# A Five-Tier Framework for Scalable Public Health Emergency and Disaster Management: Enhancing Pandemic and Climate Resilience

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## Abstract

*Escalating public health emergencies and disasters driven by climate change, urbanization, and globalization highlight the need for integrated, multisectoral preparedness frameworks. Current approaches often lack comprehensive strategies, resulting in significant human and financial losses. This study introduces a five-tier Public Health Emergency and Disaster Management (PHEDM) framework designed to strengthen resilience from community action to national policy. Using a mixed-methods approach including literature review, stakeholder consultations, and pilot testing in Uttarakhand, the PHEDM framework was developed and evaluated. Training packages, structured by Bloom's taxonomy and expert review, were implemented across Tiers I–III, targeting community volunteers, frontline workers, and subnational managers. Community Threat and Hazard Identification and Risk Assessment (THIRA) tools guided the development of Village and District Disaster Management Plans. A standardized mentor-mentee system was integrated across all tiers. Results from the Uttarakhand pilot and subsequent scale-up in Rajasthan and five additional states demonstrated significant knowledge gains (18–25%, $p < 0.001$), high satisfaction, and*

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*improved community preparedness. The PHEDM framework aligns with national and international policies, integrating climate resilience and public health. Enhanced by its mentorship system, PHEDM offers a scalable, adaptable model for strengthening health systems and community preparedness, contributing to global health security and sustainable development.*

***Keywords:*** *Public Health Emergency Management, Public Health Emergency and Disaster Management, International Health Regulation, Bloom's Taxonomy, Whole-of-Society Approach, Nature-Based Solutions, Pandemic Preparedness, Climate Resilience, Health Emergency and Disaster Risk Management*

## 1. Introduction

The escalating frequency and severity of public health emergencies driven by infectious disease outbreaks, natural and human-induced disasters, and climate-driven impacts pose significant threats to global health. The COVID-19 pandemic alone incurred indirect costs exceeding 10% of the global GDP, disrupting supply chains and livelihoods [1, 2]. Climate change exacerbates these challenges, with rising temperatures, extreme weather events, and environmental degradation amplifying the public health risks. The Conference of the Parties (COP) agreements under the United Nations Framework Convention on Climate Change (UNFCCC), including COP21, COP25, COP26, and COP29, emphasise integrated adaptation, health-focused climate resilience, and support for loss and damage in vulnerable communities [3]. Frameworks such as the World Health Organization's Health Emergency and Disaster Risk Management (WHO-Health EDRM) and its guidance on preparing for national responses to health emergencies and disasters advocate risk-based, all-hazard approaches and multisectoral collaboration to strengthen health system preparedness [4, 5]. However, a scoping review by Sasie et al. (2024) highlighted persistent gaps in public health emergency management frameworks, including fragmented coordination, limited community engagement, and inadequate integration of climate-related risks, underscoring the need for comprehensive, scalable models that bridge grassroots actions with policy [6]. Successful examples, such as Mumbai's Dharavi model for COVID-19 containment and Odisha's cyclone response, demonstrate the value of community-driven strategies [7, 8]. Field Epidemiology Training Programs (FETPs), implemented in over

80 countries, are a cornerstone of global health security, equipping public health professionals with advanced skills in disease surveillance, outbreak investigation, and data analysis to effectively manage health threats such as Ebola, Zika, and COVID-19 [9]. For instance, FETP-trained epidemiologists have strengthened national surveillance systems and led rapid response teams, contributing to timely outbreak containment and improved global health outcomes [10]. However, as noted by Sasie et al. (2024), FETPs primarily focus on individual- and institutional-level training, with less emphasis on community empowerment, climate resilience, cross-sectoral policy integration, and policies.

Drawing on lessons from the COVID-19 pandemic, Mumbai's Dharavi model, Odisha's cyclone response, the growing threat of climate change, and established systems such as the Field Epidemiology Training Program (FETP), WHO-Health Emergency and Disaster Risk Management (Health EDRM), UNFCCC, and International Health Regulations (IHR), the need to address persistent gaps in community engagement, climate resilience, and policy integration is evident. In response, an innovative five-tier Public Health Emergency and Disaster Management (PHEDM) framework was designed and developed. This innovative framework is a joint initiative of the National Institute of Disaster Management (NIDM), the National Centre for Disease Control (NCDC), and CDC India. This framework is the outcome of a systematic approach, comprehensive literature review, and multiple expert consultations aimed at bridging these gaps and enhancing preparedness for future pandemics and climate-related emergencies in the country. The PHEDM framework builds on the strengths of FETPs by integrating a five-tier model that actively engages community volunteers, frontline workers, subnational managers, national and state leaders, and policy makers. It incorporates community-led hazard, vulnerability, and risk assessment processes; climate-related health risk management; and the development of community preparedness and response plans and protocols, thereby strengthening the capacity for effective public health emergency and disaster management at all levels.

The PHEDM framework is closely aligned with India's National Health Policy (NHP) 2017, which emphasises robust emergency response systems, training community health workers, such as Accredited Social Health Activists (ASHAs), and integrating mental health initiatives, such as yoga [11]. PHEDM's Tier I empowers community volunteers, including ASHAs and Gram Panchayat members, with skills in first aid, cardiopulmonary resuscitation (CPR), and outbreak reporting, fostering community-driven preparedness, as seen in Dharavi's COVID-19 response, which reduced case growth from 12% to 1% [7]. Tier II trains frontline workers in triage, community infection control, rapid testing, and enhancement of local response capacity. Tiers III and IV strengthen a country's emergency management capacity and coordination through emergency operations centres (EOCs/PHEOCs) and hospital preparedness. Tier V engages policymakers to integrate community lessons into national frameworks. These elements align with the NHP's goals of building resilient health systems and ensuring multisectoral coordination to address pandemics and climate-related disasters.

The PHEDM framework is further aligned with India's National Disaster Management Plan (NDMP), NITI Aayog's report on future pandemic preparedness, and global benchmarks, including IHR 2005, Sustainable Development Goals (SDGs), particularly those related to health system strengthening and resilience, and COP agreements [12, 13, 14, 15]. COP25 urged countries to boost adaptation and capacity building, with India emphasising a collective journey towards a clean, green, and healthy planet. [16]. By incorporating nature-based solutions, such as afforestation and mangrove restoration, the PHEDM supports India's NDC commitments and COP25/COP29's emphasis on ecosystem-based adaptation. Unlike FETPs, which excel in epidemiological training but are less focused on climate adaptation or community engagement, the PHEDM integrates adult learning principles from Bloom's taxonomy, Incident Management/Response Systems, and well-being activities to create a continuous adaptive preparedness process [17, 18, 19].

The PHEDM framework operates within the context of global and national disaster risk reduction and public health priorities, aligned with the WHO Health EDRM, Sendai Framework for Disaster Risk Reduction (SFDRR), and UNFCCC COP agreements [4, 3, 20].

India's diverse socioeconomic and environmental landscapes require a scalable and participatory model that leverages local traditions and knowledge and integrates them into national policies. By extending FETPs' epidemiological expertise to include community action, climate resilience, and policy engagement, PHEDM addresses the need for a cohesive, evidence-based approach to mitigate and manage public health and climate-related crises [6, 9, 10].

A summary of the key research questions and their corresponding descriptions are provided below to guide the focus and objectives of this study (Table 1).

**Table 1: Overview of the PHEDM Framework: Key Questions and Contributions**

| Key Question | Description |
|---|---|
| What is already known? | Frameworks like WHO's EDRM use risk-based, all-hazard approaches but focus on isolated phases (e.g., preparedness, response). FETP, gaps remain in linking community action to policy, addressing climate threats and workforce well-being. |
| What is the new approach and how does it differ? | PHEDM offers a five-tier model: community empowerment, frontline training, emergency coordination, institutional preparedness, and policy leadership. Integrates adult learning, nature-based solutions, digital monitoring, and well-being activities. Connects grassroots to national policy via Incident Response/Management Systems for real-time, scalable coordination. |
| What are the implications for public health preparedness? | PHEDM improved participant knowledge by 25%, well-being by 94% and mentor-mentee system during training. Modular design adapts to pandemics and climate disasters, integrating community innovations into national strategies. Fosters resilient health systems |

## 2. Objectives

### Primary Objective:

1. To develop, implement, and evaluate a structured, tiered adult learning training

package for public health emergency and disaster management (PHEDM) across communities, frontlines, and professional responders.

### Secondary Objectives:

1. To evaluate the effectiveness of a tiered adult learning training package (Tiers I-III) in enhancing participants' knowledge, skills, and engagement.

2. To assess the impact of integrated well-being activities, such as yoga sessions, on participants' health and workforce fitness.

3. To explore participants' perceptions of improvements in collaboration, information sharing, and emergency response following the training.

4. To examine the integration of the PHEDM framework into national policy and emergency management systems (Tier V) and its influence on policy adoption and emergency response outcomes.

## 3. Methods

### Overview

A mixed-methods approach was employed to develop and evaluate the Public Health Emergency and Disaster Management (PHEDM) framework. The framework was developed through a narrative literature review synthesising evidence from peer-reviewed studies, policy documents, and reports on public health emergencies and climate resilience, including lessons from the COVID-19 pandemic and successful models such as Mumbai's Dharavi containment strategy [6, 7]. Multi-stakeholder expert consultations involve national and state health officials, disaster management authorities, climate experts, and community leaders to identify gaps in existing frameworks, such as working in silos, fragmented coordination, and limited community engagement, as highlighted by Sasie et al. (2024) [6]. The methodology drew on established frameworks, including the FETP model [10], World's Health Emergency and Disaster Risk Management (WHO-Health EDRM) [4], Sendai Framework for Disaster Risk Reduction (SFDRR) [20], WHO International Health Regulations (IHR) 2005 core capacities [14], WHO Joint External Evaluation (JEE) Monitoring and Evaluation Framework [21], India's National Health Policy (NHP) 2017 [11], and UNFCCC COP agreements [3]. The process targeted the cognitive, psychomotor, and affective learning domains using Bloom's taxonomy [17] to ensure comprehensive capacity building across community volunteers, frontline workers, subnational managers, national/state leaders, and policymakers. The consultations informed the design of a five-tier model, with each tier tailored to a specific role (Figure 1).

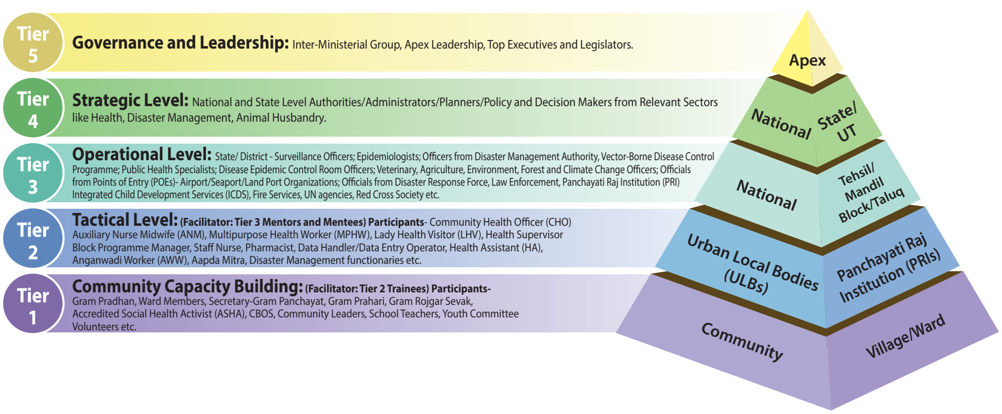



**Figure 1 : Hierarchical PHEDM Framework: A Five-Tiered Approach to Public Health Emergency and Disaster Management in India**

## PHEDM Training Package Development and Implementation

The PHEDM training package for Tiers I–III was systematically developed through a series of expert stakeholder workshops to ensure input from a diverse range of professionals in public health, disaster management and emergency response. This development process was further strengthened by rigorous external expert reviews, which provided critical evaluations and validations of the training content. Bloom's taxonomy was deliberately applied throughout the design and review phases to ensure that the curriculum comprehensively addressed the cognitive (knowledge-based), psychomotor (skills-based), and affective (attitude- and value-based) domains of learning [17]. This approach facilitated the creation of a robust and multidimensional training package capable of meeting the diverse learning needs of participants at different levels. Following the initial development, the Tier III training package underwent an additional layer of scrutiny through an external review, ensuring alignment with national and international standards and best practices. Subsequently, the package was submitted to the NIDM for formal approval of the training programme. Upon receiving NIDM approval, the Tier III training package as a participant and facilitator guide was officially published and made available for implementation [25].

Uttarakhand State was strategically selected as the site for pilot testing of the PHEDM training package, providing an opportunity to evaluate the program's effectiveness and contextual relevance in a real-world setting. The outcomes of this pilot implementation are expected to inform the further refinement and scaling of the training program across other regions.

## PHEDM Tier III Training

The Tier III pilot was conducted in two cohorts in Uttarakhand (Garhwal and Kumaon Mandals), covering all 13 districts, with 32 participants and 13 mentors in Garhwal, and 31 participants and 4 mentors in Kumaon, with a total of 80 participants. A standard cohort size of 35–40 participants was maintained throughout the Tier III training program to ensure an interactive learning environment and a manageable span of control for the facilitators.

The program was conducted over five consecutive days and was strategically structured to maximise knowledge acquisition and practical skill development in emergency response and incident management. Training commenced with a faculty preoperative workshop designed to establish foundational knowledge and align instructional objectives, followed immediately by a dedicated mentor workshop aimed at building mentoring capacity and ensuring effective knowledge transfer through evidence-based adult learning methods. Over the next three to four days, participants engaged in a balanced mix of instructor-led didactic sessions (comprising 20–30% of each day) that provided theoretical grounding in incident response principles and protocols and active learning methods (70–80%), such as case studies, scenario-based exercises, and tabletop exercises utilising Incident Response System (IRS) protocols to reinforce decision-making, problem-solving, and collaborative planning. A key feature of the program was the development and group discussion of state-specific public health threats and disaster case scenarios, which allowed participants to contextualize their learning and collaboratively address regionally relevant challenges. Specialised hands-on training was delivered by expert teams from the National Disaster Response Force (NDRF), focusing on the practical application of emergency protocols and operational procedures during crises, and included state-specific presentations to assess and enhance the understanding of existing capacities in personnel, resources and systems. Finally, emphasis was placed on sharing best practices, enhancing inter-agency collaboration, and aligning district disaster management plans (DDMP) with national disaster management plans (NDMP) and frameworks. The evaluation tools included pre and post-tests, interactive quizzes (Kahoot App), Likert scale ratings, and qualitative feedback. Integrated yoga sessions were conducted to enhance the resilience of the workforce. Post-training "hotwash" debriefings and detailed training reports provided continuous improvement [26]. Following the successful pilot implementation in Uttarakhand, the PHEDM training package was further refined and modernized based on pilot feedback and evaluation. This enabled its subsequent launch in Rajasthan and facilitated the scale-up of the program across five additional states, ensuring a broader regional impact and integration of best practices identified during the pilot phase.

## Tier I and II Training: Risk Assessment Approach and Process

For the pilot implementation of Tiers I and II in Uttarakhand, Udham Singh Nagar District was chosen under the guidance of State Health, Disaster Management, and Panchayati Raj leadership. Nausar Village Panchayat (VP) in the Khatima Block was selected based on hazard and vulnerability assessments. Stakeholders recommended conducting a comprehensive risk assessment prior to training to establish a resilient community model. An adapted Community Threat and Hazard Identification and Risk Assessment (THIRA) tool was developed and applied by a multidisciplinary team comprising members of the Integrated Disease Surveillance Program (IDSP), Disaster Management, Panchayati Raj, local authorities, community leaders, and frontline workers. This multidisciplinary team worked under the guidance of experts from the NCDC, the NIDM, and CDC India.

The assessment process involved systematic identification and evaluation of local threats and hazards using the Community THIRA tool, with risks assessed for their scale, likelihood, and potential impacts. Guided by the trained team, the community analyzed existing capabilities, identified critical gaps, and developed targeted plans for resource allocation and capacity building. This structured assessment provided a robust evidence base for tailoring training modules, developing a Village Disaster Management Plan (VDMP), and establishing relevant protocols, ensuring that preparedness strategies were aligned with the specific needs and vulnerabilities of the community.

The risk assessment also guided the refinement of Tier I and II training packages before pilot testing, which involved 41 and 35 participants for Tier I and II, respectively, at Nausar Village. The methodology was participatory and multisectoral, engaging local volunteers, leaders, and frontline workers through flip chart instructions, group discussions, practical exercises, and disaster simulations. The training emphasised community risk assessment, VDMP, protocol development, and the application of adult learning principles. Each Tier I and II training session was delivered over three half-day sessions to facilitate active participation and accommodate community schedules. Monitoring and evaluation included pre- and post-training assessments and participant feedback to measure improvements in knowledge, skills, and community preparedness.

## Scaling and Policy Integration

Following pilot testing and refinement based on participant feedback and emerging evidence, the Tier I and II curricula were launched in Alwar District, Rajasthan. Tier III is similarly scaled to the additional states. Tier IV was not advanced, pending the review of Tier III outcomes. For Tier V, policymakers engaged in workshops, leadership summits, and policy briefs to align the PHEDM framework with broader emergency preparedness strategies [27].

### Data Collection and Evaluation

Quantitative and qualitative data were collected to assess PHEDM's feasibility, impact, and policy integration of the PHEDM. Pre- and post-training assessments measured knowledge and skill gains, while interactive tools, such as Kahoot App quizzes and Likert-scale ratings, evaluated participant engagement [26]. Qualitative feedback from focus groups, including participants, faculty members, stakeholders, and "hotwash" debriefings, provided insights into adaptability to infectious diseases and climate-related hazards. Policy integration was evaluated through stakeholder consensus at the Leadership Summit and adoption of PHEDM-aligned policies [27]. Data were analysed to ensure alignment with the IHR 2005, JEE, NHP 2017, and COP priorities, with continuous refinement based on the findings of the analysis.

## 4. Results

The pilot implementation and evaluation of the PHEDM framework in Uttarakhand demonstrated significant improvements in participants' knowledge, practical skills, and overall community preparedness for public health emergencies and disasters. These positive outcomes informed the program's successful launch in Rajasthan and supported its subsequent scale-up to include five additional states. Utilising a mixed-methods approach that integrated Bloom's taxonomy and the Community THIRA tool, the training was effectively tailored across Tiers I–III. The evaluation findings indicate that this approach enabled scalable capacity building for both pandemic preparedness and climate-related hazards, highlighting the adaptability and effectiveness of the PHEDM framework in diverse settings.

### PHEDM Tier III Training Outcomes

The Tier III pilot in Uttarakhand's Garhwal and Kumaon Mandals engaged 80 participants, including 17 mentors from the health, disaster management, animal health, climate, and law enforcement sectors [25]. Pre- and post-training assessments showed a significant increase in mean knowledge scores from 55% to 78% (23% absolute gain, $p < 0.001$), reflecting enhanced operational coordination and resource management skills (Table 2). Participants rated the sessions highly (mean 4.3/5 on a Likert scale), with 85% reporting improved well-being from integrated yoga sessions, supporting the NHP 2017's holistic health focus [11]. Real-time evaluation via interactive tools, such as the Kahoot App, was well received (99% positive feedback), aligning with the method's emphasis on immediate assessment. The mentor-mentee system, with mentors matched to two to four mentees, achieved 95% completion, ensuring effective knowledge transfer [24].

**Table 2 : Uttarakhand Pilot Test-Pre and post-training evaluation of knowledge and skills**

| Metrics | Pre-Training | Post-Training | Change/Outcomes |
|---|---|---|---|
| **Mean Knowledge Score** | 55% | 78% | +23% ($p < 0.001$) |
| **Mean Session Rating (Likert)** | - | 4.3/5 | Good satisfaction |
| **Yoga Session Positive Feedback** | - | 85% | Improved well-being |
| **Feedback on Real Time assessment** | - | 99% | High acceptance of immediate evaluation |

Scaling to Rajasthan formally launched further improved outcomes, with knowledge scores rising from 59% to 84% (25% gain, $p < 0.001$), session ratings of 4.6/5, and 91% positive yoga feedback, demonstrating the framework's adaptability (Table 3). [26].

## PHEDM Tier III Launch in Rajasthan

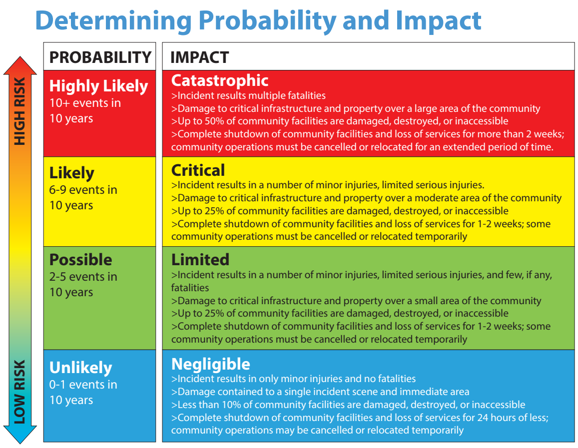
**Table 3 : PHEDM Tier III Launch in Rajasthan- Pre and post-training evaluation of knowledge and skill**

| Metrics | Pre-Training | Post-Training | Change/ Outcomes |
|---|---|---|---|
| **Mean Knowledge Score** | 59% | 84% | +25% (p <0.001) |
| **Mean Session Rating (Likert)** | - | 4.6/5 | High satisfaction |
| **Yoga Session Positive Feedback** | - | 91% | Improved well-being |
| **Top 3 Scorers Facilitated** | - | 3 per cohort | Boosted motivation |

## PHEDM Tier I and II: Community-Level Outcomes

In Nausar Village, Uttarakhand (population: 4,896; area: 686.8 hectares), the Community THIRA tool identified key hazards, including frequent health threats (Typhoid, Dengue, Malaria: highly likely, critical impact) and environmental risks (floods: 2010, 2013, 2019; earthquakes: November 2022; potential dam failure: unlikely, catastrophic) [23]. Existing capabilities, such as the functional Panchayati Raj Institution (PRI) system, Village Health Sanitation and Nutrition Committee, one health sub-centre, one wellness centre, five Anganwadi Kendras, and active community organisations (Mahila & Yuva Mangal Dal), supported preparedness, although gaps in healthcare capacity and historical data were noted (Table 4)

**Table 4 : Nausar Village Hazard and Risk Assessment**




1. Flood-Likely and Limited
2. Earthquake- Possible and Limited
3. Typhoid- Highly Likely and Critical.
4. COVID-19 Pandemic- Possible and Critical
5. Dengue- Highly Likely and Critical.
6. Malaria- Highly Likely and Critical.
7. Electrocution- Possible and Critical.
8. Flashfloods- Possible and Limited.
9. Snakebite- Possible and Critical.
10. Dam Failure- Unlikely and Catastrophic

## PHEDM Tier I

Tier I training (41 participants) increased the knowledge scores from 56% to 74% (18% gain, $p < 0.001$), with high satisfaction (4.8/5) and 94% yoga positive feedback (Table 5).

**Table 5 : Pre and post-training evaluation of knowledge and skills**

| Metrics | Pre-Training | Post-Training | Change/Outcomes |
|---|---|---|---|
| **Mean Knowledge Score** | 56% | 74% | +18% (p <0.001) |
| **Mean Session Rating (Likert)** | - | 4.8/5 | Very High satisfaction |
| **Yoga Session Positive Feedback** | - | 94% | Strong positive impact |
| **Top 3 Scorers Facilitated** | - | 3 per cohort | Boosted motivation |

## PHEDM Tier II

Tier II training (35 participants) improved knowledge from 58% to 83% (25% gain, $p < 0.001$), with a 4.6/5 session rating and 90% positive yoga feedback (Table 6). The top scorers (three per cohort) were motivated.

**Table 6 : Pre and post-training evaluation of knowledge and skills**

| Metrics | Pre-Training | Post-Training | Change/Outcomes |
|---|---|---|---|
| **Mean Knowledge Score** | 58% | 83% | +25% (p <0.001) |
| **Mean Session Rating (Likert)** | - | 4.6/5 | High satisfaction |
| **Yoga Session Positive Feedback** | - | 90% | Improved well-being |
| **Top 3 Scorers Facilitated** | - | 3 per cohort | Boosted motivation |

The training facilitated the establishment of Community Emergency Management Teams (CEMTs) and Community Emergency Response Teams (CERTs) in Nausar Village, comprising the Gram Pradhan, ward members, Accredited Social Health Activists (ASHAs), community leaders, and school teachers. CEMTs adopted the Incident Management/Response System (IMS/IRS) model to coordinate management functions, while CERTs were responsible for immediate response activities, aligning with the National Health Policy (NHP) 2017's emphasis on community participation. This collaborative approach led to the development of a comprehensive Village Disaster Management Plan (VDMP) and associated protocols, thereby strengthening community resilience to the identified hazards (Figure 2). When scaled to Alwar and Rajasthan, the model demonstrated sustained improvement, with Tier I and II training further reinforcing VDMP development and promoting community-driven preparedness.

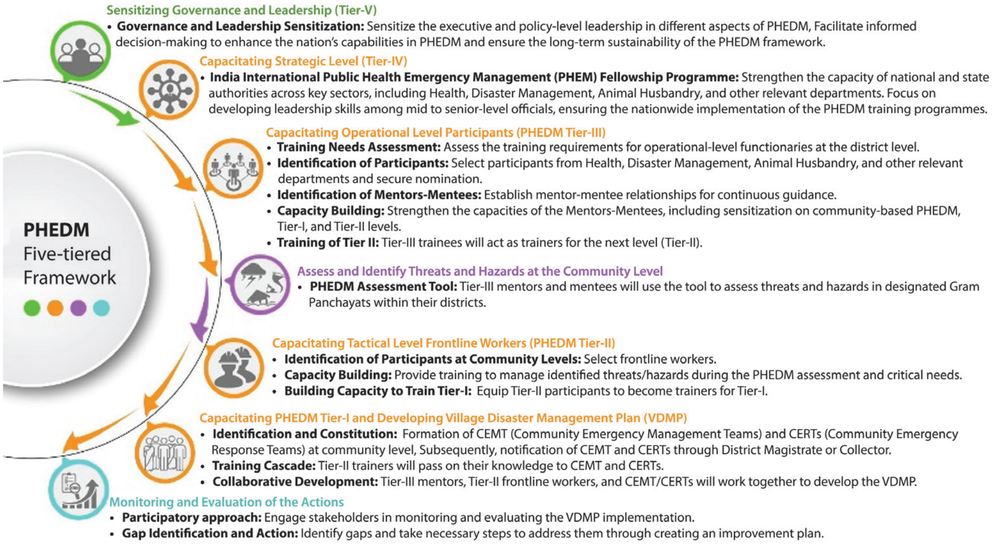



**Figure 2 : PHEDM Five-Tiered Framework: Strengthening Public Health Emergency and Disaster Management in India**

## 5. Discussion

The Public Health Emergency and Disaster Management (PHEDM) framework demonstrated significant improvements in knowledge, skills, and community preparedness across Tiers I–III, addressing the critical gaps in public health emergency management identified by Sasie et al. (2024), such as fragmented coordination and limited community engagement [6]. The mixed-methods approach, integrating a narrative literature review, multi-stakeholder consultations, and pilot testing in Uttarakhand and launched in Rajasthan, facilitated the development of a scalable five-tier model that aligns with India's National Health Policy (NHP) 2017 [11], WHO International Health Regulations (IHR) 2005 [14], and UNFCCC COP priorities for climate-resilient health systems [3]. The significant knowledge score gains (18% for Tier I, 25% for Tier II, and 23–25% for Tier III, $p < 0.001$) reflect the effectiveness of training packages designed to engage experts, community leaders, volunteers, and stakeholders using Bloom's taxonomy, which targets the cognitive, psychomotor, and affective domains [17]. These outcomes compare favourably with Field Epidemiology Training Programs (FETPs), which typically achieve 15–20% knowledge gains in epidemiological training but lack PHEDM's focus on community empowerment and climate adaptation [9, 10].

The application of the Community THIRA tool in Nausar Village identified critical health (Typhoid, Dengue, Malaria) and environmental (floods, earthquakes) hazards, enabling tailored training and the development of Village Disaster Management Plans (VDMPs). This community-driven approach, supported by the formation of Community Emergency Management Teams (CEMTs) and Community Emergency Response Teams (CERTs), aligns with the NHP 2017's emphasis on community participation and strengthens local resilience, mirroring successful models such as Mumbai's Dharavi containment strategy [11, 7]. The high satisfaction ratings (4.3–4.8/5) and positive yoga feedback (85–94%) underscore the framework's holistic approach, addressing workforce well-being as prioritized by the NHP 2017 [11]. The mentor-mentee system, with 95% completion, facilitated effective knowledge transfer and cascade training, and enhanced scalability across tiers [24].

Tier III's success in Uttarakhand (80 participants) and Rajasthan (knowledge gain from 59% to 84%) demonstrates the PHEDM's adaptability to subnational coordination needs, aligning with the IHR 2005 core capacities for surveillance and response [14]. The integration of emergency operations centres (EOCs/PHEOCs) and climate risk assessments supports the Sendai Framework for Disaster Risk Reduction (SFDRR) and the WHO Health EDRM priorities for multisectoral collaboration [3, 4]. The leadership summit's stakeholder consensus highlights the PHEDM's potential for policy integration, aligning with NITI Aayog's pandemic preparedness recommendations and UNFCCC COP25/COP29's focus on health resilience [13, 3]. However, the deferred implementation of Tier IV limits insights into national-level outcomes, and the framework's reliance on pilot settings (Uttarakhand) and launch in (Rajasthan) may constrain generalisability to diverse contexts [26].

The inclusion of nature-based solutions, such as afforestation, in Tier I training aligns with India's Nationally Determined Contributions (NDCs) and COP25/COP29 ecosystem-based adaptation goals, addressing climate-driven hazards, such as floods and heat waves [3, 11, 16]. Unlike traditional frameworks, PHEDM's integration of climate resilience and community engagement in PHEDM positions it as a comprehensive model for addressing the dual challenges of pandemics and climate change, as highlighted by Sasie et al. [6]. The high acceptance of real-time evaluation tools (99% for Tier III) suggests that interactive methods, such as the Kahoot App, enhance engagement, supporting the method's emphasis on robust evaluation [26]. These findings underscore PHEDM's potential of PHEDM to bridge the gaps in global health security and disaster risk reduction, offering a scalable model for India and beyond.

## 6. Conclusion

The PHEDM framework effectively enhanced knowledge, skills, and community preparedness across Tiers I–III, as evidenced by significant knowledge gains (18–25%, $p < 0.001$), high satisfaction (4.3–4.8/5), and positive well-being outcomes from yoga sessions (85–94%) in the Uttarakhand pilot and Rajasthan launch [26]. The Community THIRA tool and mentor-mentee system (95% completion) enabled tailored VDMPs and scalable capacity building, addressing gaps in community engagement and climate resilience, as identified by Sasie et al. [6]. The framework's alignment with the NHP 2017, IHR 2005, SFDRR, and UNFCCC COP agreements positions it as a robust model for integrating public health and climate adaptation [11, 14, 16]. The stakeholder consensus of the leadership summit underscores its potential for national policy integration [27]. The PHEDM offers a scalable, evidence-based approach to strengthen health systems and community resilience, contributing to global health security and sustainable development.

## 7. Recommendations

1. **Scale PHEDM Implementation:** Expand Tiers I–III to additional states, leveraging digital platforms to sustain training and cascade knowledge transfer, and build on the mentor-mentee system's 95% completion rate [25].

2. **Advance Tier IV and V:** Implement and evaluate Tier IV to strengthen national-level preparedness and engage policymakers through regular summits to ensure sustained policy integration [27].
3. **Enhance Climate Integration:** Incorporate advanced climate risk assessments into all tiers, aligning with COP25/COP29 priorities and India's NDCs to address escalating climate-driven hazards [3, 16].
4. **Strengthening Community Networks:** Supporting CEMTs and CERTs with ongoing training and resources to maintain VDMPs and ensure long-term community resilience [25].
5. **Leverage Technology:** Integrate real-time evaluation tools, such as the Kahoot App and digital learning platforms, to enhance engagement and monitor outcomes across diverse settings [26].

## 8. Limitations

The limitations of this study are typical of pilot studies and do not undermine the robust outcomes achieved. The deferred implementation of Tier IV, planned for a future phase, limits current insights into national-level preparedness but does not affect the success of Tiers I–III. Pilot testing for Tiers I and II was conducted in Nausar Village, Uttarakhand, and launched in Alwar, in Rajasthan. Tier III was piloted in 13 districts in Uttarakhand and launched in Rajasthan, further expanded to five additional states, successfully producing Village and District Disaster Management Plans (VDMPs/DDMPs), and establishing Community Emergency Management and Response Teams (CEMTs/CERTs). However, broader applications across India's diverse contexts are required to confirm their scalability. Self-reported feedback, including Likert-scale ratings (4.3–4.8/5) and yoga session feedback (85–94%), was consistent with standard evaluation methods but may benefit from objective validation in future studies [26]. The lack of long-term follow-up data, typical for initial pilots, limits insights into sustained outcomes, which can be addressed through extended monitoring [25]. These limitations highlight opportunities for further research to enhance the scalability and impact of the PHEDM frameworks.

## 9. Data Access Statement

Research data supporting this publication are available from NIDM training and provided by Integrated Disease Surveillance Programme, Department of Medical Health and Family Welfare, Dehradun, Government of Uttarakhand.

Link1: https://nidm.gov.in/modules.asp

Link 2: https://doi.org/10.18231/j.ijfcm.2023.010

## 10. Ethical Considerations

Administrative permission from the participants in the training and individual informed consent were obtained. Responses were anonymous, and average scores were analysed while keeping all records confidential.

## 11. Funding

No funding was obtained for the manuscript development.

## 12. Competing Interests

The authors declare no competing interests.

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## References


1. Faramarzi A., Norouzi S., Dehdarirad H., Aghlmand S., Yusefzadeh H., Noughabi J. J. (2004). The global economic burden of COVID-19 disease: a comprehensive systematic review and meta-analysis. Systematic Review. 2024 February, 13(1): 68-10. 10.1186/s13643-024-02476-6
2. Das A., Sivaram M., S. T. (2021): Economic impact of COVID-19 pandemic on dairy sector: a meta-analysis. Indian J Anim Sci. 2021, 91:582-94. 10.56093/ijans.v91i7.115908
3. United Nations Framework Convention on Climate Change: https://unfccc.int/. Paris Agreement. UNFCCC, 2015. https://unfccc.int/process-and-meetings/the-paris-agreement
4. World Health Organization, Health Emergency and Disaster Management Framework (WHO Health-EDRM): https://iris.who.int/handle/10665/326106
5. World Health Organization's guidance on preparing for national response to health emergencies and disasters. Geneva: World Health Organization. (2021). https://www.who.int/publications/i/item/9789240037182
6. Sasie S. D., Ayano G., Zuylen P. V., Aragaw F. M., Darebo T. D., Torres L. G., Mulugeta A., Spigt M. (2025). Developing a comprehensive framework for evaluating public health emergency management program implementation: a scoping review. Public Health. 2024, 239:22-31. 10.1016/j.puhe.2024.12.012
7. Kudtarkar S. G. (2021). Dharavi Model: a framework for containing COVID-19 pandemic in resource-limited democratic settings. London J Res Humanit Soc Sci. 2021, 21, Issue 5:75-84.https://journalspress.com/LJRHSS_Volume21/Dharavi-Model-A-Framework-for-Containing-Covid-19-Pandemic-in-Resource-Limited-Democratic-Settings.pdf
8. Bose S. (2020). Following the Odisha example for developing community-based disaster management in India. New Delhi: Observer Research Foundation. https://www.orfonline.org/expert-speak/following-the-odisha-example-for-developing-community-based-disaster-management-in-india
9. Bell E., Mittendorf C., Meyer E., Barnum O., Reddy C., Williams S., Baggett H., Ruiz R. T. (2022). Continuing Contributions of Field Epidemiology Training Programs to Global COVID-19 Response. Emerging Infectious Diseases, 28(13): 129-137. https://doi.org/10.3201/eid2813.220990
10. Traicoff D. A, Rangel G. S., Wilkins Y. E., Lopez A., Diaz A., Caceres V., (2015). Strong and Flexible: Developing a Three-Tiered Curriculum for the Regional Central America Field Epidemiology Training Program. Pedagogy in health promotion, 1(2): 74–82. PMCID: https://pmc.ncbi.nlm.nih.gov/articles/PMC5502830/
11. Ministry of Health and Family Welfare, Government of India. NHP 2017. https://nhsrcindia.org/sites/default/files/2021-07/National%20Health%20Policy%202017%20%28English%29%20.pdf
12. National Disaster Management Authority. National disaster management plan (NDMP). New Delhi: National Disaster Management Authority, 2019. https://ndma.gov.in/sites/default/files/PDF/ndmp-2019.pdf
13. NITI Aayog. Report of the expert group on future pandemic preparedness and emergency response. New Delhi: NITI Aayog, 2024. Report-of-the-Exper-Group--Future-Pandemic-preparedness-and-emergency-response.pdf
14. WHO: International Health Regulations (2005) - Third edition. WHO (ed): WHO, ISBN: 978-92-4-158049-6; 2016. iris.who.int/bitstream/handle/10665/246107/9789241580496-eng.pdf.
15. United Nation: Sustainable Development Goals (SDGs). UN (ed): UN, 2015. https://sdgs.un.org/goals
16. Press Information Bureau, Government of India Statement at UNFCCC COP 2019 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1595787
17. University of Central Florida. Bloom's taxonomy. Orlando: University of Central Florida, 2024. https://fctl.ucf.edu/teaching-resources/course-design/blooms-taxonomy/

18. Ginsberg A. C., Fisher H., Awan J., Rico A., Thomas T., Rose D., Vagi S., Jenkins L., Nelson C. (2022). Conceptual framework for understanding incident management systems during public health emergencies. Disaster Med Public Health Prep. 2022, 17:158. https://dx.doi.org/10.1017/dmp.2022.77
19. Ranjan P., Barnwal R. K., Mahto P. N., Choudhary N. (2023). Students' feedback on yoga training as part of the foundation course in the MBBS curriculum. Asian J Pharm Clin Res. 2023, 16:179-81. https://dx.doi.org/10.22159/ajpcr.2023.v16i10.48128
20. United Nations's Sendai Framework for Disaster Risk Reduction (SFDRR): https://www.undrr.org/implementing-sendai-framework/what-sendai-framework
21. WHO-Joint external evaluation tool: International Health Regulations (2005): JEE 2022: https://www.who.int/publications/i/item/9789240051980.
22. Allen T., Spencer R. (2023). Barriers and enablers to using an emergency operations center in public health emergency management: A scoping review. Disaster Med Public Health Prep. 2023, 17:407. 10.1017/dmp.2023.50
23. National Institute of Disaster Management: EOC/PHEOC Emergency Operations Centre/Public Health Emergency Operations Center Development Package. New Delhi: National Institute of Disaster Management (ed): 2024, ISBN: 978-81-969180-9-5; 2025. https://nidm.gov.in/PDF/Modules/EOC_PHEOC_NIDM24.pdf
24. Gagliardi A. R., Webster F., Perrier L., Bell M., Straus S. (2014). Exploring mentorship as a strategy to build capacity for knowledge translation research and practice: a scoping systematic review. Implement Sci. 2014, 13:122. https://dx.doi.org/10.1186/s13012-014-0122-z
25. Parkash S., Sharma R., Menchion W. C., Chauhan H., Thapa R., Kaur H., Kathait A., Dogra A. (2022). Training Module on Public Health Emergency and Disaster Management- Professional Development Programme (PHEDM-PDP) - Tier II. National Institute of Disaster Management,ISBN:978-81-957965-8-8.
26. Parkash S., Chauhan H., Sharma R. (2023). Public Health Emergency and Disaster Management Professional Development Programme (PHEDMPDP) - Tier III Training, Rajasthan (Batch 1). National Institute of Disaster Management, 2023. https://nidm.gov.in/PDF/TrgReports/2023/May/Report_30-01May2023sp.pdf.
27. Parkash S., Chauhan H., Sharma R., Ratnoo R. (2024). High-Level Governance and Leadership Summit on PHEDM. ED, NIDM (ed): National Institute of Disaster Management, ISBN: 978-81-969180-5-7; 2024. https://nidm.gov.in/PDF/pubs/High-Level%20Governance%20and%20Leadership%20Summit%20on%20PHEDM25.pdf