks posed by the factors discussed in the particular section. For Ex: At the end of the section inquiring about pilgrims' perceptions regarding drinking water arrangements, we asked the pilgrims to list out the health risks which, according to them, were posed by the drinking water arrangements at the event site. The

verbatim response to this question was recorded as such in the questionnaire by the interviewer. We categorized the enlisted risks under four categories, namely infectious, non-infectious, injuries, and a few other miscellaneous were put under the category 'others. ' We followed the same process for the responses to similar open-ended questions under all the sections. In the final section, we asked the study participants about their perception of the overall risks associated with the MG event. Apart from categorizing risks, we further probed the participants to prioritize the health risks/problems they enlisted by giving any score/rank between 1 and 4 to the problems/risks mentioned by them, where one referred to the top, and four referred to the least priority. From this response, we ascertained the participants' perceived importance to identified health risks.

3.4.7 Data Analysis

We computed the mean and median to describe the quantitative data. We calculated frequencies and proportions for the categorical data. We performed inferential statistics like the Chi-square test to compare the proportions between the groups (residents and visitors) and the Student t-test to compare the means between the groups. *p*-value< 0.05 was considered statistically significant. The outcome variable was risk perception [(Y/N), categorical variable] and the determinants studied were the resident status of the pilgrims (residents/visitors) and other socio-demographic variables (categorical) like gender, age group, educational status, family type, employment status, and socioeconomic status. The independent effect of the variables mentioned above in determining the risk perception after adjusting for the confounders was expressed as

adjusted odds ratio with a 95% confidence interval, which was computed using logistic regression.

3.4.8 Quality assurance

We trained the nursing student volunteers recruited to aid in data collection. The questionnaire used for the community survey was translated into local vernacular language Tamil and back-translated back to English by an independent translator, whose mother tongue was English and had no knowledge of the questionnaire. We supervised the volunteers periodically to ensure data completion and accuracy.

3.5 Ethical considerations

We received ethical clearance from the Institutional ethics committee (IEC) of the ICMR-National Institute of Epidemiology. We gave a detailed explanation about the study to all the study participants and obtained the written informed consent before the study began. To assure the participant's consent, we obtained either a signature or thumb impression on the consent form and communicated their right to withdraw from the study at any stage. We included only those participants in the study who consented without any coercion. We sought written approval from the Director, Department of Public Health and Preventive Medicine, Tamil Nadu, to conduct the research study in the MG of Deepam festival at Thiruvannamalai. The data were only accessible to the researcher and the research guide. The researcher was solely responsible for retaining the confidentiality of the data obtained. The information obtained was used exclusively for research purposes.

RESULTS

CHAPTER 4

RESULTS

4.1Results of Key informant interviews (KIIs) (Objective 1)

In this section, the results of the key informant interviews on the risks associated with religious mass gatherings are reported.

The median age of the sample was 43 years (interquartile range (IQR) 35-51 years). Males constituted 86.7% (13/15) of the sample. Around 40% (6/15) were in the age group of 30-40 years. The median 'total work experience was 14 (IQR 6-20) years, whereas the median experience in MGs was 8 (IQR 3-15) years. (Table 2)

Table 2: Demographic details of the participants of key informant interviews (KII) (N=15)

Variable	**n (%)**
Gender	
Male	13 (86.7)
Female	02 (13.3)
Age group in years	
30-40	6 (40.0)
40-50	4 (26.7)
50-60	5 (33.3)
Work experience in years	
Less than 10	7 (46.7)
10-20	5 (33.3)
Greater than 20	3 (20.0)
Experience in MG in years	
Less than 10	8 (53.3)
10-20	6 (40.0)
Greater than 20	1 (06.7)
Variable	**Median (IQR)**
Age in years	43 (35-51)
Total work experience in years	14 (06-20)
Experience in MG in years	08 (03-15)

From the data analysis of the interviews, four major themes and 17 subthemes were identified. The major themes and sub-themes identified from the interviews are enumerated in Table 3.

Table 3: Themes and sub-themes that emerged from Key Informant Interviews (KIIs)

S. No	Major Themes	Sub-themes
1	Event Characteristics	*Event duration* *Activity level* *Venue-Topographical Characteristics* *Special rituals*
2	Participant Characteristics	*Participant profile* *Size of the crowd* *Psychosocial behavior of participants*
3	Environmental Characteristics	*Season* *Transport facility* *Sanitation and Hygiene facility* *Safe water facility* *Food safety* *Solid waste management facility*
4	Medical services and Disaster preparedness characteristics	*Level of medical services* *Crowd management* *Fire safety* *Natural calamities management*

Event Characteristics

From the interactions with the participants, it emerged that event characteristics played an essential role in the effective pre-event planning and management of any MG. Since event characteristics vary with each MG event, it is important to overview the specific dimensions associated with the event in question. Since venues where such MG events differ from one event to event, hence have different risk profiles. Therefore preparedness activities and resource requirements are also different for various events.

Activity Level

The majority of the participants from different departments unanimously agreed that the extent and type of activity level are crucial for the organizers to understand for planning MG events. It is essential to know whether the participants will be predominantly seated, mobile, or long queues of them standing for long hours. The extent of activity level has a role to play as well when it comes to the planning of an MG event. Whether the activity level will be the same on all days or will it vary over days during the festival. In some religious gatherings, pilgrims visit the venue to perform certain holy rituals on dedicated days only. Depending on pilgrims' predominant activity in the MG event, there can be varied health risks like stampedes, crush injuries, dehydration due to walking long distances and exaggerating existing illnesses like asthma, hypertension, and cardiac issues.

"We coordinate with other line departments to plan for the potential disasters in that festival venue, it is always event specific. We must understand the geographical area where the event is happening, what kind of visitors will come, what kind of activities the pilgrims will be indulging in, whether there is going to perform journey by foot, whether pilgrims will be sitting or standing for the congregation, understanding the needs of various stakeholders, crowd management & traffic management strategies to be adopted by the police department, also the action plan of the health department." (Disaster management official)

You see…. we have all types of religious gatherings in Tamil Nadu. For instance, in an event like the Velankanni Madha festival, people reach the event site by walking from

even Chennai nearly 400 KMs. Foot injuries are commonly found along with burns to soles. Higher numbers of cardiovascular emergency cases have been reported in the past, even among the people in the age group 30-40 years. (Epidemiologist)

Event Duration

Most MG events are of defined duration. The duration may vary from one day to a few days or more than a month. Participants mentioned that as per the government guidelines, pilgrimage centers are divided into 'Places of Perennial Pilgrimage' and 'Periodic Fairs and Festivals. ' Places of Perennial Pilgrimage have some special religious sanctity of their own apart from the occurrence of a holy day and which attracts pious persons in considerable numbers throughout the year, while periodic fairs and festivals centers are those at which pilgrims congregate in numbers only on one or more special occasions during the year when the attraction may be either religious or secular or both. In Periodic fairs and festivals, it is only at the time of the actual fairs and festivals that the place gains importance and calls for special public health measures.

"Public health measures are planned depending upon the type of festival. At places of periodic fairs and festivals, we plan for special measures well in advance, like bringing in additional manpower and material to meet the demand of a huge number of pilgrims over a fixed period of time. In contrast, places which are visited by pilgrims round the year, there we carry out our routine activities with regards to sanitation and disease surveillance." (Health Officer)

"MG events at fairs and festivals happening periodically are surely more challenging to manage because suddenly there is a surge. You know the transmission rate of infectious diseases rise when pilgrims come together in huge numbers at a common point of time. In addition to that, challenges of safe drinking water, food safety, security etc.,arise during the event." (Epidemiologist)

Topographical Characteristics

Another aspect of MG events that influences public health decision making is the topography of the area. Many famous religious sites are built on top of the hills that are difficult to reach due to narrow pathways. Many temples are also built by the riverside or seaside. The *ghats* (series of steps leading down to a body of water) along the banks of water bodies usually serve as the place for taking holy dip/bathing and performing other prayer rituals. There is a high probability of drowning and injury at such sites due to falling on ghats' slippery surface. If the pathway leading to the MG event consists of forest cover, managing the MG event is also delegated to forest department officials. Besides, officials' from disaster management have to put all preparations in place in case of a forest fire.

"Festivals happening in and around the forest area leads to man and animal conflict, cases of snake bites and bee stings are commonly reported." (Epidemiologist)

"Due to hilly terrains, pilgrims suffer a lot, though they never consider those issues as problems." (Epidemiologist)

"There is a high risk of drowning at all pushkaram festivals." (Disaster Management Official)

"Pilgrims perform prayers along the bank of rivers. They end up disposing of pooja items like flowers, diyas, idols in the water bodies leading to pollution of flowing water. This is very annoying. Very difficult to make them adhere to rules that restrict such activities."(Health officer).

Special Rituals

Participants believed that one of the significant health challenges is pilgrims' belief in performing special acts and rituals with a poor understanding of the dangers and diseases of those acts and practices. Every religious MG event is marked by the unique rituals performed by the pilgrims to thank the Almighty for fulfilling their wishes or asking for forgiveness for the sins committed by them. From circumambulation to walking on ambers, head tonsuring, taking a holy dip in sacred water bodies, displaying fireworks, the immersion of idols in the water, animal sacrifice, and many such activities are performed by the pilgrims who are a source of major public health issues. Different departments like police, fire safety department, health department, temple authorities all play a role in handling these activities.

"Pilgrims perform special rituals to give thanks to the almighty for fulfilling their wishes, or sometimes they do so in order to seek the fulfillment of their desires. There is this ritual called Theemithi (To walk on embers). It is a form of ritual that devotees perform to worship the deities … Even with the knowledge of the dangers of the fire, devotees perform this ritual…we always try to take care that no mishap should occur. Like it has happened at certain places where due to stampede, some devotees tripped in embers…

"Every Ammavasai (new moon day), several thousand people visit the temple at Tiruvannamalai to set themselves free of all problems through prayer and circumambulating bare feet around the holy hill of Arunachalam. Many of them say no matter how hard it is to be going around the hill, but a sincere prayer at this place lights up their lives, and the positive results help them gain their happiness and confidence back. You know, they live by this staunch belief."

"Offering the hair is our way of giving thanks for God's blessings." (Officials from temple administration)

"During the Thaipoosam festival of Palani, devotees parade around bearing kavadis (a wooden structure placed around the shoulders. Some carry milk and rosewater kavadis around the street and some even pull heavy sleds attached to their bodies with hooks and end up getting their bodies pierced. It is in such gatherings where devotees are predominantly mobile that our forces have to plan not only for crowd management but also safety and security." (Police official)

The temples have many shaving halls and shops for hair tonsuring ceremony in the vicinity. Locally they are called as 'Kalyana Katta' or Kesh Danam,it is mainly a sacrifice, and also a way of shedding the ego. Problem is that the barbers use the same razor on dozens of devotees, increasing the chances of spreading the infections among the pilgrims. You know, through open wounds, viruses like HIV, hepatitis C, and B can be transferred from one person to another. Moreover, through dirty hands, there's also a risk of getting many skin infections; it is difficult for us to ascertain how many

devotees contract diseases due to repeated use of the same razor because most of them go back to their home towns. (Epidemiologist)

Participant Characteristics

All MG events are unique. Some MG events are markedly different from others because of the participants that it caters to. Depending on the participants' profile, age, origin, and psychosocial behavior, health-related behaviors will be specific to the event in question. Also, MG events are the occasions where people with a shared group identity congregate for a defined period. According to the KIs, preparedness activities are tweaked according to the participant characteristics.

Crowd size

Participants were of the standard view that officials depend on past events' attendance to estimate the number of participants. Staffing and other public health arrangements are made accordingly. There are certain 'sacred' days when a surge in the number of participants is expected to perform certain religious rituals. Certain days turn out to be chaotic because of VIP visits. As the number of pilgrims becomes too high, the rate of accident and disease, extreme traffic delays, all of this often rises. Special arrangements to curb issues such as stampedes and violence are needed on such days to counter intense crowding.

"Head count is not possible, it is based on estimation, experience of previous years helps."

(Police official)

"Based on the crowd size, number of stages provided and based on the previous experience, number of vehicles and other resources are distributed for the event". (Public Health Researcher)

"Normally, in Kumbakonam, malaria is not prevalent. But people from all over India and outside India visit, so we never know who the carriers are and they might introduce the disease in this population." (Health officer)

"Strength of our system is planning of events based on experience……we maintain minutes of meetings held in the previous years. That's how we decide our future course of action." (Revenue Official)

Participant Profile

There are religious gatherings that predominantly attract a specific section of the community to the event. For example, a religious gathering meant for the LGBT community will require intense health promotion activities, counseling participants about condom usage, and IEC activities to promote safe sex practices. MG events majorly attracting the elderly & disabled population calls for special provisions for dealing with issues like exacerbation of existing health issues. In addition to this, arrangements like adequate resting places for the elderly and disabled in particular. Women's safety is an essential aspect of female-focused religious events and in general as well. Certain MGs are centered around newborn kids as a central predicament. Parents bring their newborn kids to seek the blessings of the almighty.

"I feel amenities for disabled people are not very good at the time of our fairs and festivals. They have special problem and special needs, you know. So, I suggest our government should consider them while planning for the festival. I think we can improve in that aspect." (Official from temple administration)

"I have seen sudden chaos in the crowd of standing pilgrims resulting in stampedes. Waiting for a prolonged period of time in crowded queues causes suffocation and escalates the problem of asthma in the patients. Elderly pilgrims suffering from arthritis face problems and even pilgrims with existing cardiac & respiratory issues have difficulty in over-crowded places." (Epidemiologist)

"Depending upon the type of crowd, we do try and have safety plans accordingly…Yes women and young kids are most vulnerable. We keep surveillance through CCTV cameras at the vulnerable places." (Police Official)

Psychosocial Behavior of participants

Participants believed that sometimes visitors consider going to the pilgrimage places as an activity of adventure and fun. They usually end up indulging in alcohol and drugs, sometimes leading to violence among youth groups. MG events are also the hotspots of commercial sex activities. Public health management teams expect such a psychosocial behavior to be shown at such pious places as well. Accordingly, safety arrangements are made by deploying additional police forces and restricting alcohol sales in the event area's vicinity. Intense health education activities for promoting safe sex practice are essential as prostitution is bound to happen at such events.

"Though these are religious gatherings, there are certain places where devotees come with the dual purpose of prayers as well as merry-making. Devotees put up shamianas on the outskirts of the town and even consume liquor and cook meat." (Official from temple administration)

One thing common to most of the mass gatherings but not talked about openly is the heightened brothel activity. We widely promote condom usage; actually, there is a free distribution of condoms during the Koovagam festival for eighteen days. Transgender people from all over India gather at Villipuram district of Tamil Nadu.We have observed that some transgenders from foreign countries have also participated in the celebrations in recent years. The risk of sexually transmitted diseases is common here. And we have noted that pilgrims' risk behavior will always be high on the festival's final day. Even in Velankanni Madha festival, festival time is the peak time for brothel activity. (Epidemiologist)

Environmental Characteristics

Season

Participants believed that the season in which the MG event takes place could impact infectious diseases. The summer season brings many health issues like dehydration, heatstroke among the pilgrims, fatigue, heatstroke, food, and water-borne infections. At the same time, monsoons are mostly associated with natural calamities like floods and vector-borne diseases. During the winter season, pilgrims are more prone to face respiratory health issues, asthma, etc. Accordingly, healthcare arrangements are made for MG events.

"Communicable diseases are always a challenge during MGs. Like, I am responsible for vector-borne diseases. Dengue and Malaria are both a challenge. Velankanni is a malaria-endemic area. Now, dengue has become endemic over there. In addition to that, water-borne diseases are also common. So, in such areas we monitor the surveillance and control activities of dengue and malaria. Due to flies, typhoid is common, so we also take measures against houseflies in the affected areas." (Epidemiologist)

As we know, morbidity pattern shows seasonal variation like during summer, we have more number of chickenpox cases, dehydration cases and sometimes heat stroke. During rainy season fever, we get more cases of respiratory infections. We do get diseases caused by mosquitoes like malaria and dengue. We do keep this in mind while arranging medicines before planning any health camps. (Health officer)

Transportation

Based on the expected number of pilgrims, the surplus arrangements of buses or trains are made. And this brings in the inadequacies related to transport infrastructure, road network facilities, parking, and issues like physical changes to the pedestrians' routes by which pilgrims travel to and around these festivals. The most preferred means of communication has been observed to be by railways, followed by buses. Essential public health activities include chlorination of the water supply at the principal halting stations, adequate toilet facilities near the railway stations where pilgrims gather in large numbers. Boats loaded with pilgrims in huge numbers lead to overcrowding, especially at the point of boarding. This is a triggering point for stampedes, which also poses the

problem of drowning at such places. Suppose the mass gathering event area is too large or scattered over to adjoining areas of the main event area. In that case, one can observe heightened usage of motor vehicles within the event site. This gives rise to chaos and disorder. Improper parking of vehicles causes inconvenience to the general public. Other than the traffic police, additional help is sought from local volunteers for the regulation of traffic. Wherever possible, separate entry and exit points are created for ease of traffic. Unregulated establishment of temporary bazaars on the main roads of the event area causes serious hindrance to the traffic.

In many places of pilgrimage, 'Foot pilgrimages' are performed towards holy shrines or pilgrimage sites. Commonly found issues among such pilgrims are exaggerating existing medical illnesses like cardiac issues, hypertension, and asthma. Fatigue, leg pain, slight abrasions, dehydration are some of the widely recorded health problems. Respiratory health problems emerge due to clouds of dust along the route.

"In scenarios where walking long distance to the pilgrim site is preferred or those festivals that involve walking by foot like Girivalam, pilgrims may exacerbate musculoskeletal disorders. Most of them report minor issues like fatigue, leg pain and minor abrasions." (Health officer)

"Usually, cases of suspected MIs from the medical camps at the event site are shifted to the nearest tertiary care centre. The crowd sometimes delays this transportation of patients, and so I feel specialists should also be put on duty at selective medical camps to treat cases like that of heart attack." (Public health researcher)

"We always suggest that the problem of temporary shops at random places in the event area should be controlled, a dedicated area should be allotted for this. A separate route for ambulance and fire vehicle should be allotted which should not be blocked by the crowd. Even a walking lane should be laid down to control the crowd." (Police official)

"When there is a fire accident, casualties occurring due to stampedes are way more than that occurring due to fire. Casualties that result from haphazard crowd movement and due to smoke are more common because public is unaware what to do, where to go during fire accident and hence stampedes occur as a result of that." (Fire Safety Official)

Sanitation & Hygiene Facilities

As per the participants' views, public health issues, garbage disposal, and enough sanitation facilities are to be taken care of during a mass gathering event. The requirement for temporary and mobile toilets is estimated depending upon the number of people likely to visit the MG event and its length. Sites for temporary toilets are decided after surveying the event site. Water supply is established through tanks at the toilet facilities. Failure of regular water supply to the facilities is a huge discouragement for the pilgrims to use the toilets. Inappropriate lighting at the facilities is another contributing factor due to which pilgrims avoid using toilets at night. Poor sanitation and inadequate hygiene practices put people at risk of contracting infectious diseases. Sanitation and hygiene at the place of food preparation and distribution are also critical to public health. Additional staff is mobilized from the adjoining districts to carry on the

sanitation work for the festival duration. Cleanliness of the MG event area begins a few days in advance of the event and goes for a few days post-event. High-density regions are identified, and vector control activities are undertaken in a targeted manner. The police department is actively involved in observing that the pilgrims follow the sanitary arrangements, preventing them from throwing waste materials at the festival site.

"Our duty is to ensure that pilgrims are happily enjoying their visit. For this we try to reduce the density of vectors as much as possible. During and after the event the same activities are carried out. Activities like the removal of solid waste. This sometimes goes on up to even one month after the event, then we send back our workers." (Entomologist)

Sanitation and hygiene are of prime importance to us. For this, additional sanitary workers are mobilized from the nearby taluks and districts. However, making food and stay arrangements for the additional manpower is another challenge for us. We face budget crunch most of the times. (Health Officer)

We ensure an adequate number of toilets and water facilities for the toilets; however, huge influxes of pilgrims strain the maintenance process. Civic responsibility should be instilled among the pilgrims. (Health officer)

Solid waste management

Environmental health risks associated with stagnant and polluted surface water can lead to drinking water contamination and often result from blocked drainage channels caused due to solid waste. Improper disposal of slaughtered animal carcasses poses a threat to

the environment, especially surface water pollution. Pilgrims tend to throw the trash into the water and use the water from the river body for performing ablutions at such places of the festival. This eventually ends up polluting water. Improper management of food waste poses significant risks of fly and rodent infestation and surface water pollution.

"Problems of solid waste and liquid waste are always there during the MG event. Temporary toilets are fixed but people never use those actively and they throw garbage here and there, which ends up accumulating filth and stinking smell. Especially, areas around annadhanam sites are the major sources of solid waste generation at any religious gathering" (Revenue officer)

"Except water &hygiene-related activities, I have never participated in any other activities related to air/noise or soil, so no idea regarding that. By theory we knew there are some other environmental risks but we never focused on that." (Health officer)

Food & Water Related Characteristics

Food Safety

Participants believed that many public health and environmental issues occurring at the time of MG events are attributable to poor food safety hazards. At the event site there are many points where activities related to food occur. There are the traditional roadside eateries that come up only at the time of the festival and the local eatery points. There are free food distribution (*annadhanam*) charitable sites, (*annaprasadam)* temple food, pilgrims cooking their food at temporary shelter places. It is mandatory for the food joints, including the street food carts to obtain a food license from the authorities and is

valid for a year and renewable. But the charitable food distribution points are the places that go unnoticed at such gatherings. Pilgrims, especially from adjoining places, bring cooked from their homes for charitable distribution. Consumption of contaminated food from free food distribution points leads to various food borne illnesses. From food handling to food storage and distribution, each aspect contributes to health issues. Food handlers are given health education on topics like hand washing techniques, wearing caps while cooking, etc.; through inter-personal communication and by distributing pamphlets on food hygiene before the festival. Instructions about solid waste management, water stagnation, and chlorination are also given to them. Fish and meat sellers are issued an advisory about keeping the meat covered in the market area. The veterinary department issues instructions to slaughterhouses regarding the usage of certified animals for slaughtering purposes.

According to the participants, low level of awareness of health hazards among the pilgrims is one of the major challenges. They do not understand unhealthy practices such as unhealthy food consumption. This low awareness and insufficient knowledge of the risks are the causes of infections at the time of MG events.

"Annaprasadam (temple food) is prepared by our temple cooks by the blessings of almighty, it is pure. How can it make pilgrims sick, never?" (Official from temple administration)

"Pilgrims do not follow our advice… Many of them cook food in huge amount and bring it from their hometown to the place of festival for annadhanam (to distribute it among

the devotees for free)… Such activities go unnoticed from our department and we get to know about it only when health department gets cases of diarrhea& food poisoning in huge numbers from a particular area of the festival venue." (Health Officer)

"We distribute pamphlets carrying information on food safety to all before the festival starts and sensitize them about requirement of license for carrying out food business at the event." (Revenue officer)

"See, we don't train the meat handlers as such, but yes, we educate them orally about the importance of hygiene. By merely seeing the animal (animal meant to be slaughtered) we can tell the animal's condition, whether it is fit or not. NO. We don't examine the animals as such." (Veterinary Health Officer)

Water Safety

Water safety is one of the challenges, according to the participants' views. According to them, water safety is one of the crucial elements when it comes to public health preparedness during MG events. Water scarcity is another challenging situation to deal with at such huge gatherings. To overcome the shortage of water, it has to be brought in from sources outside the town hosting the event and chlorinated at the host city's entry ports. Negligence at the entry points leads to contaminated water consumption by the pilgrims, leading to water-borne diseases. There are occasions when the health authorities remain unaware of particular sources of water within the event site. It is only during routine checks for chlorination that the health officials learn about such hidden water sources, which often turn out to be a source of health risks. Failure to remove

refuse from the banks of the river and beaches leads to water pollution. Pilgrims tend to use drinking water facilities to wash utensils and clothes and eventually leading to stagnation of water, which becomes a source of vector-borne diseases. Sanitary inspection of the water supply system and monitoring of water samples is done during the MG event to ensure that water remains free of contamination. Failure to do so leads to contamination of water.

"At the places of festivals where animal sacrifices are given to please the god and goddesses, piles of carcasses can be seen scattered in the open fields and sometimes even on the roads. I tell you this contributes hugely to water pollution in that area…. and of course the fly and rodent menace." (Veterinary Health Officer)

"Our prime focus during huge gatherings is clean drinking water. We identify all the sources of water for chlorination prior to the onset of fair. But it becomes really challenging for us when suddenly new drinking water sources arise at the time of fairs. Usually, temple authorities provide devotees with such temporary provisions without notifying us. (Epidemiologist)

We fear temple authorities, especially when we talk about chlorinating the temple's holy water (tap or well water inside the temple premises). We just cannot dare to chlorinate that water source as it would hurt the sentiments of the temple authorities as well as the pilgrims." (Health Officer)

"I think there is a scope of improvement when it comes to chlorination of water sources. We can improve in that aspect." (Health officer)

Medical services and Disaster preparedness characteristics

Level of medical services

Participants from the public health department mentioned that additional medical teams are required, which are mobilized from the adjoining towns. The use of incident management systems enables a more streamlined response in any public health incident like a disease outbreak. On-site medical care is provided to pilgrims by establishing medical camps at various event sites. They believed that minor ailments and injuries can be efficiently handled at the medical camps, reducing the burden of referrals on the hospital. Co-ordination with local private hospitals for additional medical assistance always proves to be advantageous in MG events.

Based on participants' views, one of the challenges is the absence of dedicated training for stakeholders in MG health. Furthermore, they added that most of the time, the ones involved in handling the MG event get transferred to other places of work, putting pressure on the new staff to get things done from scratch. Hence, stakeholders from different departments must be given short training focused on MG planning and management. It would sensitize them about the basic tenets of different kinds of MG events.

"Government supplies enough men and material for managing MG event effectively, as far as Tamil Nadu is concerned. We have a good surveillance system and good number of skilled persons in the system. Outcome of such a set up is that there won't be outbreaks of communicable diseases. Only stampede problem is experienced, especially during VIP visit." (Health Officer)

"In Tamil Nadu there is dedicated public health staff in the department to take part in MG events and there are guidelines available. But people do not follow it properly because of scarce resources. In other states there is no dedicated public health staff or specific guidelines available for MGs." (Revenue Official)

"NO. No dedicated training is offered to us for managing mass gatherings. Public health staff is posted at the MG event and they do their routine activities. But I think yes there can be short term training for it. Otherwise we just try to make use of the existing manpower, officials of health department & other departments as well are mobilized from the nearby areas to the venue of mass gathering. This is how it has been working." (Epidemiologist)

Crowd management

Most of the participants perceived mass gatherings as the hotspots for manmade disasters in the form of stampedes. The unexpected influx of pilgrims compared to the expected number leads to stampede like situations during MG events, especially on special days like car festival, VIP visit or auspicious day during the festival period. Huge crowd walking through the narrow pathways leading to the main temple are the triggering points for stampedes. Often, it is the rumors circulating among the pilgrims that create panic in the crowd and hence the stampede. Wherever possible, separate entry and exit access point to the festival area reinforce better crowd management. Crowd surveillance by CCTV cameras and public address system ensures better crowd management. At the time of MG events, many lodging houses spring up to draw

business out of the situation. In the pursuit of making a profit, residents vacate their homes and turn them into guest houses. Such houses, the unlicensed lodging houses, usually are poorly ventilated due to overcrowding and turn out to be a source of communicable diseases. Poor hygiene due to insufficient sanitation is common at such places.

"People potentially tend to panic as a consequence of rumor spreading. That's when we have to deal with the surge problem. Also on the days when there is a VIP visit, we are on alert. There is a major accident that occurred during the visit of a VIP at the Kumbhakonam festival in Tamil Nadu." (Police Personnel)

"We have seen that in a place where only 15 people can be accommodated, 100 are stuffed in it, what will happen? Stampedes will happen. You know, in 1992 Mahamayam, above 200 deaths occurred due to stampedes. Overcrowded places contribute immensely to transmission of communicable diseases. (Health Officer)

"My suggestion would be that we should limit the number of pilgrims visiting an event per day. Otherwise there is no point in making such arrangements, whatever is to happen will happen despite arrangements due to influx of a huge number of pilgrims." (Disaster Management Official)

Fire Safety

Depending upon the scale of the MG event, temporary shelters are built to accommodate the pilgrims. There are temporary shelters that continue to be at the host site even after the event is over. In contrast, some temporary shelters and shops are built just for the

event and then dismantled once the event is over. Pilgrims also stay at the choultries or other such free rest houses (chathiram/matt etc) put up by the charitable people who usually lack proper amenities. Mandapam/open varandahs/ spaces of temples are also used as resting places by pilgrims for stay. A commonly observed issue at temporary accommodation is that pilgrims like to cook their food using wood fire or portable LPG stoves. Many times, this becomes a source of fire accidents. A structural failure like broken railings, fire accidents due to faulty electrical wiring or synthetic tent material, etc.,are potential causes of panic among pilgrims that eventually turn into stampedes. Fire safety officials work hand in hand with other line departments in times of emergency. They believed that theirs is a department service-oriented department but expressed concerns over funds and outdated fire fighting equipment.

"Other than the usual emergency triggers of fire accidents, we also focus around the areas where devotees camp around in the temporary accommodations and cook their own food." (Fire Safety Official)

"Fire retardant material should be used for shamiana (tent) around the stage but it is not being used. Another risk is the use of open wiring in the temporary structures built during the MG event. During festivals like Deepam, temporary shops are a risk because inspection is not being done as per rules. Rules are there for establishing such temporary shop especially for cracker shops but it is not possible to inspect all shops. So, randomly one vehicle is positioned near these shops." (Fire Safety Official)

"We are getting adequate in-service training but newly recruited manpower should be given good induction training. The equipment (vehicles) need be modernized. Funding is never sufficient for our department,…..ours is a service oriented department." (Fire Safety Official)

"Major challenge involved during a MG event is the arrival of VIPs because it becomes impossible to station the fire vehicle at the right place on the day of their arrival due to special arrangements." (Fire Safety Official)

"If violence erupts, we also support the police by using jet water (vajra) to control the protest/ violence." (Fire Safety Official)

Natural calamities management

In addition to this, extreme events not specific to mass gatherings in the form of natural disasters like extreme weather conditions, cyclones, storms, or forest fires may also occur. The consequence of these sub-events is that human health is affected, and the environment is subjected to great harm. An event could be restricted to a single block or a single district of a state or sometimes it is dispersed to multiple sites across adjoining areas of the main event area. So, the geographical dispersion of the event site plays a very crucial role. Broader the geographical spread of an event, the potential of people being susceptible to health risks eventually puts an additional burden on the public health department. All the participants acknowledged that for executing the planned MG event safely, inter-departmental coordination plays a crucial role from the pre-event

stage onwards. Pre-event risk assessment of the event site by all the concerned departments helps foresee the potential gaps and hence prepare accordingly.

"As an administrator, crowd density and duration is most important. So what I mean is that short duration and crowd scattered over a big area is less of a risk compared to long duration of event with crowd concentrated in a small bound area." (Revenue officer)

"With huge gatherings, stampedes added with drowning and fire accidents are worst combinations and festival sites along the hills always come with the risk of landslides and fall injuries among pilgrims." (Disaster Management Official)

"We don't as such have any protocol for risk assessment for religious events. Experience is our strength; we predict risks based on previous experience. But our people are trained well to deal with the mishappenings in these events. ." (Disaster Management Official)

"No formal risk assessment is done before the event but group of people from different departments visit the festival site and submit their reports. As I said, group of people completely based on observation give a report and request resources for MG management. The resource requirement is filled based on observation and discussion with officials. There are no checklists mentioning how to assess and what to assess. Yes…. we can try to have a checklist/ report template which can guide them in making the report." (Revenue Official)

Results of Literature review

In our study, a total of 61 studies were reviewed. The studies were classified based on the type of mass gathering with the major findings derived from each study. Around 33 studies which were reviewed were solely attributed to religious mass gatherings. The variables that interact in complex and dynamic ways in a MG were identified. Multiple health and environmental risks reported in various MGs are described in a tabular form .Our review revealed that the spread of infectious diseases is an important problem pertinent to MGs including disease outbreaks such as food-borne diseases, respiratory infectious diseases and other infectious diseases associated with environmental conditions. Several mass gathering events have reported weather changes that occurred during the event, illustrating the higher number of patients expected at warmer events. Sexually transmitted infections may also occur, but they are usually underestimated and underreported. The summary of the literature review is outlined in the table given below:

Table 4 :Health and Environmental Risks associated with MG event-REVIEW OF LITERATURE MATRIX

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
1	Karamai	2019	Global	up to 2018	Planned MGs and Fairs	NA	Systematic Review	Infectious diseases, injuries, high-risk behaviors such as alcohol drinking, drug related problems and illicit sexual behaviors, environmental health problems
2	Memish	2019	Global	2013-18	Planned MGs	NA	Review	Transmission of communicable diseases, Water and sanitation related disorders, non-communicable diseases and exacerbation of comorbidities (eg: - diabetes, hypertension, COPD, and cardiovascular events), Mental health and psychosocial disorders, Thermal disorders, including heat hyperpyrexia, heat stroke, heat exhaustion, and dehydration, Stampedes, Accidents, trauma, and crush injuries, terrorist incidents (biological and chemical warfare threats, explosives, and bombs), Alcohol and substance abuse
3	Collender	2019	Coastal Equador	2004-07	Community Scale MGs	NM	Cohort	Diarrheal disease: Infectious & Acute Non-infectious (due to excessive alcohol consumption)
4	Masdalina	2018	Saudi Arabia	2004-11	Religious MG	Hajj	Secondary data analysis	Heat stroke, human traffic congestion, women with underlying chronic diseases, cardiovascular diseases, respiratory diseases and other co-morbidities Remarks: Provides a descriptive overview of mortality in Indonesian pilgrims from 2004 to 2011.
5	Muttalif et al	2019	Global	2002-11	Planned MGs	NA	Review	Invasive Meningococcal Disease

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
6	Bajaj	2019	India	2019	Religious MG	NM	Outbreak Investigation	Food poisoning/Acute diarrheal disease
7	Najim Zafer	2018	Saudi Arabia	2005-17	Religious MG	Hajj	Secondary data analysis	Acute respiratory tract infections
8	Turris	2016	Global	1999-2014	Music Festivals	NA	Review	Mortality due to trampling, motor vehicle related, structural collapse, drowning, assault, overdose of recreational drugs, falls, thermal injury, environmental causes. Remarks: Analysis of fatalities associated with music festivals, drawn from both the academic and gray literature of the past 15 years was presented
9	Ahmed	2019	Global	_	Religious & Sporting Gathering	NA	Review	Environmental, physical, infectious, non-infectious, terrorism: Stampedes, intoxication, sexual assault, fire jumping.
10	Calle	2017	Belgium	2013-14	Music Festivals	NA	Secondary data analysis	Intoxication due to ethanol and illicit drugs consumption
11	Zumla	2017	Saudi Arabia	2015	Religious Gathering	Hajj	Cross sectional	Tuberculosis and other airborne infections, respiratory diseases.
12	Ghany	2017	Saudi Arabia	2011-13	Religious Gathering	Hajj	Descriptive (Retrospective analysis)	Diarrheal diseases &Food borne infections Remarks: Catalogued the circulating enteric pathogen population in Hajj pilgrims withdiarrheal symptoms

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
13	Cheikh Sokhna	2017	Senegal	2015	Religious Gathering	Grand Magal of Touba	Cross sectional	Trauma & RTAs due to overcrowding, fatigue, heatstroke due to climactic conditions, malaria due to rainy season, diarrheal diseases& RTIs due to lack of sanitary conditions
14	Miranda	2017	Brazil	2014	Sports gathering	FIFA world cup	Cross sectional	Alcohol abuse, physical injuries, motor vehicle accidents, civil unrest, crowd crushes, structural collapse, GIT problems, high BP, heat stroke, dehydration, falls.
15	Khan	2018	Saudi Arabia	2015-17	Religious Gathering	Hajj	Retrospective data analysis	Respiratory infections, heat stroke, diabetic related skin and soft tissue infections, myalgia, osteoarthritis, sciatica and low backache precipitated due to stress, exertion, dehydration and old age. Exaggeration of existing health issues like bronchial asthma, hypertension.
16	ShujaShafi	2016	Saudi Arabia	_	Religious Gathering	Hajj	Review	Crowded conditions lead to respiratory illness, Acute food poisoning due to unhygienic preparation, prolonged storage of food, contaminated water sources, shortage of water for hand washing, health-related morbidity is exacerbated when Hajj occurs during the summer months, worsening of existing illnesses among elderly & young, Fire & trauma
17	Eberhardt	2016	Brazil	2014	Sports gathering	FIFA world cup 2014	Case–control survey	Environmental risk factors: sunburns, insect bites, diarrheal complaints, flu like symptoms, alcohol abuse, casual sexual activities.

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
18	Salmon Rousseau	2016	Saudi Arabia	1952-2015	Religious Gathering	Hajj	Literature Review	RTIs, ENT infections, influenza, pneumonia, whooping cough, TB, water borne infections like hepatitis A, gastroenteritis, furuncles, pyoderma,
19	Gocotano	2015	Philippines	2013	Religious Gathering	Pope's Visit	Secondary data analysis and KI interviews	Cold stress, hypothermia due to sudden tropical storm
20	Alqahtani	2015	Global	Till 2014	Large gatherings	Hajj, Kumbh etc	Review	Vaccine preventable diseases like Influenza, small outbreaks of measles, hepatitis -A, pertussis, TB, pneumococcal disease.
21	Sampsel	2015	Canada	2013	Any mass gathering	NA	Case series analysis	Sexual assault: often associated with alcohol and drug consumption and significant association with younger age
22	Tawfiq	2015	Saudi Arabia	1985-2014	Religious mass gathering	Hajj	Review	Pneumococcus infection, old age and presence of underlying co-morbidities contributed to the risk.
23	Adam Lund	2015	Canada	2014	Music Festival	2-day EDMA	Descriptive study	Low lightning, foggy, very loud noise, drug and alcohol overuse

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
24	Sridhar	2014	India	_	Religious Gathering	Kumbh Mela	Review	Airborne infections like influenza, measles, chicken pox, pertussis, mumps, open air defecation, enteric diseases due to water pollution (pooja items are thrown into water). RTIs, use of cow dung and firewood for cooking onsite lead to increase in cases of cough, blood borne diseases like Hepatitis-B due to ritual of head tonsuring, poor sanitary conditions, water logged areas, vector borne diseases, stampedes, high noise levels, structural collapse.
25	Lorenc	2014	United Kingdom	2012	Sports gathering	London games	Program evaluation (Mixed methods)	Sexual health planning challenges: Limited resources for health promotion & engagement, issues with private sector involvement, inconsistency in leadership and accountability
26	Alison	2014	Australia	2010	Music festivals	NA	Retrospective analysis	Headache, pain, asthma, nausea, fainting episodes, skin rashes, chest pain, substance abuse, heat exhaustion, crushing injuries, blisters, lacerations, sprain
27	Abdullah	2014	Jordan	2010	Religious Gathering	Eid-Al-Adha	Descriptive (Mixed methods)	Food & water borne diseases, drowning, injuries by marine creatures, RTAs, strain on emergency department of health,
28	Polkinghorne	2013	Australia	2007-10	Music Festival	Country music festival	Descriptive (Mixed methods)	Heat stress, skin blisters, GIT cases, unawareness of the purpose of monitoring of food preparation among food vendors, scattered refuse from the bins along the route, crowd crushes especially towards the end of festival

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
29	Al-lami	2013	Iraq	2010	Religious Gathering	Ashura MG at Karbala	Cross sectional	Complications of diabetes, CVD, fever, RTI, injuries mainly related to cultural habits such as intentional scalp lacerations practised by some attendees
30	Youbi	2013	Morocco	2009-10	Religious Gathering	Moulay AbdellahAmghar moussem	Descriptive	Digestive disorders, injuries due to fall from horses, accidents like drowning and unintentional injuries, poor sanitation, food and water contamination, suspicious supply source of private water vendor, unhygienic food preparation at small restaurants, limited access to sanitation facility due to imposition of usage fee, lack of hand washing facilities,
31	Ishola	2011	Global	2010	All planned MGs	NA	Rapid evidence assessment	Factors associated with influenza: high crowd density, prolonged durations of gatherings, indoor event, on site communal camp style accommodation, optimal hygiene facilities. Remarks: Event size, per se, is not considered a critical factor for influenza transmission
32	Hassan	2013	Pakistan	2010	Religious Gathering	Urs of Baba Farid	Descriptive study	RTIs, GITs, Injuries, NCDs (asthma, COPD, hypertension) Remarks: Surveillance data used
33	Keim	2012	China	2010	World Exposition	Shanghai expo	Descriptive study	Upper RTIs, enteric infections, injuries I including lacerations & abrasions), heat related illnesses, headache, fever, acute exacerbation of chronic disease (e.g., high blood pressure or chest pain) ,

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
34	Steffen	2012	Global	2012	All planned MGs	NA	Review	Human stampedes, heat related illness, minor traumatic injuries and medical complaints, outdoor gatherings in developing countries, crowd density and mood, warm & rarely cold weather, pollution, young& old ages, female sex are all associated with increased risk of injury, terrorism
35	Pfaff	2010	Germany	2010	Religious Gathering	Pilgrimage Taizé	Outbreak Investigation	Measles, highlights importance of travelling non-immune adolescents and young adults in spreading the disease
36	Grant	2010	United States	2004-2008	Multiday planned MGs	NA	Descriptive	Dehydration/ heat related illness, abrasions/lacerations, fall related injury majorly among females of age more than forty
37	Qaboos	2018	Saudi Arabia	2015-17	Religious Gathering	Hajj	Cross sectional study	RTIs, Iron deficiency anaemia, hyperemesis gravidarum, hypothyroidism and gestational diabetes mellitus, abortion. Remarks: study aimed to evaluate fetomaternal outcomes among pregnant Indian Hajj pilgrims
38	Soomaroo	2012	Global	1988-2011	All planned MGs	NA	Review of literature	Heat related illness, very few cases of cold related illness, hailstorm/ strong winds leading to stage collapse, air pollution, lightning strike around the venue, Shigellosis outbreak due to poor sanitation (no soap available), limited access to running water, E. coli O157 from nearby live animals , cases of leptospirosis and Legionella from whirlpool aerosol spa, Outbreak of meningococcal Disease

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
39	Simon	2008	United states of America	2005	Religious gathering	Rainbow Family of Living Light	Descriptive (Mixed methods study)	Injuries from outdoor activities, Respiratory conditions (asthma) Remarks: Recommends early collaborative planning, providing minor care, health screening, and information or referral services near the main gathering site
40	Koul	2013	India	2011-12	Religious Gathering	Amarnath Yatra	Descriptive	Acute mountain sickness (AMS) and the potentially life-threatening high-altitude cerebral edema (HACE), and high-altitude pulmonary edema (HAPE) Remarks: Pilgrims attribute the signs of AMS to the achievement of a "state of trance" as a result of divine intervention and thus refuse to interfere in this supposed state of spirituality. The normalization of the symptoms after the cave visit is never attributed to the descent, but is due to primarily to divine healing.
41	Ganie	2012	India	2006-07	Religious Gathering	Amarnath Yatra	Retrospective data analysis	Hyperglycemic emergencies with predisposing factors as High altitude, strenuous exertion of going uphill, withdrawal of insulin or oral hypoglycemic drugs, starvation, sepsis, and alcohol intake
42	Milsten	2017	United states of America	2011-14	Music festival	NA	Descriptive	Mosh pit injuries, crowd surfing injuries, head injuries

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
43	Feldman MJ	2004	United states of America	2003	Music Festival	Rolling stones concert	Descriptive	Headache, heat-related complaints, nausea or vomiting, musculoskeletal complaints and breathing problem Remarks: documented EMS response to the largest single-day, ticketed, rock concert ever held in North America
44	Munnoch	2004	Australia	2003	Planned mass gathering	Youth camp	Outbreak Investigation	Hepatitis A, contributing factors being temporary food outlets, untrained food handlers and the unhygienic preparation of food. Remarks: Preparation of food in designated food premises was recommended
45	Milsten	2004	Global	1997-99	Planned MGs	League Baseball, and rock concerts	Descriptive Retrospective data analysis)	Type of event and apparent temperature were the variables that best predicted MUR as well as common trends of injury and treatment rates
46	Bernardo	2004	Global	2004	Planned mass gathering	NA	Review	Infants and toddlers are expected to be present at large religious MGs, fairs, concerts, festivals, and family-oriented gatherings whereas sporting events attract adolescents or school going children with or without supervision. Special needs children may be especially susceptible to environmental conditions. Kids rarely carry personal identification, making the identity of an unconscious or missing child difficult to determine. Remarks: Pediatric Emergency Preparedness for Mass Gatherings and Special Events was discussed

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
47	Hadjichristodoulou	2004	Greece	2004	Sports gathering	Athens Olympics	Descriptive (Needs assessment study)	Foodborne, airborne &waterborne diseases, low risk of infectious non-endemic diseases like malaria, brucellosis, yellow fever, hemorrhagic fever, hepatitis A, high risk of non-infectious diseases: heat related illnesses, motor vehicle accidents, drowning, outdoor injuries.
48	Vasquez	2015	United states of America	2015	Sports gathering	Special Olympics world games	Review	Heat illness, dehydration, sunburn, and foot burn, injury from slipping during rains, coordination with local security, law enforcement, and fire departments, adequate availability of public water and resting area along the route.
49	Milsten	2003	Global	1977-2002	All planned MGs	NA	Review of literature	Weather, attendance, duration of event, outdoor or indoor, seated or mobile, event type, crowd mood, crowd density, alcohol & drugs, locale, age are the factors contributes to the number of patients seen at an event and the rates of injury detected

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
50	Anikeeva	2017	Australia	2015-16	Planned MGs	NA	Cross sectional	Patient presentations per event (PPE)were higher for MGs held in stadiums compared to those held in grounds and parks at events where the expected crowd size exceeded 40,00 0 with medium level of crowd density, decreased PPE at seated gatherings, PPE increased with increasing levels of cohesive behavior and cohesive dress (leading to rivalry among opposing groups). Most common presenting problems were headaches, neck pain, and blisters, sprains, abrasions, insect bites and major injuries, such as fractures and lacerations, alcohol intoxication.
51	Moore	2011	Global	_	Planned MGs	NA	Review	Event type (PPE more in cultural events), Hot weather, rain, presence of alcohol, prolonged incubation periods for certain illnesses in MGs of longer duration, dust and dense crowds can worsen preexisting respiratory conditions, crowd demographics , bounded events have increased hospital use because patientswere unlikely to venture to the outside medical facilities, mobile events compared to seated have more PPE.
52	Khan	2016	Saudi Arabia	2016	Religious Gathering	Hajj	Descriptive study	Acute confusional state, acute stress reaction, fear of being lost, surge in anxiety in first week, acute onset delirium, sleep disturbances. Remarks: Emergence of psychopathology and its determinants in Indian pilgrims on Hajj was studied

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
53	Dwivedi	2015	India	2013	Religious Gathering	Kumbh Mela	Case report	Requirement of post-event planning, sanitation quick response teams, real time monitoring of waste disposing vehicles required
54	Jani	2016	India	2013	Religious Gathering	Kumbh Mela	Descriptive	Deterioration of water quality. Remarks: Spatiotemporal profiling of bacterial communities in water bodies
55	Baranwal	2015	India	2013	Religious Gathering	Kumbh Mela	Case report	Drainage problems, fire accidents, absence of separate toilets for males and females, number of persons per toilet were high
56	Faisal	2013	India	_	All mass gatherings	NA	Comparative review	Stampedes due to rumours, competition of procurement, sudden notice, end of event- exit or surge at the beginning of event, natural or human induced hazards, surge of people on special days and accidents.
57	Burkle	2010	India	2010	Religious Gathering	Janki temple pilgrimage	Review / comment	Stampedes due to high crowd densities (e. g.1000 0 people converging on a site designed to hold no more than 1000), increasing fervor of religious celebration, scarce resource distribution, lack of advance warning to local authorities, and insufficient security measures
58	Cariappa	2015	India	2013	Religious Gathering	Kumbh Mela	Descriptive	COPD, traumatic injuries due to accidents, exaggeration of existing illnesses like diabetes & hypertension, diarrhoea, burns, dog/ monkey/snake bite, recommends integrated and intersectoral approach involving all stakeholders within and outside the system of government

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
59	Balsari	2016	India	2013	Religious Gathering	Kumbh Mela	Descriptive	Communal meals, communal bathing, fecal contamination, water-borne disease transmission , challenge of hand hygiene, Stampede, real-time information during the festival flowed very slowly across the complexnetwork of stakeholders, no written operational codes, planning mainly based on the institutional memory recorded in archival government reports and the experience of the few previous Kumbh Melas employees, long delays in response by ambulances on the busy days of heavy pedestrian traffic, no surveillance system in place, patient presentations of low severity, at times of high volumes of admissions, record keeping was almost non-existent.
60	Vortmann	2015	India	2013	Religious Gathering	Kumbh Mela	Descriptive (Mixed methods study)	Water borne diseases due to communal bathing, eating and poor hygiene, challenge of maintaining pit latrines, clogging of pipelines, wastewater pools draining directly to the river in the communal cooking and bathing areas. Data on health surveillance did not identify nationality or place of origin, excluding a participant subgroup review, population surge on bathing days, bathing areas lacked ready access to piped potable water owing to which pilgrims ended up drinking water from non-potable grey water from trucks, lack of signage of water sources, toilet facilities or hand-washing facilities.

ID	Author	Year of publication	Location	Time of study	Type of MG	Name of MG	Article Type/Study	Event/Patient related risks (Major findings)
61	Joseph	2016	India	2014	Religious Gathering	Sabarimala	Descriptive	Outbreak of food & water borne diseases, myocardial infarction, GIT illnesses, allergic reactions, air borne diseases, exacerbation of underlying medical conditions (asthma, hypertension, diabetes), animal and insect bites, human stampedes/crowd disasters, structural collapse and sun stroke. Shortage of life-saving drugs, work stress due to excess patient load &shortage of paramedics.

Based on the results of literature review and interviews with key informant, we finalized the risk assessment tool with seven domains, 23 items and 48 health risks peculiar to religious MG events. We evaluated the draft tool for face and content validation.

Validity of the tool

We circulated the preliminary draft of the risk assessment tool to six experts. We collected written as well as verbal comments on the tool as their feedback. Selected respondents assessed that the content of the tool reflects what it was intended to measure i.e. risk assessment in religious mass gatherings. Face validity is regarded as a subjective assessment of scale, so we also considered the subjective ideas of the participants throughout the data analysis.

Content validity: Table 5 describes the content validity analysis of the risk assessment tool. Out of the 23 items, 18 items were agreed upon as 'Relevant' by all the six experts. Agreement proportion expressed as Scale level Content Validity Index (S-CVI), calculated by averaging method (S-CVI/Ave =average of all I-CVI) was 0.92. In addition, S-CVI, calculated by universal agreement method (S-CVI/UA= Total number of items agreed relevant by all six experts/ Total number of items) was 0.78, indicated excellent content validity of the tool. The 'Item-Content Validity Index (I-CVI)' of 'Solid waste management' (item no 14) was 0.17. I-CVI of items 'Participant origin (item no 7) 'and 'Psychosocial behavior of participants (item no 9) 'was 0.67 and I-CVI of the items 'Area involved (item no 4)' and 'Fire safety (item no 20)' was 0.83. The items 7, 9, 14 & 20 were retained in the tool with minor modifications and 'Solid waste management' (item no 14) was merged with the item 'Sanitary and hygiene facilities. '

Table 5: Content Validity of the tool

Item no	Domain	Item Description	Rater_1	Rater_2	Rater_3	Rater_4	Rater_5	Rater_6	Number agreement	I_CVI
1	1	Activity level	×	×	×	×	×	×	6	1
2	1	Topographical Characteristics	×	×	×	×	×	×	6	1
3	1	Event Duration	×	×	×	×	×	×	6	1
4	1	Area involved	×	×	-	×	×	×	5	0.83*
5	1	Expected no of participants	×	×	×	×	×	×	6	1
6	2	Special participant profile	×	×	×	×	×	×	6	1
7	2	Participants origin	×	×	-	×	-	×	4	0.67*
8	2	Predominant age group	×	×	×	×	×	×	6	1
9	2	Psychosocial behaviour of participants	-	×	×	×	×	-	4	0.67*
10	3	Season	×	×	×	×	×	×	6	1
11	3	Type of accommodation	×	×	×	×	×	×	6	1
12	3	Access route to the event	×	×	×	×	×	×	6	1
13	3	Sanitation & Hygiene facilities	×	×	×	×	×	×	6	1
14	3	Solid waste management	-	-	-	-	-	×	1	0.17**
15	3	Special rituals	×	×	×	×	×	×	6	1
16	4	Food safety	×	×	×	×	×	×	6	1
17	4	Water safety	×	×	×	×	×	×	6	1
18	5	Crowd management	×	×	×	×	×	×	6	1
19	5	Event access points	×	×	×	×	×	×	6	1
20	5	Fire safety	×	×	×	-	×	×	5	0.83*
21	5	Natural hazards management	×	×	×	×	×	×	6	1
22	6	Level of medical services at the venue	×	×	×	×	×	×	6	1
23	7	Preplanning activities	×	×	×	×	×	×	6	1
										S-CVI/Ave: 0.92
										Total agreement: 18; S-CVI/UA: 0.78

**Item no 14-elimianted from the tool; *item no 4, 7, 9, 20 retained with minor modifications

Table 6 describes the Fleiss kappa statistics to measure the agreement between multiple experts after adjusting the component of chance agreement. Fleiss kappa value was calculated to be 0.522 (95% CI: 0.417, 0.628, P value: 0.00 1) indicated moderate agreement between the experts.

Table 6: Fleiss Kappa statistics to assess agreement between multiple experts (N=6)

Overall agreement between the experts		
Fleiss Kappa Value	95% CI	p Value
0.522	0.417, 0.628	**0.00 1**

4.2Description of Mobile web application MGRAT (Objective 2)

Content and functionality details:

The developed mobile web application is named “Mass Gathering Risk Assessment Tool (MGRAT).” Mass Gathering Risk Assessment Tool (MGRAT) (Annexure A-7) is a mobile web application-based tool that predicts a list of event-specific health and environmental risks associated with religious mass gathering events in India based on the public health managers' inputs regarding various factors enlisted in this web-based application. It is also embedded with formulas that calculate the rank for each risk predicted for an event. The tool is designed to permit the users to observe the list of risks and ranking for each risk associated with religious mass gathering events.

The app's target users are public health managers involved in the planning activities of the religious mass gatherings. The app is intended to be used before the public event, i.e., the experts' pre-event stage, to assess the forthcoming event's potential risks. The overarching aim of MGRAT is to identify and rank the essential risk-driven variables so that experts can prepare strategies and resources accordingly. Based on the rankings, the appropriate follow-up to diminish the event's health risks is recommended based on the guidelines issued by organizations World Health Organization (World Health Organization, 2015c)**.** The operating model of the MGRAT app has been depicted in Figure 6.

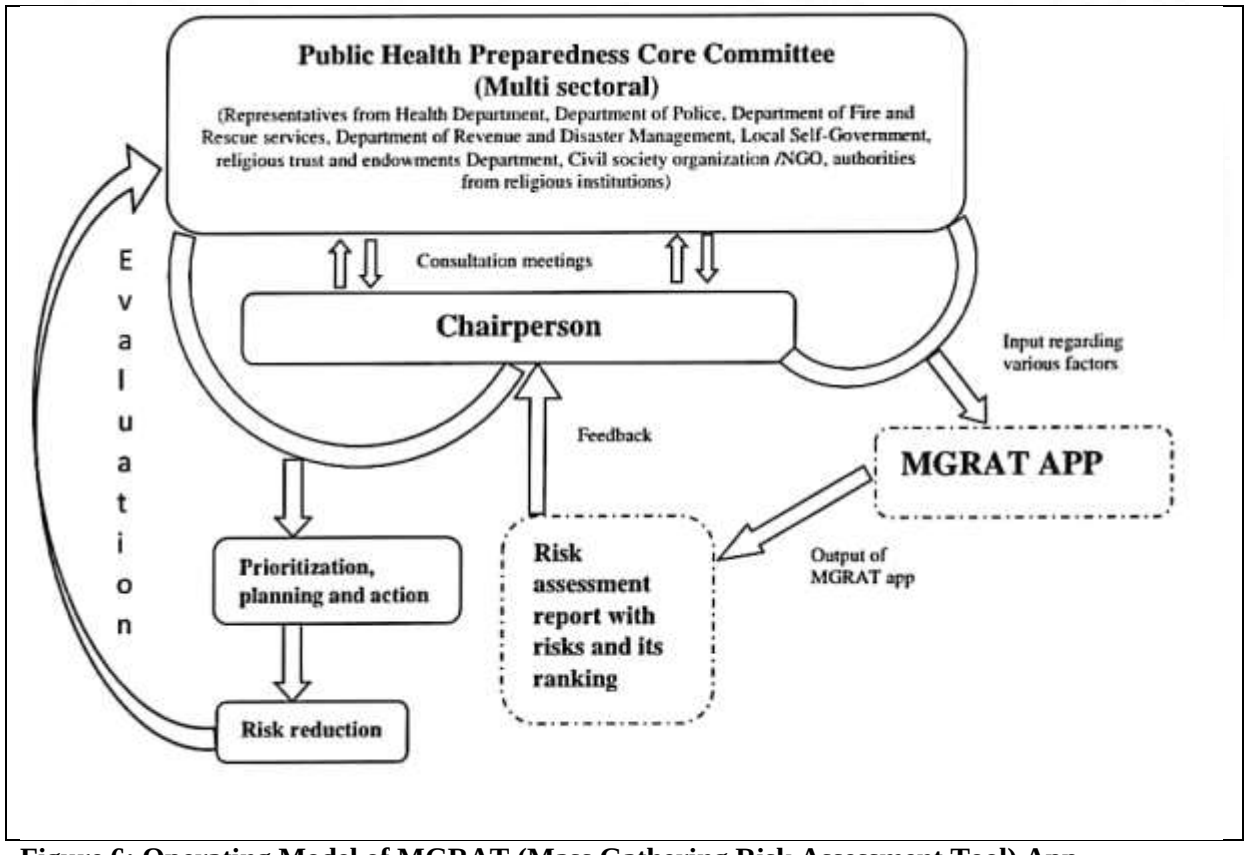

Figure 6: Operating Model of MGRAT (Mass Gathering Risk Assessment Tool) App

The MGRAT looks into the following aspects of the religious MGs' risks: (a) What are the risks can happen? (b) How likely is it to happen? (c) What are the consequences if it does happen?

The MGRAT is divided into two parts, namely:

- Part 1: Risk identification and categorization
- Part 2: Risk Characterization (Assessment and Ranking)

The MGRAT app starts with a page giving a brief introduction of the app, its development process, and the basic layout (Figure 7). Given below are the screenshots of the pages introducing the users to the MGRAT app. After this, the Part-1 of MGRAT begins by asking the user to fill up the ‘event details’ that include the event's name, venue, and duration of the event and the ‘user details’ that include name, age, gender, designation, and department of service. (Figure 8)

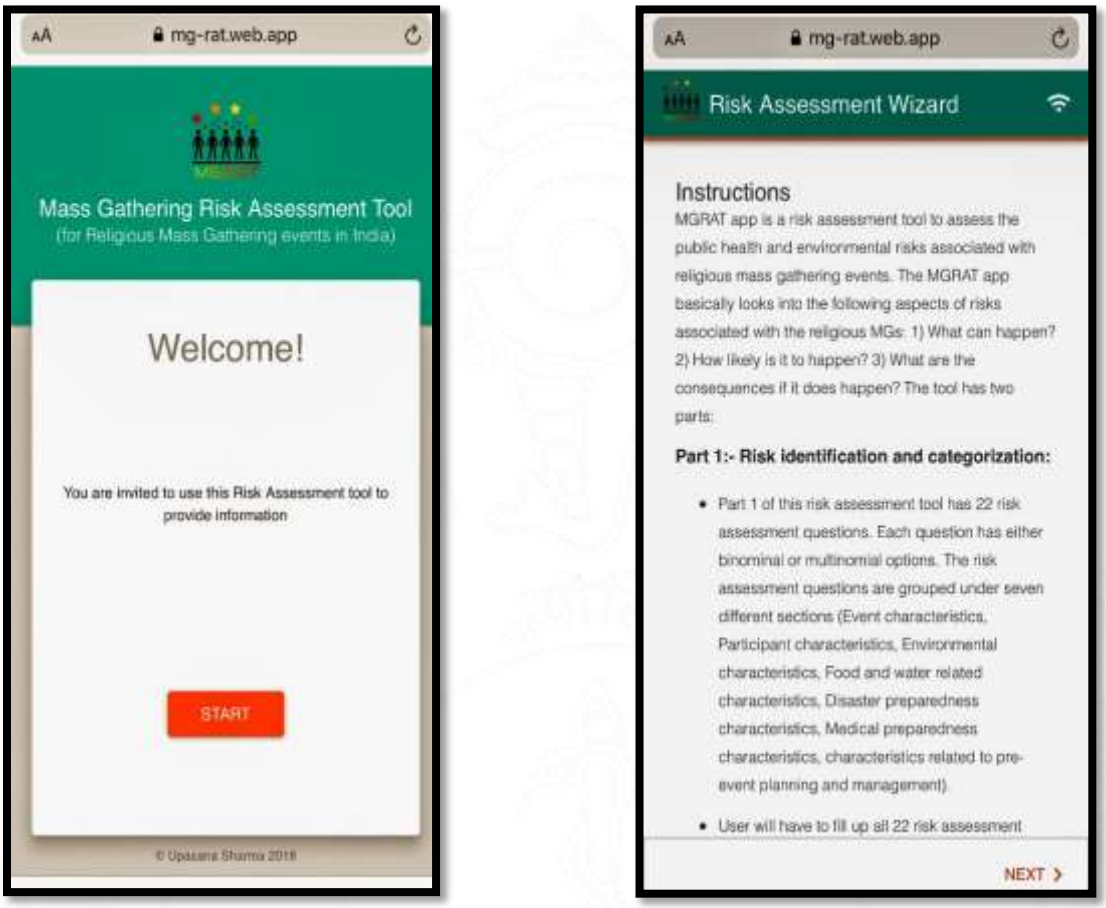

Figure 7. **Screenshots of user instruction page of MGRAT app**

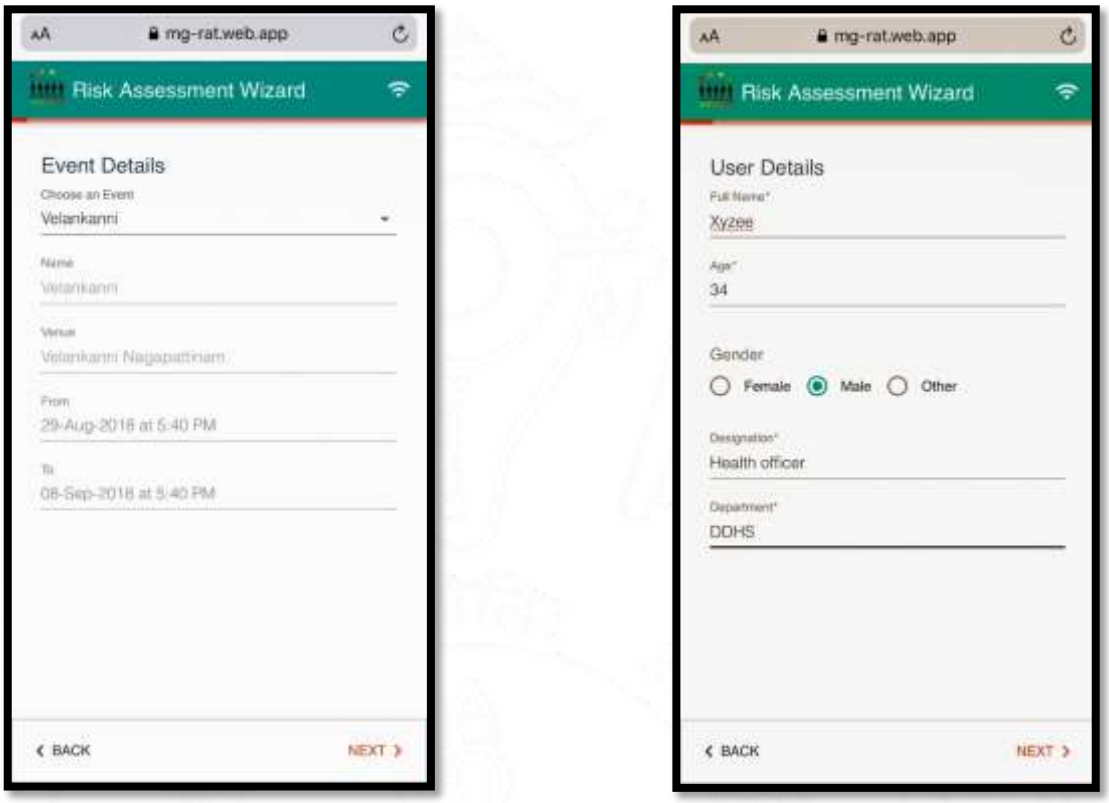

Figure 8. **Screenshots of the pages asking for the event and user details of MGRAT app**

Part 1: Risk identification and categorization

Part -1 of the MGRAT app aims to predict the potential risks that can be expected in a religious MG. In this app, the tool's identified domains were considered different sections; the items were modified as independent risk assessment questions and were grouped under their corresponding domains /sections. The factors associated with each item were modified as response options for the separate risk assessment questions. And the identified unique health risks associated with the options/factors were linked with each option/factor. Therefore, if the user selects an option (factor) for an independent risk assessment question (item) under any section (domain), the corresponding unique

risks linked with the particular option (factor) will be predicted as the risks associated with the event. We further categorized the risks into four categories, namely infectious, non-infectious, injuries, and others. The part-1 of the MGRAT consisted of seven sections that are listed below:

1. Event characteristics
2. Participant characteristics
3. Environmental characteristics
4. Food and water-related characteristics
5. Disaster preparedness
6. Medical preparedness
7. Pre-event planning and management

Part 1 of the MGRAT app has 22 independent risk assessment questions grouped under seven sections mentioned above. Each independent risk assessment has either binominal or multinomial response options. The user has to fill up the appropriate options for all the risk assessment questions based on the MG event in question. Based upon the user's response options, relevant risks linked with that option are listed in the output. Thus, at the end of part 1, a complete list of unique risks associated with the specific MG event identified based on the MGRAT app can be viewed.

For example, in the screenshot given in Figure 9, the user selects the option, ‘Sea side /river banks’ and ‘Plains’ as the options for the independent risk assessment question- ‘Topographical Characteristics’ under the section ‘Mass gathering Event Characteristics.

’ The risks linked with the options ‘Sea side /river banks’ and ‘Plains’ will be enlisted in the output of part-1. Some risk assessment questions demand multiple options as the response, those were identified, and multiple option selection facilities was enabled for those questions. The screenshot example (Figure 9) is one such question which allows user to select various options as answers.

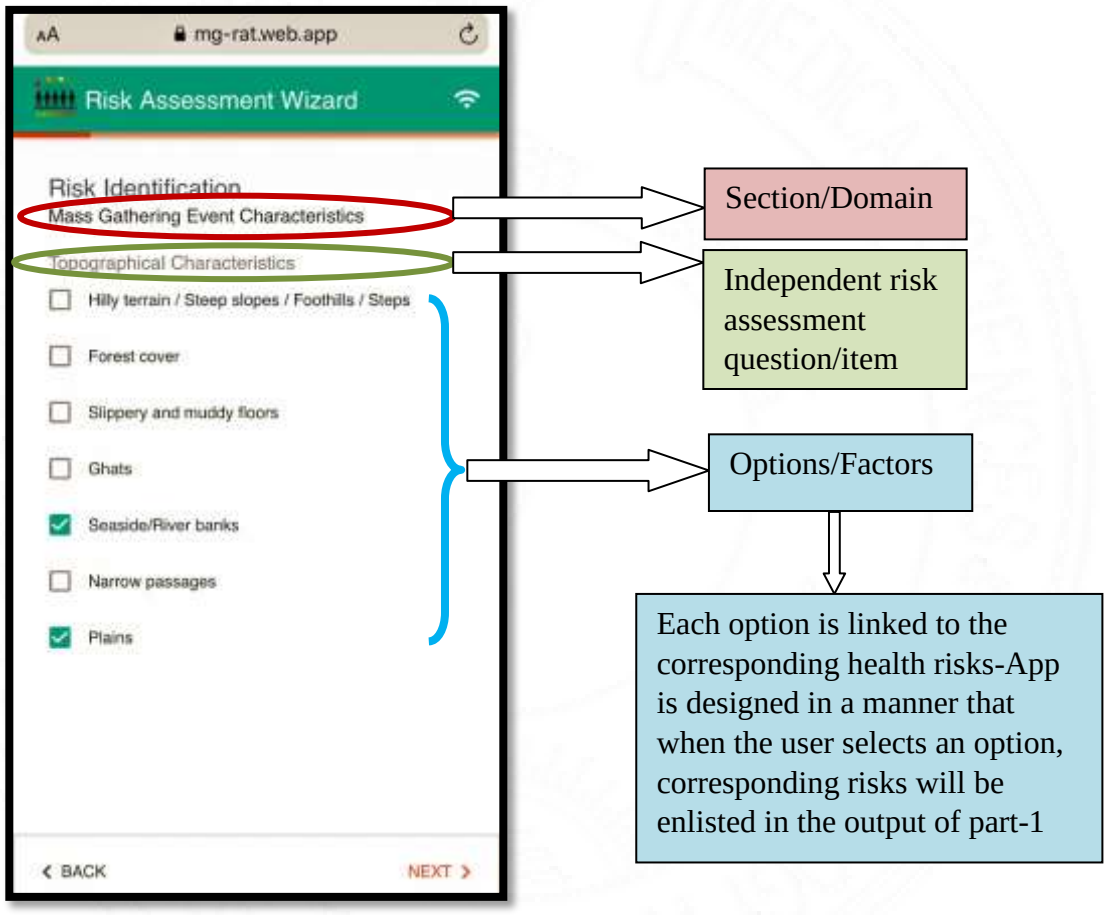

Figure 9.**Screenshot of MGRAT app page with one of the risk assessment questions with the options**

The identified risks are further categorized into four broad categories: infectious, non-infectious, injuries, and others. So, this part's output will have the list of risks grouped under the categories mentioned above. The background algorithm designed for the MGRAT web app performs this categorization part on its own. Similarly, duplication of the risks in the output is also taken care of automatically by the background algorithm. This way, different questions on seven sections appear, and the risk identification process is completed. MGRAT app promptly indicates the user regarding completion of part 1. (Figure 10)

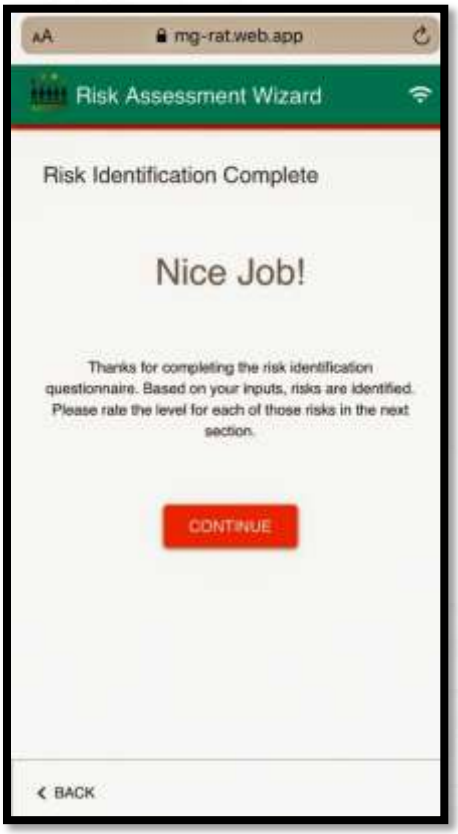

Figure 10: **Screenshot of MGRAT app page which promptly indicates the user regarding completion of part 1**

Part 2: Risk Characterization (Assessment and Ranking):

After completing the Part-1, i.e., 'Risk Identification,' the user moves on to the Part-2 of the MGRAT app. Here, the user assesses the likelihood levels and the consequences for each of the identified risks (from Part-1).

In this step, the aim is to analyze how likely the expected risks might occur and their effect if they occur. The level of likelihood and consequences of risk are to be evaluated by the user/public health managers. Based on both these parameters, a risk rank/level is assigned. The mobile app gives each identified risk's risk rank /level based on the likelihood and consequence level fed by the user for the event's risk assessment process. The rank/level of the expected risk will enable the PHP team to take the recommended actions to mitigate the risks. Thus, each factor's risk level depends on two variables: the likelihood and consequences of the possible risk. There is a significant role of subjectivity here while the app allows the user to feed her/his evaluation about the likelihood and consequence of the identified risk. However, since this app's potential users are the public health managers, MGRAT works on the assumption that their input is the outcome of their experience, multiple consultation meetings, numerous field visits, record reviews, etc. So, these are considered valid. However, the author of the MGRAT app admits this as one of the important limitations of MGRAT and believes there is a scope of improvement in this aspect in the future.

The operational definitions of likelihood and consequence levels were finalized based on the guidance documents on MGs given by the World Health Organization. (Table 7 & 8)

Table 7: Operational definitions of Likelihood levels of the risk:

Likelihood Level	Definition	Further details about the definition
Certain	Expected to occur	If the PHP team feels that a given risk is certainly going to occur, the public health official may choose the option 'Certain' for the given risk.
Likely	Considerable opportunity to occur. It frequently happened at past events	If according to the PHP team, a given riskhas a considerable opportunity to occur at the time of the event because it has occurred frequently during the past events, the official may use the option 'Likely' for the given risky
Moderate	Might occur. A few recorded incidents at past events	If there are few recorded incidents of the given risk during the past MG events, the PHP team may choose the option 'Moderate' for the given option.
Unlikely	Not expected to occur. No incidents recorded at past events	If the PHP team feels thatagivenriskis not expected to occur because no incidents have been recorded in the past at the time of MG events, he may choose the option 'Unlikely. '
Rare	Would require exceptional circumstances to occur	The option 'Rare' may be chosen if, according to the PHP team, it would take some exceptional circumstances for such a risk to occur

Table 8: Operational definitions of Consequence levels of the risk:

Consequence Level	Definition	Further details about the definition to PHP team
Catastrophic	Large numbers injured several deaths. Extensive damage	If according to the PHP team, a given risk will cause several deaths and injure a large number of pilgrims and result in straining the local services and infrastructure widely, he/she may choose the option ' Catastrophic' for the given risk
Major	Extensive illness/injuries and some deaths. Long term impacts	If a given risk is expected to cause extensive illness/ injuries and few deaths and will end up disrupting the public health and medical services, the option 'Major' may be chosen by the PHP team
Moderate	Treatment and hospital required, but no deaths.	According to the PHP team, if a given risk will lead either to deaths or injuries/ illness among the pilgrims and may also strain the public health and medical services to some extent, then the option ' Moderate' may be chosen.
Minor	A small number of illnesses/injuries, but no deaths. Short duration	If only a small number of injuries/illness will occur but no chance of deaths occurring and a situation that can be managed reasonably well by the existing public health and medical services, the option ' Minor' may be chosen by the PHP team
Insignificant	No injuries, illness, or deaths. Little or no damage	With little or no damage and no injuries/ illness or death expected due to a suspected risk, the 'Insignificant' option may be chosen by the PHP team

Thus, the user has to select the likelihood level and consequence level for each risk identified in part-1. MGRAT app displays the operational definition (interpretation) of the likelihood and consequence while selecting the option on the page before capturing the selection. This helps the user in choosing the correct level of likelihood and consequence for a given risk. (Figure 11)

The screenshot given in Figure 12 shows the page that marks the completion of Part-2 of the MGRAT app, i.e., 'Risk Characterization. ' Once the user has completed Part-2 of the app, i.e./he has entered input regarding the likelihood and consequences for all the identified risks, the MGRAT app will show the page which promptly indicates the user regarding the completion of part 2, and as the user clicks the 'view scores' icon s/he can view the score or ranking or level of

the identified risks with the interpretation and the same can be downloaded in PDF format as well.

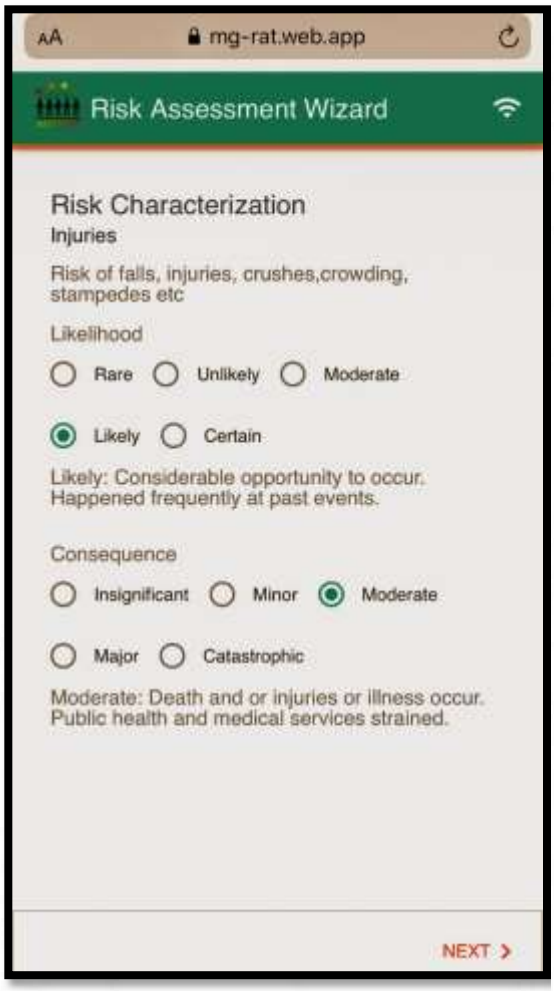

Figure 11. **Screenshots of risk characterization page of MGRAT app showing options for likelihood and consequence assessment.**

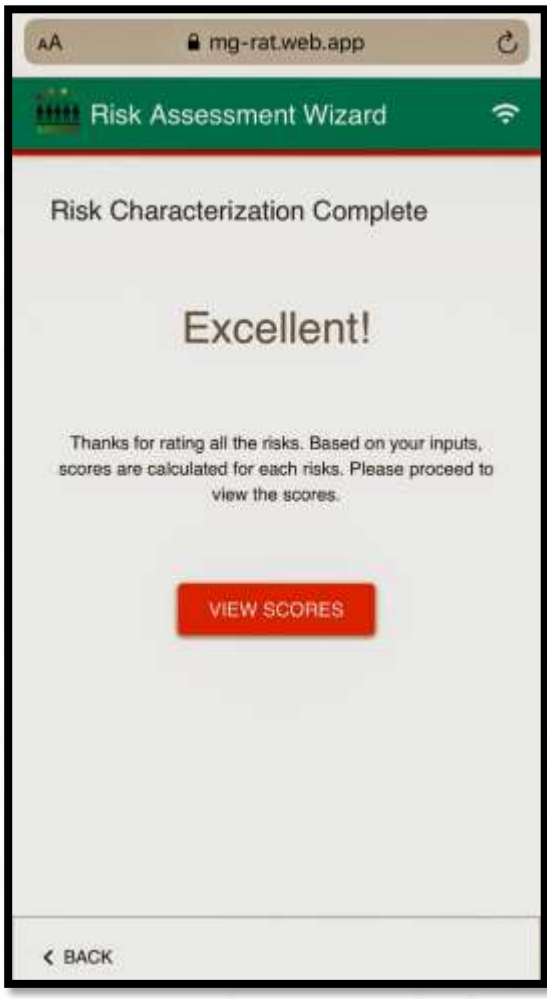

Figure 12. **Screenshot showing the page that marks the completion of Part-2 of MGRAT app**

Ranking Matrix: Calculated by MGRAT app based upon the likelihood of risk & its consequence levels:

Risk ranking is a qualitative assessment of the risks identified based on the public health managers' expert opinion involved in the preparedness and response activities of the mass gathering who are the app's intended users. The likelihood level and consequence level for each risk indicated by the user gives the specific rank/score/level of each risk.

Multiplying the values of likelihood and consequence is by far the most common method of measuring the risk. (ISO 31000 Risk management 2009) The MGRAT app gives risk rank /level/ score based on the user's inputs for the likelihood and consequence level. The rank/level/score of the expected risk enables the PHP team to take the recommended actions. A risk matrix as an output of systematic characterization of the identified risks will help public health managers prioritize risks and plan the public health measures as response activity.

Figure 13 depicts the 'Matrix of Risk Ratings/ Score/ Level, which systematically analyzes each risk. For example, a risk is assessed as unlikely or rare in its likelihood level to occur and set as major or catastrophic in its consequences level if it occurs. The risk should be considered as significant (score/rank=3). This matrix is based on the World Health Organization (WHO 2012; WHO 2015).

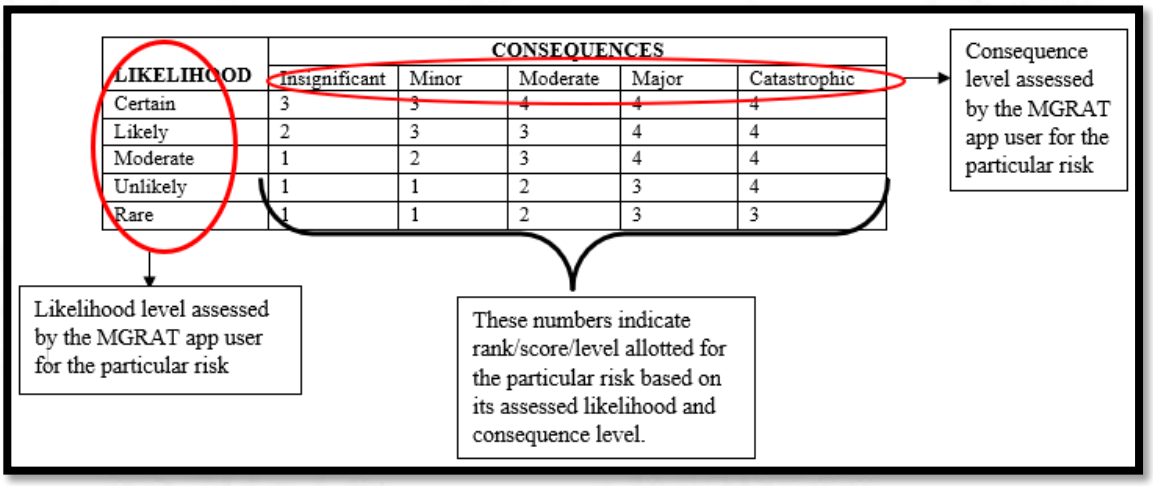

Figure 13. **Risk ranking matrix**

The two facets of interpretation and the recommended action under different risks/scores of each risk are eluded in the MGRAT app (Table 9).

Table 9: Interpretation of the risk ranks/scores and the recommended action for different ranks/ scores in the matrix

Risk rank/score (Interpretation)	**Recommended action**
1 (Low)	The routine measures can manage this. Hence, routine activities should be strengthened to be adequately in place.
2 (Moderate)	Specific monitoring or response procedures should be in place in the preparedness plan.
3 (Significant)	Some action should be taken for such a risk to reduce its consequence or likelihood.
4 (High)	Action must be taken to reduce the consequences or likelihood of the potential risk. Preparedness activities should be in place to deal with such risks on a priority basis.

MGRAT app performs the calculation in the matrix rank/score/level for each risk based on the users' inputs regarding the likelihood and consequence level for each risk in part 2 using a background algorithm designed based on the matrix system described above. The interpretation and recommended actions are linked to its appropriate risk rank/score/level. Hence, once the user clicks the 'view scores' icon, s/he can view the output page of the MGRAT app, which contains the list of identified risks grouped under four broad categories as mentioned previously, with risk rank/score/level for each identified risk and a color-coded legend showing the interpretation of the risk rank/score. At the bottom of this page, there is a 'Download' icon; as the user clicks this icon, the output document (Comprehensive risk assessment report) is downloaded in PDF format. (Figure 14)

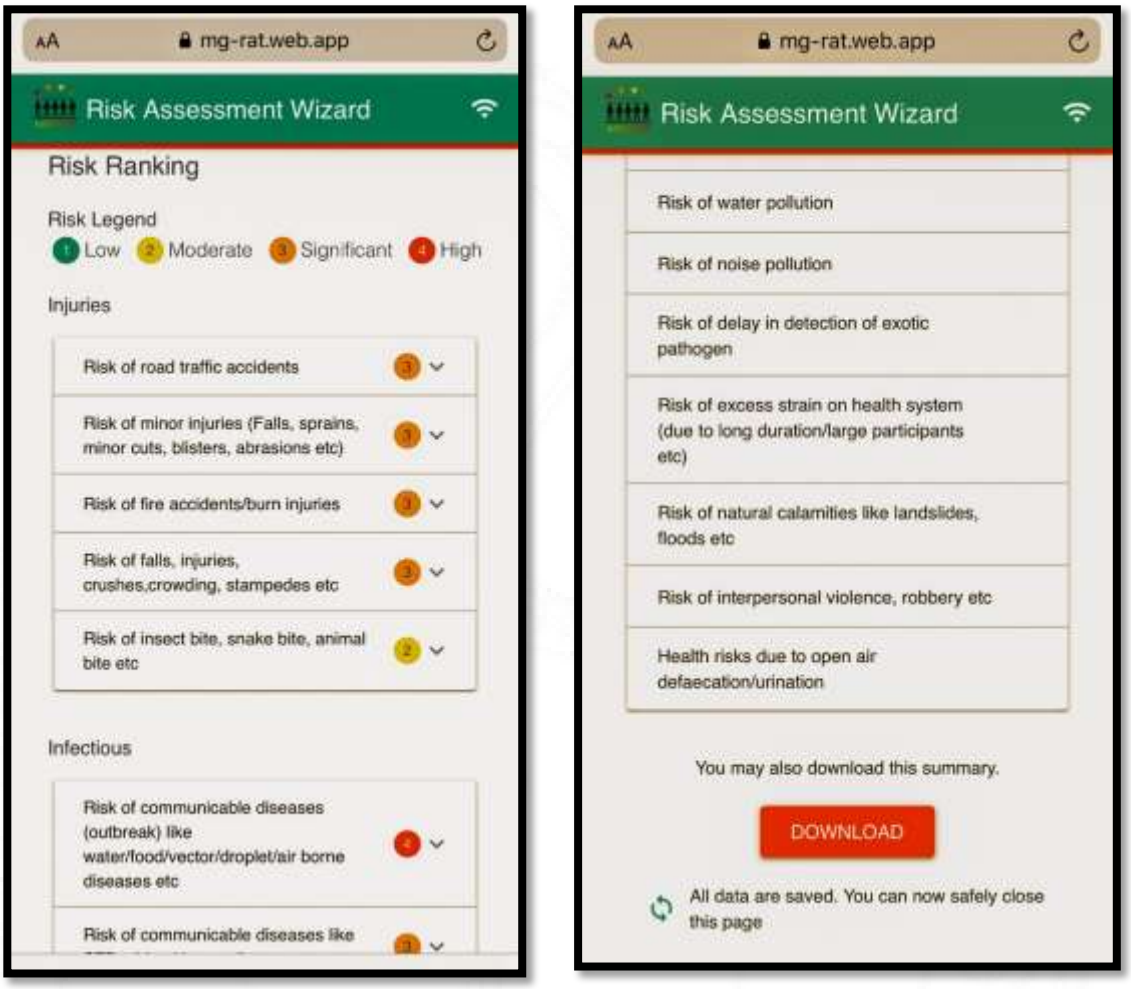

Figure 14. Screenshots showing the output page of MGRAT app showing risks, risk rank/score, colour coded interpretation of risk score (risk legend). 'Download' icon is present at the bottom the output page.

The comprehensive risk assessment report contains time and date stamp, user information, mass gathering event, and a combined summary of the outputs of part 1 and part 2 of the MGRAT app. The output is summarized in four tables, each for one of the four broad categories (Infectious, Noninfectious, Injuries, and Others) under which the risks are grouped /categorized. Each table has four columns. Column 1 denotes the list of risks under the particular category; column 2 shows the risk score/ rank/level.

Column 3 shows the interpretation of the risk score, and column 4 shows the recommended action. (Figure 15)

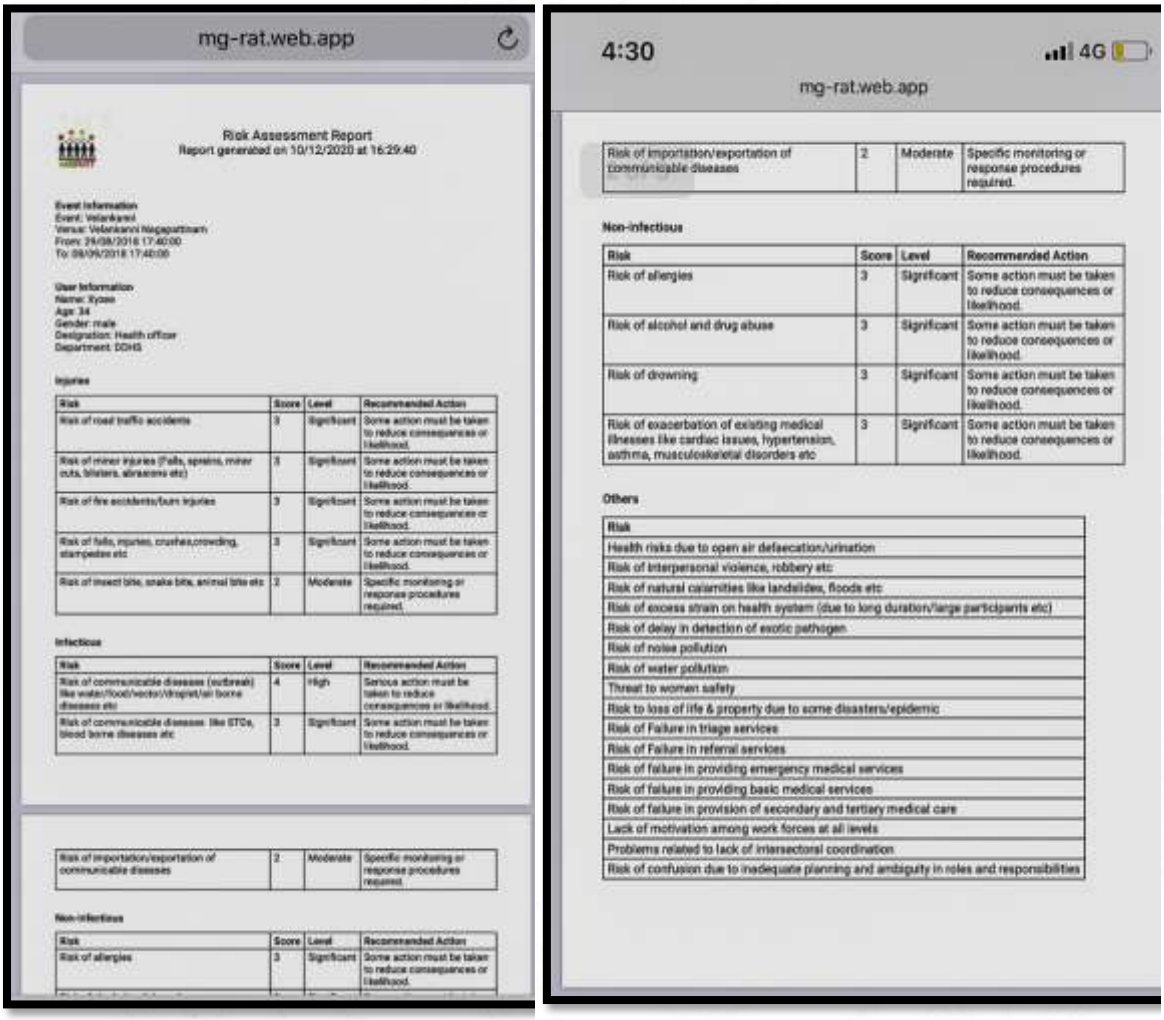

Figure 15. Comprehensive risk assessment report of MGRAT app

Using this comprehensive risk assessment report, public health managers can take necessary actions. This can serve as a guide for making adequate preparedness of potential risks & prioritizing response plans accordingly.

4.3Results of feasibility study (Objective 3)

In this section, the feasibility of the mobile app based risk assessment tool in a selected religious mass gathering 'Karthigai Deepam' of Thiruvannamalai district of Tamil Nadu is reported.

To assess the feasibility of the MGRAT app, all the core Public Health Preparedness (PHP) team members (N=49) involved in a selected religious mass gathering event ('Karthigai Deepam festival, 2018' of Thiruvannamalai district of Tamil Nadu) used the MGRAT app concerning Deepam festival and gave their feedback. In this section, for description purposes all the core Public Health Preparedness (PHP) team members (N=49) who used this app have been mentioned as 'app users. '

Out of the 49 app users, who used the MGRAT app to assess the risks associated with the Thiruvannamalai Deepam festival, 2018, about 85.7% (42/49) were males, and 14.3% (7/49) were females. The average age of the app users was 33.2 years, with a standard deviation of 9.6. As mentioned elsewhere, we categorized the app-users into high, middle, and grass-root level based upon their role in public health preparedness for this religious MG event. Out of 49 app users, 17 (34.7%) were high level, 24 (49%) were middle level, and 8 (16.3%) were grass-root level. (Table 10)

Table 10: Background information of the app users (N=49)

S. N	Variable	n (%)
1	**Gender**	
	Male	42 (85.7)
	Female	7 (14.3)
2	**Mean age (SD)**	33.2 (9.6)
3	**Designation**	
	Duty Medical officers (Mid-level)	24 (49)
	Medical officers/other Officers with managerial role (High level)	17 (34.7)
	Sanitary Inspectors (Grass root level)	8 (16.3)

Table 11 describes the descriptive statistics of the app users' feedback about the content of the MGRAT app. All (100%; 49/49) app users felt that the items in the MGRAT tool referred to the relevant aspects of the construct to be measured i.e., assessing health risks associated with religious MG event. To be specific, 32.7% (16/49) indicated the items as highly relevant and 67.3% (33/49) as quite relevant. Similarly, all (100%; 49/49) the app users felt that the items in the MGRAT tool were relevant for the setting where it is going to be applied. Most 51% (25/49) described the items as quite relevant, and the other 16 users (32.7%; 16/49) felt the items were highly relevant.

All the app users (100%; 49/49) indicated that the items of the MGRAT tool comprehensively reflected the construct (risk assessment) to be measured. Among them, the majority, 63.3% (31/49), indicated those were ‘quite reflecting. ’ The majority of the users, 57.1% (28/49), mentioned that the items were ‘highly simple and understandable’. Most (95.9%; 47/49) of them considered that the tool was feasible [(highly feasible (40.8%; 20/49) and quite feasible (55.1%: 27/49)] to apply in the given settings.

Table 11: App users feedback about the content of the tool (N=49)

S. N	Parameters	Response			
		Not relevant	**Somewhat relevant**	**Quite relevant**	**Highly relevant**
		n (%)	**n (%)**	**n (%)**	**n (%)**
1	**Items refer to relevant aspects of the construct to be measured**	0 (0)	0 (0)	33 (67.3)	16 (32.7)
2	**Items are relevant for the setting where it is going to be applied**	0 (0)	6 (12.2)	25 (51)	18 (36.7)
		Not at all	**Somewhat reflecting**	**Quite reflecting**	**Highly reflecting**
		n (%)	**n (%)**	**n (%)**	**n (%)**
3	**Items together comprehensively reflect the construct to be measured**	0 (0)	2 (4.1)	31 (63.3)	16 (32.7)
		Not at all	**Somewhat simple**	**Quite simple**	**Highly simple**
		n (%)	**n (%)**	**n (%)**	**n (%)**
4	**Items are simple and understandable (for the user)**	0 (0)	3 (6.1)	18 (36.7)	28 (57.1)
		Not at all	**Somewhat feasible**	**Quite feasible**	**Highly feasible**
		n (%)	**n (%)**	**n (%)**	**n (%)**
5	**Feasibility of application of the tool**	0 (0)	2 (4.1)	27 (55.1)	20 (40.8)

Table 12 describes the descriptive statistics of the app users' feedback and rating captured using the modified Mobile App Rating Scale (MARS), a 9-item scale.

The majority, 63.3% (31/49) of the app users, rated the app with four stars and, 28.6% (14/49) gave three stars. Regarding the appropriateness of the app's content for the target audience, most 69.4% (34/49) found that the app was well targeted with negligible issues. Regarding the app features and its components, most 51% (25/49) found the app worked perfectly with no technical bugs. Some 46.9% (23/49) of app users found that

the app to be functional with negligible issues. Around 46.9% (23/49) app users could immediately use the app and felt intuitive and simple. Regarding the app's stated goals, the majority 51% (25/49) felt that the app had specific and measurable goals that were highly achievable. Almost all the app users, 98% (47/49) felt the contents as either highly relevant or quite relevant. Regarding the visual appeal, more app users, 44.9% (22/49) indicated it to be average, and some 36.7% (18/49) felt it to have a high level of appeal. Around 67.3% (33/49) of app users found the app to be engaging and interesting. Many app users (49%, 24/49) indicated that they would recommend the app to others.

Table 12: App users feedback about the Mobile App (MARS-Modified Mobile App Rating Scale) (N=49)

S. N	Variables	n (%)
1	**Appropriateness of the app content for target audience**	
	Completely inappropriate/unclear/confusing	0 (0)
	Mostly inappropriate/unclear/confusing	1 (2)
	Acceptable but not targeted.	2 (4.1)
	Well-targeted, with negligible issues	34 (69.4)
	Perfectly targeted, no issues found	12 (24.5)
2	**Functioning of app features and its components**	
	App is broken; no/insufficient/inaccurate response	0 (0)
	Some functions work, but have major technical problems	0 (0)
	App works overall. Some technical problems need fixing/Slow at times	1 (2)
	Mostly functional with minor/negligible problems	23 (46.9)
	Perfect/timely response; no technical bugs found	25 (51)
3	**Easiness to learn to use the app**	
	No/limited instructions; menu labels/icons are confusing; complicated	0 (0)
	Useable after a lot of time/effort	0 (0)
	Useable after some time/effort	6 (12.2)
	Easy to learn “how to use the app” (or has clear instructions)	20 (40.8)
	Able to use app immediately; intuitive; simple	23 (46.9)
4	**Stated goals of the app**	
	App has no chance of achieving its stated goals	0 (0)
	lists some goals, but app has very little chance of achieving them	0 (0)
	OK. App has clear goals, which may be achievable.	9 (18.4)

	App has clearly specified goals, which are measurable and achievable	15 (30.6)
	App has specific and measurable goals, highly likely to be achieved	25 (51)
5	**Content of the app relevant to achieve the goal**	
	Irrelevant/inappropriate/incoherent/incorrect	0 (0)
	Poor. Barely relevant/appropriate/coherent/may be incorrect	0 (0)
	Moderately relevant/appropriate/coherent/and appears correct	1 (2)
	Quite Relevant/appropriate/coherent/correct	34 (69.4)
	Highly relevant, appropriate, coherent, and correct	14 (28.6)
6	**Visual appeal-How good does the app look?**	
	No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours	0 (0)
	Little visual appeal – poorly designed, bad use of colour, visually boring	1 (2)
	Some visual appeal – average, neither pleasant, nor unpleasant	22 (44.9)
	High level of visual appeal – seamless graphics – consistent and professionally designed	18 (36.7)
	As above + very attractive, memorable, stands out; use of colour enhances app features	8 (16.3)
7	**Interest level of the app**	
	Not interesting at all	0 (0)
	Mostly uninteresting	1 (2)
	OK, neutral; would engage user for a brief time (< 5 mins)	15 (30.7)
	Moderately interesting; would engage user for some time (5-10 mins)	23 (46.9)
	Very interesting, would engage user in repeat use	10 (20.4)
8	**Recommendation of this app to people who might benefit from it**	
	Not at all- I would not recommend this app to anyone	0 (0)
	There are very few people I would recommend this app to	6 (12.2)
	Maybe -There are several people whom I would recommend it to	19 (38.8)
	There are many people I would recommend this app to	8 (16.3)
	Definitely I would recommend this app to everyone	16 (32.7)
9	**Overall star rating of the app**	
	1 star	0 (0)
	2 stars	0 (0)
	3 stars- Average	14 (28.6)
	4 stars	31 (63.3)
	5 stars- One of the best apps I've used	4 (8.2)

This table (Table 13) below summarizes the outputs generated by the MGRAT app upon usage by all 49 PHP team members. They used the MGRAT app to enter the information regarding various factors (domains/items) indicated in the app. The output generated by each app-user had a list of risks and its ranking of various health risks associated with Deepam festival, Thiruvannamalai. This table describes the frequency distribution of predicted risks categorized as injuries, infectious and non-infectious and ranking by the app users. Since all app users assessed the health risks associated with a common event (2018 Deepam festival, Thiruvannamalai) using

MGRAT app, we evaluated the reliability of the app by measuring agreement between the raters (Inter-rater reliability measure), tabulated in next table (Table 14).

Table 13: MGRAT app Predicted risks and its ranking associated with Deepam festival, Thiruvannamalai (N=49)

Risk Categories	Risks Predicted by the MGRAT app	n*	Risk ranking			
			High n (%)	Significant n (%)	Moderate n (%)	Low n (%)
Injuries	Risk of falls, injuries, crushes, crowding, stampedes etc.	49	7 (14.3)	22 (44.9)	7 (14.3)	13 (26.5)
	Risk of insect bite, snake bite, animal bite etc.	49	4 (8.2)	13 (26.5)	9 (18.4)	23 (46.9)
	Risk of fire accidents/burn injuries	49	8 (16.3)	11 (22.4)	7 (14.3)	23 (46.9)
	Risk of road traffic accidents	49	6 (12.2)	14 (28.6)	6 (12.2)	23 (46.9)
	Risk of minor injuries (Falls, sprains, minor cuts, blisters, abrasions etc.)	47	5 (10.6)	30 (63.8)	5 (10.6)	7 (14.9)
	Risk of forest fire	37	1 (2.7)	6 (16.2)	2 (5.4)	28 (57.1)
Infectious	Risk of communicable diseases like water/food/vector/air borne diseases	49	9 (18.4)	23 (46.9)	2 (4.1)	15 (30.6)
	Risk of communicable diseases like STDs, blood borne diseases etc.	42	2 (4.8)	3 (7.1)	1 (2.4)	36 (85.7)
	Risk of importation/exportation of communicable diseases	37	6 (16.2)	14 (37.8)	8 (21.6)	9 (24.3)
Non infectious	Risk of exacerbation of existing medical illnesses like cardiac issues, hypertension, asthma, musculoskeletal disorders etc.	49	5 (10.2)	24 (49)	8 (16.3)	12 (24.5)
	Risk of alcohol and drug abuse	43	2 (4.7)	4 (9.3)	5 (11.6)	32 (74.4)
	Risk of dehydration/heat stroke	41	3 (7.3)	8 (19.5)	7 (17.1)	23 (56.1)
	Risk of exacerbation of childhood diseases like asthma etc.	30	2 (6.7)	14 (46.7)	6 (20)	8 (26.7)
	Risk of drowning	11	0	2 (18.2)	1 (9.1)	8 (72.7)
	Risk of allergies	5	0	2 (40)	0	3 (60)

*n=Number of raters who had predicted the particular risks

Fleiss kappa statistics that measured the agreement between all the 49 app users after adjusting the chance agreement component were 0.311 (95% CI – 0.297, 0.325, P value=0.00 1), and it was statistically significant. Fleiss kappa indicated moderate agreement among the raters in risk prediction and its ranking using MGRAT app. The agreement values were consistent and significant at the sub-group level (High/ Mid/ Grassroot level). (Table 10)

Table 14: Agreement between the raters in risk prediction and its ranking (inter-rater reliability measure) (N=49)

	Observed agreement	Expected agreement	**Fleiss' Kappa**	95% CI	**P-value**
All raters (N=49)	0.492	0.262	**0.311**	0.297, 0.325	**0.00 1**
High-level members (N=17)	0.504	0.26	**0.330**	0.311, 0.350	**0.00 1**
Mid-level members (N=24)	0.495	0.255	**0.322**	0.309, 0.335	**0.00 1**
Grassroot-level members (N=8)	0.661	0.43	**0.405**	0.347, 0.462	**0.00 1**

The graph given below (Figure 16) depicts the predicted risks enlisted under the category 'Others. ' We categorized the list of risks predicted by the MGRAT app, which could not fit into the categories like injuries, infectious, and non-infectious under the category 'Others. ' Risk of excess strain on the public health system (due to long-duration/large participants, etc.), risk of water pollution, the threat to women safety and risk of open-air defecation /urination was indicated in the 'Others' category, by all the 49 app -users.

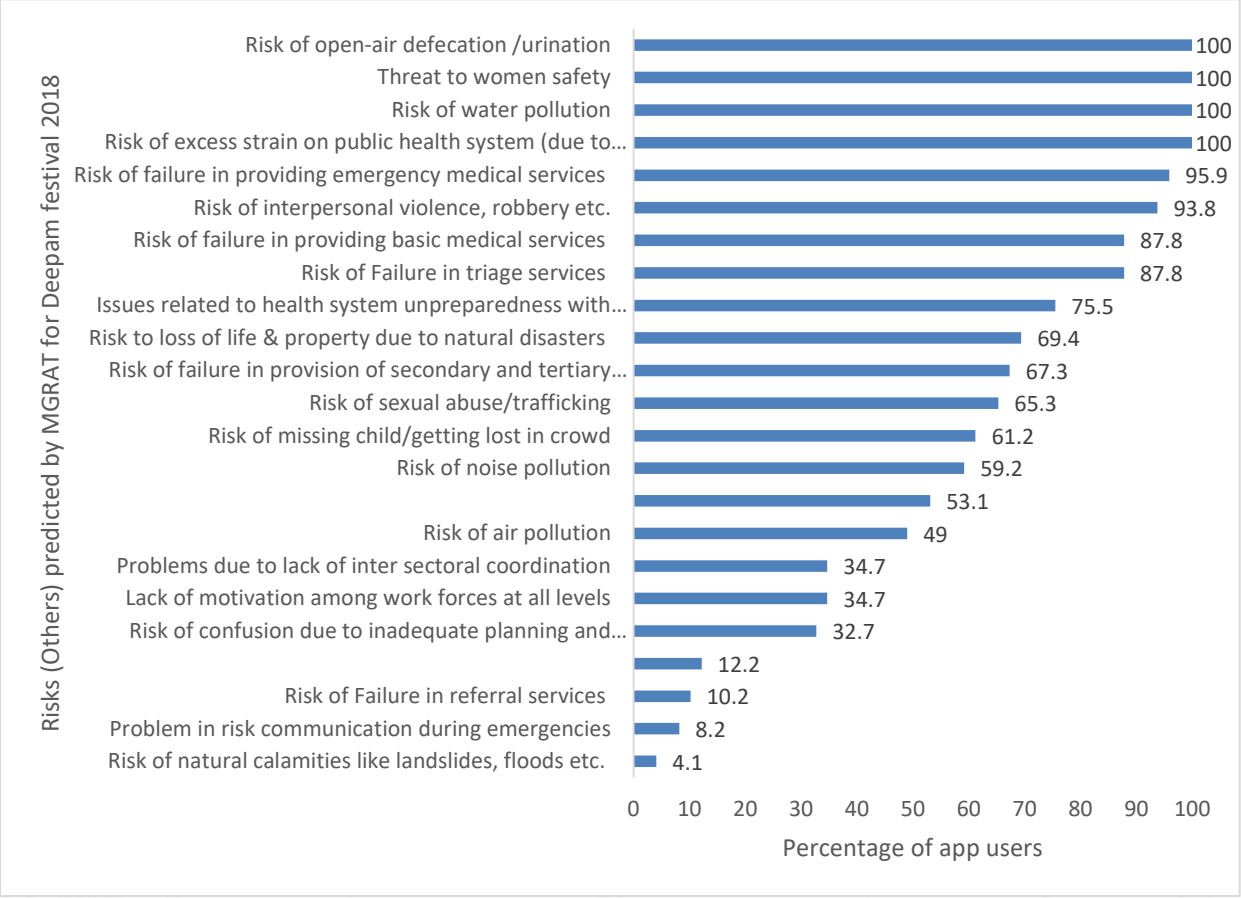

Figure 16: MGRAT app predicted risks-Others category (N=49):

4.4Results of Community Survey (Objective 4)

In this section, the results of the survey conducted on residents and visitors undertaken to assess the public perceptions regarding public health and environmental risks associated with the religious mass gathering event of the Deepam festival, 2018 held at Thiruvannamalai district of Tamil Nadu are being reported.

We did a cross-sectional survey of 400 pilgrims attending the Thiruvannamalai Deepam festival to assess their perception about the health and environmental risks associated

with religious mass gathering events and gathered information regarding their opinion about various arrangements/ facilities made available to them in the event mentioned above. We planned to compare the responses regarding risk perception between residents and visitors. So, we surveyed 200 residents and 200 visitors.

Table 15 & 16 describe the distribution of socio-demographic variables of survey participants. Of the total 400 participants, most were males, 62% (248/400). Most of them were in the age group of 20-40 years. The mean age of the population was 36.2 years, with a standard deviation of 14.1. The proportion of participants who had completed the high school level education was higher 26% (105/400) than the other educational categories. Around 10.8% (43/400) of participants were illiterates.

Around 29.3% (117/400) of the 400 respondents were unemployed, and 20.3% (81/400) of participants belonged to the skilled worker category. The majority were married, 72% (288/400), and most of them, 95% (380/400), were Hindus. The majority, 64.3% (257/400) of the participants, were from the nuclear family. The average family size was 5.25. The median family income per month of the study participants was 28000 INR, and the median per capita family income was 5607 INR. According to the B. G Prasad scale, many participants (38%; 152/400) belonged to the upper socio-economic class (2019). Almost all the socio-demographic variables were equally distributed between the two groups, i.e. visitors and residents, except the socio-economic status. The residents were relatively poor than the visitors, and this difference was statistically significant (p=0.01).

Table 15: Socio-demographic details of the respondents of the community risk perception survey (N=400)

S. No	Socio-demographic Variables (categorical)	Residents N1=200 n (%)	Visitors N2=200 n (%)	Total n (%)	P-value*
1	**Gender**				
	Male	121 (60.5)	127 (63.5)	248 (62)	0.519
	Female	78 (39.0)	73 (36.5)	151 (37.8)	
	Transgender	1 (0.5)	0 (0)	1 (0.3)	
2	**Education**				
	Doctoral/ Post-doctoral	3 (1.5)	7 (3.5)	10 (2.5)	
	Graduate/Post graduate	33 (16.5)	41 (20.5)	74 (18.5)	0.162
	Intermediate /diploma	27 (13.5)	29 (14.5)	56 (14)	
	High School	59 (29.5)	46 (14.5)	105 (26.3)	
	Middle School	32 (16)	25 (12.5)	57 (14.2)	
	Primary School	21 (10.5)	34 (17)	55 (13.8)	
	Illiterate	25 (12.5)	18 (9)	43 (10.8)	
3	**Occupation**				
	Professional	10 (5)	8 (4)	18 (4.5)	
	Semi- Professional	12 (6)	14 (7)	26 (6.5)	0.07
	Clerical/Shop owner/ farmer	34 (17)	20 (10)	54 (13.5)	
	Skilled worker	33 (16.5)	48 (24)	81 (20.3)	
	Semi –skilled worker	32 (16)	33 (16.5)	65 (16.3)	
	Unskilled worker	14 (7)	25 (!2.5)	39 (9.8)	
	Unemployed	65 (32.5)	52 (26)	117 (29.3)	
4	**Marital Status**				
	Married	143 (71.5)	145 (72.5)	288 (72)	0.824
	Single	57 (28.5)	55 (27.5)	112 (28)	
5	**Religion**				
	Hindu	193 (96.5)	187 (93.5)	380 (95)	0.276
	Muslim	3 (1.5)	8 (4)	11 (2.8)	
	Christian	3 (1.5)	5 (2.5)	8 (2)	
	Others	1 (0.5)	0 (0)	1 (0.3)	
6	**Family type**				
	Nuclear	129 (64.5)	128 (64)	257 (64.3)	0.917
	Joint	71 (35.5)	72 (36)	143 (35.8)	
7	**Socio Economic Status**[#]				
	Upper class (>=7008)	86 (43)	66 (33)	152 (38)	
	Upper Middle class (3504-7007)	48 (24)	69 (34.5)	117 (29.3)	
	Middle class (2102-3503)	29 (14.5)	30 (15)	59 (14.8)	
	Lower Middle class (1051-2101)	23 (11.5)	31 (15.5)	54 (13.5)	**0.01**
	Lower class (< =1050)	14 (7)	4 (2)	18 (4.5)	

8	**Age group**				
	< 20 years	20 (10)	20 (10)	40 (10)	
	20.1-40 years	116 (58)	109 (54.5)	225 (56.3)	0.214
	40.1-60 years	51 (25.5)	65 (32.5)	116 (29)	
	>60 years	13 (6.5)	6 (3)	19 (4.8)	

*Chi-square test # B. G Prasad scale (2019)

Table.16: Socio demographic details (quantitative variables) of the respondents of the community risk perception survey (N=400)

S. N	Socio-demographic Variables (Quantitative)	Residents (N1=200) Mean (SD)	Visitors (N2=200) Mean (SD)	P-value #
1	**Age of the participants**	36.2 (14.1)	36.5 (13.4)	0.845
2	**Number of family members**	5.2 (2.2)	5.3 (2.1)	0.463
		Median (IQR)	**Median (IQR)**	
3	**Monthly family income in INR**	28000 (12000-50000)	25000 (14000-41500	0.571**
4	**Monthly per-capita income in INR**	5607 (2500-10000)	5000 (2500-8333)	0.379**

unpaired t-test, **Mann-Whitney U test

Table 17 gives descriptive details regarding the visitors' purpose, frequency, and stay at the event site (n=200). Almost all the visitors, 65.5% (192/200), participated in the survey primarily visited the MG event for pilgrimage, and the remaining 4% (8/200) participants came to visit their relatives at the event site. Around half of the visitors (48%; 96/200) visited the place and the family. Many (37.5%; 75/200) visited individually as well. More than three-fourths of the visitors (78%; 156/200) had visited the event site multiple times, and only a few (22%; 44/200) were first-timers to the event site. Among the visitors, 75% (150/200) stayed overnight at the event site. Out of those who stayed, 34% (51/150) preferred to stay in private lodges/hotels/guest houses, etc.,whereas around 24% (36/150) of the visitors preferred choultaries. Few

participants(11.3%; 17/150) stayed at subsidized accommodation arranged by the organizers, and very few stayed at temporary shelters (6.7%; 10/150). Around 6% (9/150) of the visitors stayed in open places such as platforms, bus stands, near temples, etc.

Table 17: Details regarding the visitors' purpose, frequency, and stay at the event site (N=200)

S No	Variables	Frequency	Percentage
1	**Purpose of the visit**		
	Pilgrimage (attend MG event)	131	65.5
	Pilgrimage (Perform rituals)	61	30.5
	Visit relatives	8	4
2	**Visiting along with**		
	Individually	75	37.5
	Family	96	48
	Package tour group	5	2.5
	Friends group	24	12
3	**Frequency of visit the event site**		
	Once (first-time visit)	44	22
	2-5 times	90	45
	>5 times	66	33
4	**Overnight stay**		
	Yes	150	75
	No	50	25
5	**Staying place in event site***		
	Pvt lodges/Hotels/Guest houses	51	34
	Govt. guest houses	12	8
	Choultary	36	24
	Subsidized accommodation arranged by the organizers	17	11.3
	Friends/relative home	15	10
	Temporary shelters	10	6.7
	Open places (near temple/bus stands etc.)	9	6
6	**Number of nights staying at the event site* Median (IQR)**	2 (1-2)	
7	**Group size of the visitors Median (IQR)**	5 (3-8)	

*N=150 as the question is applicable only for the visitors who stayed overnight at the event site

Tables below describe the participants' opinion and risk perception about various aspects of religious MG event site (Thiruvannamalai Deepam festival, 2018). To assess the same, participants were asked few questions to explore their opinion and risk perception about various aspects of MG event like food, water, hygiene, transportation, safety arrangements, etc.,at the event site. Participants who responded 'no idea' for the questions were excluded from analysis for that specific question. Hence, the total number of respondents (N) may vary for each question. To assess the participants' risk perception, they were asked specific closed-ended questions to probe their health risk perception about the particular aspect of the MG event. The options given to them were 'yes/no/no idea. ' Participants who answered 'yes' or 'no' were included, and those who answered 'no idea' were excluded for analysis.

Table 18 describes the participants' perception of the roadside eateries. We found that more than half of the participants (54.9%; 217/395) felt that the cleanliness at the roadside eateries was above average and only a few (13.4% ;53/395) participants felt it as poor or very poor. Similarly, most indicated that the food was hygienically cooked (55.4%; 205/370), and the food served was covered (66.4% ; 245/369). Around 56.6% (209/369) perceived that eating food at the roadside eateries did not lead to increased health risks during the event. When we compared this proportion of visitors and residents, we found that many visitors (45.8%; 87/190) perceived that eating at roadside eateries during the MG event will increase the health risks than the residents (40.8%; 73/179). However, the difference was not statistically significant.

Table 18: Distribution of residents and visitors according to their perception of roadside eateries in the religious MG of Deepam festival (N=400)

SN	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	**Opinion regarding cleanliness at the roadside eateries (N1= 196, N2= 199, N= 395); No idea=5/400**							
	Excellent	40	20.4	37	18.6	77	19.5	0.283
	Good	66	33.7	74	37.2	140	35.4	
	Average	57	29.1	68	34.2	125	31.6	
	Poor	24	12.2	16	8	40	10.1	
	Very poor	9	4.6	4	2	13	3.3	
2	**Food hygienically cooked at the roadside eateries? (N1=182, N2= 188, N= 370); No idea=30/400**							
	Yes	102	56	103	54.8	205	55.4	0.808
	No	80	44	85	45.2	165	44.6	
3	**Food covered or not at the roadside eateries? (N1=179, N2= 190, N= 369); No idea=31/400**							
	Covered	107	59.8	138	72.6	245	66.4	0.09
	Uncovered	72	40.2	52	27.4	124	33.6	
4	**Increased health risks due to eating food at the roadside eateries? (N1=179, N2= 190, N= 369); No idea=31/400**							
	Yes	73	40.8	87	45.8	160	43.4	0.332
	No	106	59.2	103	54.2	209	56.6	

*The values of N1, N2, and N vary for each question

Table 19 describes the participants'' perception of Annadhanam distribution in the religious MG of Deepam festival. Most participants (85.3%; 318/373) opined that fresh food was served in Annadhanam. Regarding cleanliness at the Annadhanam site, a majority (59.6%; 232/389) felt that the cleanliness was above average, and around 10% of the participants felt that the cleanliness was poor or very poor. We found that the proportion of visitors perceiving cleanliness at the Annadhanam site as good was significantly more than the proportion of residents (36.4% Vs.32%, p=0.006). Similarly, regarding crowd management at the Annadhanam site, more visitors felt crowd management was good compared to the residents (36.4% Vs.24.2%, p=0.04). Most participants (71%; 185/385) felt that the provisions for elderly and disabled individuals

at the Annadhanam site were average or below average. Around 22.9% of participants felt there were no provisions for the elderly/disability at all.

Overall around 30.9% (113/366) of participants perceived that eating Annadhanam food leads to increased health risks at the religious MG event. There was no significant difference between visitors and residents in the perception of the health risks of eating Annadhanam food.

Table 19: Distribution of residents and visitors according to their perception of Annadhanam distribution in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
1	Opinion regarding quality of Annadhanam food? (N1=186, N2= 187, N= 373); No idea=27/400							
	Fresh	158	84.9	160	85.6	318	85.3	0.867
	Stale	28	15.1	27	14.4	55	14.7	
2	Opinion regarding cleanliness at the Annadhanam site? (N1=194, N2= 195, N= 389); No idea=11/400							
	Excellent	48	24.7	51	26.2	99	25.4	
	Good	62	32	71	36.4	133	34.2	**0.00 6**
	Average	54	27.8	64	32.8	118	30.3	
	Poor	24	12.4	9	4.6	33	8.5	
	Very poor	6	3.1	0	0	6	1.5	
3	Crowd management at the Annadhanam site? (N1=190, N2= 195, N= 385); No idea=15/400							
	Excellent	34	17.9	47	24.1	81	21	**0.04**
	Good	46	24.2	71	36.4	117	30.4	
	Average	83	43.7	52	26.7	135	35.1	
	Poor	18	9.5	19	9.7	37	9.6	
	Very poor	9	4.7	6	3.1	15	3.9	
4	Opinion regarding elderly/disability provisions at the Annadhanam site? (N1=193, N2= 192, N= 385); No idea =15/400							
	Excellent	10	5.2	13	6.8	23	6	0.08
	Good	45	23.3	44	22.9	89	23.1	
	Average	58	30.1	75	39.1	133	34.5	
	Poor	30	15.5	8	4.2	38	9.9	
	Very poor	8	4.1	6	3.1	14	3.6	
	No provisions	42	21.8	46	24	88	22.9	
5	Increased risk due to eating Annadhanam food? (N1=183, N2= 183, N= 366); No idea=34/400							
	Yes	58	31.7	55	30.1	113	30.9	0.734
	No	125	68.3	128	69.9	253	69.1	

*The values of N1, N2, and N vary for each question

Table 20 describes the respondents' perception of drinking water facilities in the religious MG of Deepam festival. A majority (65.3%; 246/377) of the study participants felt that the drinking water facilities were adequate. We found that the proportion of visitors who thought that the drinking water facilities were adequate were significantly higher than the residents (70.5% Vs.59.8%, p=0.03). Similarly, a high proportion of visitors (73.3%; 140/191) perceived the available water to be fit for drinking than the residents (55.1%; 98/178), and this difference was statistically significant (p=0.00 1). Around (42.9%; 166/387) of the study participants felt there were no provisions for elderly/disabled individuals at drinking water facilities of the event site. Overall (29.3%; 107/365) of the study participants perceived that there would be increased health risks due to drinking water from the facilities arranged at the event site. We found that the proportion of residents who perceived that there would be increased health risks due to drinking water from the facilities arranged at the event site was significantly more than the visitors (35.4% Vs.23.7%, p=0.02).

Table: 20: Distribution of residents and visitors according to their perception of drinking water facilities in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
1	Drinking water facilities adequacy (N1=184, N2= 193, N= 377); No idea=23/400							
	Yes	110	59.8	136	70.5	246	65.3	0.03
	No	74	40.2	57	29.5	131	34.7	
2	Available water fit for drinking? (N1=178, N2= 191, N= 369); No idea=31/400							
	Yes	98	55.1	140	73.3	238	64.5	**0.00 1**
	No	80	44.9	51	26.7	131	35.5	
3	Provisions for elderly/disability at drinking water facilities? (N1=191, N2= 196, N= 387); No idea=13/400							
	Excellent	16	8.4	14	7.1	30	7.8	
	Good	25	13.1	39	19.9	64	16.5	

	Average	35	18.3	32	16.3	67	17.3	**0.00 1**
	Poor	40	20.9	13	6.6	53	13.7	
	Very poor	5	2.6	2	1	7	1.8	
	No provisions	70	36.6	96	49	166	42.9	
4	Increased risks due to drinking water at the event site? (N1=175, N2= 190, N= 365); No idea=35/400							
	Yes	62	35.4	45	23.7	107	29.3	0.02
	No	113	64.6	145	76.3	258	70.7	

*The values of N1, N2, and N vary for each question

Table 21 describes the respondents' perception of sanitation facilities in the religious MG of Deepam festival. Around 50.1% (196/391) of participants felt that the toilet facilities were adequate. Regarding the cleanliness of toilets, about (30.9%; 120/388) participants thought that the cleanliness of toilets was poor, 8% (31/388) very poor, and around (25.5%; 99/388) participants felt it as average. We found a significant difference in the perception of the cleanliness of toilets between the visitors and residents (p=0.04), i.e.,visitors were more satisfied with the cleanliness of toilets than residents. Around 41.5% (161/388) of participants felt there were no special provisions for elderly/disabled individuals for toilet facilities at the MG event site. The majority of 66.8% (259/388) felt that the toilets' water supply was inadequate. Residents were dissatisfied with the provisions for elderly/disabled individuals for toilet facilities at the event site compared to the visitors, and this difference was significant (p=0.00 1). Overall, 43.3% (154/388) of the participants perceived that poor sanitation prevailing at toilet facilities could increase the health risks in the religious MG event of the Deepam festival.

Table 21: Distribution of residents and visitors according to their perception of sanitation facilities in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
1	Toilet facilities adequacy (N1=194, N2=197, N=391); No idea=9/400							
	Yes	90	46.4	106	53.8	196	50.1	0.143
	No	104	53.6	91	46.2	195	49.9	
2	Opinion regarding the cleanliness of toilets? (N1=192, N2=196, N=388); No idea=12/400							
	Excellent	18	9.4	36	18.4	54	13.9	
	Good	39	20.3	45	23	84	21.6	**0.046**
	Average	52	27.1	47	24	99	25.5	
	Poor	63	32.8	57	29.1	120	30.9	
	Very poor	20	10.4	11	5.6	31	8	
3	Provisions for elderly/disability at toilet facilities? (N1=194 N2= 194, N= 388); No idea=12/400							
	Excellent	10	5.2	12	6.2	22	5.7	
	Good	16	8.2	25	12.9	41	10.6	**0.00 1**
	Average	51	26.3	46	23.7	97	25	
	Poor	38	19.6	14	7.2	52	13.4	
	Very poor	13	6.7	2	1	15	3.9	
	No provisions	66	34	95	49	161	41.5	
4	Adequate water supply in the toilets? (N1=192 N2= 196, N= 388); No idea=12/400							
	Yes	57	29.7	72	36.7	129	33.2	0.141
	No	135	70.3	124	63.3	259	66.8	
5	Increased risks due to poor sanitation at the event site? (N1=192 N2= 196, N= 388); No idea=12/400							
	Yes	82	46.6	72	40	154	43.3	0.209
	No	94	53.4	108	60	202	56.7	

*The values of N1, N2, and N vary for each question

Table 22 describes the respondents' perception of medical care facilities in the religious MG of Deepam festival. A majority (67.1%; 251/374) of the study participants felt adequate medical care facilities and (61.4%; 227/370) felt sufficient numbers of medical doctors available at the religious MG event of Deepam festival. Around (56.6%; 205/362) participants thought that the drug availability was adequate, and (71.1%; 258/ 363) felt that there were enough ambulances available at the event site. Many (71.4%; 260/364) were aware of the emergency helpline number. Overall, we found no

difference in residents' and visitors' perceptions about medical services available at the religious MG event of the Deepam festival.

Table 22: Distribution of residents and visitors according to their perception of medical care facilities in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Adequate medical care facilities? (N1=184 N2= 190, N= 374); No idea=26/400							
	Yes	121	65.8	130	68.4	251	67.1	0.584
	No	63	34.2	60	31.6	123	32.9	
2	Adequate number of doctors available? (N1=187 N2= 183, N= 370); No idea=30/400							
	Yes	116	62	111	60.7	227	61.4	0.786
	No	71	38	72	39.3	143	38.6	
4	Adequate drugs/consumables available? (N1=182 N2= 180, N= 362); No idea =38/400							
	Yes	106	58.2	99	55	205	56.6	0.534
	No	76	41.8	81	45	157	43.4	
5	Enough Ambulances available? (N1=188 N2= 175, N= 363); No idea=39/400							
	Yes	133	70.7	125	71.4	258	71.1	0.886
	No	55	29.3	50	28.6	105	28.9	
6	Awareness about emergency helpline number? (N1=179, N2= 185, N= 364); No idea=36/400							
	Yes	130	72.6	130	70.3	260	71.4	0.619
	No	49	27.4	55	29.7	104	28.6	
7	Opinion regarding IEC activities (N1=193, N2= 196, N= 389); No idea (n=11)							
	Excellent	42	21.8	47	24	89	22.9	0.062
	Good	52	26.9	66	33.7	118	30.3	
	Average	70	36.3	64	32.7	134	34.4	
	Poor	25	13	11	5.6	36	9.3	
	Very poor	4	2.1	8	4.1	12	3.1	

*The values of N1, N2, and N vary for each question

Table 23 describes the respondents' perception of transportation facilities in the religious MG of Deepam festival. According to 75.8% (295/389) participants, adequate transport facilities were available at the event site. However, half of the participants (50.1%; 192/382) felt the transport facilities were not affordable, 42.9% (167/ 389) participants thought that the transport facilities were not accessible. Around 35.1% (134/382) of participants were found to have safety issues with the transport facilities. According to 81.8% (319/390) of the participants, there could be congestion issues due

to the transport arrangements at the event site. More than half of the participants (59.2%; 234/395) felt the transport arrangements were not elderly/disabled-friendly. The residents' perception of all the attributes mentioned above (availability, affordability & safety) regarding transportation facilities was significantly negative than the visitors' perception. Overall (52.7%; 197/374) of the participants felt there could be increased health risks due to the transportation arrangements at the event site of the religious MG of Deepam festival. The risk perception was significantly higher among the visitors than the residents (58.6%; Vs.46.4%, p=0.01).

Table 23: Distribution of residents and visitors according to their perception of transportation facilities in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Perceived availability about the transport (N1=192, N2= 197, N= 389); No idea=11/400							
	Yes	127	66.1	168	85.3	295	75.8	**0.00 1**
	No	65	33.9	29	14.7	94	24.2	
2	Perceived affordability about the transport facilities (N1=196, N2= 186, N= 382); No idea=18/400							
	Yes	67	34.2	123	66.1	190	49.7	**0.00 1**
	No	129	65.8	63	33.9	192	50.3	
4	Perceived accessibility about the transport facilities (N1=196, N2= 193, N= 389); No idea=11/400							
	Yes	79	40.3	143	74.1	222	57.1	**0.00 1**
	No	117	59.7	50	25.9	167	42.9	
5	Perceived safety in using transport facility (N1=192, N2= 190, N= 382); No idea=18/400							
	Yes	109	56.8	139	73.2	248	64.9	**0.00 1**
	No	83	43.2	51	26.8	134	35.1	
6	Perceived congestion due to transport facilities (N1=195, N2= 195, N= 390); No idea=10/400							
	Yes	163	83.6	156	80	319	81.8	0.358
	No	32	16.4	39	20	71	18.2	
7	Provisions for elderly/disabled for transportation facilities (N1=199, N2= 196, N= 395); No idea=5/400							
	Excellent	7	3.5	9	4.6	16	4.1	0.06
	Good	25	12.6	21	10.7	46	11.6	
	Average	56	28.1	43	21.9	99	25.1	
	Poor	50	25.1	35	17.9	85	21.5	

	Very poor	10	5	11	5.6	21	5.3	
	No provisions	51	25.6	77	39.3	128	32.4	
8	Increased health risks due to transportation arrangements at event site (N1=183, N2= 191, N= 374); No idea=26/400							
	Yes	85	46.4	112	58.6	197	52.7	**0.01**
	No	98	53.6	79	41.4	177	49.2	

*The values of N1, N2, and N vary for each question

Table 24 describes the respondents perception of crowd management arrangements in the religious MG of Deepam festival (N=400). Around 75.6% (301/398) perceived the event site of MG was highly congested. We found that a higher proportion of residents perceived the congestion was high at the event site than the visitors and the difference was statistically significant (81.4% Vs.69.8%, p=0.02). Most of the participants (83.6%; 331/396) perceived the event site was stampede prone. Among those who perceived the event site as stampede prone, around 9.7% (32/331) felt the risk as high, 46.8% (155/331) felt the risk as moderate, and 43.5% (144/331) felt the risk as mild. Few (5%; 8/161) visitors perceived the risk of the stampede as high at the event site than the residents (14.1%; 24/170), and this difference was found to statistically significant (p=0.01). Around 87.9% (342/389) of the participants perceived the crowd management at the event site to be average or above average.

Table 24: Distribution of residents and visitors according to their perception of crowd management arrangements in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Perceived level of congestion at the event site (N1=199, N2= 199, N= 398); No idea=02/400							
	High	162	81.4	139	69.8	301	75.6	**0.02**
	Medium	32	16.1	48	24.1	80	20.1	
	Low	5	2.5	12	6	17	4.3	
2	Adequate number of signage boards availability (N1=190, N2= 195, N= 385); No idea=15/400							
	Yes	118	62.1	102	52.3	220	57.1	0.11
	No	72	37.9	93	47.7	165	42.9	
3	Risk of stampedes at event site (N1=198, N2= 198, N= 396); No idea=04/400							

	Yes	170	85.9	161	81.3	331	83.6	0.27
	No	28	14.1	37	18.7	65	16.4	
4	Stampede risk severity grading (N1=170, N2= 161, N= 331[answered 'yes' for the previous question])							
	Mild	69	40.6	75	46.6	144	43.5	**0.01**
	Moderate	77	45.3	78	48.4	155	46.8	
	High	24	14.1	8	5	32	9.7	
5	Opinion regarding crowd management arrangements at event site (N1=195, N2= 194, N= 389); No idea=11/400							
	Excellent	44	22.6	59	30.4	103	26.5	0.12
	Good	72	36.9	73	37.6	145	37.3	
	Average	49	25.1	45	23.2	94	24.2	
	Poor	27	13.8	13	6.7	40	10.3	
	Very poor	3	1.5	4	2.1	7	1.8	

*The values of N1, N2, and N vary for each question

Table 25 describes the respondents' perception of stable waste management status in the religious MG of Deepam festival. The majority of the participants (60.9%; 223/366) perceived the number of dust bins available at the event site was adequate. However, half of the participants (51.3%; 184/359) perceived that waste was not removed or cleared by the authorities on time. Around (48.5%; 175/361) of the participants perceived that there could be increased health risks due to improper solid waste management at the event site of the religious MG of Deepam festival. We found no difference in residents' and visitors' perceptions about solid waste management status in the religious MG event of the Deepam festival.

Table 25.Distribution of residents and visitors according to their perception of solid waste management status in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Adequate number of dustbins available? (N1=188, N2= 178, N= 366); No idea=34/400							
	Yes	117	62.2	106	59.6	223	60.9	0.59
	No	71	37.8	72	40.4	143	39.1	
2	Timely removal of solid wastes (N1=181, N2= 178, N= 359); No idea=41/400							
	Yes	83	45.9	92	51.7	175	48.7	0.27
	No	98	54.1	86	48.3	184	51.3	
3	Increased risks due to improper solid waste management status at the event site (N1=177, N2=							

	184, N= 361); No idea=39/400							
	Yes	82	46.3	93	50.5	175	48.5	0.42
	No	95	53.7	91	49.5	186	51.5	

*The values of N1, N2, and N vary for each question

Table 26 describes the respondents' perception of safety arrangements in the religious MG of Deepam festival. Around (34.6%; 134/387) of the participants graded the safety arrangements at the event site as average. We found a significant difference in perception of safety arrangements in the religious MG of Deepam festival between the residents and visitors (p=0.00 1), i.e., residents were more dissatisfied than visitors in this aspect. The majority of the participants (65.1%; 241/370) believed that the event site was not prone to fire accidents. Around 28.7% (104/ 363) of the participants graded the fire safety arrangements at the event site as good, and 29.5% (107/263) felt it as excellent (29.5%). We found that the visitors perceived the event site of MG had better fire safety arrangements than the residents. This difference in the perception of fire safety arrangements was significant (35.5% Vs.23.2%, p=0.00 6). Around 66.9% (238/356) participants perceived that no alcohol/drug abuse activities were carried out at the event site, and this perception was significantly more among the visitors than the residents (74.3% Vs.59.3%, p=0.03).

Table 26.Distribution of residents and visitors according to their perception of safety arrangements in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Perception regarding general safety arrangements at the event site (N1=192, N2= 195, N= 387); No idea=13/400							
	Excellent	36	18.8	59	30.3	95	24.5	**0.00 1**
	Good	49	25.5	61	31.3	110	28.4	
	Average	68	35.4	66	33.8	134	34.6	
	Poor	25	13	7	3.6	32	8.3	

	Very poor	14	7.3	2	1	16	4.1	
2	Event site fire accident prone or not? (N1=185, N2= 185 N= 370); No idea=30/400							
	Yes	71	38.4	58	31.4	129	34.9	0.156
	No	114	61.6	127	68.6	241	65.1	
3	Perception regarding fire safety arrangements (N1=177, N2= 186, N= 363); No idea=37/400							
	Excellent	53	29.9	54	29	107	29.5	**0.00 6**
	Good	51	28.8	53	28.5	104	28.7	
	Average	41	23.2	66	35.5	107	29.5	
	Poor	23	13	11	5.9	34	9.4	
	Very poor	9	5.1	2	1.1	11	3	
4	Alcohol/drug abuse at the event site (N1=177, N2= 179, N= 356); No idea=44/400							
	Yes	72	40.7	46	25.7	118	33.1	**0.03**
	No	105	59.3	133	74.3	238	66.9	

*The values of N1, N2, and N vary for each question

Table 27 describes the respondents' perception of special rituals in the religious MG of Deepam festival. About 39.3% (108/275) of participants perceived that there could be increased health risks due to the animal sacrifice/slaughtering during the religious MG event of the Deepam festival. The majority of the participants did not perceive any health risks associated with special rituals like head shaving (70.3%; 239/340), ear piercing (69.3%; 212/340), or car festival (61.3%; 219/357).

Table 27: Distribution of residents and visitors according to their health risk perception of special rituals in the religious MG of Deepam festival (N=400)

S N	Variables	Residents (N1)*		Visitors (N2)*		Total (N)*		P-Value
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1	Increased health risks due to animal slaughtering/sacrifice (N1=128, N2= 147, N= 275); No idea=125/400							
	Yes	44	34.4	64	43.5	108	39.3	0.121
	No	84	65.6	83	56.5	167	60.7	
2	Increased health risks due to the head-shaving rituals at the event site (N1=170, N2= 170, N= 340); No idea=60/400							
	Yes	51	30	50	29.4	101	29.7	0.906
	No	119	70	120	70.6	239	70.3	
3	Increased health risks due to ear piercing rituals at the event site (N1=170, N2= 170, N= 340); No idea=60/400							
	Yes	38	25.7	56	35.4	94	30.7	0.08
	No	110	74.3	102	64.6	212	69.3	
4	Perceive increased health risks due to car festival? (N1=171, N2= 186, N= 357); No idea=43/400							
	Yes	59	34.5	79	42.5	138	38.7	0.122
	No	112	65.5	107	57.5	219	61.3	

*The values of N1, N2, and N vary for each question

Table 28 describes the overall risk perception of participants associated with the religious MG of the Deepam festival. More than half of the participants (60.4%; 229/379) perceived that there would be increased health risks during MG. We found a higher proportion (65.6%; 126/192) of residents' perceived health risks associated with the religious MG event compared to visitors (55.1%; 103/187), and the difference was statistically significant (p=0.04).

Table 28.Distribution of residents and visitors according to their overall perception of health risks associated with the religious MG of Deepam festival (N=400)

Perceived increased health risks due to MG event	**Residents (N1=192)**		**Visitors (N2=187)**		**Total (N*=379)**		**P-Value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	
Yes	126	65.6	103	55.1	229	60.4	**0.04**
No	66	34.4	84	44.9	150	39.6	

*No idea=21/400

Table 29 describes the type of health risks associated with the religious MG of the Deepam festival reported by the participants. Out of 229 respondents who said ‘yes’ to the question ‘Do they perceive increased health risks due to MG event?” were asked an open-ended question to enumerate the list of risks they perceive to be associated with the religious MG of Deepam festival and rank each one of them. Hence, each participant was allowed to list multiple health risks. The documented risks were further analyzed and categorized into four categories (Infectious, non-infectious, injuries, and others) by the researcher.

Around 91.3% (209/229) participants mentioned at least one risk under the 'infectious disease' category, 72.9% (167/229) participants indicated at least one risk under the category 'injuries, ' 44.4% (102/229) participants mentioned at least one risk under 'non-infectious diseases' category and 2.6% (6/229) participants indicated at least one risk that did not fit into any of the categories and hence was categorized as 'Others. '

Table.29. Type of perceived health risks associated with the religious MG of Deepam festival by the participants (N=229)

S. No	Type of health risks	Frequency	Percentage**
1	Infectious diseases	209	91.3
2	Non-Infectious diseases	102	44.5
3	Injuries	167	72.9
4	Others	6	2.6

**Multiple options possible, so total percentage may exceed 100

Table 30 describes the participants' ranking of the perceived health risks associated with the MG event of the Deepam festival. Of the total 209 respondents who had listed at least one of the health risks categorized as infectious diseases, around 78.9% (165/209) gave the first rank to the health risks that could be categorized as infectious diseases. From the 167 participants who had listed at least one of the health risks categorized as injuries, around 29.9% (50/167) gave the first rank to the health risks that could be categorized as injuries. From the 102participants who had listed at least one of the health risks categorized as non-infectious diseases, only 14.7% (15/102) gave the first rank to the health risks that could be categorized as injuries.

Table 30.Participants ranking of the perceived health problems (N=229)

S. No	Health Risks	N	Rank							
			1		II		III		IV	
			n	%	n	%	n	%	n	%
1	Infectious diseases	209	165	78.9	32	15.3	12	5.7	-	-
2	Non-Infectious diseases	102	15	14.7	63	61.8	24	23.5	-	-
3	Injuries	167	50	29.9	71	42.5	46	27.5	-	-
6	Others	6	-	-	1	16.7	-	-	5	83.3

Table 31 describes the respondents' perception of overall arrangements in the religious MG of Deepam festival. Most of the participants (94.8%; 372/392) were felt that the arrangements at the event site of religious MG of Deepam festival were average and above (Good=45.7%; 179/392, Excellent=9.9%; 39/392 and Average =39.3%; 154/392)

Table 31.Distribution of residents and visitors according to their perception of overall arrangements in the religious MG of Deepam festival (N=400)

Variables	Residents (N1=193)		Visitors (N2=199)		Total (N*=392)		P-Value
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
Excellent	23	11.9	16	8	39	9.9	0.167
Good	89	46.1	90	45.2	179	45.7	
Average	76	39.4	78	39.2	154	39.3	
Poor	5	2.6	14	7	19	4.8	
Very poor	0	0	1	0.5	1	0.3	

*No idea=8/400

Determinants of Participants' Risk Perception

In this section, the participants' socio-demographic factors affecting the perception of health risks associated with the religious MG event are reported. We analyzed the differences in perceptions of health risks related to the MG event of the Deepam festival by different socio-demographic factors. We further conducted separate logistic regression analyses to see the

We compared the differences in perceptions of health risks of roadside eateries, *Annadhanam*, drinking water facilities, sanitation, stampedes, transportation, car festival, head shaving/ear piercing rituals, animal sacrifice, solid waste management, and overall health risk perception associated with MG event of Deepam festival different socio-demographic factors. We further conducted a logistic regression analysis to measure the independent effect (adjusted odds ratio) of the socio-demographic factors on risk perception.

As mentioned elsewhere, to assess the participants' risk perception, participants we asked specific closed-ended questions to probe their health risk perception about the particular aspect of the MG event of the Deepam festival. The options given to them were 'yes/no/no idea.' Participants who answered 'yes' or 'no' were included, and those who answered 'no idea' were excluded for inferential analysis.

Table 32 reports the logistic regression analysis of the participants' socio-demographic factors affecting the overall perception of health risks associated with the religious mass gathering event of the Deepam festival. The factor 'resident status' was found to be

statistically significant (Adjusted OR=1.525; 95% CI = 1.00 4, 2.316; p=0.048). The interpretation is that after adjusting for the factors like gender, age, education, occupation, family type, marital status, and per capita income, residents were 1.525 times more likely to perceive health risks associated with the MG event of the Deepam festival to the visitors.

Table 32.Socio-demographic factors of the pilgrims affecting the perception of health risks associated with the religious MG event

Variable	Category	Adjusted OR*	95% CI	P-value
Gender	Male (R)	0.846	0.538, 1.332	0.470
	Female			
Age group	< 40 years (R)	1.105	0.688, 1.776	0.680
	> 40 years			
Education	till middle school (R)	0.874	0.557, 1.370	0.557
	High school & above			
Occupation	Unemployed (R)	0.705	0.425, 1.168	0.175
	Employed			
Family type	Nuclear (R)	0.837	0.538, 1.303	0.431
	Joint			
Marital status	Married (R)	1.164	0.695, 1.950	0.563
	Single			
Residential status	**Visitor (R)**	**1.525**	**1.00 4, 2.316**	**0.048**
	Resident			
Per capita income	< 5000 Rs (R)	0.899	0.582, 1.388	0.630
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 33 reports the result of logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks associated with eating in roadside eateries in the religious MG event of Deepam festival. None of the selected factors were a significant predictor of perception of the roadside eateries' health risks at the MG event of Deepam festival.

Table 33: Socio-demographic factors of the participants affecting the perception of health risks of roadside eateries in the religious MG event

Variable	Category	Adjusted OR*	95% CI of adjusted OR	P-value
Gender	Male (R)			
	Female	0.809	0.513, 1.276	0.362
Age group	< 40 years (R)			
	> 40 years	0.788	0.489, 1.269	0.327
Education	till middle school (R)			
	High school & above	0.759	0.483, 1.195	0.234
Occupation	Unemployed (R)			
	Employed	0.944	0.577, 1.545	0.818
Family type	Nuclear (R)			
	Joint	1.409	0.910, 2.182	0.124
Marital status	Married (R)			
	Single	0.868	0.520, 1.446	0.586
Residential status	Visitor (R)			
	Resident	0.812	0.535, 1.234	0.330
Per capita income	< 5000 Rs (R)			
	> 5000 Rs	1.082	0.703, 1.666	0.720

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 34 reports the result of logistic regression analysis of socio-demographic factors of the participants affecting the perception of health risks associated with eating at the *Annadhanam* sites at the religious MG event of Deepam festival. It was found that the factor 'family type' was found to be a statistically significant predictor (Adjusted OR=1.982; 95% CI= 1.236, 3.178; p=0.04). The interpretation is that after adjusting for the factors like gender, age, education, occupation, marital status, residential status, and per capita income, participants who belonged to joint families were 1.982 times more likely to perceive health risks of eating at *Annadhanam* sites at the MG event of Deepam festival when compared to the participants belonged to nuclear families.

Table 34: Socio-demographic factors of the participants affecting the perception of health risks of eating at the Annadhanam sites at the religious MG event

Variable	Category	Adjusted OR*	95% CI of adjusted OR	P-value
Gender	Male (R)	0.753	0.457, 1.241	0.266
	Female			
Age group	< 40 years (R)	1.165	0.689, 1.971	0.569
	> 40 years			
Education	till middle school (R)	0.726	0.445, 1.184	0.199
	High school & above			
Occupation	Unemployed (R)	0.769	0.454, 1.303	0.329
	Employed			
Family type	**Nuclear (R)**	**1.982**	**1.236, 3.178**	**0.04**
	Joint			
Marital status	Married (R)	1.435	0.833, 2.471	0.194
	Single			
Residential status	Visitor (R)	1.066	0.676, 1.682	0.782
	Resident			
Per capita income	< 5000 Rs (R)	1.00 5	0.689, 1.971	0.569
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 35 reports the logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of drinking water facilities arranged at the religious MG event. The factor 'family type' was found to be a statistically significant predictor (Adjusted OR= 1.702; 95% CI= 1.054, 2.746; p=0.029). The interpretation is that after adjusting for the other selected factors, participants belonging to joint families were 1.7 times more likely to perceive health risks of drinking water facilities at the MG event when compared with the participants' belonging to nuclear families. Similarly, another factor 'residential status was also found to be a statistically significant predictor (Adjusted OR=1.869; 95% CI= 1.172, 2.980; p=0.009).

Table 35: Socio-demographic factors of the participants affecting the perception of health risks of drinking water facilities arranged at the religious MG event

Variable	Category	Adjusted OR*	95% CI of adjusted OR	P-value
Gender	Male (R)	0.985	0.593, 1.636	0.953
	Female			
Age group	< 40 years (R)	1.001	0.593, 1.687	0.998
	> 40 years			
Education	till middle school (R)	0.826	0.505, 1.352	0.447
	High school & above			
Occupation	Unemployed (R)	1.240	0.699, 2.202	0.462
	Employed			
Family type	**Nuclear (R)**	**1.702**	**1.054, 2.746**	**0.029**
	Joint			
Marital status	Married (R)	0.606	0.334, 1.098	0.098
	Single			
Residential status	**Visitor (R)**	**1.869**	**1.172, 2.980**	**0.009**
	Resident			
Per capita income	< 5000 Rs (R)	0.870	0.593, 1.687	0.569
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 36 reports the result of logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of sanitation facilities at the religious MG event of Deepam festival. None of the selected factors were found to be significant predictors.

Table 36: Socio-demographic factors of the participants affecting the perception of health risks of sanitation facilities at the religious MG event

Variable	Category	Adjusted OR*	95% CI of adjusted OR	P-value
Gender	Male (R)	1.137	0.717, 1.801	0.586
	Female			
Age group	< 40 years (R)	1.129	0.688, 1.853	0.630
	> 40 years			
Education	till middle school (R)	0.699	0.442, 1.105	0.126
	High school & above			
Occupation	Unemployed (R)	1.134	0.686, 1.874	0.624

	Employed			
Family type	Nuclear (R)	1.227	0.784, 1.919	0.371
	Joint			
Marital status	Married (R)	1.055	0.625, 1.781	0.842
	Single			
Residential status	Visitor (R)	1.327	0.866, 2.036	0.194
	Resident			
Per capita income	< 5000 Rs (R)	0.684	0.441, 1.061	0.090
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 37 reports the result of logistic regression analysis of socio-demographic factors of the participants affecting the perception of health risks of the stampede at the religious MG event of Deepam festival. The factor 'family status' emerged as a statistically significant predictor (Adjusted OR= 2.407; 95% CI= 1.264, 4.582; p=0.00 7). The interpretation is that the participants' belonged to joint families were 2.4 times more likely to perceive the health risks of stampedes at the MG event of Deepam than the participants who belonged to nuclear families. This association was significant after adjusting for gender, age, education, occupation, marital status, per capita income, and residential status.

Table.37: Socio-demographic factors of the participants affecting the perception of health risks of stampede risk at the religious MG event

Variable	**Category**	**Adjusted OR***	**95% CI of adjusted OR**	**P-value**
Gender	Male (R)	1.236	0.678, 2.253	0.488
	Female			
Age group	< 40 years (R)	0.936	0.504, 1.737	0.834
	> 40 years			
Education	till middle school (R)	0.960	0.532, 1.734	0.893
	High school & above			
Occupation	Unemployed (R)	0.522	0.259, 1.050	0.068

	Employed			
Family type	**Nuclear (R)**	**2.407**	**1.264, 4.582**	**0.00 7**
	Joint			
Marital status	Married (R)	0.722	0.377, 1.380	0.324
	Single			
Residential status	Visitor (R)	1.368	0.792, 2.361	0.261
	Resident			
Per capita income	< 5000 Rs (R)	0.944	0.534, 1.668	0.843
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 38 reports the logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of transportation at the religious MG event of the Deepam festival. It was found that the factor 'resident status' emerged to be a statistically significant predictor (Adjusted OR= 0.615; 95% CI= 0.406, 0.932; p=0.022). The interpretation is that the residents were 38.5% less likely to perceive transportation-related health risks at the MG event of the Deepam festival than the visitors. This association was statistically significant after adjusting for age, gender, education, occupation, family type, marital status, and per capita income.

Table 38: Socio-demographic factors of the participants affecting the perception of health risks of transportation at the religious MG event

Variable	**Category**	**Adjusted OR***	**95% CI of adjusted OR**	**P-value**
Gender	Male (R)	0.926	0.590, 1.453	0.739
	Female			
Age group	< 40 years (R)	1.113	0.694, 1.784	0.656
	> 40 years			
Education	till middle school (R)	0.727	0.461, 1.144	0.168
	High school & above			
Occupation	Unemployed (R)	1.170	0.712, 1.922	0.536
	Employed			

Family type	Nuclear (R)	1.403	0.901, 2.186	0.134
	Joint			
Marital status	Married (R)	0.746	0.446, 1.248	0.264
	Single			
Residential status	**Visitor (R)**	**0.615**	**0.406, 0.932**	**0.022**
	Resident			
Per capita income	< 5000 Rs (R)	1.088	0.705, 1.677	0.704
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 39 reports the logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of the car festival at the religious MG event of Deepam festival. It was that that the factor 'family type' was found to a statistically significant predictor (Adjusted OR=1.629; 95% CI=1.034, 2.567; p value= 0.035) after adjusting for the factors like age, gender, education, occupation, marital status, resident status, and per capita income. The interpretation is that the participants' who belonged to joint families were 1.629 times more likely to perceive the health risks of the car festival at the religious MG event of Deepam festival when compared to the participants who belonged to nuclear families.

Table 39: Socio-demographic factors of the participants affecting the perception of health risks of the car festival at the religious MG event

Variable	**Category**	**Adjusted OR***	**95% CI of adjusted OR**	**P-value**
Gender	Male (R)	0.683	0.426, 1.095	0.114
	Female			
Age group	< 40 years (R)	0.940	0.569, 1.553	0.809
	> 40 years			
Education	till middle school (R)	0.721	0.450, 1.155	0.174
	High school & above			
Occupation	Unemployed (R)	1.226	0.729, 2.063	0.442
	Employed			
Family type	**Nuclear (R)**	**1.629**	**1.034, 2.567**	**0.035**
	Joint			

Marital status	Married (R)	1.035	0.608, 1.762	0.900
	Single			
Residential status	Visitor (R)	0.720	0.464, 1.119	0.144
	Resident			
Per capita income	< 5000 Rs (R)	0.792	0.504, 1.244	0.312
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 40 reports the logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of the head-shaving/ ear piercing rituals performed at the religious MG event. It was found that the factor 'per capita income' emerged as a statistically significant predictor (Adjusted OR= 0.568; 95% CI= 0.347, 0.929; p=0.024). The interpretation is that the participants with an income greater than 5000 INR were 43% less likely to perceive risks of head shaving/ ear piercing rituals at the religious MG event of Deepam festival than the participants with an income lesser than 5000 INR. This association was significant after adjusting for gender, age, education, occupation, family type, marital status, and residential status.

Table 40: Socio-demographic factors of the participants affecting the perception of health risks of the head-shaving/ ear piercing rituals performed atthe religious MG event

Variable	**Category**	**Adjusted OR***	**95% CI of adjusted OR**	**P-value**
Gender	Male (R)	0.736	0.433, 1.249	0.256
	Female			
Age group	< 40 years (R)	1.296	0.750, 2.238	0.353
	> 40 years			
Education	till middle school (R)	0.967	0.575, 1.626	0.899
	High school & above			
Occupation	Unemployed (R)	1.163	0.663, 2.040	0.598
	Employed			
Family type	Nuclear (R)	1.00 5	0.612, 1.651	0.983
	Joint			
Marital status	Married (R)	1.311	0.734, 2.342	0.360

	Single			
Residential status	Visitor (R)	1.066	0.662, 1.717	0.791
	Resident			
Per capita income	**< 5000 Rs (R)**	**0.568**	**0.347, 0.929**	**0.024**
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 41 reports the result of logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of the animal sacrifice at the religious MG event of Deepam festival. None of the factors was significantly associated with the participants' perception of health risks associated with the animal sacrifice rituals at the religious MG event of the Deepam festival.

Table 41: Socio-demographic factors of the participants affecting the perception of health risks of the animal sacrifice at the religious MG event

Variable	**Category**	**Adjusted OR***	**95% CI of adjusted OR**	**P-value**
Gender	Male (R)	0.801	0.466, 1.375	0.421
	Female			
Age group	< 40 years (R)	1.056	0.601, 1.854	0.851
	> 40 years			
Education	till middle school (R)	0.823	0.479, 1.413	0.479
	High school & above			
Occupation	Unemployed (R)	0.837	0.477, 1.468	0.535
	Employed			
Family type	Nuclear (R)	1.136	0.676, 1.911	0.629
	Joint			
Marital status	Married (R)	1.166	0.644, 2.111	0.613
	Single			
Residential status	Visitor (R)	0.662	0.401, 1.092	0.106
	Resident			
Per capita income	< 5000 Rs (R)	1.436	0.857, 2.404	0.169
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Table 42 reports the logistic regression analysis of the participants' socio-demographic factors affecting the perception of health risks of solid waste management at the

religious MG event of the Deepam festival. None of the factors was significantly associated with the participants' perception of health risks associated with solid waste management at the religious MG event of the Deepam festival.

Table 42: Socio-demographic factors of the participants affecting the perception of health risks of the solid waste management at the religious MG event

Variable	Category	Adjusted OR*	95% CI of adjusted OR	P-value
Gender	Male (R)	0.808	0.512, 1.276	0.360
	Female			
Age group	< 40 years (R)	1.320	0.814, 2.140	0.260
	> 40 years			
Education	till middle school (R)	0.851	0.539, 1.344	0.891
	High school & above			
Occupation	Unemployed (R)	1.461	0.884, 2.416	0.139
	Employed			
Family type	Nuclear (R)	1.501	0.965, 2.334	0.072
	Joint			
Marital status	Married (R)	1.267	0.758, 2.115	0.367
	Single			
Residential status	Visitor (R)	0.882	0.579, 1.345	0.561
	Resident			
Per capita income	< 5000 Rs (R)	0.832	0.538, 1.287	0.409
	> 5000 Rs			

(R) indicates reference category; Adjusted OR, 95% CI and P-value obtained by Logistic regression

Morbidity Report

In this section, a morbidity report from the medical camps conducted by the Department of Public Health and Preventive Medicine, Tamil Nadu, during the last two days of the Deepam festival, 2018, is described (Table 43). Under the infectious disease morbidity category, fever and diarrhea were the most commonly reported morbidities. Bites (animal/insect) was the major morbidity (18 out of 25, 72%) reported under the non-infectious category. More than one-third of all the reported morbidities (37.8%) were

injuries. Two cardiovascular events were reported in critically ill patients, and four cases of severe injury were immediately referred to the nearby tertiary care centre.

Table 43: Morbidity report from the medical camps conducted by the Department of Public Health during the last two days of the Deepam festival, 2019 (Surveillance data; N=119)

Morbidity category	Morbidity reported	n	Percentage within morbidity category (n/N1)	Percentage out of total morbidity reported (n/N)
Infectious (N1=49)	Fever with cough	18	36.7	15.1
	Fever above 3 days	6	12.2	5.0
	Fever with rash	4	8.2	3.4
	Diarrhea	18	36.7	15.1
	Dysentery	1	2.0	0.8
	Conjunctivitis	2	4.1	1.7
(n/N2)				
Others/Non-infectious* (N2=25)	Bites	18	72.0	15.1
	Skin rashes/allergy	2	8.0	1.7
	Heat related illness	3	12.0	2.5
	Critically ill (cardiovascular events)	2	8.0	1.7
(n/N3)				
Injuries (N3=45)	All injuries (No further classification details were captured in surveillance data)	45	100	37.8

*The categorization 'Non-infectious' was done by the researcher, the original categorization given for the surveillance system was 'others

The bar chart (Figure 17) below describes the distribution of reported morbidity according to morbidity category. Among the 119 reported cases, infectious diseases were the most commonly reported (49/119; 41.2%), followed by injuries (45/119; 37.8%) and non-infectious diseases (25/119; 21%).

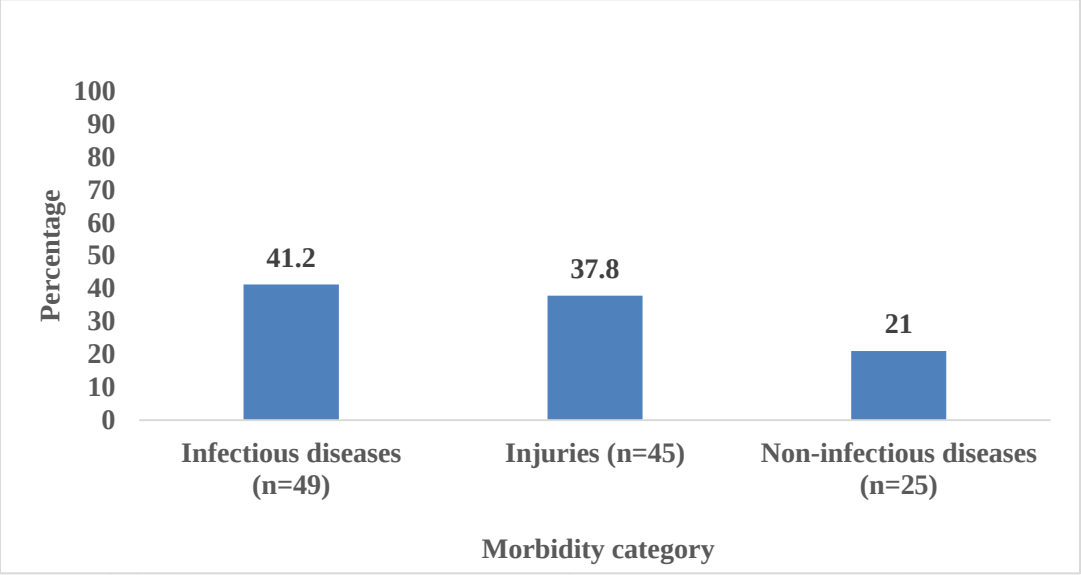

Figure.17: Distribution of morbidity reported according to the morbidity category (N=119)-Surveillance data

Triangulation and Comparison of MGRAT output with surveillance data and community risk perception (*predicted Vs. perceived Vs. reported)*

The tables (Tables 44, 45, 46, 47) below were extracted from various parts of study results and assembled here to demonstrate data triangulation and indirectly check the validity of the MGRAT app. We observed that the MGRAT app could predict almost all the morbidities reported at the Deepam festival, event as the risks associated with the event. This proves the validity of the MGRAT app.

Infectious diseases followed by injuries were the commonly reported morbidity categories, and these were also perceived as priority health risks in the community survey. The same had been reflected in the MGRAT app output as well. We also observed that the morbidity category of non-infectious diseases was the least commonly reported, and it was the least perceived health risk category by the community members.

However, the MGRAT output of the 49 app users predicted few non-infectious disease risks like the risk of exacerbation of existing medical illnesses like cardiac issues, hypertension, asthma, musculoskeletal disorders as the risks associated with MG event. Around 49% (24/49) output of the app users ranked the risk mentioned earlier as 'significant, ' and 10.2% (5/49) output ranked it as 'high. '

Table.44: MGRAT app Predicted risks and risk ranking associated with the Deepam festival, Thiruvannamalai (N=49)

Risk Categories	Risks Predicted by the MGRAT app	n*	Risk ranking			
			High n (%)	Significant n (%)	Moderate n (%)	Low n (%)
Injuries	Risk of falls, injuries, crushes, crowding, stampedes etc.	49	7 (14.3)	22 (44.9)	7 (14.3)	13 (26.5)
	Risk of insect bite, snake bite, animal bite etc.	49	4 (8.2)	13 (26.5)	9 (18.4)	23 (46.9)
	Risk of fire accidents/burn injuries	49	8 (16.3)	11 (22.4)	7 (14.3)	23 (46.9)
	Risk of road traffic accidents	49	6 (12.2)	14 (28.6)	6 (12.2)	23 (46.9)
	Risk of minor injuries (Falls, sprains, minor cuts, blisters, abrasions etc.)	47	5 (10.6)	30 (63.8)	5 (10.6)	7 (14.9)
	Risk of forest fire	37	1 (2.7)	6 (16.2)	2 (5.4)	28 (57.1)
Infectious	Risk of communicable diseases like water/food/vector/air borne diseases	49	9 (18.4)	23 (46.9)	2 (4.1)	15 (30.6)
	Risk of communicable diseases like STDs, blood borne diseases etc.	42	2 (4.8)	3 (7.1)	1 (2.4)	36 (85.7)
	Risk of importation/exportation of communicable diseases	37	6 (16.2)	14 (37.8)	8 (21.6)	9 (24.3)
Non infectious	Risk of exacerbation of existing medical illnesses like cardiac issues, hypertension, asthma, musculoskeletal disorders etc.	49	5 (10.2)	24 (49)	8 (16.3)	12 (24.5)
	Risk of alcohol and drug abuse	43	2 (4.7)	4 (9.3)	5 (11.6)	32 (74.4)
	Risk of dehydration/heat stroke	41	3 (7.3)	8 (19.5)	7 (17.1)	23 (56.1)
	Risk of exacerbation of childhood diseases like asthma etc.	30	2 (6.7)	14 (46.7)	6 (20)	8 (26.7)
	Risk of drowning	11	0	2 (18.2)	1 (9.1)	8 (72.7)
	Risk of allergies	5	0	2 (40)	0	3 (60)

*n=Number of raters who had predicted the particular risks

Table.45: Health risks perceived by the respondents of community survey (N=229)

S. No	Variables	Frequency	Percentage**
1	Infectious diseases	209	91.3
2	Non-Infectious diseases	102	44.5
3	Injuries	167	72.9
4	Others	6	2.6

**Multiple options possible, so total percentage may exceed 100

Table.46: Distribution of morbidity reported at medical camps conducted by the Department of Public Health during the last two days of the Deepam festival, 2018according to morbidity category mentioned in the surveillance data (N=119)

Morbidity category	n	Percentage
Infectious diseases	49	41%
Injuries	45	38%
Non-infectious diseases	25	21%
Total	119	100%

Table.47: Detailed Morbidity report from the medical camps conducted by the Department of Public Health during last two days of the Deepam festival, 2019--Surveillance data (N=119)

Morbidity category	Morbidity reported	n	Percentage within morbidity category (n/N1)	Percentage out of total morbidity reported (n/N)
Infectious (N1=49)	Fever with cough	18	36.7	15.1
	Fever above 3 days	6	12.2	5.0
	Fever with rash	4	8.2	3.4
	Diarrhea	18	36.7	15.1
	Dysentery	1	2.0	0.8
	Conjunctivitis	2	4.1	1.7
(n/N2)				41.2
Others/Non-infectious* (N2=25)	Bites	18	72.0	15.1
	Skin rashes/allergy	2	8.0	1.7
	Heat related illness	3	12.0	2.5
	Critically ill (cardiovascular events)	2	8.0	1.7
(n/N3)				21
Injuries (N3=45)	All injuries (No further classification details were captured in surveillance data)	45	100	37.8

*The categorization 'Non-infectious' was done by the researcher,the original categorization given for the surveillance system was 'others

DISCUSSION

CHAPTER 5

DISCUSSION

The first objective of our study was to development a Risk Assessment tool for which experts holding administrative and managerial positions and/ or with vast experience in field level implementation from the Departments of health, police, fire and rescue service, disaster management authority, revenue, temple authorities, etc.,were purposively identified as key informants and interviews were carried out. The departments identified in our study covered almost all the core stakeholder departments for mass gathering event management identified by the national disaster management authority. ('NDMA managing crowds guide. pdf', n.d.)

In our study, the median age of the sample of key informants was 43 years (ranged from 35-51 years), their work experience in mass gatherings ranged from 3 to 15 years, and notably only two out of fifteen (13.3%, 2/15) key informants were females. In a study done in Finland to identify the factors to be considered for mass gathering preparedness by rescue authorities, the researchers had employed the key informant interview method, and the informants' age varied from 32 to 61 years and work experience from duties considering mass gathering ranged from 2 to 25 years and informants included 12 men and 3 women, these socio-demographic characteristics including gender distribution were comparable with our study. (Koski et al.*2*020) .In both the studies (our study and Finland study), the sample was purposive and the gender distribution in the sample

could not be generalized. However, it is pertinent to highlight that out of 15 key informants, who were occupying various administrative/managerial positions or with vast fieldwork, the proportion of females was minuscule. This skewed gender distribution may be due to the reflection of the prevailing gender disparity in the workforce, especially in the administrative/managerial position in society across the world. Perhaps, it is more pronounced in developing countries like India. The socially constructed gender stereotypes have delineated certain jobs and skills to be male and female-oriented. This concept of gendered jobs and gendered skills are important barriers to female participation in an administrative and managerial position and the worst part is that these disparities have become a norm in the society. The analysis of Meyer et al (2005) provides support for the hypothesis that women are most likely to be underrepresented in fields that members believe require raw intellectual talent and decision-making skills which women are stereotyped to possess less than do men. (Meyer et al.2015)

In our study, we identified seven domains (characteristics related to the event, participant, environment, food & water-related, disaster preparedness, medical service preparedness, and pre-event planning activities), twenty-two items and multiple factors attached with each item from the key informant interviews and literature review. The identified domains were considered as different sections of the RA tool; the items were modified as independent risk assessment questions and they were grouped under their corresponding domains /sections. The factors associated with each item were modified as response options for the independent risk assessment questions. Arbon P developed a

conceptual model for mass gathering health based on the idea that health risks associated with mass gathering events are due to various key characteristics that can be grouped into three domains namely biomedical, psychosocial and environmental domain. According to this model, the health risks associated with mass gathering events can be better understood as an inter-relationship between these three domains. In this model, the biomedical domain takes into account the number of patients and their type in an attempt to understand the biomedical influences on them. The crowd behaviour forms the part of psychosocial domain. The environmental domain incorporates the environmental features of MGs including the weather and terrain. Each domain interacts with the others and produces health effects.(Arbon 2004).Thus, Arbon stated that studying these characteristics would help to predict health risks and appropriate interventions could be adapted to prevent adverse health events.

In our study, out of the seven identified domains, domains like event characteristics, participant characteristics, environment, food & water-related and the items under these domains were, by and large, matching with the characteristics and domains described by Arbon's conceptual model. The items or sub-themes grouped under event and participant characteristics deal with factors like event type, event duration, crowd size, crowd density, participant profile, and their behavior like alcohol or drug use, etc. These items could fit into the biomedical and psychosocial domain described in the Arbon model with some overlapping. Similarly, the items or sub-themes grouped under food and water-related characteristics and environmental characteristics deal with the season, sanitation, water safety, and food safety, etc. These items could fit into the

environmental domain described in Arbon's conceptual model. However, the other three domains identified in our study like disaster preparedness, medical service preparedness, and preplanning activities and the items identified under these domains were unique and could not fit into Arbon's conceptual model. These additional domains deal with the assessment of available resources and capacity across various core departments involved in mass gathering event management. Previous research shows that MG events may primarily strain resources of the medical services, health care facilities, police forces, and other rescue forces, which highlight the vitality of assessment of resources and preparedness level of the core departments in risk management of mass gathering events. (Zeitz et al.2005; Chhabra et al.2018). The need for multiple authorities to prepare for MG with adequate capacity and sufficient resources and its impact on emergency hospital admissions during mass gathering events was emphasized in the Australian study by. (Zeitz et al.2005) The same study also reported that police workload correlated with emergency medical service workload. Hence, the additional domains (disaster preparedness, medical service preparedness, and preplanning activities) which do not fit into the original Arbon's conceptual model could be grouped into a single broad domain called "System preparedness domain" with two sub domains namely 'health system preparedness' and 'other systems preparedness' which includes systems like police, fire safety, and rescue, revenue and disaster management authority. The interrelation between the preparedness status of these other systems along with health system preparedness plays a significant role in the incidence of health adverse events associated with MG events. If we collate the newly identified domain "system

preparedness" with the Arbon conceptual model (Table 48), it may show the interaction effect of the "system preparedness" domain with the existing domains in influencing health effects. Hence, it is proposed to conceptualize a new model called the, "MGRAT conceptual model "in which the "system preparedness domain" may be incorporated as a fourth domain in Arbon's three-domain conceptual model, which is expected to be more beneficial in risk assessment and response activities to reduce health risks associated with MG events.

Table 48: Comparison of domains identified in our study with Arbon's conceptual model

Domains identified in our study in tandem with the conceptual model	**Arbon's conceptual model (3 domains)**
Event Characteristics Participant Characteristics Environment Characteristics Food and water-related Characteristics	Biomedical domain Psychosocial domain Environmental domain
Additional domains not in fit with the conceptual model	**Proposed new domain to the model**
Disaster preparedness Characteristics Medical service preparedness Characteristics Pre-planning activities Characteristics	**"System preparedness domain"** • Health system preparedness • Other system preparedness (Police, Fire and rescue, Revenue and Disaster management)

Our results showed that the event characteristics and participant characteristics are vital to understanding the health risks associated with religious MG events. Previous studies (Janchar et al.2000; Milsten et al.2002; Zeitz et al.2007; Baird et al.2010; Wood et al.2010; Moore et al.2011; Locoh-Donou et al.2013; Gocotano et al.2015) showed that variables like type of event, duration of the event, participants profile, and their psychosocial behaviour like alcohol and drug use, crowd density, etc.,are important determinants of medical attention, patient presentation, and injury profiles during mass gathering events. These variables are similar to the subthemes grouped under the broad themes (event characteristics and participant characteristics) that emerged in our study. A study conducted with rescue authorities indicated that factors like event characteristics and the profile of participants were pivotal factors to be considered while formulating a emergency plan for MG preparedness. (Koski et al.2020)

Our results project that it is vital to understand if the participants are going to be predominantly seated, mobile, or whether there are going to be long queues of pilgrims standing for long hours. A review on crowd dynamics at a religious MGs in India has highlighted that crowd behavior differs across the events and also stated that understanding the crowd predominant activity level is required to support appropriate and timely crowd management principles in the planning of crowd control measures and provision of early warning systems at MGs. (Gayathri et al.2017)Previous studies have shown that understanding the motivations of the audience makes it possible to gain an accurate picture of how motivations might affect the behavior of the crowd. (Ranse et al.2014; Hutton et al.2018) Segregating visitors by personality, age, special needs, etc.

to provide differentiated attention and/or service has been suggested previously as well (Chase et al 2010). The unique features of MGs in India include the predominance of old and vulnerable people in traditional MGs, as opposed to young and middle-aged groups that gather for music and sporting activities in other countries (Sanyal &Madan, 2011). The diversity levels in terms of people's mix (Sadhus, Rural, urban and international citizens) are much more involved in such mass religious gatherings in India (Gayathri et al.*2*017).

The importance of understanding crowd behavior in the pre-event phase for an adequate assessment of crowd management has been highlighted in another review study. (Zeitzet al.2009) Overlooking this factor can lead to major stampedes. (Gayathri et al.*2*017)As per the findings of our study, the expected number of participants for any event is an important factor for the MG preparedness. The space covered for the event (whether it is confined to a limited area or spread out in large or many areas) tells us about the crowd density and is a crucial factor that determines health risks associated with religious MG events. Religious MG events are cosmically crowded that the risk of a disaster is ever-present.”Hajj", a Muslim pilgrimage to Mecca is an annual event, considered as one of the most crowded religious MG events across the globe. This event has been extensively studied for health risks associated with MG. It was reported that the event attracts more than 3 million pilgrims over one week who undertake their religious duties bound within constrained avenues of time and space. This limitation of space burgeoned by a huge number of pilgrims has to led to series of disasters over several years. (Memish et al.2019) Similarly, "The Kumbh Mela", a hindu religious

pilgrimage festival which is possibly the largest religious MG event in the world (Baranwal et al.2015; Cariappa et al.2015; Dwivedi and Cariappa, 2015; Sridhar et al.2015; Balsari et al.2016; Jani et al.2018) attracts more than 120 million pilgrims is spread over 2 months, held every three years alternatively along the banks of four holy rivers in India. Notably, the organization of this event is spread over many areas abating the crowd density. Constant evaluations of crowd flow have reduced the risk of crush injuries, stampedes, and other mass casualty incidents. (Memishet al.2019) Previous studies have shown that there is a dose-response relationship between event duration and health risks associated with mass-gathering events. (Milsten et al.2002; Arbon, 2004) Some studies failed to show such a relationship of duration of the event with health risks owing to reduced crowd density. Hence, duration and crowd density have an interactive effect on health risks associated with MG events. (Friedman et al.2017) Detailed case studies of globally prominent religious MG events and associated previous studies have highlighted the importance of factors like crowd density and event duration; in line with the factors which emerged from our study. It is also evident that the identified items are interdependent in modifying health risks associated with MG events.

As a part of participant characteristics, psychosocial behaviour like the use of alcohol and drugs; involvement in commercial sex activity emerged as the determinants of health risks associated with religious MG events. Previous studies have shown that substance use and intoxication can potentially have a significant effect on health care events at MG events (Milstein 2002). Intoxicated individuals in gatherings are

associated with elevated patient presentation rates, also elevating the workload on emergency departments like police forces. (Bullock et al.*2*018) During the London Olympics 2012, it was reported that 1.8% of sexual assaults were related to the events and 16% of commercial sex workers stated that their sexual activity started during the event. Sex workers are one of the special groups among the people who have a significantly high number of contacts with MG event participants. Behavioural surveillance of such groups would be critical in infectious diseases monitoring and control activities related to MG events. (Llorente Nieto et al.2017) It was also reported that drug abuse, unsafe sexual behaviour and violent inflicts are some of the notable social and behavioural risk factors associated with MG events. (Elachola, 2016) Environmental characteristics like season, transportation, sanitation, and hygiene facilities, food and water safety emerged as prominent factors affecting MG health (Eberhardt et al.*2*016). The items related to food and water safety were highly emphasized in the key informant interviews which were considered as a separate domain in the tool. Many studies have highlighted the importance of environmental factors like season, sanitation, food and water safety affecting the health of pilgrims and environment- in the MG events; which supports our study findings. (Milsten et al.2002; Shinde 2007; Johansson et al.2012; Ranse et al.2017).Literature indicates that in the past the administration of MGs has recognized the risk of waterborne disease in the heavily populated urban area of Kumbh Nagri in India, where communal cooking, communal feeding, communal bathing, and poor sanitation are the norm. (Patel & Burke 2009)

Locoh-Donou et al. *(*2016) in his study reported that the absence of free and safe

drinking water supply is strongly associated with patient presentations. Acute food poisoning during the Hajj in summer months has been reported due to unhygienic food preparation, prolonged storage of food, contaminated water sources, shortage of water for hand washing, hence resulting in exacerbated health-related morbidity. (Shafiet al.2016) Food and waterborne infectious diseases have been reported in many of the religious MGs. (Soomaroo& Murray 2012; Abdullah et al.2013; Polkinghorne et al.2013; Youbi et al.2013; Sridhar et al.2015)

The contributing factors reported for various water and food-related health issues are temporary food outlets, untrained food handlers and the unhygienic preparation of food (Munnoch et al.2004), lack of ready access to piped water (Vortmann et al.2015) and unavailability of soap (Soomaroo& Murray 2012). Food preparation conditions could be fully hygienic and safe, but the unhygienic distribution of food leads to health problems and hazards for MGs participants. (Tavanet al.2020)

The predominant weather conditions during the MG have been cited as a major factor influencing the number and types of injuries presented for treatment at the MG events. (Chang et al.2010) However, the impact of temperature is not much evident whereas the relative humidity has been reported to have a far more consistent effect on the number of hospital presentations.(Arbonet al.2001).Due to seasonal variations, malaria has been reported in the MGs happening in the rainy season (Sokhna et al.2017). Ahmed et al. (2006) have reported that heat exhaustion and heatstroke are leading causes of non-communicable diseases' morbidity and mortality, particularly in the summer due to the

absence of air conditioning, arduous physical rituals, reduced shade, and inadequate fluid intake.

The need to acknowledge the availability of clean water and sanitation facilities is critical when planning a mass gathering event. Aerosolized whirlpool spa was reported to be the source of an outbreak of Legionella reported during a fair in Belgium as the water was not changed during the fair. (Schrijver et al.2003)In addition to water sanitation, similar monitoring of ice sources has also been recommended. (Salmon-Rousseau et al 2016) In a study by Tavan et al. (2020) it has been reported that improper disposal of waste and insufficient numbers of toilets that are often crowded and filthy, contribute to a decrease in the standard of environmental hygiene at the gathering. A study on Kumbh Mela in India reported that an estimated 80 percent of Mela pilgrims are mostly from rural India, where fewer than 20 percent have access to sanitation facilities and open defecation was commonly practiced. (Nath 2003)

In MGs, due to high spatial population density, human-to-human transmission of airborne diseases is facilitated. Previous research indicates that multi-day gatherings with crowded group accommodation are often associated with an increased risk of respiratory infection transmission. (Balkhy et al.2004; El Bashir et al.2004; Ishola & Phin, 2011)

Inadequate transportation during MG events has been reported to contribute to the pilgrim's risk of disease. (Helbing et al.2007; Johansson et al.2012) At the time of MG events, the regular travel of residents from home to work combined with significant

movements of pilgrims on the local and regional scales result in major congestion on road networks and public transport. (Anderson et al.2016) Issues associated with road traffic and pedestrian congestion at the event site can even require ambulances to be placed in standby mode. (De Lorenzo 1997)

Our study revealed that most unique rituals are performed by the pilgrims during the South Indian religious MG events with a belief of thanking the Almighty for fulfilling their wishes or to ask for forgiveness for the sins committed by them. From circumambulation to walking on ambers, head tonsuring, taking a holy dip in sacred water bodies, display of fireworks, the immersion of idols in the water, animal sacrifice/slaughtering, and many other activities are performed by the pilgrims which are a source of major public health issues (Karthikeyan 2009; Memish 2013) Traditionally religious MGs involved killing of an animal directly or supervised slaughtering by the pilgrims exposing them and the environment to different risks (Rahman, 2017) Different rituals pose unique health and environmental risks to the pilgrims and the place where the MG is hosted. These findings are in line with the findings of previous studies. (Sridhar et al.2015)

In a study conducted by Yadav et al. (2020)for deciphering the impact of ritualistic mass bathing on the river microbial ecology after an MG event, an increase of priority skin and enteric pathogens was observed. Due to the offerings made by devotees, the solid waste management was not satisfactory and the level of pollution at the Ganga Ghat had increased during Kumbh Mela. (Kasthala and Lakr, 2015)

Medical preparedness emerged as a major category both from KIIs and literature review and this is in line with what has been reported in other studies that have projected provision of on-site medical support at MGs to have significantly reduced the number of people seeking medical emergency transport to the hospital and thus reduced the burden on local health services. (Grange et al.2003; Ahmed et al.2006)According to Madzimbamuto (2003),even local hospitals should be involved with emergency planning in preparation for potential mass gathering disasters which is consistent with our findings. Pre-event preparation meetings were projected as important for the planning of MG activities. This concurs with the previous findings wherein poor initial contact with emergency medical services was a crucial finding in the stampedes at the Akashi fireworks incident in Japan (Lee & Hughes 2005) and the religious temple in Uttar Pradesh (Burkle & Hsu 2011). Analysis of previous crowd disasters has shown that pre-planning is essential for MG events. (Soomaroo and Murray, 2012)Some environments for MGs are so crowded that the risk of a disaster is ever-present.(Burkle & Hsu 2011).MG health and disaster management share important elements that can be used for augmenting disaster preparedness at the time of MGs (Lund et al.2012). This supports the category 'Disaster preparedness' that emerged from our study. In addition to this, inter-sectoral coordination emerged as an important category from our study. This is consistent with other studies that have mentioned that to ensure the event runs smoothly, related sectors such as transport, etc also need to be taken into account (David &Roy 2016). The sharing of information and integrative preparation has proven to be

major elements for enhancing security and resource assessment in MGs. (Berner *et al.*,2015)

This section discusses the feasibility of using the mobile app-based risk assessment tool (MGRAT). The development of a mobile app for utilization in a low-resource MG setting requires iterative testing and adaptation to produce a validated intuitive design. We tested the app in the religious mass gathering (MG)'Karthigai Deepam' of Thiruvannamalai district of Tamil Nadu. As the intended app users were public health officials, we included all the public health preparedness team members involved in the planning and management of Deepam festival in the feasibility study. To obtain an equivocal and practical user experience of the app, we categorized the app users into 'high, middle and grass root level'; based upon their role in public health preparedness for this religious MG event. This was expected to aid in removing bias and support the app's implementation and usability at every stratum of the public health domain involved in managing the MG.

Most app users reported that the tool's items reflect the relevant aspects of the construct to be measured, i.e., assessment of public health and environmental risks. Many of the users reported the application of the tool to the MG settings as highly relevant. All items were reported to be simple and understandable by most of the users. For a health app to be successfully adopted and regularly used, it has to be feasible or usable by an individual. (Roberts et al.2018) This was reflected in our study wherein most app users found the application of the tool to be feasible.

The MGRAT app is the first Mass Gathering Risk Assessment app, to our knowledge, to receive multidimensional feedback of app quality indicators of *engagement, functionality, aesthetics,* and *information quality,* as well as subjective app *quality in line with Mobile App Rating Scale (*Stoyanov et al.*2*016)from the app users. Engagement reflects the ability to sustain usage of the app due to positive features like being targeted towards the intended audience with concise and simple displays of data (Vivian 2012). These positive features were reflected in the feedback from the MGRAT users in our study. Overall, app users consistently reported the ability to learn and utilize the MGRAT app quickly and easily which was similar to the usability of specific healthcare apps (Liew et al.*2*019). The majority of the app users reported that MGRAT had a perfect timely response with no technical bugs. This was made possible by the Progressive Web Application (PWA) design, which excludes the need for app installation, significantly reducing the burden of network coverage. In contrast, previous research found that low network coverage and signal strength are also a significant constraint on mobile technology implementation. (Vivian 2012) (Nightingale et al.2017) have reported in their study that app information's accuracy and relevance is a desirable component of mHealth apps. This is reaffirmed by our study findings where in users have reported the quality of the information provided in MGRAT to be quite coherent and appropriate. Goals management is a necessary function to allow app users to evaluate the attainment of the specified objectives holistically. The majority of the app users felt that our app had specific and measurable goals that were highly likely to be achieved**.** Visual appeal is increasingly seen as an essential factor in perceived usability,

interaction, and overall appraisal of user interfaces. Many app users felt that the visual appeal of MGRAT was consistent and professionally designed with average visual appeal. A study by Vaghefi &Tulu (2019) reported that a clean interface helps users navigate the app despite its complex nature. End-user recommendation of a mobile app is vital to measure the value of the app's outcome. A high number of app users in our study would recommend our app to several people, similar to a study by De la Torre Díez et al. (2017) which reported that all app users would recommend the app to other users. The majority of the users rated our app with four stars. This is consistent with the app quality rating criteria employed by mhealth app development and usability studies in diverse populations. (Vivian, 2012)

Infectious diseases followed by injuries were the commonly reported conditions in the surveillance report generated from the medical camps conducted by DPH during the Deepam festival. In the community survey, infectious diseases were identified as priority health risks, and this was demonstrated in the MGRAT output following PHP team members' risk assessment. Additionally, MGRAT output also indicated the risk of exacerbating existing medical illnesses like cardiac issues, hypertension, asthma, and musculoskeletal disorders under the non-infectious risks category. This has been demonstrated in the past studies (Khan et al.2006, 2018; Memish, Zumla, et al.,2014; Memish et al.,2019). Overall, we observed that risks predicted by using MGRAT app were comparable to almost all the morbidities detected by the surveillance system set up at the time of the Deepam festival. This proves the validity of the MGRAT app.

Since all the study participants assessed the health risks associated with a common event (KarthigaiDeepam festival, Thiruvannamalai) using MGRAT app, the app's reliability was assessed by measuring agreement between the raters (Inter-rater reliability measure). Fleiss kappa indicated fair agreement among the raters in risk prediction and its ranking using MGRAT app. The agreement values were consistent and significant at the sub-group level (High/ Mid/ Grassroot level). The findings are compatible with the STREET tool of Berner et al. *(*2015)developed for similar settings in Sweden that had inter-rater reliability of kappa 0.37.

To accomplish the objective of assessing perceptions of pilgrims about the risks associated with MGs, we analyzed the data in two ways: First, perceptions of pilgrims (residents and visitors) about MG associated health risks were analyzed along with the difference in their perceptions. Following this, factors associated with the differences in the perception of health risks among the pilgrims were analyzed.

Overall, around forty three percent pilgrims perceived that eating food at the road side eateries at the time of MG posed health risks. This is reflected in the findings from a study done in another country (Alqahtani et al.2016) which reported that lower proportion of pilgrims avoided eating food from street vendors and least compliant with measures for preventing food related health risks such as avoiding unclean fruits and vegetables at the time of MGs.

However when we compared the proportion of visitors with the residents, we found that greater proportion of visitors perceived that eating at road side eateries during the MG

event could pose health risks than the residents. However, this difference was not found to be significant.

Overall, only (30.9%) participants perceived that eating food at the Annadhanam site led to health risks during the MG event; however, we could not establish any significant difference between visitors and residents regarding perception of the health risks associated with eating food at Annadhanam site.

Most of the pilgrims opined that food items served in the Annadhanam were fresh. This could be due to the fact that religious sentiments are associated with annadhanam. Pilgrims regard the *prasadam* offered at the places of worship as pure and sacred. Despite the fact that Food Safety and Standards Act (FSSAI 2006) in India has taken the food consumed during religious gatherings such as '*prasadam*' and 'community eating' under its purview, food poisoning outbreaks (Alzahrani et al.2012; Kumar et al.2015; Bajaj & Dudeja, 2019) are commonly reported at the places of worship. Food poisoning and lack of hygiene at pilgrims have been cited as the main causes of the spread of communicable diseases such as gastrointestinal diseases making it an important challenge pertinent to MGs.

Contrary to previous studies (Jonas et al.2011) many pilgrims in our study considered that drinking water could not be a source of health risks at the time of religious MG event of Deepam festival. Residents perceived increased health risks due to drinking water when compared to visitors and the difference was statistically significant. . The residents may negatively evaluate the possibility of hosting a mass gathering, as it may have a negative impact on the environment (Li et al.2018) through increased pollution.

This could be the reason behind residents perceiving high health risks of drinking water at the time of MG.

Around half of the participants perceived the toilet facilities to be inadequate while the other half found it adequate. During the 2013 and 2016 Kumbh Mela ceremonies, in spite of toilets being available, pilgrims engaged in open defecation and urination (David & Roy 2016) There was a significant difference in the perception of cleanliness of the toilets among residents and visitors as residents carried a poor perception when compared to the visitors. Residents were not satisfied with the provisions for elderly/disabled individuals for toilet facilities at the event site compared to the visitors and this difference was significant. Overall, the study participants perceived that poor sanitation prevailing at toilet facilities could increase the health risks in the religious MG event of Deepam festival. In support of our findings, a systematic review conducted by Gautret & Steffen (2016) reported that most of the outbreaks of GIT infections associated with faecal-oral transmission resulted from non-compliance with hygiene rules and inadequate sanitation. This was mostly observed among adult participants, including elderly participants. Majority of the study participants felt there were adequate medical care facilities, medical doctors, drug availability and ambulances available at the religious MG event of Deepam festival. Overall, we found no difference in the perception of residents and visitors about medical services available at the religious MG event of Deepam festival. This may be attributed to the fact that the Tamil Nadu model of public health is renowned for its effectiveness in delivering quality health services at an affordable rate, particularly to rural citizens. Tamil Nadu is the only state with a

distinctive public health system at district level and was the first state to enact the Public Health Act in 1939. (Parthasarathi & Sinha 2016) These findings are also comparable to that of a systematic review conducted by Ranse *et al. (*2017) according to which majority of the studies stated that in-event health professionals were present at the mass gathering. Literature also suggests (Hodgetts &Cooke 1999) that utilization rate of medical services increases for the outdoor events wherein attendees move about at the venue. This is so because the risk of illness or injury to each person visiting the MG is augmented compared to that of a person spending time at home and hence supplement the routine systems becomes a necessity.

The difference in the perception of availability, affordability, accessibility and safety of the transport facilities between visitors and residents was found to be significant. The risk perception was significantly higher among the visitors than the residents. Incidents have been reported wherein the main reasons cited for the stampede was that public security bureau had not enforced any effective traffic control even though they were instructed. (Yh et al.*2*017) Trauma risk has been reported to be a big cause of morbidity and mortality at the religious MG of Hajj due to extreme traffic (Al-Harthi & Al-Harbi 2001)

Higher proportion of residents perceived the congestion to be high at the event site than the visitors and the difference was statistically significant. Most of the participants perceived the event site to be highly congested, stampede prone and crowd management arrangements were perceived to be average or above average at the festival site in Thiruvannamalai. Fear of being crushed in crowded places isn't the only concern;

another major worry is disease transmission (Ahmed et al.2006; Karampourian et al.2019)Milstein et al. (2003) has reported that factors such as dust and dense crowds can worsen pre-existing respiratory conditions, hence , resulting in huge number of participants seeking medical care. In another study on the Hajj reported that the magnitude of the disaster does not hamper the pilgrimage festival, but the crowding as the result of Mass gathering leads to growing number of traumatic accidents, delays in treatment and other violations against public order every year (Batty et al.2003) (Batty. From management point of view, it has been highlighted in the past (Alaska et al.2017) that crowd control initiatives, such as the use of crowd simulation models, video surveillance, modification of the transport system, etc.,played a crucial role in improving safety during religious pilgrimage of Hajj.

However, half of the participants perceived that waste was not removed or cleared in a timely manner by the authorities and many of them perceived that there could be increased health risks due to improper solid waste management at the event site of the religious MG of Deepam. The spectrum of logistical issues for MGs is broad and involves the management of solid waste as well but the density of pilgrims can preclude the use of vehicles used for refuse removal. This could explain the reason the untimely manner removal of waste. Another study however states that around 200 tonnes of solid waste was removed from Kumbh every day (Baranwal et al.2015)

Visitors perceived the event site of MG to be safer compared to the residents and this difference in the perception of safety was significant. These findings are in contradiction

with a study in which the safety of the tourists' luggage and baggage during crowded religious ceremonies was not satisfactory (Kumar, 2015). In a recent study conducted to investigate the factors needed to be considered for preparation of MGs stated that as per the rescue authority's safety of the venue infrastructure is a factor that should be included in the emergency plan. (Koski *et al.*,2020b)More than half of the participants perceived that no alcohol/drug abuse activities were carried out at the event site and this perception was significantly more among the visitors than the residents. In contrast to religious MG events, excessive alcohol consumption and recreational drug use has been increasingly reported in sports and music concerts which in turn increases the risk of intoxication, injury and extreme behaviours (Ahmed and Memish, 2019). In another study conducted to determine pilgrims' expectation and satisfaction levels by finding the extent to which the pilgrims' expectations were met with hospitality services in Katra; indifferent attributes were found which included availability of only vegetarian food and non-alcoholic drinks. Studies indicate that event characteristics, such as the event type, alcohol and drug use affect the injury profiles and need for medical attention (Janchar et al.2000; Wood et al.2010; Moore et al.2011) and understanding crowd behaviour would allow adequate crowd management assessment in the pre-event phase (Zeitz *et al.*,2009) since intoxicated participants are more vulnerable to accidents (Milsten et al.,2002) and might also cause elevated workload for police forces (Zeitz *et al.*,2007). Majority of the participants were of the opinion that the event site was not prone to fire accidents. Participants graded the fire safety arrangements at the event site as good or excellent. This is in contrast to the findings of a study of earth's biggest religious MG of

MahaKumbh Mela held in India where fire incidents were one of the major shortfalls which was identified was that of and thus reduction in fire incidents was suggested for making MGs safer (Baranwal et al.2015).

Most of the study participants perceived the cleanliness at the place of animal sacrifice to be poor or very poor and few participants perceived that there could be increased health risks due to the animal sacrifice/slaughtering during the religious MG event of Deepam festival. This is contrary to the findings reported in other studies that have reported human infections resulting from direct contact with infected animals used for slaughtering. (Rahman et al.1999; Basturk et al.2016)

Majority of the participants did not perceive any health risks associated with special rituals like head shaving/head tonsuring, ear piercing, car festival or fire walking. This is contrary to the findings of studies reporting health risks occurring as a result of special rituals performed at religious MGs. Head tonsuring, which is quite commonly practiced at the places of religious MGs, facilitates the spread of blood-borne diseases, including hepatitis B, C and HIV (Gatrad & Sheikh, 2001). The Saudi authorities have brought in aggressive legislative approach to discourage unlicensed barbers operating in the Hajj and recommend that pilgrims need to be mindful of such risks and must only be shaved at the approved centres. (Ahmed et al.2006) Skin infections have been reported among pilgrims who perform lengthy rituals of standing, walking and exposure to heat (Fatani et al.2000). Also, mass bathing in rivers has been reported to be a cause of gastrointestinal disease in religious mass gatherings like Kumbh Mela. (Sridhar et al.2015)Majority of the participants perceived that the religious MG event of Deepam

festival could majorly pose infectious diseases followed by injuries and non infectious diseases. This is in contrast to the studies that have reported non-communicable diseases and injuries to have caused more deaths and morbidity at the time of MGs when compared to communicable diseases. (Wetterhall et al.1998; Hsieh et al.2009)However, among communicable diseases, respiratory tract infections followed by the gastrointestinal infections have been reported to be the most common diseases in religious MGs (Khamis 2008; Tabatabaei & Metanat, 2015)Contagious diseases linked to religious mass gatherings differ according to demographic type, location, and ethnicity (Karampourian et al.2019)

A significant association was established between residence status and perception of overall health risks associated with the MG event of Deepam festival. Residents were 1.525 times more likely to perceive health risks associated with MG event than visitors. Family status (p=0.029) and resident status (p=0.00 9) were associated with perceived health risks associated with the drinking water facilities , stampedes and car festival at MG of Deepam festival. Joint families were 1.7 times and residents were 1.87 times more likely to perceive health risks associated with drinking water facilities arranged during the MG event than nuclear families. Joint families were 1.9 times (p=0.04) more likely to perceive health risks of eating food at the Annadhanam sites, 1.6 times(p=0.03) more likely to perceive health risks of car festival and 2.4 times (0.00 7) more likely to perceive health risks of stampede than the nuclear families attending the MG of Deepam festival.

Residents were 1.87 times more likely to perceive health risks associated with drinking water facilities arranged during the MG event than the visitors.

Our findings that family status and residence status were associated with perceived health risks of mass gatherings are consistent with findings from previous studies. Previous research findings which support the results of our study stated that family members could also regulate each other's behaviours, provide information and encouragement to behave in healthier ways and utilize health care services more effectively (Cohen, 2004; Thomas *et al.*,2017)

It has been stated in the previous studies that nuclear family systems showed higher percentages of poor health status indicators compared to joint or extended families and it is the presence of social networks within the joint family framework that plays a role in minimizing indicators of poor health status. The diverse structure of joint family groups promotes knowledge and awareness of health with potential to share information on safety . (Ferrer et al.2017)

Apart from this, proportion of visitors perceiving cleanliness at Annadhanam site as good was significantly more than the proportion of residents. The difference in this perception could be due to the tendency of visitors to compare different places of pilgrimage on various parameters. They may have found this place of pilgrimage 'good' in terms of cleanliness relative to other places of pilgrimage they had visited, whereas residents of Thiruvannamalai found the level of cleanliness not so good at the time of MG event compared to other days. Similarly, visitors felt crowd management was good when compared to the residents. At the time of MG events, there is huge

influx of pilgrims from outside the town hosting the MG. This is the time when the host town is overflowing with crowd and the residents tend to feel overwhelmed seeing unmanageable crowds around their dwelling place compared to the normal days.

Overall, most of the pilgrims (71%) felt that the service at the Annadhanam site was not well accessible for elderly and people with disabilities. As per the guidelines formulated for crowd management and public safety in India, by the National Disaster Management Authority of India (NDMA 2014) for managing crowd at events and venues of MGs, the MG planning team should prepare the course of action keeping in mind the specific populations like the elderly and the individuals with disabilities and others with access and functional needs. It specifically recommends having a list of paramedics and civil defence society members who have undergone training in transportation of disabled visitors. Under the key skills listed under training component of the stakeholders, it has been mentioned that the persons should be assigned specific roles in the plan that will require special skills such as providing assistance services for the elderly, persons with disabilities and others with access and functional needs. It also highlights the need to provide key information regarding evacuation routes, shelter in place procedures and locations, effectively to pilgrims with disabilities or others with access and functional needs. (NDMA 2014)

All the guidelines emphasize in one voice that the most effective way of ensuring access in MGs for potentially vulnerable populations is to consider them at the very earliest stages of planning of the event. Efforts should be made to have facilities like providing dedicated parking spaces close to the event for people with disabilities, supplying

occasional seating points, keeping them in mind while laying out evacuation procedures, ensuring cables are secure and don't present a trip hazard, dedicated queue at places of community food distribution and drinking water facility. Seamless access for elderly and people with disabilities to the MG events is not only about physical access to infrastructure but also includes access to appropriate communication to people with sensory impairments and mobility impairments.

Compared to the visitors, residents were (38%) less likely to perceive health risks associated with the transportation facilities arranged in religious MG event. This association was found to be statistically significant after adjusting for the factors age, gender, education, occupation, family type, residence status, marital status and per capita income.

Pilgrims with the income greater than 5000 were (43%) less likely to perceive risks associated with head shaving/ ear piercing rituals in religious MG event. This association was found to be significant after adjusting for the factors like gender, age, education, occupation, family type, marital status, residence status and per capita income. None of the factors found to significantly predict the pilgrims' perception of health risks associated with the animal sacrifice rituals in religious MG event. Published literature on MGs has mentions of participation of special population in religious MGs. A study conducted for describing mental morbidities among Indian pilgrims during Hajj 2016 highlights that in addition to being physically exhausting activity, for elderly pilgrims with chronic medical illnesses it is also psychologically a stressful situation due to insecurity resulting from being on a foreign territory exposed to an altogether

different culture, fear of being lost, language problems and a spiritual atmosphere which is overwhelmingly challenging. The authors go on to say decompensation takes place in the elderly due to highly stressful circumstances during Hajj especially in the elderly who suffer from co morbid physical ailments (Khan et al.2017). For Hajj, arrangement of special air-conditioned tunnels with separate sections for walkers, runners, and disabled pilgrims is done.(CDC, n.d.) Previous studies (Leonard et al.2006.; Lundet al.2015)have emphasized the importance of planning the MG events keeping in mind the needs of special population and also be flexible to deal with special medical problems as they develop depending on the composition of crowd.

5.1 Limitations

Our findings are limited because only so much can be determined from evaluation of a Risk assessment mobile app in a single religious mass gathering event. For the community survey, during the planning stages of the project, we anticipated obtaining access to temple authority registers/databases (such as pilgrims' registers for pooja/Archana) which we would use as the sampling frame for the probability sampling method. Hence, we calculated sample size and incorporated inferential statistics in our analysis plan. However, we learned later that there is no such useful database that can be used as a sampling frame. We used the non-probability sampling method (purposive quota sampling), as described in the methods section, because there was no other way to follow the probability sampling method. Despite the fact that we used a non-probability sample, we decided to use the sample size calculated previously. The descriptive

analysis of the socio-demographic characteristics (age, gender etc.) of the study has been found to be comparable to the other studies that dealt with pilgrims attending Indian religious mass gathering events (Joseph et al 2020; Sreedhar et al 2008). This implies that the study sample is comparable to that of the study population that we intended to study. We undertook this inferential statistics not to draw any conclusive inference about the observed associations. However, such analysis can certainly throw light on factors which may be explored further in the subsequent research studies. Hence, due to the systematic procedure used in the conduct of our study and selection of relatively high quality of user sample, we have confidence that results outlined here reflect those most salient to a generic pilgrim population represented in any religious mass gathering setting. Moreover, following purposive quota sampling on high yielding sites enabled us to capture distinct information and perspectives about the aspects of mass gathering events.

Also, as this app was tested and validated only in the context of religious mass gathering. This may limit the generalizability and utility of the MGRAT app in a diverse setting like India providing challenges in extrapolating the findings to other types of Mass gathering events. So, there is a need to test this novel app in multiple religious and widespread MG events to get data regarding its validity and reliability to assert the robustness of this app.

The features of this app appear to be primitive with no real-time data entry and integration available. While characterizing the identified risks; there is a significant role

of subjectivity that comes into play wherein the user has to feed her/his evaluation about the likelihood and consequence of the identified risk. MGRAT works on the assumption that the inputs given by the public health managers are the outcome of their experience, multiple consultation meetings, multiple field visits, record review, etc, and hence considers the inputs given by them reliable. This as one of the important limitations of the app with a scope of improvement in this aspect in the future. This app has been developed in the English language; this could pose a linguistic barrier in a multilingual society like India. However, it was assumed that the intended users of this app who are qualified public health managers will not face this language barrier.

In the stipulated period of the study, the participants had a limited experience using the MGRAT app, therefore giving them a longer time to explore the app may have probably yielded additional insights.

5.2 Recommendations

- Our study highlights that MG health service delivery system which is inclined towards Infectious diseases should be magnified towards Non- infectious diseases as well.
- During MG planning & management, culturally relevant health promotion activities should be included.
- Enlisted limitations create a window of opportunity for future scope of improvisation of the MGRAT app. For instance, the app could be improvised to

integrate real-time data which would further improve the accuracy and efficiency in decision making and will eliminate the role of subjectivity.

- The accumulated data (data repository) could be used for developing prediction models which will aid in resource estimation and priority allocation of resources.
- This app could further serve as a prototype based on which other MG related applications could be developed like risk communication app.
- The MGRAT app is a promising tool to aid public health managers in conducting risk assessment in MG settings. It could serve as a baseline framework for the systemization of risk assessment process of religious MGs in Indian setting with huge potential for further evolvement.
- The results yielded by the MGRAT app could provide future directions for research in pilgrim satisfaction which would look aid in the aspect of arduousness as a virtue in driving pilgrim movement and geography as a source of attraction for pilgrims.

SUMMARY OF FINDINGS AND CONCLUSION

CHAPTER 6

SUMMARY OF FINDINGS AND CONCLUSION

The study focused on developing a risk assessment tool for religious mass gatherings in Indian settings. We developed and validated a new risk assessment tool-MGRAT. We tested the feasibility of using MGRAT in the religious MG of Tamil Nadu, India. We conducted a cross sectional survey to assess public perceptions regarding public health and environmental risks associated with the religious MG event of Tamil Nadu. Our study led to the development of a RA tool which consists of features pertinent to planned religious MGs of Indian context conceptualized by a unique model called, "The MGRAT conceptual model" which comprises of three domains of the Arbon's conceptual model in addition to a "System Preparedness domain" that emerged from our study.

The major findings are summarized as follows-

- We identified seven domains (characteristics related to the event, participant, environment, food & water-related, disaster preparedness, medical service preparedness, and pre-event planning activities), twenty-two items and multiple factors attached with each item from the key informant interviews and literature review.
- The identified domains were considered as different sections of the RA tool; the items were modified as independent risk assessment questions and they were

grouped under their corresponding domains /sections. The factors associated with each item were modified as response options for the independent risk assessment questions.

- Scale level Content Validity Index (S-CVI) was 0.92 indicated excellent content validity of the risk assessment tool. Interrater agreement among six raters after adjusting for the chance agreement was assessed using Fleiss kappa with a value of 0.522 indicating moderate agreement which was statistically significant.
- The validated tool was developed into a web based app named Mass Gathering Risk Assessment Tool (MGRAT), which intends to identify and characterize the risks associated with religious mass gathering events in Indian setting. It is a device responsive Progressive Web Application and is developed with a configuration-driven model. The app along with the data is hosted in the worldwide served Google's Firebase Cloud platform.
- The MGRAT app was used by all the public health preparedness team members involved in the MG event of Deepam festival, 2018 to assess its feasibility. Majority of the users (96%) found the application of the tool to be feasible and around 63.3% of them rated the app with a 4-star rating.
- The inter-rater reliability of the MGRAT app was assessed by measuring the agreement between users in risk prediction and ranking after adjusting for the chance agreement using Fleiss kappa was 0.311 indicating a fair agreement between all users and it was statistically significant.

- Community risk perception revealed that more than half of the participants (60.4%) perceived that there would be increased health risks during MG. Around 91.3% participants mentioned at least one risk under the 'infectious disease' category, 72.9% participants indicated at least one risk under the category 'injuries, ' 44.4% participants mentioned at least one risk under 'non-infectious diseases' category. Residential status appeared to be a significant predictor of health risk perceptions among the participants (Adjusted OR= 1.525; 95% CI of adjusted OR=1.00 4, 2.316; p=0.048).
- We found that infectious diseases followed by injuries were given priority by the health system and community. The same had been reflected in the MGRAT app output as well. However, it is pertinent to note that the MGRAT output of the 49 app users predicted few non-infectious disease risks as well like the risk of exacerbation of existing medical illnesses like cardiac issues, hypertension, asthma, musculoskeletal disorders as the risks associated with MG event.

6.1 Conclusions

Mass Gatherings pose a high risk of infectious diseases regardless of their duration, size, and place. The surveillance morbidity report, community survey and the output generated by the app users in our study pointed that focus is directed majorly towards communicable diseases, followed by injuries. Formulation of a response plan should be done by public health authorities, along with event organizers, which is needed to

enhance thedisease surveillance systems, which varies according to the nature of the event, thereby enabling early detection of potential public health threats .

In view of the public health threats that might originate from religious MGs, pilgrims are less likely to perceive health risks associated with annadhanam food and special rituals performed during these events due to the sanctity and beliefs that has been deep-rooted for centuries, challenging the established facts as per available literature. Thus, laying proof that conventional concepts of disease and crowd control do not adequately address the complexity of MGs.

In an effort to encompass the wide array of characteristics that might arise during different types of MGs, the three domains of Arbon conceptual model were clubbed with addition of “System Preparedness domain” to form The MGRAT conceptual model.

With the development of use of mobile technologies to mitigate risks associated with MGs, there was a need for an MG risk assessment app that is guided by sound evidence but anchored in real-time experience, which would open avenues for risk preparedness strategies in the context of MGs around the globe. Evidently, our study led to the development of the first risk assessment mobile App called the “MGRAT” which consists of features pertinent to planned religious mass gathering of Indian context. Our tool is feasible, valid and reliable which could be replicated across various religious mass gatherings. The evidence generated by the MGRAT app can be used to formulate

risk management guidelines that could assist event planning and health-care policy makers.

The integration of a novel mobile app for Risk assessment would provide an opportunity to strengthen risk assessment and risk mitigation capabilities for MG host cities and countries, enhancing multi agency public health practices which forms a lasting domestic public health legacy, and forms a repository of new knowledge that would benefit the hosts of future MGs worldwide.

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PUBLICATIONS FROM PhD WORK

1. Sharma U, Desikachari BR, Sarma S. Protocol for development of a risk assessment tool for planning and management of religious mass-gathering events of India-a health system-strengthening initiative. *Pilot Feasibility Stud*.2019 Jun 24; 5: 83. doi: 10.1186/s40814-019-0464-z. PMID: 31293791; PMCID: PMC6591856.

2. **Sharma U**, Desikachari BR, Sarma S. Content validity of the newly developed risk assessment tool for religious mass gathering events in an Indian setting (Mass Gathering Risk Assessment Tool-MGRAT). *J Family Med Prim Care*.2019 Jul; 8 (7): 2207-2211. doi: 10.4103/jfmpc. jfmpc_380_19. PMID: 31463231; PMCID: PMC6691416.

PRESENTATIONS IN CONFERENCES

1)10th annual conference of The Consortium of Universities for Global Health (CUGH), 2019 held at Chicago, USA: Presented a poster on the topic, "Development of a Risk Assessment Tool for Planning and Management of Religious Mass Gathering Events of India- A Health Systems Strengthening Initiative"

2)1st International Bioethics Health Sciences Conference – BIOETHICON2019 held in Chennai, at SRM Medical College Hospital & Research Centre, on November 8-10, 2019: Presented a poster on the topic "Public Health Governance for Religious Mass Gatherings in India"

DETAILS ABOUT AWARDS FROM PhD WORK

1) Received ICMR Travel grant to Non-ICMR scientists for attending international conference

APPENDIX

A-1

Literature search-data extraction Form

Proforma no:

Title of the article/document: .....

Name of the Journal: .....

S. No	Items	Options	Response
1	What type of literature	1. Published article in an indexed journal (1) 2. Published in a website (2) 3. Department publications (3) 4. Unpublished article (4) 5. Others (8), Mention:	☐
If option 1, for the previous question, Go to 2, else skip to 4			
2	What is the name of the database	1. Pubmed /Medline (1) 2. Embase (2) 3. Web of science (3) 4. Others (8), Mention:	☐
3	What is the type of article	1. Original article (1) 2. Meta analysis/Systematic review (2) 3. Research brief (3) 4. Review article/View point (4) 5. Commentary/Letter to the editor (5) 6. Monographs(6) 7. Others (8), Mention:	☐
4	Title of the Study:		
5	Author (s) & Organisation (s):		
6	Source: (Journal Name/Department name/website URL etc):		
7*	Year of Publication:		
8*	Objectives of the study :		
9*	Study design	1. Quantitaive (1) 2. Qualitative (2) 3. Mixed Method (3)	☐

		4. Others (8)	
10*	Details about the study design of this article:		
11*	Study area in the article:		
12*	Time of conducting the study		
13*	Type of MG		
14*	Name of MG		
15	Summary of the study findings:		

*For question no.7 to 13, enter 99 for not applicable and 999 for not mentioned

****

A-2

Key informants' Interview Schedule

1. Name:	2.Age: .....yrs	3. Gender: 1. Male (1) 2. Female (2)	☐
4. Designation	..... 5. Department:		
6. Experience in Planning and Management of MG event	1. Yes (1) 2. No (2)		☐
7. If Yes, Type of MG event* (If experience in multiple type of events, enter the type of event with maximum experience)	1. Religious event(1) 2. Sporting event (2) 3. Cultural event (3) 4. Political event (4) 5. Others (8) Mention:		☐
8. Total number of years of service	..... years		
9.Total number of years of experience in MGs	.....years		
10. a) Have you undergone any formal training related to MG event management?.. b) If so mention the details....? c)Did you find the training adequate ? d)If no training has been given, do you feel the need of the training	1. Yes (1) 2. No (2) .... 1. Yes (1) 2. No (2) 1. Yes (1) 2. No (2)		☐ ☐ ☐
11. Guiding questions (following are the questions only to guide the researcher to prevent deviation of the in-depth interview from its focus/objective)			
a) Briefly describe your role/experience in planning and management of MG event?			
b) According to you, what are the health risks associated with MG events during the course of event?			

.....

c) According to you, what are the health risks associated with MG events after the course of event?

.....

d) According to you, what are the environmental risks associated with MG events during the course of event?

.....

e) According to you, what are the environmental risks associated with MG events after the course of event?

.....

f) Would you like to organize the reported risks as certain classification according to some crriteria like type of MG events/ Type of risks etc?..... If So, Kindly proceed.....

.....

g) What is your opinion regarding preparedness of our system in tackling the risks mentioned by you?.....you can grade on the scale of very good/good/average/poor/very poor....You can grade for individual risks and for overall.....

.....

h) What are the strengths you observed in the present system of MG management?

.....

i) What are the weaknesses (scope for improvement) observed in the present system of MG management?...Would you like to suggest some solution for the problems identified?

.....

j) Is there any formal risk assessment process carried out before/during planning and management of MG event

.....

k) How do you estimate resources required for MG event planning and management?

.....

l) Do you have any checklist/ tool/framework for risk assessment for planning and management of MG events? .....

m) If you were given the responsibility to develop a risk assessment tool/checklist for planning and management of MG event, what all items would you like to include in the tool? How would you assess those items in the field?(check list for risk assessment to prevent communicable diseases/Non Communicables/Stampedes/fire accidents/drowning/other injuries at various sites)

.....

n) Any other suggestions : .....

Thanks for your valuable time and help!!!

Signature of the Expert

Signature of the researcher

****

A- 3

Content validity Questionnaire for Experts

Expert no: .....

Respected Sir/Ma'am,

I kindly request you to go through the attached tool and give your valuable opinion.

A. Details of the Expert

Name: ....., Age .....Yrs, Gender: 1. Male (1), 2 Female ( )

Designation: ....., Department: .....

B. Overall tool / scale content assessment:

1. Whether all the items refer to relevant aspects of the construct to be measured (Face validity)?
    1. Not Relevant (1) 2. Somewhat relevant (2) 3. Quite relevant (3) 4. Highly relevant (4) ☐

2. Whether all the items together comprehensively reflect the construct to be measured?
    1. Not reflecting (1) 2. Somewhat reflecting (2) 3. Quite reflecting (3) 4. Highly reflecting (4) ☐

3. Whether all the items are relevant for the setting where it is going to be applied? ☐
    1. Not Relevant (1) 2. Somewhat relevant (2) 3. Quite relevant (3) 4. Highly relevant (4)

4. Whether all the items are simple and understandable (for the user) ☐
    1. Not at all (1) 2. Somewhat simple (2) 3. Quite simple (3) 4. Highly simple (4)

C. Item wise assessment for relevance to the underlying construct:

Use the code: Not relevant (1), somewhat relevant (2), quite relevant (3), highly relevant (4)

Item no	Item	Response
		☐
		☐
		☐

Thanks for your valuable time and help!!!

Signature of the Expert

Signature of the researcher

Mobile App Evaluation questionnaire for the App Users (Public Health Preparedness Team)

Proforma no: .....

Details of the Respondent:

1. Name: ....., 2. Age .....Yrs, 3. Gender: 1. Male (1), 2 Female (2) ☐
4. Designation: ....., 5. Department: .....
6. Brief Description of the App: .....
7. Is the app content (visual information, language, design) appropriate for the target audience?
    a. Completely inappropriate/unclear/confusing (1)
    b. Mostly inappropriate/unclear/confusing (2)
    c. Acceptable but not targeted. May be inappropriate/unclear/confusing (3) ☐
    d. Well-targeted, with negligible issues (4)
    e. Perfectly targeted, no issues found (5)
8. How accurately/fast do the app characteristics (functions) and components (buttons/menus) work?
    a. App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken characteristics, etc.) (1)
    b. Some functions work, but have major technical problems (2)
    c. App works overall. Some technical problems need fixing/Slow at times (3) ☐
    d. Mostly functional with minor/negligible problems (4)
    e. Perfect/timely response; no technical bugs found (5)
9. How easy is it to learn to use the app; how clear are the menu labels/icons and instructions?
    a. No/limited instructions; menu labels/icons are confusing; complicated (1)
    b. Useable after a lot of time/effort (2)
    c. Useable after some time/effort (3) ☐
    d. Easy to learn "how to use the app" (or has clear instructions) (4)
    e. Able to use app immediately; intuitive; simple (5)
10. Does app have specific, measurable and achievable goals (specified in app store description or within the app itself)?
    a. App has no chance of achieving its stated goals (1)
    b. Description lists some goals, but app has very little chance of achieving them (2)
    c. OK. App has clear goals, which may be achievable.(3) ☐
    d. App has clearly specified goals, which are measurable and achievable (4)
    e. App has specific and measurable goals, which are highly likely to be achieved (5)
    f. Not Applicable (99)

11. Is app content correct, well written, and relevant to the goal/topic of the app?
    a. Irrelevant/inappropriate/incoherent/incorrect (1)
    b. Poor. Barely relevant/appropriate/coherent/may be incorrect (2)
    c. Moderately relevant/appropriate/coherent/and appears correct (3) ☐
    d. Relevant/appropriate/coherent/correct (4)
    e. Highly relevant, appropriate, coherent, and correct (5)
    f. N/A There is no information within the app (99)
12. Visual appeal: How good does the app look?
    a. No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours (1)
    b. Little visual appeal – poorly designed, bad use of colour, visually boring (2)
    c. Some visual appeal – average, neither pleasant, nor unpleasant (3) ☐
    d. High level of visual appeal – seamless graphics – consistent and professionally designed (4)
    e. As above + very attractive, memorable, stands out; use of colour enhances app characteristics/menus (5)
13. Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?
    a. Not interesting at all (1)
    b. Mostly uninteresting (2)
    c. OK, neutral; would engage user for a brief time (< 5 mins) (3) ☐
    d. Moderately interesting; would engage user for some time (5-10 mins) (4)
    e. Very interesting, would engage user in repeat use (5)
14. Would you recommend this app to people who might benefit from it?
    a. Not at all- I would not recommend this app to anyone (1)
    b. There are very few people I would recommend this app to (2)
    c. Maybe -There are several people whom I would recommend it to (3) ☐
    d. There are many people I would recommend this app to (4)
    e. Definitely I would recommend this app to everyone (5)
15. What is your overall star rating of the app?
    a. 1 star -One of the worst apps I've used (1)
    b. 2 stars (2)
    c. 3 stars- Average (3) ☐
    d. 4 stars (4)
    e. 5 stars- One of the best apps I've used (5)

****

A- 5

Feedback Questionnaire for the App Users (Public Health Preparedness Team)

Proforma no: .....

A.Details of the Respondent

Name: ....., Age .....Yrs, Gender: 1. Male (1), 2 Female ( )

Designation: ....., Department: .....

B. Overall tool / scale content assessment:

5. Whether all the items refer to relevant aspects of the construct to be measured?
   1. Not Relevant (1) 2. Somewhat relevant (2) 3. Quite relevant (3) 4. Highly relevant (4) ☐

6. Whether all the items together comprehensively reflect the construct to be measured?
   1. Not reflecting (1) 2. Somewhat reflecting (2) 3. Quite reflecting (3) 4. Highly reflecting (4) ☐

7. Whether all the items are relevant for the setting where it is going to be applied? ☐
   1. Not Relevant (1) 2. Somewhat relevant (2) 3. Quite relevant (3) 4. Highly relevant (4)

8. Whether all the items are simple and understandable (for the user) ☐
   1. Not at all (1) 2. Somewhat simple (2) 3. Quite simple (3) 4. Highly simple (4)

9. How would you rate the feasibility of application of the tool in your setting ☐
   1. Not at all (1) 2. Somewhat feasible (2) 3. Quite Feasible (3) 4. Highly feasible (4)

10. What are the strengths of this risk assessment tool?

_____

_____

C. What are the areas which need improvement?

_____

D. Any additional comments/suggestions for improvement:

_____

Thanks for your valuable time and help!!!

Signature of the Respondent

Signature of the researcher

A-6

Questionnaire to assess community's perceptions regarding risks associated with the religious mass gathering event/ இந்த திருவிழா கூட்டதில் பங்கேற்பதன் மூலம் ஏற்படும் அபாயங்களை சமுதாயம் எவ்வாறு உணர்ந்துள்ளது என்பதை அறியும் நேர்க்காணல்

Proforma No/ பதிவு எண்: ..... Date/ தேதி: ...../...../.....

PART 1: GENERAL / பகுதி 1**:** பொது கேள்விகள்

Section A: Socio-demographic details of the respondent/ பிரிவு அ**:** பங்கேற்பாளரின் அடிப்படை தகவல்கள்:

[1]Name of the respondent: பங்கேற்பாளரின் பெயர்	[2]Age: ..... Yrs வயது ..... வருடங்களில்	[3]Gender: 1. Male /ஆண் (1) 2. Female/ பெண் (2) 3. Transgender/ திருநங்கை (3) ☐
[4]Address & Contact details of the respondent/ பங்கேற்பாளரின் முகவரி மற்றும் தொலைபேசி விபரம்	House No/ வீட்டு எண் : ....., Street Name/ தெரு பெயர்:..... City/Town/Village/ நகரம் / கிராமம்: ....., State/ மாநிலம்: ..... Country/ நாடு. ....., Mobile/ கை பேசி:.....	
[5]Education of the respondent/ பங்கேற்பாளரின் கல்வி தகுதி (Mention the exact education in the dotted line and encircle the appropriate option/ சரியான கல்வி தகுதியை கோடிட்ட இடத்தில் நிரப்பவும் மற்றும் மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)	---------- ☐ 1. Doctoral/ honours/ Post doctoral/(முனைவர் மற்றும் அதற்கு மேல்) (7) 2. Graduate /Post graduate/(பட்டதாரி / பிந்தைய பட்டதாரி) (6) 3. Intermediate/diploma /(இடைநிலை/ டிப்ளோமா) (5) 4. High School/ உயர்நிலை பள்ளி (4) 5. Middle School/ நடுநிலை பள்ளி (3) 6. Primary School/ ஆரம்ப பள்ளி (2) 7. Illiterate/ படிக்கவில்லை (1)	

[6]Occupation of the respondent/ பங்கேற்பாளரின் தொழில் (Mention the exact Occupation in the dotted line and encircle the appropriate option/ சரியான தொழிலை கண்டறிந்து கோடிட்ட இடத்தில் நிரப்பவும் மற்றும் மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)	---------- 1. Professional/ தொழில் நிபுணர் – துறை சார்ந்த சேவை (10) 2. Semi- professional/ அரை தொழில் நிபுணர் (6) 3. Clerical/Shop owner/farmer/ (எழுத்தர்/ கடை உரிமையாளர்/ விவசாயி) (5) 4. Skilled worker / திறன் வாய்ந்த தொழிலாளி (4) 5. Semi-skilled/ திறனற்ற தொழிலாளி (3) 6. Unskilled/ திறனற்ற தொழிலாளி (2) 7. Unemployed/ வேலை இல்லாதவர் (1)
[7]Marital Status/ திருமண நிலை	1. Married/ மணமானவர் (1) 2. Single/ மணமாகவில்லை (2) 3. Others/ இதர (8), Mention/ குறிப்பிடவும்: .....
[8]Religion/ மதம்	1. Hindu/ இந்து (1) 2. Muslim/ இஸ்லாம் (2) 3. Christian / கிறிஸ்துவர் (3) 4. Others/இதர (8) Mention/ குறிப்பிடவும்: .....
[9]Type of Family குடும்பத்தின் வகை	1. Nuclear/ தனி குடும்பம் (1) 2. Joint/ கூட்டு குடும்பம் (2) 3. Others/ இதர (8), Mention/ குறிப்பிடவும்: ..... 4. Not Applicable/ பொருந்தாது (99)
[10]Total No of Family members/ மொத்த குடும்ப நபர்களின் எண்ணிக்கை	.....
[11]Total Family Income in Rs/ மொத்த குடும்ப வருமானம் (ரூபாயில்)	.....
[12] Are you a resident of this place/town/village/city?/ நீங்கள் இந்த இடம் / நகரம் / கிராமம் / நகரில் வசிக்கிறீர்களா?	1. Yes/ ஆம் (1) 2. No, I am a visitor/tourist/ இல்லை, நான் சுற்றுலாபார்வையாளர் (0)
If option 2 for the previous question, move to Q no 13, else Skip to 20/ மேற்கண்ட கேள்விக்கு பதில் 2 எனில், கேள்வி எண் 13 க்கு செல்லவும், இல்லையெனில் 20 க்கு செல்லவும்	

[13]Purpose of visiting this place/ இந்த இடத்திற்கு வருகை புரிந்ததர்க்கான நோக்கம் என்ன	1. Pilgrimage (to attend the MG event)/ யாத்திரை திருவிழாவில்) கலந்து கொள்ள((1) 2. Pilgrimage (to perform certain rituals)/ யாத்திரை)திருவிழாவில் சில சடங்குகள் செய்ய((2) 3. As a part of adventure tour/ சாகச சுற்றுப்பயணத்தின் ஒரு பகுதியாக (3) 4. As a part of business/ வியாபாரநிமித்தமாக (4) 5. Visit relatives/friends/ உறவினர்கள் நண்பர்களைப் / பார்வையிட (5) 6. In transit / செல்வழியில் (6) 7. Others/ இதர (8), Mention/ குறிப்பிடவும்: .....
[14]You are here as a(n)/part of/ தாங்கள் இங்கு யாருடன் வந்துள்ளீர்கள்	1. Individual/ தனியாக (1) 2. Family group/ குடும்பத்தினருடன் (2) 3. Package tour group/ சுற்றுலா குழுவினருடன் (3) 4. Friends group/ நண்பர்களுடன் (4) 5. Others/ இதர (8), Mention/ குறிப்பிடவும்: .....
[15]Number of times you have/had visited this place/ தாங்கள் எவ்வளவு முறை இவ்விடத்திற்கு வந்துளீர்கள்	1. Once (first time)/ ஒரு முறை (முதல் முறை) (1) 2. 2-5 times/ 2 -5 தடவை (2) 3. > 5 times/ > 5 தடவை (3)
[16]If you are a part of group, How many of you are here today? தாங்கள் இங்கு குழுக்களாக வந்துளீர்கள் எனில், எவ்வளவு பேர் இன்று உங்களுடன் இங்கு உள்ளார்கள் ?	..... (enter 99 for Not applicable/ பொருந்தாது எனில் 99 என எழுதவும்)
[17]Are you staying overnight /Planning to stay over night தாங்கள் இரவு தங்குகிறீர்களா/ இரவு தங்க திட்டமிட்டுளீர்களா	1. Yes/ ஆம் (1) 2. No/ இல்லை (2)
[18]If yes, How many nights ஆம் எனில் எவ்வளவு இரவுகள்	..... (enter 99 for Not applicable/ பொருந்தாது எனில் 99 என எழுதவும்)

[19]Where have you been staying/are you planning to stay / தாங்கள் இங்கு எங்கு தங்குகிறீர்கள் / எங்கு தங்க திட்டமிட்டுளீர்கள்	1. Pvt Lodges/Hotels/guest houses / தனியார் லாட்ஜ்/ ஹோட்டல்/ விருந்தினர் மாளிகை (1) ☐ 2. Govt. guest houses / அரசு விருந்தினர் மாளிகை((2) 3. Choultary (places belonging to temples/philanthropist organizations-free of cost)/ இலவச சத்திரம் (3) 4. Subsidized accomodation arranged by event organizers / நிகழ்ச்சி ஏற்பாட்டார்கலால் வழங்கப்பட்ட தங்கும் இடம் (மாணிய விலையில்) (4) 5. Friends/relative home/ நண்பர்கள்/ உறவினர்கள் வீடு (5) 6. Temporary shelters / தற்காலிக முகாம் (6) 7. Open places (near temple/Bus stand/ railway station/platform/ etc)/ திறந்த இடம் (கோவில் அருகில்/ பேருந்து நிலையம்/ ரயில் நிலையம்/ நடைமேடை போன்றவை)(7) 8. Others/ இதர (8), Mention/ குறிப்பிடவும்: ..... 9. Not applicable/ பொருந்தாது (99) **SKIP to Section B/ பிரிவு ஆ க்கு செல்லவும்**
[20]You are residing here since how many years/ தாங்கள் எவ்வளவு வருடங்களாக இங்கு வசித்து வந்துளீர்கள்	1. Less than 1 year/ ஒரு வருடங்களுக்கு குறைவாக (enter in months/ மாதத்தில் எழுதவும் .....) (1) ☐ 2. 1-5 years /1 – 5 வருடங்கள் (2) 3. >5 years/ >5 வருடங்கள் (3) 4. Not applicable/ பொருந்தாது (99) **SKIP to section C/ பிரிவு இ க்கு செல்லவும்**

PART 2: RESPONDENTS' PERCEPTIONS REGARDING PREPAREDNESS ACTIVITIES AT THE EVENT SITE/ பகுதி 2: திருவிழா கூட்டத்தில் முன்னெச்சரிக்கை ஏற்பாடுகளை பற்றிய பங்கேற்பாளரின் கண்ணோட்டம்

Section B: Respondents' perception regarding the accommodation site (only for tourists/visitors)/ பிரிவு ஆ இட வசதி பற்றிய பங்கேற்பாளரின் :கண்ணோட்டம்) சுற்றுலா பார்வையாளர்கள் மட்டும்(

1. What is your opinion regarding the space adequacy (e.g.:- adequate number of beds) at your place of accommodation in this visit? / இந்த வருகையின் போது தாங்கள் தங்கும் இடத்தில் போதுமான அளவு இட வசதி பற்றிய தங்கள் கருத்து என்ன? (எடுத்துக்காட்டு : போதுமான மெத்தையின் எண்ணிக்கை)

    a. Excellent / அருமை (1)
    b. Good/ நன்று (2) ☐

c. Average/ சராசரி (3)
d. Poor / மோசம் (4)
e. Very poor/ மிக மோசம் (5)
f. Not applicable/ பொருந்தாது (99)

2. How would you grade the privacy at your place of accommodation in this visit? /இந்த வருகையின் போது தாங்கள் தங்கும் இடத்தில் தங்களுக்கு கொடுக்க பட்ட தனிமையை எவ்வாறு தரப்படுதுவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)

3. Did you find any structural damage at your place of accommodation which may cause injury? / தாங்கள் தங்கும் இடத்தில் காயம் விளைவிக்கும் ஏதனும் கட்டமைப்பு சேதத்தை பார்த்தீர்களா ?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (0)
   c. Not applicable / பொருந்தாது (99)

4. If yes, how would you grade the risk?/ ஆம் எனில் அபாய தன்மையின் தரத்தை எவ்வாறு கூறுவீர்கள்?
   a. Mild/ லேசான (1)
   b. Moderate/ மிதமான (2)
   c. Severe / கடுமையான (3)

5. How would you grade the lighting at your place of accommodation in this visit? /இந்த வருகையின் போது தாங்கள் தங்கும் இடத்தில் உள்ள வெளிச்சத்தை எவ்வாறு தர படுத்துவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)

6. How would you grade the ventilation at your place of accommodation in this visit?/ இந்த வருகையின் போது தாங்கள் தங்கும் இடத்தில் உள்ள கற்றோட்டத்தை எவ்வாறு தர படுத்துவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)

c. Average/ சராசரி (3)
d. Poor / மோசம் (4)
e. Very poor/ மிக மோசம் (5)
f. Not applicable/ பொருந்தாது (99)

7. Whether there are/were enough blankets available for you/all the members of your group?/ உங்களுக்கும் உங்களுடைய குழுவினில் உள்ள அனைத்து நபர்களுக்கும் தேவையான அளவு போர்வைகள் உள்ளனவா/இருந்தனவா?
   a. Yes / ஆம் (1)
   b. Partially available/ ஓரளவு இருந்தது (2)
   c. No (Not available at all) / ஒருபொழுதும் இல்லை (0)
   d. Not applicable /பொருந்தாது (99)
8. How would you grade the cleanliness of the blankets?/ போர்வையின் சுத்தத்தை எவ்வாறு தர படுத்துவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)
9. Whether there are toilets available at your place of accommodation in this visit?/ இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் கழிப்பிடம் இருந்தனவா?
   a. Yes (separate)/ ஆம் (தனி) (1)
   b. Yes (common)/ ஆம் (பொதுக்கழிப்பறை) (2)
   c. No / இல்லை (0)
   d. Not applicable/ பொருந்தாது (99)
10. Whether there are bathing places available at your place of accommodation in this visit?/இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் குளிப்பதற்கான இடம் இருந்தனவா?
   a. Yes (separate)/ ஆம் (தனி) (1)
   b. Yes (common)/ ஆம் (பொதுக்குளியலறை) (2)
   c. No / இல்லை (0)
   d. Not applicable/ பொருந்தாது (99)
11. How would you grade the cleanliness at Toilets?/ கழிப்பிடத்தின் சுத்தத்தை எவ்வாறு தர படுத்துவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)

f. Not applicable/ பொருந்தாது (99)

12. How would you grade the cleanliness at bathing places?/ குளிப்பிடத்தின் சுத்தத்தை எவ்வாறு தர படுத்துவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)
13. How would you grade the overall cleanliness of your accommodation place in this visit?/ இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் உள்ள ஒட்டுமொத்த சுத்தத்தை எவ்வாறு தரப்படுத்துவீர்கள்
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)
14. Whether you faced any insect bite problems at the accommodation site?/ தாங்கள் தங்கிய/ தங்கும் இடத்தில ஏதனும் பூச்சி கடி பிரச்சனையை சந்தித்தீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (0)
    c. Not applicable / பொருந்தாது (99)
15. If yes, how would you grade the insect problems faced at your place of accommodation in this visit?/ ஆம் எனில் இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் உள்ள பூச்சி கடி பிரச்சனையை எவ்வாறு தரப்படுத்துவீர்கள்?
    a. Mild/ லேசான (1)
    b. Moderate/ மிதமான (2)
    c. Severe / கடுமையான (3)
    d. Not applicable/ பொருந்தாது (99)
16. Whether you faced any rodent problems at the accommodation site? தாங்கள் தங்கிய/ தங்கும் இடத்தில் ஏதனும் கொறி விலங்கு (எ.டு: எலி) பிரச்சனையை சந்தித்தீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (0)
    c. Not applicable / பொருந்தாது (99)
17. If yes, how would you grade the rodent problems faced at your place of accommodation in this visit? ஆம் எனில் இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் உள்ள/இருந்த கொறி விலங்கு (எ.டு: எலி) பிரச்சனையை எவ்வாறு தரப்படுத்துவீர்கள்?

a. Mild/ லேசான (1)
b. Moderate/ மிதமான (2)
c. Severe / கடுமையான (3)
d. Not applicable/ பொருந்தாது (99)

18. Whether food is available at your place of accommodation in this visit?/ இந்த வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் உணவு கிடைத்ததா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (0)
    c. Not applicable / பொருந்தாது (99)
19. What is your opinion regarding the quality of the food (based on cleanliness)? / உணவு தரத்தை (சுத்தத்திர்கேற்ப) பற்றிய தங்களுடைய கருத்து என்ன ?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)
20. Whether drinking water facility is available at your place of accommodation site in this visit?/ வருகையின் போது தாங்கள் தங்கும்/தங்கிய இடத்தில் தண்ணீர் வசதி இருந்தனவா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (0)
    c. Not applicable / பொருந்தாது (99)

21. What is your opinion regarding the quality of the drinking water (based on cleanliness)?/ . தண்ணீர் தரத்தை (சுத்தத்திர்கேற்ப) பற்றிய தங்களுடைய கருத்து என்ன ?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)
22. What is your opinion regarding the special provisions made for disabled/elderly etc?/ ஊனமுறோர் மற்றும் முதியோருக்கான சிறப்பு ஏற்ப்பாடுகள் பற்றிய தங்களுடைய கருத்து என்ன ?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)

e. Very poor/ மிக மோசம் (5)

f. No provisions at all / ஏற்பாடுகளே இல்லை (6)

g. Not applicable/ பொருந்தாது (99)

23. How would you rate the safety and security arrangements (life and belongings) made at your accommodation place? / தாங்கள் தங்கும்/ தங்கிய இடத்தில் பாதுகாப்பு ஏற்பாடுகள் (வாழ்க்கை மற்றும் உடைமைகள்) பற்றிய தரத்தை எவ்வாறு கூறுவீர்கள்?

a. Excellent / அருமை (1)

b. Good/ நன்று (2)

c. Average/ சராசரி (3)

d. Poor / மோசம் (4)

e. Very poor/ மிக மோசம் (5)

f. Not applicable/ பொருந்தாது (99)

24. Do you feel that there are increased risks of developing any health related problems because of your stay in the place of accommodation in this visit?/ இந்த வருகையின் போது தாங்கள் தங்கிய/ தங்கியிருக்கும் இடத்தினால் எந்தவொரு சுகாதார சம்பந்தப்பட்ட பிரச்சனைகள் ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் உணர்கிறீர்களா?

a. Yes / ஆம் (1)

b. No/ இல்லை (0)

c. Don't Know/ No idea/ தெரியவில்லை/ யோசனை இல்லை (88)

25. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

26. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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Section C: Respondents' perception regarding the eating outlets (restaurants/roadside eateries) at the event site/ பிரிவு இ திருவிழா இடங்களில் உணவுகள் விற்கப்படும் கடைகளை : பங்கேற்பாளரின் பற்றிய (சாலையோர உணவகங்கள் /உணவகங்கள்)கண்ணோட்டம்

1. Based on your experience, what is your opinion regarding the overall cleanliness maintained at the restaurants/ roadside eateries at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் உணவகங்கள் மற்றும் சாலையோர உணவகங்களில் பராமரிக்கப்படும் ஒட்டுமொத்த தூய்மை பற்றிய உங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)

2. Based on your experience, do you feel that the food stuff served/sold at the roadside eateries at the event site was hygienically cooked? / உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் இருக்கும் சாலையோர உணவகங்களில் பரிமாறப்படும் / விற்பனையாகும் உணவு பொருட்கள் ஆரோக்கியமாக சமைத்திருப்பதாக உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
3. Based on your experience, what do you have to say about the food stuff served/sold at the roadside eateries at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் இருக்கும் சாலையோர உணவகங்களில் பரிமாறப்படும் / விற்பனையாகும் உணவு பொருட்கள் பற்றி நீங்கள் என்ன கூற நினைக்கிறிர்கள்?

    a. Covered/. உணவு மூடி இருந்தது (1)
    b. Uncovered/ உணவு மூடாமல் இருந்தது (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

4. Based on your experience, do you feel that the food stuff served/sold at the restaurants at the event site was hygienically cooked?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் இருக்கும் உணவகங்களில் பரிமாறப்படும் / விற்பனையாகும் உணவு பொருட்கள் ஆரோக்கியமாக சமைத்திருப்பதாக உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)

c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

5. Based on your experience, what is your opinion regarding management (sitting arrangement, queue management etc) in the restaurants/roadside eateries at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் உள்ள உணவகங்கள் / சாலையோர உணவகங்களில் மேலாண்மை (உட்கார வசதி, வரிசையாய் நிற்க ஏற்பாடு செய்தல் போன்றவை) பற்றிய உங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)

6. Based on your experience, what is your opinion regarding ventilation (windows/fans/ACs etc) in the restaurants at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் உணவகங்களில் காற்றோட்டம் (ஜன்னல்கள் / மின் விசிறிகள் / ஏசி போன்றவை) குறித்து உங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)

7. Based on your experience, what is your opinion regarding the special provisions made for disabled/elderly/ children etc in the restaurants /roadside eateries at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா நடைபெறும் இடத்தில் உள்ள உணவகங்கள் / வயதானவர்கள் மற்றும் குழந்தைகள் ,சாலையோர உணவகங்கள் ஊனமுற்றோர் போன்றவவற்றோருக்கான சிறப்பு ஏற்பாடுகள் தொடர்பான உங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/ பொருந்தாது (99)

8. Do you feel that there are increased risks of developing any health related problems because of people eating in the restaurants /roadside eateries at the event site?/ இத்திருவிழா நடைபெறும் இடத்தில் உள்ள உணவகங்கள் சாலையோர உணவகங்களில் சாப்பிடுவதால் (அ) சுகாதார சம்பந்தப்பட்ட பிரச்சனைகள் அதிகரிக்கும் என்று நீங்கள் நினைக்கிறீர்களா?
   a. Yes/ ஆம் (1)

b. No/ இல்லை (2)

c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

9. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐

10. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?

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Section D: Respondents' perception regarding Annadhanam site (Free food distribution places) and prasadam provided at the event site

பிரிவு ஈ : திருவிழா கூட்டங்களில் கொடுக்கப்படும் அன்னதானம் (இலவச உணவு விநியோக இடங்கள்) மற்றும் பிரசாதம் பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Based on your experience, what do you have to say about the cooked food being distributed at the Annadhanam site (Free food distribution places)?/ உங்கள் அனுபவத்தின் அடிப்படையில், அன்னதானம் தளத்தில் சமைக்கப்பட்ட உணவைப் பற்றி என்ன சொல்ல விரும்புறீர்கள்?

   a. Fresh/ புதியது (1)

   b. Stale/ பழையது (2) ☐

c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

2. Based on your experience, what do you have to say about the cooked food being distributed at the Annadhanam site (Free food distribution places)? உங்கள் அனுபவத்தின் அடிப்படையில், அன்னதானம் தளத்தில் சமைக்கப்பட்ட உணவைப் (இலவச உணவு விநியோக இடம்) விரும்புறீர்கள் பற்றி என்ன சொல்ல?
   a. Covered/. உணவு மூடி இருந்தது (1)
   b. Uncovered/ உணவு மூடாமல் இருந்தது (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

3. Based on your experience, what do you have to say about the uncooked food (like fruits, vegetables, dry fruits, etc being distributed at the Annadhanam site (Free food distribution places)?/ உங்கள் அனுபவத்தின் அடிப்படையில், சமைக்காத உணவு (பழங்கள், காய்கறிகள், உலர்ந்த பழங்கள் போன்றவை) அன்னதானம் தளத்தில் விநியோகிக்கப்படுவதைப் பற்றி என்ன சொல்ல விரும்புறீர்கள்?
   a. Fresh/ புதியது (1)
   b. Stale/ பழையது (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

4. Based on your experience, what do you have to say about the uncooked food being distributed at the Annadhanam site (Free food distribution places)?/ உங்கள் அனுபவத்தின் அடிப்படையில், சமைக்காத உணவை அன்னதானம் தளத்தில் விநியோகிக்கப்படுவதைப் பற்றி என்ன சொல்ல விரும்புறீர்கள்?
   a. Covered/. உணவு மூடி இருந்தது (1)
   b. Uncovered/ உணவு மூடாமல் இருந்தது (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

5. Based on your experience, what is your opinion regarding the cleanliness maintained at the Annadhanam site (Free food distribution places)?/ . உங்கள் அனுபவத்தின் அடிப்படையில், அன்னதான தளத்தில் (இலவச உணவு விநியோக இடங்களில்) பராமரிக்கப்படும் தூய்மை பற்றிய உங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/ பொருந்தாது (99)

6. Based on your experience, what is your opinion crowd management (sitting arrangement, queue management etc) Annadhanam site (Free food distribution places)? / உங்கள் அனுபவத்தின் அடிப்படையில், அன்னதான தளத்தில் கூட்ட நெரிசலை (உட்கார்தல் மற்றும் வரிசை ஏற்பாடு போன்றவை) பற்றிய உங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
7. Based on your experience, what is your opinion regarding the special provisions made for disabled/elderly in the Annadhanam site (Free food distribution places)?/ . உங்கள் அனுபவத்தின் அடிப்படையில், அன்னதான தளத்தில் (இலவச உணவு விநியோக இடங்களில்) ஊனமுற்றோர் / வயதான /குழந்தைகள் போன்றோருக்கான சிறப்பு ஏற்பாடுகள் தொடர்பான உங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
8. Do you feel that there are increased risks of developing any health related problems because of people eating in Annadhanam site (Free food distribution places)?/ அன்னதான தளத்தில் (இலவச உணவு விநியோக இடங்களில்) உணவை உண்பதால் ஏதேனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள்உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)

b. No/ இல்லை (2)

c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

9. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐

10. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?

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11. Based on your experience, what is your opinion regarding the quality of the food provided as Prasadam at the event site?/ உங்கள் அனுபவத்தின் அடிப்படையில், திருவிழா கூட்டத்தில் வழங்கப்பட்ட பிரசாதத்தின் தரத்தைப் பற்றி உங்களது கருத்து என்ன?

a. Excellent / அருமை (1)

b. Good/ நன்று (2)

c. Average/ சராசரி (3)

d. Poor / மோசம் (4)

e. Very poor/ மிக மோசம் (5)

f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

☐

12. Do you feel that there are increased risks of developing any health related problems because of people eating prasadam provided at the event site?/ 1திருவிழாவில் கொடுத்த பிரசாதத்தை உண்பதால் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரிக்கும் என்று நீங்கள் நினைக்கிறிர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

13. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?

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Section E: Respondents' perception regarding drinking water arrangement at the event site/
திருவிழாவில் கொடுக்கப்படும் குடிநீர் ஏற்பாடு பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are adequate numbers of drinking water facilities available at the event site?/ திருவிழா நடைபெறும் இடங்களில் போதுமான அளவு குடிநீர் வசதிகள் உள்ளனவா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
2. Do you think that the water available in the drinking water facilities available at the event site is fit for drinking?/ திருவிழா கூட்டத்தில் கொடுக்கப்படும் குடிநீர் குடிப்பதற்கு உகந்தது என்று நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
3. If No, Mention the reason / இல்லை எனில், காரணத்தை குறிப்பிடவும்?
    .....
    .....
4. What is your opinion regarding the cleanliness maintained at the drinking water facilities available at the event site?/ திருவிழா கூட்டத்தில் கொடுக்கப்படும் குடிநீர் விநியோகிக்கும் இடத்தின் சுத்தத்தை பற்றி தங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
5. Do you feel that there is continuous supply of water (functional) at drinking water facility at the event site?/ திருவிழா கூட்டத்தில் தொடர்ச்சியாக தண்ணீர் கொடுக்கப்படுகிறது என நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
6. What is your opinion regarding the special provisions made for disabled/elderly in the drinking water facilities available at the event site?/ திருவிழாவில் குடிநீர் விநியோகிக்கும் இடத்தில

ஊனமுற்றோர் மற்றும் வயதநோருகோன சிறப்பு ஏற்பாடுகள் தொடர்பாக உங்கள் கருத்து என்ன?

a. Excellent / அருமை (1)
b. Good/ நன்று (2)
c. Average/ சராசரி (3)
d. Poor / மோசம் (4)
e. Very poor/ மிக மோசம் (5)
f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

7. Do you feel that there are increased risks of developing any health related problems because of people using unsafe drinking water facilities arranged at the event site?/ திருவிழாவில் ஏற்பாடு செய்துள்ள பாதுகாப்பற்ற குடிநீரை அருந்துவதால் ஏதேனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனைய ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் நினைக்கிறிர்களா?

a. Yes/ ஆம் (1)
b. No/ இல்லை (2)
c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

8. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

9. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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Section F: Respondents' perception regarding sanitation arrangement at the event site/ திருவிழா கூட்டங்களில் கொடுக்கப்படும் சுகாதார ஏற்பாடு பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are adequate numbers of toilets available at the event site?/ திருவிழா கூட்டத்தில் போதுமான அளவு எண்ணிக்கையில் கழிப்பறைகள் உள்ளனவா**?**
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

2. What is your opinion regarding the cleanliness maintained in the toilets available at the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் கழிப்பறைகளின் சுத்தத்தை பற்றி தங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

3. Do you feel that there is adequate and continuous supply of water in the toilets?/ திருவிழா கூட்டத்தின் பொழுது கழிப்பறையில் போதுமான அளவு மற்றும் தொடர்ச்சியாக தண்ணீர் கொடுக்கப்படுகிறது என நினைகிறீர்களா ?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

4. What is your opinion regarding the special provisions made for disabled/elderly in the toilets available at the event site?/ திருவிழா நடைபெறும் இடத்தில் உள்ள கழிப்பறைகளில் ஊனமுற்றோர் மற்றும் வயதானவர்களுக்கான சிறப்பு ஏற்பாடுகள் தொடர்பான உங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

5. In your opinion, were there adequate numbers of hand washing points at the event site?/ திருவிழா நடைபெறும் இடத்தில் போதுமான அளவு கைகழுவும் இடம் இருக்கு என்று நீங்கள் நினைக்கிறிர்களா ?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
6. Was there adequate supply of soap/hand washing liquid at the hand washing points? / கைகளை கழுவும் இடத்தில் போதுமான அளவு சோப்பு (அகை கழுவுதல் திரவம் (உள்ளனவா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
7. Do you feel that there are increased risks of developing any health related problems due to poor sanitation at the event site?/ திருவிழாவில் உள்ள மோசமான சுகாதாரம் மற்றும் கழிவறையில் சுகாதாரமின்மை காரணமாக உடல் நலக்கேடு ஏற்படுவதற்க்கான அபாயங்கள் அதிகரிக்கும் என்று நீங்கள் உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
8. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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    .....

    (Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

9. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
   .....
   .....

Section G: Respondents' perception regarding the medical care facilities available at the event site:/ திருவிழா கூட்டங்களில் கொடுக்கப்படும் மருத்துவ பராமரிப்பு வசதிகள் பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are adequate medical care facilities at the event site?/ திருவிழா கூட்டத்தில் போதுமான அளவு எண்ணிக்கையில் மருத்துவ பராமரிப்பு வசதிகள் உள்ளன என்று நினைகிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
2. Do you feel that there are adequate numbers of medical camps arranged for the event?/ திருவிழா கூட்டத்தின் போது தேவையான எண்ணிக்கையில் மருத்துவ முகாம் நடைபெறுகிறது என்று நினைகிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
3. Do you feel that there are adequate numbers of doctors available in the medical camps and other medical care facilities at the event site?/ . திருவிழா கூட்டத்தின் போது முகாம்களில் தேவையான அளவு மருத்துவர்கள் மற்றும் மருத்துவ பராமரிப்பு வசதிகள் இருந்ததாக நினைகிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
4. Do you feel that there are adequate numbers of paramedical staffs available in the medical camps and other medical care facilities at the event site? / திருவிழா கூட்டத்தின் போது முகாம்களில் தேவையான அளவு மருத்துவ உதவி பணியாளர்கள் மற்றும் மருத்துவ பராமரிப்பு வசதிகள் இருகின்றது என்று நீங்கள் நினைகிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
5. Do you feel that there are enough drugs/consumables available in the medical camps and other medical care facilities at the event site?/ திருவிழா கூட்டத்தின் போது முகாம்களில் தேவையான அளவு மருந்து/நுகர்பொருட்கள் இருந்ததாக நினைகிறீர்களா?

a. Yes/ ஆம் (1)
b. No/ இல்லை (2)
c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

6. Do you feel that there are enough emergency ambulance services available at the event site?/ திருவிழா கூட்டத்தின் போது தேவையான அளவில் அவசர ஆம்புலன்ஸ் வசதி இருந்ததாக நினைகிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
7. What do you think about the preparedness of the medical team at the event site in handling medical emergencies and other medical problems?/ திருவிழா கூட்டத்தின் போது மருத்துவ அவசரநிலை மற்றும் பிற மருத்துவப் பிரச்சினைகளைக் மருத்துவ குழு எவ்வாறு தயார் நிலையில் இருந்து கையாளுகிறது என்று நினைக்கிறீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
8. What is your opinion regarding the cleanliness maintained in the medical camps arranged at the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் ஏற்பாடு செய்யப்பட்டுள்ள மருத்துவ முகாமில் உள்ள சுத்தத்தை பற்றி தங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
9. What is your opinion regarding the biomedical waste management followed in the medical camps arranged at the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் ஏற்பாடு செய்யப்பட்டுள்ள மருத்துவ முகாமின் உயிரியல் கழிவு மேலாண்மை (எ.டு. உபயோகித்த ஊசி மற்றும் பஞ்சு) பற்றிய தங்கள் கருத்து என்ன?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)

e. Very poor/ மிக மோசம் (5)
f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

10. Are you aware about the medical emergency helpline number?/ மருத்துவ அவசர எண் பற்றி உங்களுக்கு விழிப்புணர்வு உள்ளதா?
    a. Yes/ ஆம், Mention/ குறிப்பிடவும் ..... (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

11. What is opinion about IEC (posters, announcements, pamphlets etc) activities regarding diseases control and preventive measures arranged at the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் நோய் கட்டுப்பாட்டு மற்றும் பாதுக்காப்பு சம்பந்தமான IEC (போஸ்டர்கள், அறிவிப்புகள், துண்டு பிரசுரங்கள் போன்றவைபற்றிய உங்கள் (கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

12. What is your opinion regarding the special provisions made for disabled/elderly in the medical facilities arranged at the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் உள்ள மருத்துவமனைகளில் ஊனமுற்றோர் மற்றும் வயதானவர்களுக்கான வசதிகள் பற்றி உங்கள் கருத்து என்ன?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

13. Do you feel that the current level of medical care facilities at the event site is adequate to deal (control & prevent) the health problems associated with the event?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் தற்பொழுது ஏற்பாடு செய்யப்பட்டுள்ள மருத்துவ பராமரிப்பு வசதிகள் நோய் கட்டுப்பாட்டு மற்றும் பாதுக்காப்பு சம்பந்தமான பிரச்சனைகளை சமாளிக்க ஏதுவாக இருக்கின்றது என்று நினைகிறீர்களா ?

14. If No, kindly mention those problems/ இல்லை எனில், பிரச்சனைகளை குறிப்பிடுக
    .....
    .....

15. Any suggestions for improvement? ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?

.....

.....

Section H: Respondents' perception regarding the transportation facilities:/ திருவிழா கூட்டங்களில் ஏற்பாடு செய்யப்படும் போக்குவரத்து வசதிகள் பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Problems faced in the transportation facilities arranged to reach the event site?/ போக்குவரத்து மூலம் திருவிழா நடைபெறும் இடத்தை சென்றடைய ஏற்படும்/ ஏற்பட்ட தொந்தரவுகள்?

a. Perceived Availability (numbers /choices etc) / போதுமான அளவு போக்குவரத்து ஏற்பாடு செய்ததாக உணர்கிறீர்களா (எண்கள் / விருப்பங்கள்)?

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88) ☐

b. Perceived Affordability (Acceptable cost)/ ஏற்கத்தக்க விலையில் கிடைக்கிறது என்று நினைகிறீர்களா? ☐

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

c. Perceived Accessibility/ எளிதில் கிடைக்ககுடியதாக உணர்கிறீர்களா? ☐

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

d. Perceived safety/ போக்குவரத்து வசதி பாதுகாப்பானதாக உணர்கிறீர்களா?

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88) ☐

e. Perceived congestion/ போக்குவரத்து மிகவும் நெரிசலாக இருப்பதாக உணகிரீர்களா?

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88) ☐

2. Problems faced public/private transportation facilities arranged to commute with in the event site?/ திருவிழா நடக்கும் ஊருக்குள் உள்ள போக்குவரத்து ஏற்பாட்டால் ஏற்படும் பிரச்சனைகள்?

a. Perceived Availability (numbers /choices etc) / போதுமான அளவு போக்குவரத்து ஏற்பாடு செய்ததாக உணர்கிறீர்களா (எண்கள் / விருப்பங்கள்)?

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

b. Perceived Affordability (Acceptable cost)/ ஏற்கத்தக்க விலையில் கிடைக்கிறது என்று நினைகிறீர்களா? ☐

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

c. Perceived Accessibility/ எளிதில் கிடைக்ககுடியதாக உணர்கிறீர்களா? ☐

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

d. Perceived safety/ போக்குவரத்து வசதி பாதுகாப்பானதாக உணர்கிறீர்களா?

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88) ☐

e. Perceived congestion/ போக்குவரத்து மிகவும் நெரிசலாக இருப்பதாக உணகிரீர்களா? ☐

1. Yes/ ஆம் (1) 2. No/ இல்லை (2) 3. No idea/ யோசனை இல்லை (88)

3. Is there any separate pedestrian lane available at the event site?/ திருவிழா நடைபெறும் இடத்தில் தனியாக பாதசாரிகள் நடக்க பாதை வசதிகள் உள்ளனவ

a. Yes/ ஆம் (1) b. No/ இல்லை (2) c. No idea/ யோசனை இல்லை (88)

4. Is there any separate lane for cycle available at the event site?/ திருவிழா நடைபெறும் இடத்தில் தனியாக மிதிவண்டி செல்ல பாதை வசதிகள் உள்ளனவா?

a. Yes/ ஆம் (1) b. No/ இல்லை (2) c. No idea/ யோசனை இல்லை (88)

5. What is your opinion regarding the special provisions made for disabled/elderly etc in the transportation facilities arranged to reach and within the event site?/ திருவிழா கூட்டம் நடைபெறும் இடத்தில் உள்ள ஊனமுற்றோர் / வயதான போன்றவொருக்கான போக்குவரத்து வசதிகள் தொடர்பான உங்கள் கருத்து என்ன?

a. Excellent / அருமை (1)
b. Good/ நன்று (2)
c. Average/ சராசரி (3)
d. Poor / மோசம் (4)
e. Very poor/ மிக மோசம் (5)
f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

6. Do you feel that there are increased risks of developing any health related problems because of the transportation facilities arranged to reach the site and at the event site?/ திருவிழாவில் இருக்கும் போக்குவரத்து ஏற்பாட்டால் ஏதேனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரிக்கும் என்று நீங்கள் உணர்கிறீர்களா?

a. Yes/ ஆம் (1)
b. No/ இல்லை (2)
c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

7. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

8. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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Section I: Respondents' perception regarding the crowd management in the main event site (temple/shrine /mosque etc)/ திருவிழா கூட்டங்களில் (கோவில், புன்னியதலம், மசூதி போன்றவை) ஏற்பாடு கூட்ட நெரிசல் மேலாண்மை பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Perceived level of congestion at main event site?/ திருவிழாவில் கூட்ட நெரிசல் பற்றிய தங்கள் கண்ணோட்டம் என்ன?
   a. High / அதிகமாக (1)
   b. Medium/ மிதமாக (2)
   c. Low/ குறைவாக (3)
   d. No idea/ யோசனை இல்லை (88)

2. What is your opinion regarding the crowd management facilities arranged at the entry site?/ நுழைவாயிலில் கூட்ட நெரிசல் ஏற்படாமல் இருக்க மேற்கொண்ட நடவடிக்கைகள் எவ்வாறு உள்ளன என்று கருதுகிறீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

3. Do you feel adequate number of signage boards were displayed in numerous places of the event site to guide the attendees?/ பங்கேற்பாளர்களுக்கு வழிகாட்டுவதற்கு திருவிழா நடைபெறும் பல இடங்களில் தேவையான சுட்டுக்குறி பலகைகள் காட்டப்பட்டுள்ளனவா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

4. Do you feel that there is a risk for stampedes at the event site?/ திருவிழா நடைபெறும் இடத்தில் கூட்ட நெரிசலில் காயம் மற்றும் உயிரழப்பு ஏற்படும் அபாயம் உள்ளது என்று நினைக்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

5. If yes, how would you grade the risk?/ ஆம் எனில் அபாயத்தின் தரத்தை எவ்வாறு விளக்குவீர்கள்?
    a. Mild / லேசான (1)
    b. Moderate/ மிதமான (2)
    c. High / கடுமையான (3)
    d. Don't Know/ No idea/ தெரியவில்லை (அ) யோசனை இல்லை (88)

6. Do you feel that there are increased risks of developing any other health/environment related problems because of the current state of crowd management facilities and crowd behaviour at the event site?/ திருவிழாவில் நடைபெறும் இடத்தில் தற்பொழுது உள்ள கூட்ட நெரிசலால் ஏதனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரிக்கும் என்று நீங்கள் உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

7. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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    (Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems	Options	Response

பிரச்சனைகள்	விருப்பங்கள்	பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

8. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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Section J: Respondents' perception regarding solid waste management system at the event site/ திருவிழா கூட்டங்களில் உள்ள திட கழிவு மேலாண்மை அமைப்பு பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are adequate numbers of dust bins/solid waste collection receptacles available at the event site?/ திருவிழா கூட்டத்தில் போதுமான அளவு எண்ணிக்கையில் குப்பை கூடைகள்/ திட கழிவு சேகரிப்பு வாங்கிகள் உள்ளன என்று நினைகிறீர்களா
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
2. Do you feel that there is timely removal of solid wastes from the collection bins/ சேகரிப்பு தொட்டியிலிருந்து திட கழிவுகள் நேர நேரத்திருக்கு எடுக்கப்படுகிறது என உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
3. Do you feel that appropriate separation of solid wastes at source generation / collection site?/ திட கழிவுகள் சேகரிப்பு தொட்டியிலிருந்து சரியாக பிரிதெடுகிறது என உணர்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

4. Do you feel that the wastes collected are appropriately disposed? / சேகரிக்கப்பட்ட கழிவுப்பொருள்கள் சரியான முறையில் அகற்றப்படுக்கிறது என்று நீங்கள் நினைக்கிறீர்களா?

a. Yes/ ஆம் (1)
b. No/ இல்லை (2)
c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

5. How would grade the solid waste management system at the event site?/ திருவிழா நடைபெறும் இடத்தில் திட கழிவு மேலாண்மையை எவ்வாறு தரம் கூறுவீர்கள்?
   a. Excellent / அருமை (1)
   b. Good/ நன்று (2)
   c. Average/ சராசரி (3)
   d. Poor / மோசம் (4)
   e. Very poor/ மிக மோசம் (5)
   f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

6. Do you feel that there are increased risks of developing any health related or environmental problems because of current state of solid waste management system at the event site?/ திருவிழாவில் நடைபெறும் இடத்தில் தற்பொழுது உள்ள திட கழிவு மேலாண்மை அமைப்பால் ஏதனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் உணர்கிறீர்களா?
   a. Yes/ ஆம் (1)
   b. No/ இல்லை (2)
   c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

7. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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   (Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

8. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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Section K: Respondents' perception regarding other safety arrangements (Miscellaneous):

பிரிவு ஓ: திருவிழா கூட்டங்களில் உள்ள பாதுகாப்பு ஏற்பாடுகள் பற்றிய பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are adequate numbers of Police personnel posted at the event site?/ திருவிழா கூட்டத்தில் போதுமான அளவு எண்ணிக்கையில் காவலாளர்கள் பணியில் அமர்த்தப்பட்டனர் என்று நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
2. How would you grade the behaviour of Police personnel towards the public?/ பொது மக்களிடம் காவல் துறையின் நடத்தையை எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
3. How would you grade the safety arrangements (to prevent theft/violence/anti terror activities etc) at the event site/ திருவிழா நடைபெறும் இடத்தில் பாதுகாப்பு ஏற்பாடுகளை (திருட்டு, வன்முறை, பயங்கரவாத எதிர்ப்பு போன்றவை) எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

4. Do you feel that there are adequate numbers of Fire service arrangements at the event site?/ திருவிழா கூட்டத்தில் போதுமான அளவு எண்ணிக்கையில் தீ அணைப்பு ஏற்பாடுகள் உள்ளன என்று நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

5. Do you feel that the event is prone to fire accidents?/ திருவிழா நடைபெறும் இடத்தில் தீ விபத்து ஏற்பட வாய்ப்புள்ளது என நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

6. How would you grade the safety arrangements (to prevent from fire accidents) at the event site/ திருவிழா நடைபெறும் இடத்தில் பாதுகாப்பு ஏற்பாடுகளை (தீ விபத்து ஏற்படாமல் தடுக்கும்) எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

7. Do you feel that there is excessive use of alcohol/other drug abuse at the event site?/ திருவிழா நடைபெறும் இடத்தில் அதிக அளவிலான மது/ போதை பொருட்கள் உபயோகப்படுத்துவதாக நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

8. Do you feel that there is a risk of drowning at the event site? திருவிழா நடைபெறும் இடத்தில் நீரில் மூழ்கி உயிர்சேதமோ அல்லது அதை சார்ந்த பிரச்சனை வருவதற்கான வாய்ப்பு இருக்கிறது என நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

9. How would you grade the safety arrangements (to prevent from drowning in the bathing Ghats/river side/seas side etc) at the event site?/ திருவிழா நடைபெறும் இடத்தில் பாதுகாப்பு ஏற்பாடுகளை (நீர்ப் பகுதியில் மூழ்காமல் தடுக்க) எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)

d. Poor / மோசம் (4)
e. Very poor/ மிக மோசம் (5)
f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

10. Is there any ritual includes animal sacrifices common at the event site?/ திருவிழா நடைபெறும் இடத்தில் விலங்குகளை பலி கொடுக்கும் சடங்குகள் இருக்கிறதா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
11. How would you grade the cleanliness and other safety arrangements made in the animal sacrifice site to prevent disease spread?/ நோய் பரவாமல் தடுக்க விலங்குகளை வெட்டும் இடத்தில் பாதுகாப்பு ஏற்பாடுகள் மற்றும் சுகாதார ஏற்பாடுகளை எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
12. Do you feel that there are increased risks of developing any health related or environmental problems because of the animal sacrifices at the event site? திருவிழா நடைபெறும் இடத்தில் விலங்குகளை வெட்டுவதால் (அ) பலி கொடுப்பதால் ஏதனும் சுகாதாரம் மற்றும் சுற்று சூழல் சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் நினைக்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
13. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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    (Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	

14. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?
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15. Are rituals like hair shaving common at the event site?/ திருவிழா நடைபெறும் இடத்தில் தலைக்கு மொட்டை அடித்தல் இயல்பானதா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

16. Do you feel that there are increased risks of developing any health related or environmental problems because of hair shaving etc at the event site?/ திருவிழாவில் நடைபெறும் இடத்தில் மொட்டை அடிப்பதால் ஏதனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் நினைக்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

17. Are rituals like ear piercing etc common at the event site?/ திருவிழா நடைபெறும் இடத்தில் காது குத்துதல் இயல்பானதா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

18. Do you feel that there are increased risks of developing any health related or environmental problems because of ear piercing at the event site? . திருவிழா நடைபெறும் இடத்தில் காது குத்துதலால் ஏதனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை ஏற்படுவதற்க்கான அபாயங்கள் அதிகரித்துள்ளன என்று நீங்கள் நினைக்கிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)

c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

19. How would you grade the cleanliness and other safety arrangements made in the hair shaving/ear piercing site to prevent disease spread? மொட்டை/ காது குத்தும் இடத்தில் நோய் பரவாமல் தடுக்க செய்துள்ள பாதுகாப்பு ஏற்பாடுகளை எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
20. How would you grade the safety arrangements made for car festival at the event site?/ திருவிழா நடைபெறும் இடத்தில் தேர்த் திருவிழாக்கான பாதுகாப்பு ஏற்பாடுகளை எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
21. How would you grade the safety arrangements made for fire walking at the event site?/ திருவிழா நடைபெறும் இடத்தில் தீ மிதி திருவிழாக்கான பாதுகாப்பு ஏற்பாடுகள எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)
22. Do you feel that there are problems that people have to face because of special processions like car festival and fire walking at the event site?/ தேர்த் திருவிழா மற்றும் தீ மிதி திருவிழா போன்ற சிறப்பு நிகழ்ச்சி காரணமாக மக்கள் பல்வேறு பிரச்சினைகள எதிர்கொள்ள வேண்டிய நிலை உள்ளது என்று நீங்கள் நினைகிறீர்களா?
    a. Yes/ ஆம் (1)
    b. No/ இல்லை (2)
    c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)
23. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐

24. Any suggestions for improvement?/ ஏதேனும் முன்னேற்றதிர்க்கான ஆலோசனை?

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PART 3: OVERALL RISK PERCEPTION/ திருவிழாவில் பங்கேற்பதால் ஏற்படும் ஒட்டு மொத்த அபாயத்தை பற்றி எவ்வாறு உணர்ந்துள்ளீர்கள் என்பதின் கண்ணோட்டம்

Section L: Respondents' perception regarding the overall risks associated with the event/ திருவிழாவில் பங்கேற்பதால் ஏற்படும்ஒட்டு மொத்த அபாயத்தின் பற்றி பங்கேற்பளாரின் கண்ணோட்டம்

1. Do you feel that there are increased risks of developing health related problems during mass gathering event days when compared with normal days?/ சாதாரணமான நாட்களை விட திருவிழா நடைபெறும் நாட்களில் ஏதனும் சுகாதார சம்பந்தப்பட்ட பிரச்சனை அதிகமாக ஏற்படும் என்று நீங்கள் நினைகிறீர்களா?

a. Yes/ ஆம் (1)
b. No/ இல்லை (2)
c. Don't Know/ No idea/ தெரியவில்லை /யோசனை இல்லை (88)

☐

2. If yes, kindly mention those problems with reasons/ ஆம் எனில் பிரச்சனைகளை அதன் காரணங்களுடன் குறிப்பிடவும்

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(Enter respondents actual verbatim in above mentioned space. Interviewer/researcher later can categorise the response to the following options / மேற்கூறிய இடத்தில் பங்கேற்பாளரின் சொல்லை சொல் மாறாமல் எழுதவும். பின்னர் நேர்காணலை காண்போர்/ ஆராய்ச்சியாளர் கீழே கொடுக்கப்பட்டுள்ள மாதிரி நிலையை குறிப்பிட்டு வட்டமிடவும்)

Problems பிரச்சனைகள்	Options விருப்பங்கள்	Response பதில்
a. Infectious diseases/ தொற்று நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
b. Non Infectious diseases/ தொற்றா நோய்கள்	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐
e. Others/ இதர	1. Yes/ஆம் (1) 2. No/ இல்லை (2)	☐

3. Would you like/able to arrange the mentioned problems in decreasing order of risk?/ நீங்கள் மேலே குறிபிட்டுள்ள பிரச்சனைகளை அதன் அபாயங்களுக்கேற்ப மேலிருந்து கீழ் தர வரிசை படுத்தி குறிப்பிடுக

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(Enter 88 in all boxes for don't Know/ No idea)/ (தெரியவில்லை/ யோசனை இல்லை என்றால் 88 என்று எழுதவும்)

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Problems/ பிரச்சனைகள்	Rank/ தரவரிசை
a. Infectious diseases/ தொற்று நோய்கள்	
b. Non Infectious diseases/ தொற்றா நோய்கள்	
C. Physical Injuries & Trauma/ உடல் காயங்கள், விபத்து மற்றும் பேரதிர்ச்சி	
e. Others/ இதர	

4. Could you please grade the overall arrangements (Preventive/control measures) made by the event organizers?/ நிகழ்வு ஏற்பாட்டாளர்களால் செய்யப்பட்ட ஒட்டுமொத்த ஏற்பாடுகள் (நோய் தடுப்பு / கட்டுப்பாட்டு நடவடிக்கைகள்) பற்றி எவ்வாறு தரம் கூறுவீர்கள்?
    a. Excellent / அருமை (1)
    b. Good/ நன்று (2)
    c. Average/ சராசரி (3)
    d. Poor / மோசம் (4)
    e. Very poor/ மிக மோசம் (5)
    f. Not applicable/No idea/ பொருந்தாது (அ) யோசனை இல்லை (99)

5. Give your suggestions for further improvement in conducting risk free/reduced risk MG event? (open ended)/ திருவிழனாலும் மற்றும் திருவிழாவில் இருக்கும் கூட்டத்தினாலும் ஏற்படும் அபாயங்களை குறைத்து மற்றும் தடுத்து திருவிழாவை நடத்துவதற்கு தங்களுக்கு தோன்றும் யோசனைகளை கொடுக்கவும்?

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Interviewer's signature/ நேர்கானல் நடத்துபவரின் கையொப்பம்: .....

MGRAT

A-7

Risk Assessment Tool for Religious Mass Gatherings (MGRAT)

Overview of the proposed tool:

This is mass gathering risk assessment tool to assess the risks associated with religious mass gathering events. The tool has two parts. They are:-

Part 1:- Risk identification and categorization: Based upon various characteristics (like mass gathering event characteristics, participant characteristics, environmental characteristics, food and water related characteristics, disaster preparedness and medical preparedness characteristics) risks specific to the events are identified. The identified risks are further categorized into three broad categories like Infectious, Non infectious and Physical injuries by the researcher.

- Who will fill this part?
  - Public Health preparedness team members
- What they will fill?
  - PHP member will choose the relevant factors associated with different characteristics of the MG, which are listed in the tool.
- Outcome of part 1:
  - Based upon the various characteristics of the event, specific risks will be identified and categorized into three broad categories like Infectious, non infectious and Physical injuries.

Part 2: Risk Characterization (Assessment and Ranking): Each one of the identified risks (from part 1) will be assessed for its likelihood levels and consequences. Based on these parameters, a rank/level will be assigned for each risk. This rank will signify the level of action or planning required. Hence it will guide the public health preparedness team in prioritizing preparedness and response planning as per the level of risk of the expected risks.

- Who will fill this part?
  - Public Health preparedness team members
- What they will fill?
  - Likelihood and consequences of the identified risks
- Outcome of part 2:
  - Likelihood, consequences and rank/level for each risks identified

Proforma no: .....

Details of the event and Public Health Preparedness (PHP) team members:

1. Name of the event: _____

2. Venue: _____

3. Duration of the event / Date: _____to_____

4. Details of the Respondent (PHP team member)

   i. Name: .....

   ii. Age .....Yrs

   iii. Gender: 1. Male 2 Female ☐

   iv. Designation: .....

   v. Department: .....

Part 1:

Risk identification and categorization:

Section A: MASS GATHERING EVENT CHARACTERISTICS					
CHARACTERISTICS	**FACTORS**	**EXPECTED RISKS**	**RISK CATEGORISATION**		
			Infectious	**Non-Infectious**	**Injuries**
Activity Level	Seated	• Risk of collapse if infrastructure inadequate to support attendees			
	Standing	• Risk of injuries, fatigue			
	Mobile	• Risk of injuries, crushes • Risk of stampedes • Exaggeration of existing medical illnesses like cardiac issues, hypertension, asthma, • Risk of musculoskeletal injuries			
Topographical Characteristics	Hilly terrain / Steep slopes/ Foothills/Steps	• Risk of falls, Risk of landslides, floods due to cloudburst • Exaggeration of existing medical conditions • Acute mountain sickness • Risk of road traffic accidents			
	Forest cover	• Risk of insect bites, animal bites (Man animal conflict) • Risk of communicable diseases (Zoonotic diseases) • Special coordination with Veterinary department • Risk of forest fire			
	Slippary&Muddy floors	• Risk of fall			
	Ghats	• Risk of drowning • Risk of falling on slippery surface Contamination of water			
	Seaside/River banks	• Risk of drowning • Natural calamities like floods • Provision of coast guards and other disaster management activities			

	Narrow passages	• Risk of stampedes			
Duration	≤ 24 hours	• Lack or decrease of perceived vulnerability by participants • Lack of preparations by participants, health systems due to shorter duration			
	1 day – week	• Lack or decrease of perceived vulnerability by participants • Lack of preparations by participants, health systems due to shorter duration			
	>1 week- <=1 month	• Higher risk of communicable diseases • Increased duration of strain on public health system			
	> 1 month	• Higher risk of communicable disease • Extended strain on public health systems due to need to function at surge capacity for the whole period			
Occurrence	Perennial	• Excessive reliance on previously used systems • Inflexible health systems			
	Periodic	• Inadequate health systems • Lack of planning			
Area involved	Indoor	• Poor air circulation			
	Outdoor	• Potential for inadequate sanitation, food and water preparations			
	Venue restricted to one place	• Overcrowding • Spread of infectious diseases			
	Venue spread over a couple of places	• Difficulty locating services near attendees due to geographic spread			
	Rural	• Increased distance to health services, particularly advanced level care • Increased potential for contact with animals and insects			
	Temporary	• May lack infrastructure for safe food and water delivery • May lack infrastructure for emergency medical services • May lack financial capacity to create infrastructure			

	Permanent	• Infrastructure may be aged or failing • Infrastructure may need upgrading in order to comply with current standards			
Section B: PARTICIPANT CHARACTERISTICS					
CHARACTERISTICS	**FACTORS**	**EXPECTED RISKS**	**RISK CATEGORISATION**		
			Infectious	**Non-Infectious**	**Injuries**
Special Participant profile	Disabled	• Local infrastructure may not be adequate • Will need special care • Special arrangements at the venue site			
	Transgender	• Risk of communicable diseases • Risky sexual behavior • Will need focus on health promotion activities			
	Elderly	• Risk of non-communicable disease • May require higher levels of health services			
Participant origins	National	• Low perceived vulnerability with health risks • Potentially low immunity for imported infectious diseases			
	International	• Risk of importation/exportation of disease • Risk of delayed access to healthcare due to unfamiliarity with healthcare system • Risk of delayed detection of pathogens by inexperienced healthcare system • Risk of environmental risks for those not acclimatized such as heat or cold, altitude, pollution • Communicable disease for unvaccinated or vulnerable travellers to endemic pathogens and parasites • Unknown immunity of participant			

Predominant Age group	Elderly >=60 years	• Risk of non-communicable disease • May require higher levels of health services			
	Adolescents , 11-19 years	• Risk of respiratory diseases • Risk of minor injuries (Falls, sprains, minor cuts blisters, bites) • Risk of alcohol and drug abuse • Risk of sexually transmitted infections • Risk of violence			
	Children, 5-11 years	• Risk of respiratory diseases • Risk of minor injuries (Falls, sprains, minor cuts blisters, bites) • Risk of missing/getting lost			
	Under-5 children	• Risk of respiratory diseases& Gastrointestinal illness • Risk of minor injuries (Falls, sprains, minor cuts blisters, bites) • Risk of missing/getting lost			
Psychosocial Behaviour of Participants	Alcohol and drug use	• Risk of violence • Risk of road accidents due to drunk driving • Risk of blood borne infections • Risk of acute intoxication due to drugs			
Section C: ENVIRONMENTAL CHARACTERISTICS					
CHARACTERISTICS	**FACTORS**	**EXPECTED RISKS**	**RISK CATEGORISATION**		
			Infectious	**Non-Infectious**	**Injuries**
Season	Summer	• Risk of dehydration, heat stroke/hyperthermia • Risk of waterborne disease • Risk of allergies			
	Winter	• Risk of hypothermia • Risk of respiratory diseases • Exaggeration of asthma • Risk of injuries with snow or ice			
	Wet /Rainy season	• Drowning, flood			

		• Waterborne disease • Potential increase in vector-borne and waterborne diseases • Loss of property, damage to infrastructure			
Accommodation	Temporary shelters	• Existing infrastructure may not be adequate due to unexpected large influx of crowd • Risk of fire accidents due to cooking on site • Insufficient Ventilation due to overcrowding • Risk of airborne diseases • Insufficient Sanitation/Hygiene • Improper waste management			
Access route to the event site	Event site mainly connected by railways and buses	• Risk of Stampede at crowded places • Risk of road traffic accidents			
	Event site connected by boat	• Risk of drowning • Risk of stampede due to crowd near boarding place • Risk of Stampede			
	Significant level of commuting required by motor vehicles within the event site	• Risk of road traffic accidents • Air pollution			
Sanitation & Hygiene	None	• Increased risk of infectious disease, including respiratory and diarrheal diseases • Lack of hand washing facilities • Lack of toilets • Increased risk of open defecation			
	Hand washing facilities available	• Decreased risk of infectious disease • Location of hand washing stations near each group of toilets will increase the usability of facilities			
	Temporary/Mobile Toilets	• Improved sanitation and waste disposal • Insufficient or no interrupted water supply will discourage people from using the facility			
		• Improper location can contaminate water supply/surface water			

	Permanent Toilets	• Insufficient or no interrupted water supply will discourage people from using the facility			
	Toilets concentrated in one area of the venue	• Risk of crowding & queuing problems			
	Signage for location of toilets	• Absence /Insufficient signposts will encourage participants for open urinating and defecating			
	Adequate lightning of toilets	• Absence of lightning will encourage people for open urinating and defecating in the night			
Waste Management	Garbage thrown in open	• Contamination of surrounding soil, groundwater and surface water • Breeding ground for pathogenic microorganisms and vectors of disease • Decomposition of garbage in open will attract rodents			
	Garbage bins with lids	• Garbage bins without lids will Contamination of surrounding soil, groundwater and surface water • Breeding ground for pathogenic microorganisms and vectors of disease • Presence of rodents			
	Improper burning of waste	• Air pollution			
	Protective equipment for sanitary workers – Absent/Inadequate	• Risk of accidental splashes of the disinfecting and chemicals as well as accidental contamination by sewage among workers • Injury to workers during collection and removal of waste from the site e.g. cuts , needle stick injuries; infectious diseases			

Special Rituals	Fire Walking	• Risk of burns • Risk of fire accident			
	Circumambulation	• Physical exhaustion , shortness of breath, heat exhaustion, sun burns • Risk of exaggeration of musculoskeletal disorders • Risk of exaggeration of existing health issues like cardiac issues, asthma • Overcrowding around places of rituals • Respiratory tract diseases • Road traffic accidents • Sleep deprivation			
	Taking holy bath /Community bathing in rivers	• Risk of drowning, Risk of Water pollution • Gastrointestinal illness • Risk of Stampede			
	Offerings of materials like ghee, oil, flowers etc to the river	• Contributes high levels of organic matter to the river causing water pollution • Risk of water borne diseases • Mass awareness programme among public about ill effects of such offerings in the holy water bodies			
	Idol Immersion in water	• Risk of drowning • Risk of violence • Risk of stampede • Idols are usually painted & paint contains chromium , turpentine oil which may end up with water pollution • Risk of contamination and sedimentation to the lake water • High levels of zinc, calcium and strontium in water may be detected and this find their way into "fishes and birds inhabiting the lake, which finally reach the humans through food (bioaccumulation) • Red, blue, orange and green colors contain mercury, zinc oxide, chromium and lead, which are potent carcinogens. Lead and Chromium also add in the water bodies through *Sindoor* (a traditional red colored cosmetic powder, usually worn by married women and often used in the festivals).			

	Head tonsuring	• Risk of blood borne infections like HIV, Hepatitis B • Cut injuries , Crowding			
	Fire works	• Risk of fire accidents • Burn injuries			
	ReligiousMusic nights/Jagrans	• Risk of electricity related burn injuries • Sleep deprivation • Stampede • Noise pollution • Violence • Risk of alcohol/drug abuse			
	Animal Sacrifice/slaughtering	• Risk of Zoonotic diseases due to slaughtering of infected animals • Risk of Food borne zoonotic diseases • Risk of occupational hazards like hand injury among inadequately trained lay persons slaughtering animals • Risk of backache, wounds among workers • Meat contamination due to poor hygiene among meat handlers • Health hazards created by presence of rats, flies & other animals around the carcasses			
Section D: FOOD & WATER RELATED CHARACTERISTICS					
CHARACTERISTICS	**FACTORS**	**EXPECTED RISKS**	**RISK CATEGORISATION**		
			Infectious	**Non-Infectious**	**Injuries**
Food Safety	Formal preparation by professional food handlers	• Lower risk of food-borne illness • Improved food security			
	Food preparation by local vendors	• Increased risk of food-borne illness • Risk of selling stale food			
	Food preparation by people themselves on site	• Increased risk of food-borne illness due to cooking unhygienic surroundings			

	Practice of *Annadhanam* i.e.Food donation in the community by a family or an individual	• Increased risk of food-borne illness due to distribution of stale food • Increased risk of water borne diseases			
	Practice of *Annaprasadam* i.e Food offering for pilgrims by the temple				
Water safety	Temporary Water distribution system	• Source of water borne diseases • Inadequate water supply points will attract people towards water sources unfit for drinking			
	Chlorination check points at the entry points of the host city	• Absence of chlorination check points will increase the risk of water borne diseases due to contaminated water transported by tank trucks			
	Sanitary inspection of the water supply system and monitoring of water samples on a regular basis during the MG	• Absence or inadequate activity may lead to supply of water unfit for drinking			

Section E: DISASTER PREPAREDNESS CHARACTERISTICS

CHARACTERISTICS	FACTORS	EXPECTED RISKS	RISK CATEGORISATION		
			Infectious	Non-Infectious	Injuries
Crowd Management	Signage	• Assists in audience flow, Conveys orientation, directions and emergency information, Reduced risk of crowding			
	Use of CCTVs	• Assists in identifying problems in a crowd resulting from surges, excessive densities or public disorder			
	Identifiable staff	• Can be easily spotted by supervisors as well as public in case of emergencies			
	Public announcement system	• Assists in evacuation process for in emergencies			

Event Access Points	Entry points also serve as the Exit points	• Risk of stampede due to crowd			
	Emergency entrances and exits for fire and ambulance vehicles.	• Reduced risk of morbidity & mortality due to fire accidents & other medical emergencies			
Fire Safety	Dedicated fire station in the host city	• Reduced risk of morbidity & mortality due to fire accidents			
	Adequate fire personnel, fire safety equipments/vehicles etc	• Reduced risk of morbidity & mortality due to fire accidents			
Natural Hazards Management	Deployment of disaster response forces at the event site	• Absence of such forces may lead to increased damage to life & property due to natural disasters			
Section F: MEDICAL PREPAREDNESS CHARACTERISTICS					
CHARACTERISTICS	**FACTORS**	**EXPECTED RISKS**	**RISK CATEGORISATION**		
			Infectious	**Non-Infectious**	**Injuries**
Level of medical services at the venues	First aid posts	• Absence of first aid help may lead failure in triage services • In its absence, potential contact point for higher level medical support services will be missing and absence of this may increase the risk of morbidity & mortality due to diseases of infectious , non-infectious origin or due to injuries			
	On-site Medical Camps & Mobile medical units	• Absence of this may lead failure in providing basic medical services, emergencies & triage services and potential contact point for higher level medical support services will be missing and absence of this may increase the risk of morbidity & mortality due to diseases of infectious , non-infectious origin or due to injuries			
	On-site hospitals for participants	• Absence of this may lead to difficulty in accessing higher level medical support services and absence of this may increase the risk of morbidity & mortality due to diseases of infectious , non-infectious or due to injuries			
	Ambulance services	• Absence will lead to delay in accessing medical care during emergencies • Absence of this may increase the risk of morbidity & mortality due to diseases of infectious , non-infectious origin or due to injuries			
	Incident command centre	• Absence will lead to increased risk of outbreak of diseases			

	/Surveillance system	• Early detection of diseases not possible			
	Implementation of Biomedical waste management guidelines	• Absence/Inadequate implementation may lead to iatrogenic infectious diseases			

Part 2: Risk Characterization:

Further, the next step will be to analyze how likely the risks are and what effect they will have if they occur. The level of likelihood and consequences of risk will be evaluated by the PHP team members. Based on both these parameters, a risk rank/level will be assigned. Risk rank /level will be given by the mobile app based on likelihood and consequence level fed by the PHP team member responsible for risk assessment process of the MG event. The rank/level of the expected risk will enable the PHP team in taking the recommended actions.

S.No.	Risk Category	Health Risk	Likelihood**	Consequences#	$Risk ranking /level(based upon matrix$)-given by the app

****Likelihood Levels of the risk will be set up in the following manner:**

Certain	Expected to occur.
Likely	Considerable opportunity to occur. Happened frequently at past events
Moderate	Might occur. A few recorded incidents at past events
Unlikely	Not expected to occur. No incidents recorded at past events
Rare	Would require exceptional circumstances to occur

 # Consequences Levels will be set up in the following manner:

Catastrophic	Large numbers injured, several deaths. Extensive damage

Major	Extensive illness/injuries and some deaths. Longer-term impacts
Moderate	Treatment and hospital required, but no deaths. Possible environmental impact or financial loss
Minor	Small number of illness/injuries, but no deaths. Short duration
Insignificant	No injuries, illness, or deaths. Little or no damage

$ Ranking Matrix (This will be calculated by the mobile application based upon the likelihood of risk & its consequence levels.)

This table of risk ratings will help to analyze each risk systematically. This will guide in taking decisions about how to prepare for each risk & prioritizing what risks to plan for when response plans are developed. For e.g. An unlikely or rare risk might rank high (3 or 4) because the consequences are major or catastrophic.

	Consequences				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Certain	3	3	4	4	4
Likely	2	3	3	4	4
Moderate	1	2	3	4	4
Unlikely	1	1	2	3	4
Rare	1	1	2	3	3

Interpretation of the ranks/levels in the matrix is given in the table given below:

Level of Risk	**Recommended Action**
4 = High	Action must be taken to reduce consequences or likelihood
3 = Significant	Some action must be taken
2 = Moderate	Specific monitoring or response procedures required
1 = Low	Managed by routine measures

Signature of the PHP member: _____

Pilot and Feasibility Studies

STUDY PROTOCOL Open Access

Protocol for development of a risk assessment tool for planning and management of religious mass-gathering events of India—a health system-strengthening initiative

Upasana Sharma[1*], B. R. Desikachari[2] and Sankara Sarma[1]

Abstract

Background: Religious mass gatherings (MGs) have always been an integral part of our society. At the outset, mass-gathering events provide challenging settings to plan a suitable emergency public health response. Published studies basically talk about retrospective reviews, case studies of the public health preparedness, or health care provided at individual events. Developing an understanding of the variables associated with MGs is the first step for public health managers. Risk assessment (RA) is a crucial part of pre-event planning as it helps foresee potential risks. Based on RA, one can develop preventive measures and ensure that the infrastructure to control the potential problems is in place. This study is an attempt to systemize RA process during MG events in a country that is culturally rich but with poor resources to handle such events. A RA tool will be developed for planning and management of religious MG events of India.

Methods/design: Various strategies will be used to develop the risk assessment tool (RA tool). Extensive review of literature clubbed with key informant interviews will be done in order to identify the risk variables and decide the domains and items of the tool. Further, this tool will be developed as a mobile-based application. The feasibility of the mobile-based RA tool will be tested in real-time MG event in one part of the country. Concurrently in the same event, a community survey of residents and visitors will be done in order to assess public perceptions of public health and environmental risks associated with MG events.

Discussion: The findings of this study will provide insights into the public health and environmental concerns that need to be considered if preventive strategies and intervention programs are to be designed for MG events. A "RA Tool," which can be used in the planning and management of MG events by the public health managers will strengthen the existing health systems preparedness plans for MGs.

Keywords: Religious mass gathering planning and preparedness, Risk assessment tool, India mass gatherings, Community perspectives of mass gatherings, Mass gathering healthcare

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Background

According to the World Health Organization (WHO), a mass-gathering event (MG) is a gathering of persons that is usually defined as "the congregation of more than a specified number of people (this may be as few as one thousand persons; although most of the literature available, describes these as gatherings that exceed 25000 people) at a specific location for a specific purpose (a social function, a large public event, a sports competition) for a defined period of time" [1]. MGs can be either planned or spontaneous and recurrent or sporadic. Planned MGs may include sporting, social, cultural, religious, and political events. Examples include music festivals, the Olympic Games, the Hajj, and the Kumbh mela [1, 2]. Spontaneous MGs by their nature are more difficult to plan for and may include events such as funerals of religious and political figures [2]. MGs may also include the gatherings of displaced populations due to natural disasters, conflicts, and wars [1].

Such gatherings have several public health implications. There is increased risk of disease transmission because of huge influx of those attending the event. Overcrowding and overwhelmed medical services in such gatherings often aggravate the risk of infectious disease outbreaks [3]. Considerable challenges are posed by a mass gathering event (MG) in terms of communicable and non-communicable disease surveillance, emergency preparedness, environmental health, vaccination, crowd management, and various other issues [4]. In spite of the fact that MGs are an undeniably regular activity of our society that are attended by huge crowds, such gatherings are not very well understood. Even though such gatherings are accumulations of "well people," vast number of people associated with MGs can put a serious strain on the entire health care system [3]. Along these lines, such MG events are more perilous and hazardous in terms of higher incidence of injury and illness compared to population in general [5]. Preplanning for MG events is crucial, and identification of potential health risks can be a vital element in pre-event planning for a MG [6]. Broadly, it includes health management and major incident planning [7]. Public health managers need to plan for, and respond to, a wide range of incidents and emergencies that could affect health or patient care. These could be anything from extreme weather conditions to an outbreak of an infectious disease or a major transport accident related to the MG event [1]. It is important to note that planning for MG events offer a chance to enhance health service delivery, strengthen public health systems, and escalate health promotion activities [8] but failure to plan sufficiently can also disturb the routine health services as the existing system is not attuned to deal with such gatherings of people [9]. The aim of public health at MGs is to prevent or limit the risk of injury or ill health and boost safety for participants, spectators, and residents of host community. Scope of planning for MG is largely dependent on the type of event, risk assessments (RAs), and available resources. Unfortunately, effective preparedness to mitigate and control health risks are inadequate when it comes to planning and management of MG events, especially in countries with poor resources [1]. It is important to note that public health priorities are determined based on the assumptions laid down during initial stages of public health planning of MGs [10]. For instance, in the development of any surveillance system, utilizing syndromic surveillance during MGs requires making suitable inquiries of the data before the event. Those inquiries are a result of RA, a process which has to be performed before and during the event in order to determine what public health-related outcomes will potentially occur and whether these outcomes can be addressed through syndromic surveillance [11]. RA serves as an initial step in the process of planning [12]. RA for a MG is a process that determines the intent and implementation of risk reduction measures, response planning, and capacity building for health functions. RA for MGs is undertaken to empower the public health authorities to identify and evaluate the generic characteristics of a MG which introduce or escalate specific threats. It incorporates assessment of the potential public health effects of the MG [1]. Systematic assessment of risks also helps to identify the potential health security risks that require cooperation of other departments and government agencies [8]. Existing research in the field of MG health is dedicated to the development of rapid diagnostic methods, monitoring and response, and treatment and vaccines. Public health surveillance systems are less likely to include information on non-infectious health threats such as air quality, which can be extremely important for event organizers. This area poses particular challenges for traditional public health surveillance which is generally designed to detect when things happen. This is where RA comes into picture [13]. For example, the leading causes of morbidity and mortality during the Hajj are heat-related illnesses and trauma-related injuries. Identification of such risks had allowed event planners to instigate preventive measures and rapid response strategies. For instance, provision of shaded areas reduced the incidence of heat-related illnesses and effective crowd control reduced the risk of a stampede. Drug and alcohol use were identified as health risks for other types of MGs [14]; therefore, restriction of their use mitigated the associated illnesses. In the context of limited resources, it has been suggested that one can choose to alleviate more likely events even if their potential impacts are smaller. Events that are catastrophic, but extremely unlikely, can then be given less priority [15]. During religious gatherings in India, some special events and unforeseen events occur at the places of religious MGs besides fixed places of worshipping. Special events

like idol procession, chariot pulling, fire walking, and animal sacrificing happen pulling larger crowds within the MGs and causing more damage to human beings and property. History is in replete with incidences when MGs at fairs and festivals of India have turned into the hotspots of various types of risks [16]. Fire incidents have been reported to have occurred as a result of plastic sheets used as construction material for building cottages as temporary shelters for the pilgrims and also due to the use of liquid petroleum gas cylinders in the Kumbh mela premises and presence of unplanned and faulty electrical lines near lodging areas [17]. Previous studies [18, 19] have reported impaired water quality of Ganges River and consequential health risks by virtue of mass ritualistic bathing and insisted time and again that water of river Ganges was not fit for drinking or bathing purposes. A 10-year analysis of public health safety in 27 traditional MG events of India indicated around 936 dead and 540 injured casualties [20].

On examining the literature, we found that in the field of MG health, Paul Arbon has attempted to explain the process of RA using The Arbon Model. The Arbon technique is based on regression model that includes factors like attendance, seated vs mobile spectators, bounded vs unbound event, indoor vs outdoor event, sporting vs nonsporting event, humidity, and strictly daylight or night vs all day event and has been primarily used to define impacts on pre-hospital services [21].

Maurer's formula has been used to define the quality and number of resources to be deployed at the time of event [22]. These conceptual models are based on the idea that MG health can be understood as an interrelationship between three domains: (1) the biomedical, (2) the environmental, and (3) the psychosocial. Key features influence the rate of injury and illness and characterize each domain. These key features are more or less well understood and combine to produce an effect (the patient presentation rate) and a response (the health plan) [23].

According to the WHO [1], the process of RA can be accomplished in two ways, namely, strategic RA and case-based RA. The former method is undertaken before the event to thoroughly examine the potential risks. In addition to this, case-based RA may be required if a significant health concern is detected during the course of the event. It is worth mentioning that WHO has pointed out that event assessment and host country context assessment are extremely important for RA process [1]. A tool based on the modified version of British "Purple Guide" (a British guide for health, safety and welfare at music and other events) adjusted to Swedish context was developed with the aim to improve the quality of event's planning. The reliability and validity of this tool was assessed on simulated case studies rather than real-life events [24]. A stratification scoring model was developed by Hartmann et al. [25] to predict resource use at the MGs. This model categorizes events into only three discreet severity types (minor, intermediate, major). Variables included are limited to attendance, heat index (if outdoor), presence of ethanol, crowd age, and crowd intention. For this, a retrospective observational study was conducted using records of 55 events of varying type. However, details of the various encounters during each event were not always available. Major shortcoming of this analysis was the inability to identify the individual impact of each of the predictive factors. To find a safe and easy method for the estimation of healthcare resources at sporting events, a template based on validated Swedish version of British event safety guide for music events was proposed by a team of researchers [26]. It was tested in six fictitious events. The authors concluded in their study that template could be used to estimate the healthcare resources in Sweden. However, they recommended that use of such a template requires some experience from previous RAs.

Here, it is pertinent to note that the foundation principles of the published studies with regard to RA have been the following: (1) based on availability of previous data, (2) tested on simulation case studies, (3) studies conducted in developed nations, (4) emphasis on medical care and medical resource estimation based on RA, and (5) nature of events in which the tools/models were tested focused on sports and music, leaving a huge scope of exploring the religious events.

Keeping in mind the end goal of planning and delivery activities at MGs, it is imperative to understand the MGs settings and RAs. Hence, in order to put the right measures in place to address the foreseeable and unforeseeable risks, the proposed RA tool will be fundamental in identifying potential public health risks and prioritize planning and response activities specific to the MG event. This activity will also be a step in the direction to establish a framework for a long-lasting national public health legacy. Against this backdrop, this study has been designed to achieve the following objectives:

1. To develop a risk assessment tool (RA tool) to assess the public health and environmental risks associated with religious mass-gathering (MG) events of Tamil Nadu
2. To develop a mobile application (app) based on the developed RA tool
3. To test the feasibility of the real-time application of the developed mobile app-based tool in a selected MG event of Tamil Nadu
4. To assess public perceptions of public health and environmental risks associated with MG event of Tamil Nadu

Methodology

The research will be accomplished in various stages. The design of each stage has been described under relevant objectives. The following diagram represents the overall design of the research study (Fig. 1).

Objective 1

The first aim of this study is to develop a RA tool to assess the public health and environmental risks associated with religious MG events in Tamil Nadu.

Study design

Qualitative study design will be elicited to develop the RA tool.

Study Methods

Key informant interviews and review of literature will be conducted to achieve the first objective of the study.

Key informant interviews

This include representatives from the Core Departments (Department of Public Health and Preventive Medicine, Department of Medical and Rural Health Services, Department of Police, Department of Fire and Rescue services, Department of Revenue and Disaster Management), officials from the Department of Veterinary Services, Community leaders, and NGOs, with experience in planning and management of MG event (at least one MG event). Academics and researchers with experience in MG and/or disaster management and/or scale development will be the subjects to be interviewed.

Review of literature

An extensive review of literature about the risks associated with the MGs, theoretical basis for RA and available RA tools for MG events, globally and nationally available RA tools, frameworks and guidance documents for MG will be done. The purpose of conducting the review of literature will be to identify the risks associated with the MGs reported in the previous studies. Identified health and environmental risks will be indicated in the RA tool. Identified risks will be categorized into relevant domains and items of the tool. A data extraction tool will be prepared by the researcher and used to extract information like study design, study area, place of study and other relevant details from the literature. Search strategy and database name will also be documented.

Study setting

Tamil Nadu, a state in the southern part of India, also known as the land of temples, will be the study site. It celebrates fairs and festivals round the year in all the districts with varying number of participants. Pilgrimage centers in Tamil Nadu are divided into "Places of Perennial Pilgrimage" and "Periodic Fairs and Festivals" [27]. Places of Perennial Pilgrimage are the ones which possess some special religious sanctity of their own apart from the occurrence of a holy day and which attracts pious persons in considerable numbers throughout the

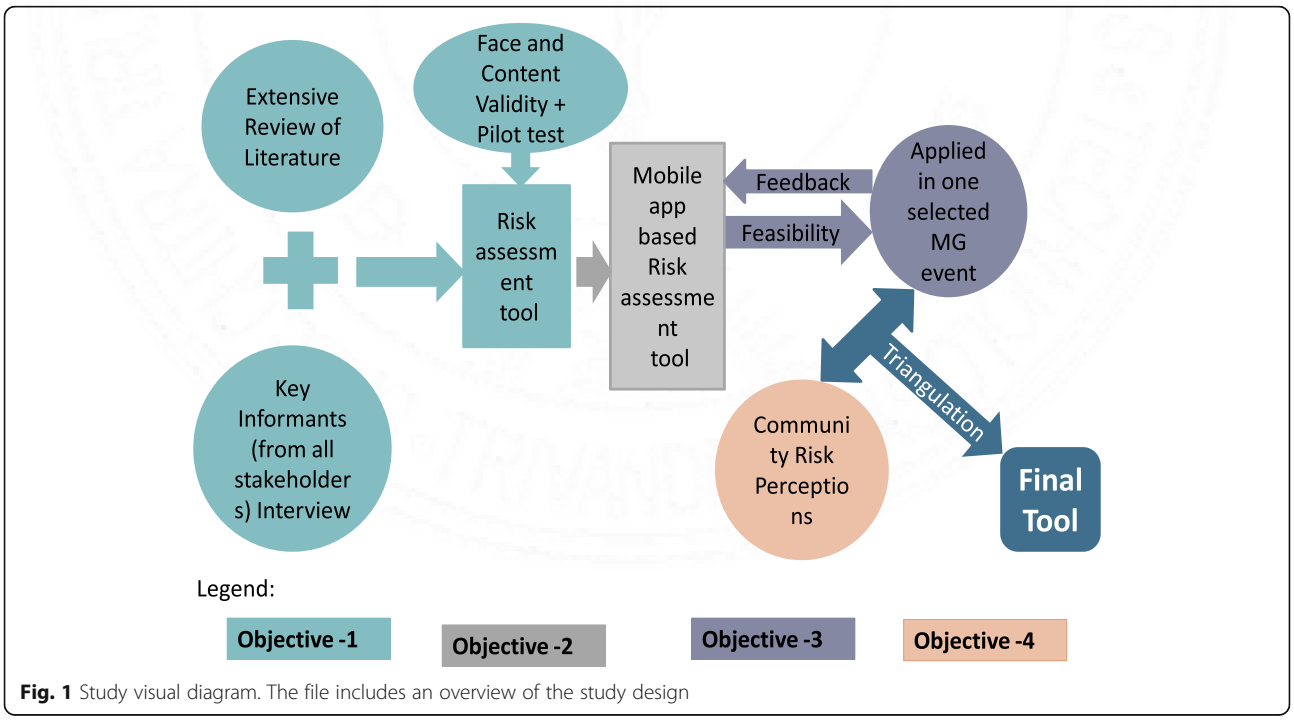

Fig. 1 Study visual diagram. The file includes an overview of the study design

year, while places of fairs and festivals are those at which pilgrims congregate in numbers only on one or more special occasions during the year when the attraction may be either religious or secular or both. At places of periodic fairs and festivals, it is only at the time of the actual fairs and festivals that the place springs into importance and calls for special public health measures. Tamil Nadu is one of the states in India with best public health outcome indicators and one of the very few states with a dedicated public health care [28]. Public health has its own dedicated directorate in the State Health Department, in place since 1922 [29].The division has three key directorates which are hierarchically on an equivalent balance under the Health Secretary: the Directorates of Public Health, of Medical Services, and of Medical Education. At a district level, The Deputy Director of Health Services (DDHS) is responsible for the health of the district as a whole. DDHS broadly focuses on preventive and primary health care and is accountable to the Directorate of Public Health (DPH) for delivering both these types of service. DDHS manages all the workers at the district and block levels downwards who work on rural health, including all the staff of the Primary Health Centers and sub centers. However, in large municipalities, public health services are managed by municipal health officers (MHOs) nominated from the Directorate of Public Health as well. Usually, MHOs are supported by a staff of Sanitary Inspectors. Public health service arrangement in Tamil Nadu is greatly enabled by the fact that it has a Public Health Act. It gives the legislative foundation to Directorate of Public Health for policy planning and execution of public health activities. In Tamil Nadu, preparedness and management of MG events is guided by the Public Health Code (Part III Fairs and Festivals and Epidemics) and Tamil Nadu Public Health Act (1939). This document [27] lists around 123 fairs and festivals as "notified events" in the gazette for undertaking public health measures in the festival area.

Data collection

Key Informants involved in planning and management of MG events in the state of Tamil Nadu will be identified. We will conduct one to one semi structured interview among the identified key informants regarding their experiences, opinions, suggestions, risks, needs, and challenges associated with MG events. Once redundancy in responses is apparent, sampling recruitment will be ceased.

A semi-structured interview schedule will be used to guide the interview. The interview will be audio recorded. Transcript of each interview will be made on the same day. If and when needed, help of trained field investigators proficient in Tamil language to aid in language-related issues will be taken. KIs will be conducted in order to draw relevant domains and items from their real-time experience. Various risks identified through literature review and from discussion with KIs will be categorized under broad domains and sub domains or items.

Face and content validity of the developed tool

The face and content validity of the developed RA tool will be assessed by a group of experts (2–6 experts). Due care will be taken in selection of experts which will include public health experts, epidemiologists, academics with research experience in tool development, and government health administration officials. Using a self-administered content validity questionnaire, the experts will be asked to assess the relevance and representation of each item generated on a four-point Likert scale as 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant in order to avoid having a neutral and ambivalent midpoint. In a situation, where other kinds of validity are not feasible, content validity is an established and accepted method for validation in scientific community. Content validation methods focus on content relevance and content representation [30]. Multiple statistical measures of content validity like CVI and Kappa will be reported. To strengthen the validation exercise, the risks assessed by the tool will also be compared with the surveillance data of the MG event and the same will be reported.

Data analysis

Textual (content) analysis of key informant interviews will be done. Domains and items will be extracted from the textual data. Data collected from experts through content validity questionnaire will be entered and analyzed with the statistical software Epiinfo 7.1.5.2 version. Descriptive statistics like agreement proportions between the experts will be calculated. S-CVI (Scale Content Validity Index), index for inter-rater agreement (agreement proportion), and Kappa agreement coefficient will be calculated. Content validity index (CVI) is the most widely used index in quantitative evaluation [31] because it is simple for calculation, is easy to understand, and provide information about each item, which can be used for modification or deletion of instrument items. There are two kinds of CVI namely content validity of individual items (I-CVI), and the second is content validity of the overall scale (S-CVI). Researchers recommend [32] that a scale with excellent content validity should be composed of I-CVIs of 0.78 or higher and S-CVI/UA and S-CVI/Ave of 0.8 and 0.9 or higher, respectively. Kappa statistic is a consensus index of inter-rater agreement that adjusts for chance agreement [33] and is an important supplement to CVI because Kappa provides information about degree of agreement beyond chance [34].

Pilot test

The developed RA tool will be pilot tested among public health experts in a small MG of Tamil Nadu and appropriate changes will be made in the tool accordingly.

Expected benefits

Literature review along with the views of key informants' will guide in identification of various public health and environmental risks associated with the MG events and a RA tool in its initial form will be developed.

Objective 2

The second aim of this study is to develop a mobile application based on the developed RA tool.

Methods

An interdisciplinary team comprising of researcher, public health expert, an expert in scale development, and a software professional will be formed. Appropriate number of team meetings/discussions will be done. A smart phone-based mobile application will be developed based on the developed RA tool. Operational difficulties faced during the development of the mobile app will be documented.

- Content: developed RA tool
- Language: English
- Compatible Operating System: Android/iOS
- Target Audience: public health managers involved in planning and management of MG Events

Expected benefits

A smartphone-based mobile app based on the RA tool will be developed.

The mobile app will be based on the RA assessment tool. The intended audiences for the app are the public health managers who are involved in the preparedness activities of the MGs. The app will be used prior to the public event, i.e., pre-event stage by the experts to assess the potential risks that could be posed by the prospective event. The RA mobile app is expected to be useful for the following:

- Identify factors causing risk
- Avoid pitfalls and uncover opportunities
- Communicate risk to others
- Plan better strategies

The ultimate goal of the mobile app based on the RA tool is to identify and rank the most important factors driving the risks, so that the experts can plan strategies and resources accordingly. Based on the ranking, appropriate follow-up to diminish health risks of the event would be recommended based on the guidelines issued by organizations like WHO and other organizations of global importance. Here, a decision regarding what recommendations to include would be a part of the process of developing the RA tool.

Objective 3

The third aim of this study is to test the feasibility of the application of mobile app based RA tool in a selected religious MG event of Tamil Nadu.

Study design

A cross-sectional study design will be employed to achieve this objective.

Study population

Public health preparedness team members of the selected religious MG event of Tamil Nadu, i.e., health officers, medical officers, epidemiologists, sanitary officers, Deputy Director of health services, entomologists, and representatives from fire and rescue services department, department of police, and department of revenue and disaster management will be the participants.

Study setting

A religious MG of perennial nature where larger crowds than usual foregather in the form of seasonal festivals notified by the government of Tamil Nadu will be selected as per convenience.

Sample size and sampling procedure

Representatives from various departments involved in public health planning and management will be purposively selected for the study.

Data collection

Representatives from the public health preparedness team will be briefed about the developed mobile app-based RA tool by the researcher. Selected members of public health preparedness team will be requested to use the developed mobile app-based RA tool in the selected MG event to assess the risks associated with the MG. Feedback regarding the mobile app and its content will be collected using a self-administered questionnaire. Operational difficulties faced during the application of the developed tool will be noted.

Data collection tools

Data will be collected using two tools: (i) The mobile application will be evaluated using a modified version of Mobile Application Rating Scale (MARS) for android-based mobile application. It is a self-administering mHealth app quality rating tool that provides a multidimensional measure of the app quality indicators of engagement, functionality, esthetics, and information quality as well as app

subjective quality. It has been pilot tested on both iPhone as well as android apps [35]. (ii) Self-administered feedback questionnaire will be used to collect feedback on parameters like relevance, comprehensiveness, simplicity, and feasibility on Likert scale from the participants.

Data analysis

Data will be entered and analyzed with statistical software Epiinfo 7.1.5.2 version. Descriptive statistics like median and proportions will be used to express the ordinal data collected from the participants using the modified version of Mobile Application Rating Scale (MARS) and self-administered feedback questionnaire.

Expected benefits

Potential risks associated with selected MG event and state of planned control measures placed at the event site will be identified. Feasibility of application of the tool and operational difficulties faced during the use of mobile app-based RA tool in a real-time MG event will be assessed including the feedback of the participants regarding the mobile app. Feedback/suggestions/real-time experiences will help in further changes/modifications in the developed tool.

Objective 4

The fourth aim of this study is to assess public perceptions of public health and environmental risks associated with MG event of Tamil Nadu.

Study design

A community-based cross-sectional study will be conducted to achieve the last objective of the research study.

Study population

Participants (outsiders attending MG event) and residents (food vendors, hotel staff, community members, etc.) of the host town, i.e., place of the MG event will be subjects of the community survey.

Study setting

Selected religious MG event of Tamil Nadu is the same event selected for objective no. 3.

Sample size

We assume that 50% of people attending a MG event perceive risks positively. With the relative precision of 10% and confidence interval of 95%, required sample size is calculated to be 384 (OpenEpi). With the assumption that 5% participants will be non-responders;,a total of 400 participants will be surveyed for the study.

Sampling procedure

Due to the absence of sampling frame, purposive quota sampling will be used. Multiple points in the event area will be selected, and at each point, participants will be selected randomly during different time points to achieve a representative sample.

Data collection instrument

A pre-designed and pre-tested semi structured questionnaire (translated into local language, i.e., Tamil) will be used to collect data.

Data collection

Data will be collected using the pre-designed and pre-tested semi-structured questionnaire to understand the risks perceived by the people attending the MG event. Help of appropriately trained field investigators will be taken to aid in language related issues.

Data analysis

Data will be entered and analyzed with statistical software Epiinfo 7.1.5.2 version. Mean and median will be computed to describe quantitative data. Proportions will be calculated for the categorical data. Inferential statistics like chi-square test will be used to compare the proportions between the groups and Student t test will be used to compare the means between the groups. Groups here indicate the comparison of perceptions between visitors and residents and other sociodemographic variables like gender, age group, educational status, employment status, and socioeconomic status.

Expected benefits

Risk perceptions, challenges, and problems faced by the people attending the selected MG event will be reported. Findings of this community survey will be triangulated with the mobile app findings, and based on that, tool will be finalized.

Quality assurance

Field investigators recruited to aid the researcher in language related issues will be appropriately trained. The questionnaire used for community survey will be translated into local vernacular language and translated back to English by an independent translator, whose mother tongue is English and who has no knowledge of the questionnaire. Questions will be asked in the local vernacular language and responses will be recorded. The field investigators will be supervised periodically to ensure data completion and accuracy. The data will be double verified before entry and analysis.

Discussion

This study aims to develop a RA tool consisting of characteristics peculiar to planned religious MGs of Indian context. This is an effort to systemize the process of RA by building upon the available guidelines and frameworks. A RA tool for planned MGs would be prepared that can be replicated across various religious gatherings of the state of Tamil Nadu and later across the country.

This will be achieved using a range of research methodologies namely key informant interviews and survey method. The novel RA mobile application developed during the course of the study will be field tested in a real-time religious MG event of the country.

Literature indicates [1–8] that we might be well equipped for response activities but the scientific concept of RA, i.e., to understand the existing risks, identify the risks, characterize the risks, and plan for risk reduction strategies accordingly, are at an infant stage in our country. The little that has been done in the field of MG has generally focused on description of preparedness activities of single event, crowd control, and prevention of stampedes with little attention to public health preparedness. It is pertinent to ask how current information and comprehension about MG events can be connected crosswise over various events. This study will take into account experiences, opinions, suggestions, risks, needs, and challenges associated with MG events by conducting one to one semi-structured interviews among the identified key informants. In addition, perspectives of the community, i.e., residents and visitors, will be explored and taken into account for the development of tool. This will help to understand community perspectives which will be useful to identify and understand the characteristics of MG event and also help to plan measures to address the risks identified.

As a part of the process of development of RA tool, community representatives like religious priest, community leaders, and members of civil society organizations will be included in key informants' interviews. Thus, perspectives of the community will be explored and taken into account for the development of tool. The community (participants and visitors) risk perception survey will be conducted for triangulation purpose. Moreover, this survey may also provide insight into some "event specific" risks which could have not been considered by the researcher while developing the tool based on literature review and key informant interviews. The community risk perception survey will also provide information regarding difference in risk perception between the residents and visitors and difference in other sociodemographic indicators like gender, age, and socioeconomic status as well. Since it is a feasibility study, risk perception of the participants of MG events where the tool is applied is necessary to improve the tool further till it reaches the stage of complete validation.

This research will hence contribute to public health preparedness activities of MG events in a country like India with infrastructure limitations. The size and number of MG events in the future will continue to increase, and hence, this emerging area of MG health demands research for the safe conduct of MGs. The deliverables of this research, i.e., RA tool in the form of mobile application, can be used in the planning and management of MG events by the public health managers.

Limitations

Due to resource constraints, the developed risk assessment (RA) tool will be field tested in a single religious MG event. Since religious MGs are diverse in nature, each MG is unique in itself. So, it is advisable to test the RA tool in multiple MG events to ensure its validity. This study will serve as an initial step towards systemizing the process of RA in the state of Tamil Nadu giving enough scope to fine tune it in future. The novel RA tool that will result from this research study will be limited to risk identification and its characterization. It is recognized that further research studies will be needed to add on components like risk-wise recommendations and resource estimation to the RA tool.

Abbreviations

CDC: Centre for Disease Control; DDHS: Deputy Director of Health Services; I-CVI: Item-Content Validity Index; MARS: Mobile Application Rating Scale; MG: Mass gatherings; MHO: Municipal Health Officers; NDMA: National disaster management authority; NGO: Non-governmental organization; PHP: Public health preparedness; RA: Risk assessment; S-CVI/Ave-Scale: Scale-Content Validity Index/Average; S-CVI/UA-Scale: Scale-Content Validity Index/Universal Average; WHO: World Health Organization

Acknowledgements

We thank Dr. Manoj Murhekar (Director, ICMR-NIE, Chennai), Dr. Sanjay M Mehendale (Ex-ADG, ICMR, New Delhi), and Dr. R Ramakrisnan (Ex-Scientist-G, ICMR-NIE, Chennai) for their support.

Funding

NA

Availability of data and materials

NA

Authors' contributions

All the authors contributed to the conception and design of the study. US drafted the first version of the manuscript. US, BRD, and SS revised the manuscript. BRD critically reviewed the manuscript for important intellectual content. All authors have approved the final manuscript.

Authors' information

US is supported by the Indian Council of Medical Research (ICMR) Senior Research Fellowship.

Ethics approval and consent to participate

Approval for the study has been obtained from the institutional ethics committee of ICMR-National Institute of Epidemiology, Chennai. Participants will be informed about the purpose of the study by information sheet which will be provided in English as well as local language and consent for participation will be obtained (Project ID No.: NIE/IEC (A)/03/2017/254).

Consent for publication
NA

Competing interests
The authors declare that they have no competing interests.

Publisher's Note

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Received: 28 October 2018 Accepted: 5 June 2019
Published online: 24 June 2019

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ISSN 2249-4863

Journal of Family Medicine and Primary Care

www.jfmpc.com

Official Publication of the Academy of Family Physicians of India

Volume 8 / Issue 7 / July 2019

Original Article

Content validity of the newly developed risk assessment tool for religious mass gathering events in an Indian setting (Mass Gathering Risk Assessment Tool-MGRAT)

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Abstract

Background: Risk assessment (RA) for mass gathering events is crucial to identify potential health hazards. It aids in planning and response activities specific to the event but is often overlooked by the event organizers. This paper reports the content validity process of a newly developed tool called Mass Gathering Risk Assessment Tool (MGRAT), which intends to assess the risks associated with religious mass gathering events in Indian settings. **Methods:** Qualitative approach was followed to identify the risks associated with mass gathering events and to identify the domains and items to be included in the RA tool. The draft tool was shared with six experts who were selected by the convenient method; selected experts were requested to assess the tool and give their comments about the domains, items, relevant responses, and overall presentation of the tool using content validity questionnaire. Content validity index and Fleiss kappa statistics were calculated to assess the agreement between multiple raters. **Results:** Agreement proportion expressed as scale-level content validity index (S-CVI) calculated by the averaging method is 0.92. S-CVI; calculated by universal agreement is 0.78. Fleiss kappa statistics to measure the agreement between multiple experts after adjusting the component of the chance agreement is 0.522 (95% CI: 0.417, 0.628, *P* value: 0.001). **Conclusion:** MGRAT is a valid tool, which has an appropriate level of content validity. As the number of raters increases, there will be difficulty in achieving consensus among all the items, which is the reason for lower Content Validity Index/Universal Average (CVI/UA) when compared with Content Validity Index/Average (CVI/Ave). Fleiss kappa statistics also indicated moderate agreement among the raters beyond the chance agreement, which also supports the appropriate content validity of MGRAT.

Keywords: Content validity, health risks, mass gathering, religious events, risk assessment

Introduction

According to the World Health Organization, MG event or MG is a gathering of persons that is usually defined as "the congregation of more than a specified number of people (this may be as few as one thousand persons; although most of the literature available describes these as gatherings that exceed 25,000 people) at a specific location for a specific purpose (a social function, a large public event, and a sports competition) for a defined period of time."[1]

Mass gatherings cause notable challenges in terms of communicable and non-communicable disease surveillance,

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Received: 10-05-2019 **Revised:** 13-05-2019 **Accepted:** 22-05-2019

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_380_19

How to cite this article: Sharma U, Desikachari BR, Sarma S. Content validity of the newly developed risk assessment tool for religious mass gathering events in an Indian setting (Mass Gathering Risk Assessment Tool-MGRAT). J Family Med Prim Care 2019;8:2207-11.

emergency preparedness, environmental health, vaccination, food safety, crowd management, etc.[2] In spite of the fact that MGs are an undeniably regular element of our society attended by huge crowds, yet such occasions are not very well understood. Although such gatherings are accumulations of "well people," vast number of people associated with MGs can put a serious strain on the entire health care system.[3] Along these lines, such MG events are more perilous and hazardous in terms of higher incidence of injury and illness compared to the population in general.[4]

Preplanning for MG events is crucial and identification of potential health risks can be a vital element in the pre-event planning phase.[1] Risk assessment (RA) is an integral component of risk governance and serves as an initial step in the process of planning RA for an MG is a process that determines the intent and implementation of risk reduction measures, response planning, and capacity building for health functions.[5] RA for MGs is undertaken to empower the public health authorities to identify and evaluate the generic characteristics of a MG that introduce or escalate specific threats. Systematic assessment of risks also helps to identify the potential health security risks that require the cooperation of other departments and government agencies.[2]

During religious gatherings in India, some special events and unforeseen events occur at the places of religious MGs besides fixed places of worshipping. Special events such as idol procession, chariot pulling, fire walking, and animal sacrificing happen pulling larger crowds within the MG events and causing more damage to human beings and property. History is replete with incidences when MGs at fairs and festivals of India have turned into the hotspots of various types of risks and disasters.[6] A ten-year analysis of public health safety in 27 traditional MG events of India indicated around 936 dead and 540 injured casualties.[7]

Although public health system in India efficiently manages most of the religious MG events, there is no systematic process of the RA conducted in the field. Most of the process of RA is either overlooked or depends upon intuition and previous experiences. There is a need to systemize the process of RA for MG events for further risk reduction.[6,8,9] Hence, to place the right measures in place to address the foreseeable and unforeseeable risks, the proposed RA tool (MGRAT-Mass Gathering Risk Assessment Tool) in this study will be fundamental in identifying potential public health risks and prioritize planning and response activities specific to the religious MG events in an Indian setting.

Validity and reliability assessment are an essential part of tool development. Content validity is the index of whether the items in a test, both individually and as a whole represent the construct that it is proposed to measure. Content validity is concerned with the comprehensiveness of the item pool and representativeness of the mass gathering RA items included in the tool. After the initial design of the tool, content validity assessment is the leading process in the development of the tool to assess the contents for appropriateness for further field testing the tool.[10-12] This paper reports the content validity process of a newly developed tool called MGRAT, which intends to assess the risks associated with mass gathering events in the Indian settings.

Methods

Initial process involved in the development of MGRAT tool

A qualitative approach was followed to identify the risks associated with mass gathering events and to identify the domains and items to be included in the RA tool. First, an extensive review of literature about the risks associated with the mass gatherings, theoretical basis for RA and available RA tools for mass gathering events was done. Second, key informants ($n = 15$) involved in the planning and management of religious mass gathering events in the state of Tamil Nadu, India were purposively identified and interviewed using a semi-structured interview guide. Principle of redundancy was followed. Content/Thematic analysis was done. A detailed explanation of the steps/process involved in identifying the domains and items is not reported in this paper.

Domains and Items identified

A sum total of forty-eight unique health risks were identified. Stampedes, fire accidents, structural collapse, drowning, outbreak of communicable diseases, exacerbation of existing medical illnesses (such as cardiac diseases, asthma, etc), etc., are some of the health risks identified. Seven domains (characteristics related to event, participant, environment, food and water related, disaster preparedness, medical service preparedness, and pre-event planning activities) and twenty-three items were generated from the content analysis of key informant interviews and literature review.

Content validity process

For evaluating content validity, the draft tool was shared with six experts who were selected by the convenient method. Draft tool was circulated among six subject experts for review (four experts from the department of public health and preventive medicine and two academics/research consultants). Selected experts were requested to assess the tool and give their comments about the domains, items, relevant responses, and overall presentation of the tool.

They were also requested to assess the tool according to whether all the items refer to relevant aspects of the construct to be measured, whether all the items together comprehensively reflect the construct and whether all the items are relevant for the setting where it is going to be applied, are simple and understandable. Using a self-administered content validity questionnaire, the experts were requested to assess the relevance of each item generated on a four-point Likert scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant to avoid having a neutral and ambivalent midpoint).

Content validity questionnaire consisted of 28 questions. Out of these 23 questions addressed, the assessment of relevance of all the individual items (n = 23) under 7 domains in the developed tool. There were 5 questions addressed to assess the over-all relevance, comprehensiveness, usability, simplicity, understandability, etc.

Data collected from experts through content validity questionnaire were entered and analyzed with statistical software Epi info 7.1.5.2 version. Agreement proportions between the experts were calculated. Content validity index for overall scale (S-CVI) and item wise (I-CVI) were calculated. Fleiss kappa statistics to assess the agreement between multiple raters adjusting for chance agreement were calculated.

Ethical committee clearance

Approval for the study was obtained from the institutional ethics committee. Participants were informed about the purpose of the study by information sheet, which was provided in the English language and informed written consent for participation was obtained.

Results

Table 1 indicates that out of the twenty-three items, eighteen items were agreed upon as "Relevant" by all the six experts. The item "Solid waste management" was agreed upon as "Relevant" by only one rater and "Irrelevant" by the other five experts. Item-content validity index (I-CVI) of "Solid waste management" (item no 14) was calculated to be 0.17. The I-CVI of items "Participant origin (item no 7)" and "Psychosocial behavior of participants (item no 9)" was 0.67 and I-CVI of item "Area involved (item no 4)" and "Fire safety (item no 20)" was 0.83. The items 7, 9, 14, and 20 were retained in the tool with minor modifications, and "Solid waste management" (item no 14) was merged with "Sanitary and hygiene facilities."

Agreement proportion expressed as scale level content validity index (S-CVI) calculated by averaging method (S-CVI/Ave = average of all I-CVI) was calculated to be 0.92. In addition, S-CVI calculated by universal agreement method (S-CVI/UA = Total number of items agreed relevant by all six experts/Total number of items) was calculated to be 0.78. Table 2 shows Fleiss kappa statistics to measure the agreement between multiple experts after adjusting the component of chance agreement was 0.522 (95% CI: 0.417, 0.628, P value: 0.001). As per the interpretation of Fleiss' kappa (κ) (from Landis and Koch 1977), 0.522 indicates moderate agreement.

Discussion

The study reports the content validity process of the newly developed tool called MGRAT. The tool was shared with six subject experts, and they were requested to assess and rate the tool. Agreement between the experts expressed as CVI and Fleiss kappa statistics in assessing the tool as "Relevant" was calculated and reported.

Table 1: Content Validity Index (CVI)

Item no	Domain	Item Description	Rater_1	Rater_2	Rater_3	Rater_4	Rater_5	Rater_6	Number agreement	I_CVI
1	1	Activity level	×	×	×	×	×	×	6	1
2	1	Topographical characteristics	×	×	×	×	×	×	6	1
3	1	Event duration	×	×	×	×	×	×	6	1
4	1	Area involved	×	×	-	×	×	×	5	0.83*
5	1	Expected no of participants	×	×	×	×	×	×	6	1
6	2	Special participant profile	×	×	×	×	×	×	6	1
7	2	Participants origin	×	×	-	×	-	×	4	0.67*
8	2	Predominant age group	×	×	×	×	×	×	6	1
9	2	Psychosocial behavior of participants	-	×	×	×	×	-	4	0.67*
10	3	Season	×	×	×	×	×	×	6	1
11	3	Type of accommodation	×	×	×	×	×	×	6	1
12	3	Access route to the event	×	×	×	×	×	×	6	1
13	3	Sanitation and hygiene facilities	×	×	×	×	×	×	6	1
14	3	Solid waste management	-	-	-	-	-	×	1	0.17**
15	3	Special rituals	×	×	×	×	×	×	6	1
16	4	Food safety	×	×	×	×	×	×	6	1
17	4	Water safety	×	×	×	×	×	×	6	1
18	5	Crowd management	×	×	×	×	×	×	6	1
19	5	Event access points	×	×	×	×	×	×	6	1
20	5	Fire safety	×	×	×	-	×	×	5	0.83*
21	5	Natural hazards management	×	×	×	×	×	×	6	1
22	6	Level of medical services at the venue	×	×	×	×	×	×	6	1
23	7	Preplanning activities	×	×	×	×	×	×	6	1

S-CVI/Ave: 0.92. Total agreement: 18; S-CVI/UA: 0.78. **Item no 14 merged with item no. 13; *item no 3, 7, 9, 20 retained with minor modifications

Table 2: Fleiss Kappa statistics to assess agreement between multiple experts (*n*=6)

Overall agreement between the experts		
Fleiss Kappa Value	**95% CI**	***P***
0.522	0.417, 0.628	0.001

Agreement proportion measured by averaging method showed 92% agreement and when measured by universal agreement method, it showed 78% agreement. These results support the excellent content validity of the developed MGRAT. However, the CVI of the instrument using universal agreement approach was found to be low compared to the averaging method. This is because of the fact that high number of content experts makes consensus difficult. The developed tool MGRAT is a pioneer attempt to develop a RA tool to assess health risks associated with mass gathering events in Indian settings. We could not find previously reported measures of agreement to compare with the agreement values of MGRAT found in this study. However, content validity studies reported that scale with excellent content validity should be composed of I-CVIs of 0.78 or higher value and S-CVI/UA and S-CVI/Ave of 0.7 and 0.9 or higher value, respectively.[11,13-15]

Although content validity index measures are widely used to estimate content validity by researchers, the problems with those measures are that they overlook the percentage of agreement between the experts owing to chance. Therefore, Wynd *et al.*, propose that both CVI and multi-rater kappa statistic should be calculated in the content validity studies because unlike the CVI, kappa adjusts for chance agreement.[12] The chance agreement is an issue of concern while studying agreement indices among assessors, especially when we place four-point scoring within two "relevant" and "not relevant" classes. In other words, kappa statistic is a consensus index of inter-rater agreement that adjusts for chance agreement and is an important supplement to CVI because Kappa provides information about the degree of agreement beyond chance. Nevertheless, the CVI is mostly used by researchers because it is simple for calculation, easy to understand, and provide information about each item, which can be used for modification or deletion of instrument items.[10,12]

In the present study, Fleiss kappa statistics to measure the agreement between multiple experts after adjusting the component of chance agreement showed a significant agreement value of 0.522 (95% CI: 0.417, 0.628, *P* value: 0.001). As per the interpretation of Fleiss' kappa (κ) (from Landis and Koch 1977), 0.522 indicates moderate agreement. Overall, CVI and Fleiss' kappa (κ) both the measures suggest that the content validity of the newly developed tool is appropriate. MGRAT was judged to be valid, appropriate, and feasible to assess the health risks associated with the MG events.

All seven domains were retained after the content validity process. Out of 23 items, 22 items were retained and 1 item was removed after the content validity process. The item "Solid waste management" was merged with "Sanitation and Hygiene facilities" after the content validity process as it was agreed upon as relevant by only one rater and irrelevant by the other five experts. Thus, in the refined MGRAT after content validity, there were 7 domains and 22 items. This validated MGRAT was developed further into a mobile web APP (web-based application) and field tested for its feasibility assessment in one of the religious mass gathering events in Tamil Nadu, India.

Limitations

Limitations of the study are that the experts' feedback is subjective; thus, the study is subjected to bias that may exist among the experts. If content domain is not well-identified, this type of study does not necessarily identify content that might have been omitted from the instrument owing to the assessment. However, experts are asked to suggest other items for the instrument, which might help minimize this limitation.

This content validity study included a multidisciplinary team of experts. An effort was made to quantify the agreement and efforts to report kappa statistics to assess agreement beyond the chance agreement are some of the advantages of this study. Added to that, the idea of the development of systematic RA tool to assess health risks associated with mass gathering events is itself pioneer effort in India.

Content validity is a systematic process, which includes the judgment/quantification on instrument items by content experts. Such a process should be the leading study in the process of making an instrument to guarantee instrument reliability and prepare a valid instrument in terms of content for the preliminary test phase.[16] To conclude, the present study indicated that the MGRAT is a valid tool, which enjoys an appropriate level of content validity. As the number of rater's increases, there will be difficulty in achieving consensus among all the items, which is the reason for lower CVI/UA when compared with CVI/Ave. Fleiss kappa statistics also indicated moderate agreement among the raters beyond the chance agreement, which also support the appropriate content validity of MGRAT.

Acknowledgements

We thank Dr. Manoj Murhekar (Director, ICMR-NIE, Chennai), Dr. Sanjay M Mehendale (Ex-ADG, ICMR, New Delhi) and Dr. R Ramakrisnan (Ex-Scientist -G, ICMR-NIE, Chennai) for their support.

Financial support and sponsorship

Upasana Sharma is supported by Indian Council of Medical Research (ICMR) Senior Research Fellowship.

Conflicts of interest

There are no conflicts of interest.

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THE NEW INDIAN EXPRESS

Study highlights need for risk assessment during religious mass gatherings

At the same time, an officer of the Health Department said the risk assessment at religious mass gatherings in state is limited to Sabarimala and Guruvayur shrines.

Published: 15th October 2019 06:47 AM | Last Updated: 15th October 2019 06:47 AM

By Dileep V Kumar

Express News Service

THIRUVANANTHAPURAM: The Achutha Menon Centre for Health Science Studies (AMCHSS) under the Sree Chitra Tirunal Institute for Medical Sciences and Technology has come out with a study underscoring the need to develop a road map for addressing the potential health risks during religious gatherings.

Titled 'Content validity of the newly developed risk assessment tool (Mass Gathering Risk Assessment Tool-MGRAT) for religious mass gathering events in an Indian setting', the study underscores the need for planning and identification of health risks during religious mass gatherings.

"The public health system effectively manages most of the religious mass gathering events. But when it comes to the risk assessment conducted in the field, it is almost nil. Hence, to place the right measures in place to address the foreseeable and unforeseeable risks, the proposed MGRAT tool will be fundamental," reads an excerpt from the study.

It also highlights that the developed tool, MGRAT, is a pioneer attempt to develop a risk assessment tool to assess health risks associated with mass gatherings in Indian settings.

The study that identifies a sum total of 48 unique health risks including stampedes, fire accidents, structural collapse, drowning, outbreak of communicable diseases, exacerbation of existing medical illnesses such as cardiac diseases, asthma, and others, also says that a ten-year analysis of public health safety in 27 traditional mass gathering events of India indicated around 936 death and 540 injured casualties.

At the same time, an officer of the Health Department said the risk assessment at religious mass gatherings in state is limited to Sabarimala and Guruvayur shrines.

"The department is yet to conduct a risk assessment at religious mass gatherings. But during Sabarimala season, the monitoring of infectious diseases is carried out through Integrated Disease Surveillance Programme. In the case of Guruvayur, the focus is on malaria monitoring," said the department officer.

"At times of H1N1 outbreak, the department also issues advisory to remain cautious during religious mass gatherings," the officer said.

The study was carried out by Sankara Sarma and Upasana Sharma of AMCHSS and B R Desikachari, a retired officer of Department of Public Health and Preventive Medicine, Government of Tamil Nadu.

ICMR-NATIONAL INSTITUTE OF EPIDEMIOLOGY

(Indian Council of Medical Research)
Department of Health Research,
Ministry of Health & Family Welfare, Govt. of India

To

Dr. Upasana Sharma, PhD Scholar
School of Public Health
ICMR - National Institute of Epidemiology, Chennai

20.12.2017

Sub: NIE-IEC (Acad.) review of research proposals.
Reference: Review of your protocol by NIE-IEC (Acad.) at meeting dated 29 Nov, 2017

Subject (Type of review)	Full review of New proposal
Project ID No.	**NIE/IEC(A)/03/2017/254**
Project Title	Development of a Risk Assessment tool for Planning and Management of Religious Mass Gathering Events of Tamil Nadu, India- A Health Systems Strengthening Initiative
Principal Investigator	Dr. Upasana Sharma (2014/PhD (NIE)/21

Thank you for submitting your proposal which was considered at the IEC (Acad.) meeting on 29th Nov, 2017 at ICMR-NIE and the documents related to the study referred above have been reviewed and discussed.

The decision of the NIE-IEC (Acad.) is under:

Approved	
Approved with suggestion*	√
Revision	
Rejected	

* The Committee gave the following suggestions:

- Provide the tentative list of districts and festivals proposed for carrying out the study
- Describe the procedure for selection of festivals to be included in this project
- Already available crowd management systems like Tirumala Tirupati Devastanams can be reviewed for developing the tool
- Include the women sex workers, beggars in the special participant profile – page 98
- Provide adequate training to the interviewers for maintaining uniformity in administering the questionnaire
- Bring the abbreviations list to the initial part of the proposal
- Provide reference for Page 6 first paragraph
- Study population (Page 9) – The reason for not including the State Disaster Management Authority needs to be explained
- Pilot test (Page 10) – correct the typo error in the sentence formation
- Objective 2 – Methods (page 10) – The sentences appear incorrect – can be revised
- Expected benefits (Page 12) – Availability of an android application is one of the benefits and can be mentioned here
- Objective 4 (Page 13) – The actually actual time of the survey needs to be mentioned
- Please include women sex workers and beggars as special participants in the study (Pg 98)
- Page 30 Q no: 11 – family income – monthly / yearly? - please mention
- Page 31 - Q 13 – Purpose of visit to the place may be more than one – provide options appropriately

Best regards,

Dr. Prabu Rajkumar
Scientist D and for Member-Secretary, NIE-IEC (Acad.)
ICMR - NIE, Chennai

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WHO Collaborating Centre for Leprosy Research and Epidemiology


KARTHIGAI DEEPAM FESTIVAL
From : 14.11.2018 to 23.11.2018
OM NAMASHIVAYA
SHIVAYA NAMA OM
HOLY FLAG HOISTING
SILVER KARPAGA VIRUTCHAM
SILVER KAMADHENU VAHANAM
SILVER RISHABHA VAHANAM
SILVER RADHAM
MAHA RADHAM
BHARANI DEEPAM
MAHA DEEPAM
ALL ARE WELCOME

Document Information

Analyzed document	PhDCompiled_ us_PLAIG CHECK.docx (D90334540)
Submitted	12/21/2020 5:05:00 AM
Submitted by	Sankara Sarma
Submitter email	sarma@sctimst.ac.in
Similarity	4%
Analysis address	rasma.sctims@analysis.urkund.com

Sources included in the report

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