



Strengthening Prehospital Emergency Care in Low- and Middle-Income Countries: A Scoping Review

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Abstract

Prehospital emergency care is a critical component of emergency care systems, particularly for time-sensitive trauma and medical conditions. However, many low- and middle-income countries have experienced persistent structural and operational challenges that have limited timely access to care. This scoping review aimed to identify and map strategies implemented to strengthen prehospital emergency care in low- and middle-income countries. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guidelines. A systematic search was conducted in Web of Science, ProQuest, Scopus, and ScienceDirect. Eligible studies were screened, data were extracted, and findings were synthesized using thematic narrative analysis. Twenty-five studies met the inclusion criteria. The evidence showed that strengthening prehospital emergency care required integrated system-level approaches, including community first responder engagement through task shifting, technology-supported coordination and dispatch, context-appropriate transport models, formal emergency medical service development, and standardization with continuous quality improvement. The implementation of these strategies varied according to local resources and system capacity. This review provided a comprehensive synthesis of system-level strengthening strategies across low- and middle-income countries, extending beyond previous reviews that primarily examined individual interventions, and offered an integrated framework to inform future policy, implementation, and research.

Keywords

EMS;
prehospital care;
health services accessibility;
LMICs;
ambulance services

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Introduction

Prehospital emergency care (PEC) is a critical component of emergency care systems, playing a key role in reducing morbidity and mortality in trauma and other time-sensitive medical emergencies (Nafea et al., 2025). Its effectiveness depends on the health system's ability to provide

a rapid, coordinated, and continuous response from the scene to healthcare facilities (WHO, 2025b). However, PEC systems in many low- and middle-income countries (LMICs) remain underdeveloped because of fragmented governance, limited resources, inadequate transportation and communication infrastructure, and weak coordination between prehospital and hospital services (Bhattarai et al., 2023; Delaney et al., 2024; Nafea et al., 2025). These systemic limitations are reflected in poor access to timely prehospital care and unfavorable patient outcomes. For example, more than half of trauma-related deaths in Malawi occur before patients reach a healthcare facility (Mulima et al., 2021), while only a small proportion of trauma patients in Cameroon receive prehospital emergency care (Ngekeng et al., 2024). Similarly, the World Health Organization estimates that the vast majority of global road traffic deaths occur in LMICs, highlighting persistent inequities in access to emergency care (WHO, 2023). Comparable challenges are also observed in non-trauma emergencies, where survival following out-of-hospital cardiac arrest remains low despite emergency medical service activation (Sarah et al., 2025). Collectively, these findings suggest that improving prehospital emergency care in LMICs requires comprehensive system strengthening rather than isolated interventions (Quake et al., 2024; Phillips et al., 2025).

The WHO emphasizes the importance of integrating PEC within the broader emergency care system, spanning the continuum from on-scene care and patient transport to definitive management at referral facilities. This integration involves strengthening multiple components of the system, including community responders, drivers, dispatchers, and Emergency Medical Services (EMS) personnel through context-specific training (WHO, 2021, 2025a). A range of adaptive strategies has been implemented across resource-limited settings. For example, lay first responder programs in Uganda have been shown to improve response times and expand service coverage (Brown et al., 2023), while context-appropriate transport innovations, such as motorcycle ambulances, have been used to accelerate early response in resource-limited settings (Eisner, Smith and Wylie, 2024). However, existing evidence remains fragmented across individual components of PEC, and no review has comprehensively mapped system-level strengthening strategies across the continuum of care in LMICs while considering their implementation approaches and contextual challenges. Given the broad and heterogeneous nature of the available evidence, encompassing diverse interventions, settings, and study designs, a scoping review was considered the most appropriate approach to systematically map the existing evidence, identify key concepts, and highlight knowledge gaps rather than evaluate the effectiveness of a single intervention. Accordingly, this review sought to answer the following question: What system-level strategies have been implemented to strengthen prehospital emergency care across the continuum of care in low- and middle-income countries? This scoping review aimed to map these strategies, their implementation approaches, and the contextual factors influencing their implementation.

Materials and Methods

Study Design

This study employed a scoping review to map strategies to improve the quality of PEC in LMICs. The review followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines. It was informed by the methodological framework developed by Arksey and O'Malley, with subsequent refinements by Levac and colleagues (Tricco et al., 2018). The Population-guided search and study selection process–Concept–Context (PCC) framework was used to ensure a systematic, clearly defined, and focused formulation of the research question. The literature search identified 1,057 records across four databases, comprising 287 records from Scopus, 471 from ProQuest, 162 from Web of Science, and 137 from ScienceDirect, before duplicate removal (Figure 1).

Eligibility criteria

Population: Individuals, communities, first responders, healthcare workers, EMS personnel, and services involved in PEC in LMICs, as classified by the World Bank (2025).

Concept: Strategies, interventions, or innovations aimed at strengthening the quality, efficiency, accessibility, or performance of PEC, encompassing clinical, operational, system-level, and managerial aspects.

Context: PEC services across the continuum of care, including on-scene management, evacuation, and transport to healthcare facilities.

Studies were included if they involved the target population, addressed strategies to strengthen PEC within the specified context, were conducted in LMICs, were primary research articles published in English with full-text availability, and were published between 2020 and 2025. Studies were excluded if they involved populations, concepts, or contexts outside the scope of this review, were conducted in high-income countries, or were review articles, editorials, conference abstracts, or other non-peer-reviewed publications. Following the screening and eligibility assessment, 25 studies met the inclusion criteria and were included in the final review.

Search strategy and database

The search strategy was developed based on the PCC framework and applied across four electronic databases: Web of Science, ProQuest, Scopus, and ScienceDirect. The database search was conducted on 26 December 2025. Search terms were combined using Boolean operators ("AND" and "OR"), incorporating keywords related to PEC and health system strengthening, such as "prehospital care," "emergency medical services," "intervention," "strategy," "program," "training," "quality improvement," "health system strengthening," "dispatch," "communication," "transport," "low- and middle-income countries," "developing countries," and "resource-limited settings."

Study Selection Process

All retrieved records were exported to the Rayyan software for duplicate removal. The remaining studies underwent a two-stage screening process, consisting of independent title and abstract screening by two reviewers, followed by full-text assessment to determine eligibility based on the study objectives. Discrepancies were resolved through discussion, with a third reviewer involved when necessary. The study selection process was illustrated using the PRISMA-ScR flow diagram.

Data Extraction

Two reviewers independently extracted data using Microsoft Excel 2021 to ensure consistency and accuracy, including publication year, authors, country, strategy domain, intervention type, and reported outcomes.

Methodological Quality Appraisal

The methodological quality of included studies was appraised using the Joanna Briggs Institute (JBI) critical appraisal tools, tailored to each study design. Appraisal was conducted independently by two reviewers. In line with the purpose of scoping reviews, study quality did not serve as a basis for exclusion. Risk of bias was classified according to the proportion of criteria met: low ($\geq 70\%$), moderate (50–69%), and high ($< 50\%$).

Data Synthesis

A narrative synthesis was conducted using thematic analysis to identify and interpret patterns within the data. Findings were grouped deductively into relevant thematic categories. The analytical process included data familiarization, systematic coding, and iterative theme development and refinement. Themes were reviewed collaboratively to ensure they accurately represented the data.

and aligned with the study objectives. Results were presented narratively and complemented by a summary table.

Results and Discussions

Study characteristic

Following screening and eligibility assessment, 25 studies met the inclusion criteria (Figure 1). The methodological quality of all included studies was assessed using the JBI Critical Appraisal Tools, with the appraisal checklist selected based on each study's design. A summary of the quality assessment results is presented in Table 1. However, country-level representation may exceed the total number of studies because several studies covered multiple countries. The studies were distributed across three LMIC regions: Sub-Saharan Africa (n=17), South and Southeast Asia (n=6), and Latin America (n=2). Within Sub-Saharan Africa, most studies originated from South Africa (n=6) and Sierra Leone (n=5), followed by Uganda (n=3) and Tanzania (n=2). Single studies were conducted in Liberia, the Democratic Republic of the Congo, and Chad. However, the Chad study formed part of a multinational study conducted across Uganda, Chad, and Sierra Leone. In Asia, studies were conducted in Pakistan (n=2), India (n=2), Thailand (n=2; including one study involving Laos), and Laos (n=1). Latin America was represented by studies from Bolivia (n=1) and Guatemala (n=1) (Table 2). Therefore, country-specific counts cannot be summed to obtain the regional total because one study contributed to more than one country. Regional totals represent the number of included studies, with each study counted only once.

The included studies demonstrated considerable methodological heterogeneity. Quasi-experimental and mixed-methods studies were the most frequently represented designs (n = 6 each), followed by simulation studies (n = 4), qualitative studies (n = 3), cross-sectional studies (n = 2), retrospective observational studies (n = 2), one descriptive study (n = 1), and one feasibility study (n = 1). No randomized controlled trials (RCTs) were identified. Most studies evaluated interventions or programs implemented in real-world service settings rather than under controlled trial conditions (Table 2).

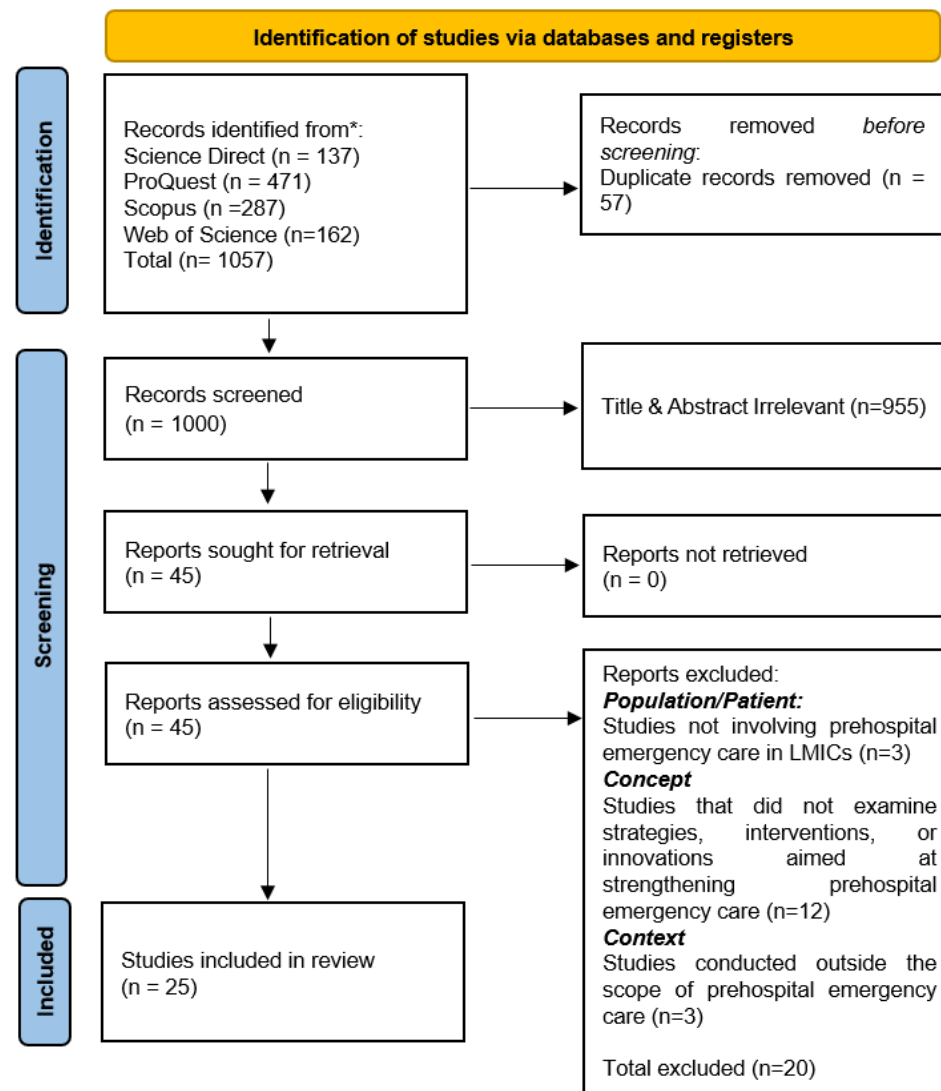


Figure 1. PRISMA-ScR flow diagram

Table 1. Summary of critical appraisal results

References	Study Design	JBIChecklist Score	Risk Bias Grade Outcome
(Apiratwarakul <i>et al.</i> , 2021)	Description: cross-sectional study	N/A	Not Appraised
(Apiratwarakul <i>et al.</i> , 2022)	Cross-sectional study	7/8 (87,5%)	Low risk
(Brady <i>et al.</i> , 2024)	Qualitative study	10/10 (100%)	Low risk
(Brown <i>et al.</i> , 2023)	Mixed-methods (pre-post and qualitative study)	Quant: 7/9 (77.8%) Qual: 7/10 (70%)	Low risk
(Caviglia <i>et al.</i> , 2021)	Retrospective interrupted time-series study	N/A	Not Appraised
(Delaney <i>et al.</i> , 2023)	Simulation study	N/A	Not Appraised
(Delaney <i>et al.</i> , 2024)	Mixed methods (Quasi-experimental study and qualitative study)	Qual: 5/10 (50%) Quan: 8/9 (88.9%)	Moderate risk Low risk

(Delaney <i>et al.</i> , 2025)	Simulation study	N/A	Not Appraised
(Diango <i>et al.</i> , 2023)	Mixed Methods (pre-post and qualitative analysis)	Quant: 7/9 (77.8%) Qual: 8/10 (80%)	Low risk
(Drake <i>et al.</i> , 2024)	Quasi-experimental study	7/9 (77.8%)	Low risk
(Eisner <i>et al.</i> , 2020)	Quasi-experimental study	8/9 (88.9%)	Low risk
(Idris <i>et al.</i> , 2025)	Quasi-experimental study	7/9 (77.8%)	Low risk
(Jackson <i>et al.</i> , 2022)	Quasi-experimental study	6/9 (66.7%)	Moderate risk
(Levi <i>et al.</i> , 2025)	<i>Mixed methods (Quasi-experimental study and Qualitative study)</i>	Quant: 8/9 (88.9%) Qual: 8/10 (80%)	Low risk
(McCaul <i>et al.</i> , 2020)	Qualitative Study	10/10 (100%)	Low risk
(Mishra <i>et al.</i> , 2020)	Simulation Study	N/A	Not Appraised
(Mohan <i>et al.</i> , 2021)	Quasi-experimental study	7/9 (77.8%)	Low risk
(Mould-Millman <i>et al.</i> , 2023)	<i>Mixed methods (Quasi-experimental study and qualitative study)</i>	Quant: 9/9 (100%) Qual: 8/9 (88.9%)	Low risk
(Ndile <i>et al.</i> , 2020)	Quasi-experimental study	8/9 (88.9%)	Low risk
(Ononge <i>et al.</i> , 2023)	Mixed methods (descriptive and qualitative study)	Qual: 8/10 (80%)	Low risk
(Pule, Hodgkinson and Hardcastle, 2022)	Descriptive study	N/A	Not Appraised
(Rafaqat <i>et al.</i> , 2025)	<i>Feasibility study</i>	N/A	Not Appraised
(Reynolds <i>et al.</i> , 2024)	Qualitative study	8/10 (80%)	Low risk
(Stassen, Alkzair and Kurland, 2020)	<i>Retrospective matched cohort study (reported by the authors as a case-control study)</i>	9/11 (81.8%)	Low risk
(Stassen, Tsegai and Kurland, 2023)	Simulation study	N/A	Not Appraised

N/A = not available

Table 2. Data extraction

References	Country	Strategy Domain	Type of Intervention	Outcome
(Apiratwarakul <i>et al.</i> , 2021)	Laos and Thailand	Formal EMS Development	EMS training for Laos emergency medicine residents to build capacity in dispatch, emergency medical consultation, EMS technology, and system management.	Self-reported confidence after EMS training across several areas, including EMS technology, organizational management, dispatcher duties, medical oversight, resuscitation, and disaster management.
(Apiratwarakul <i>et al.</i> , 2022)	Thailand	Adaptive Transport Models	Deployment of motorcycle ambulances equipped with an AED and emergency care kit for rapid urban emergency response	The response time of motorlances was shorter than a conventional ambulance, and the use of AEDs on a motorlance can increase the chances of survival for patients with cardiac arrest outside the hospital in public places where AEDs are not available.
(Brady <i>et al.</i> , 2024)	South Africa	Formal EMS Development	Philippi Project: community-based ambulance model with autonomous crews coordinating locally and engaging with police and community groups.	The Philippi Project emerged as a potentially transformative community-based EMS model; however, its long-term sustainability was constrained by organizational hierarchy, the COVID-19 pandemic, and a violent incident.

(Brown <i>et al.</i> , 2023)	Uganda	Community-Based First Response	Basic prehospital care training for motorcycle taxi drivers (boda) with first aid kit provision.	Improved basic emergency care capacity and skill use in a short time and at a low cost
(Caviglia <i>et al.</i> , 2021)	Sierra Leone	Formal EMS Development	Implementation of a nationwide, free ambulance-based NEMS	Healthcare access improved, with hospital admissions increasing by 43% overall; 80.1% of post-implementation patients arrived by NEMS ambulance
(Delaney <i>et al.</i> , 2023)	Sierra Leone	Digital Coordination Systems	Mobile-based dispatch system (Beacon) coordinating trained lay first responders.	Using Beacon, the median response interval was 5 minutes 39 seconds, and median first-aid skill completion was 89%; the estimated cost was US\$179.02 per DALY averted per 100,000 people. No clinical patient outcomes were assessed.
(Delaney <i>et al.</i> , 2024)	Uganda, Chad, Sierra Leone	Community-Based First Response	Training and equipping motorcycle taxi drivers as lay first responders through a 5.5-hour context-adapted trauma care course.	Knowledge increased from 39.5% to 73.6%; LFRs recorded 2,171 patient encounters, provided hemorrhage control in 61% of cases, and transported 98.5% of patients by motorcycle. The program's program's low-cost model has a US\$51.65 per DALY averted in resource-limited settings.
(Delaney <i>et al.</i> , 2025)	Sierra Leone	Digital Coordination Systems	SnooCODE: offline alphanumeric grid-based navigation tool for coordinating lay first responders.	Effective, low-cost emergency medical dispatch tool to strengthen EMS in resource-limited settings.
(Diango <i>et al.</i> , 2023)	DRC	Community-Based First Response	Three-day WHO CFAR training for community health workers	Self-confidence increased from 17.9% to 95.3% ($p < 0.001$). Participants considered the course contextually appropriate and well organized, although 94.7% felt the 3-day duration was insufficient
(Drake <i>et al.</i> , 2024)	Tanzania	Community-Based First Response	A 30-minute context-adapted bleeding control course with practical skills training and first-aid kits for boda-boda drivers.	This course increased participants' perceived knowledge of bleeding control, their ability to apply skills, and their intention to intervene. Participants utilized field skills, transported the injured, and handed off care.
(Eisner <i>et al.</i> , 2020)	Sierra Leone	Community-Based First Response	A 5-hour, context-adapted trauma course using bilingual teaching, hands-on practice, first-aid kits, and a training-of-trainers model for lay first responders.	Increased LFR knowledge and engagement in prehospital care; scalable, cost-effective strategy in resource-limited settings
(Idris <i>et al.</i> , 2025)	Pakistan	System Quality Improvement	KPI-based Performance Measurement Framework designed to monitor and reduce CIA	Identified EMS performance gaps and guided targeted quality-improvement actions; post-implementation data showed fewer

(Jackson <i>et al.</i> , 2022)	Bolivia	Community-Based First Response	A 4-hour, Spanish-language, context-adapted trauma first responder course combining didactic teaching and hands-on skills training.	CIA cases. Increased knowledge of first responder skills and improved confidence in these abilities
(Levi <i>et al.</i> , 2025)	Guatemala	Community-Based First Response	CrashSavers, a mobile phone-based self-training program using didactic materials, virtual-reality cases, and a low-cost bleeding simulator to teach tourniquet placement to firefighters	A low-cost, easily accessible, self-taught course that combined didactic instruction, VR cases, and simulation successfully trained bomberos to control bleeding from an extremity.
(McCaul <i>et al.</i> , 2020)	South Africa	System Quality Improvement	Development, adaptation, and implementation of evidence-based prehospital clinical practice guidelines.	Identification of challenges, recommendations, and priority actions for strengthening prehospital CPG development and implementation.
(Mishra <i>et al.</i> , 2020)	India	Adaptive Transport Models	Simulation of a dispatcher-coordinated taxi system as backup to the existing ambulance service.	The simulation estimated shorter response times, reduced travel distances, and increased coverage after adding taxis to the existing ambulance fleet.
(Mohan <i>et al.</i> , 2021)	India	Community-Based First Response	Basic Emergency Care Course combining lectures, audiovisual materials, and mannequin-based skills training for community health workers and residents.	Significant improvement in knowledge with sustained one-year retention and application of skills in community-based PEC.
(Mould-Millman <i>et al.</i> , 2023)	South Africa	System Quality Improvement	Simplified prehospital trauma care bundle (five core elements) delivered through High-Efficiency EMS Training for shock management.	Achieved high implementation effectiveness, with improvements in providers' knowledge, skills, and attitudes, while no statistically significant improvement was observed in patient clinical outcomes.
(Ndile <i>et al.</i> , 2020)	Tanzania	Community-Based First Response	Postcrash first aid (PFA) educational program for traffic police officers.	A PFA educational program has been shown to improve police officers' knowledge and perceived confidence in their first-aid skills.
(Ononge <i>et al.</i> , 2023)	Uganda	Digital Coordination Systems	Emergency call center and Kampala Digital Emergency Transport System for real-time ambulance request, dispatch, and tracking (maternal and newborn emergencies).	Improved coordination, referral efficiency, and faster access to emergency care in urban prehospital systems.
(Pule, Hodkinson and Hardcastle, 2022)	South Africa	Adaptive Transport Models	HEMS as a transport modality for trauma patients	HEMS was predominantly used for long-distance interhospital transfer of severely injured trauma patients; No mortality benefit was established
(Rafaqat <i>et al.</i> , 2025)	Pakistan	Digital Coordination	Development and pilot implementation of EMCON, a	Demonstrated technical feasibility, adaptability to EMR and manual-

		Systems	digital platform connecting hospitals, ambulances, and patients for real-time resource information, interhospital transfer, ambulance coordination, and emergency-care guidance.	record settings, successful real-time data updating, and positive end-user feedback during pilot implementation.
(Reynolds <i>et al.</i> , 2024)	Liberia	Digital Coordination Systems	MORES, combining obstetric triage training with a templated two-way WhatsApp referral and pre-notification system between rural facilities and district hospitals.	Participants reported high usability, improved prehospital transfer, attentiveness, patient care, coordination/ accountability, and referral feedback.
(Stassen, Alkzair and Kurland, 2020)	South Africa	Adaptive Transport Models	HEMS as a transport modality for trauma patients	HEMS does not seem to improve mortality over GEMS
(Stassen, Tsegai and Kurland, 2023)	South Africa	Adaptive Transport Models	HEMS as a transport modality for trauma patients	HEMS rarely provided a time advantage over simulated GEMS transport for primary emergency responses, with benefit occurring only when the road distance to hospital exceeded 119 km under a non-simultaneous dispatch model.

AED = Automated External Defibrillator; CFAR = Community First Aid Responder; CIA = collapse in ambulance; CPGs = Clinical Practice Guidelines; DALY = Disability-Adjusted Life Year; EMCON = Emergency Connection; EMS = Emergency Medical Services; GEMS = Ground Emergency Medical Services; HEMS = Helicopter Emergency Medical Services; KPI = Key Performance Indicator; LFR = Lay First Responder; MORES = Mobile Open-Source Emergency Response System; NEMS = National Emergency Medical Services; PEC = Pre-hospital Emergency Care.

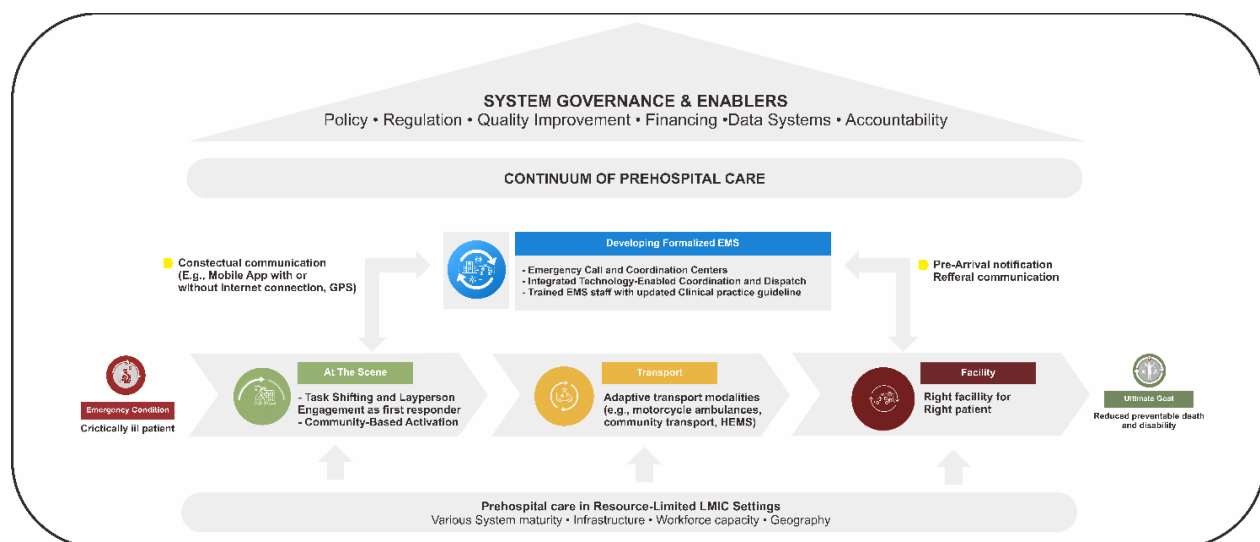


Figure 2. Strategies to strengthen PEC in LMICs

Strategies to Strengthen PEC in LMICs

Thematic analysis of the 25 included studies identified a range of strategies implemented across LMICs to strengthen PEC. These strategies span multiple stages of the care continuum, including on-scene management, evacuation and transport mechanisms, and integration of services with healthcare facilities.

Task shifting to community members as first responders.

Most included studies reported task-shifting approaches involving laypersons, including community volunteers, public transport drivers, firefighters, and community health workers, to perform first-responder roles at the scene (Eisner *et al.*, 2020; Ndile *et al.*, 2020; Mohan *et al.*, 2021; Jackson *et al.*, 2022; Brown *et al.*, 2023; Diango *et al.*, 2023; Delaney *et al.*, 2024; Drake *et al.*, 2024; Levi *et al.*, 2025). Programs such as Community First Aid Responder (CFAR) and Lay First Responder (LFR) initiatives in Africa and Asia, as well as Trauma First Responder training in Latin America, involved lay communities in early emergency response, particularly in settings where formal EMS remained limited (Eisner *et al.*, 2020; Jackson *et al.*, 2022; Diango *et al.*, 2023). A multi-country study in sub-Saharan Africa reported that trained motorcycle taxi drivers managed 2,171 real-world patient encounters and that the program was cost-effective (US\$51.65 per DALY averted) (Delaney *et al.*, 2024). Targeted training interventions, including post-crash first aid training for traffic police and motorcycle taxi drivers, were associated with improved knowledge, confidence, and application of first aid skills (Ndile *et al.*, 2020; Brown *et al.*, 2023). In Tanzania, a brief bleeding-control course for motorcycle taxi drivers was associated with improved perceived knowledge, confidence, and reported use of bleeding-control skills in real-world situations (Drake *et al.*, 2024).

Strengthening coordination and dispatch systems through digital integration

Several studies reported the use of digital communication and dispatch systems within PEC in LMICs (Ononge *et al.*, 2023; Reynolds *et al.*, 2024; Delaney *et al.*, 2025; Rafaqat *et al.*, 2025). A range of interventions have been developed, including mobile-based emergency call centers and digital platforms such as EMCON in Pakistan, MORES in Liberia, KDETS in Uganda, and the SNOOCODE mobile system in Sierra Leone, which operates without reliance on internet connectivity. These interventions facilitated communication and coordination among dispatch centers, ambulances, lay first responders, healthcare facilities, and other emergency care providers across the prehospital pathway. Several studies reported that these systems facilitated coordination, referral processes, and timely emergency response across the prehospital pathway (Ononge *et al.*, 2023; Reynolds *et al.*, 2024; Delaney *et al.*, 2025; Rafaqat *et al.*, 2025). In Sierra Leone, simulation studies evaluating Beacon and SnooCODE demonstrated that digital dispatch systems could facilitate timely first-responder activation and coordination, while achieving favorable response intervals, high first-aid skill performance, and cost-effectiveness in simulated emergencies (Delaney *et al.*, 2023, 2025).

Adaptive transport systems in PEC

In settings characterized by geographic barriers, traffic congestion, and limited availability of conventional ambulance fleets, several LMICs have adopted adaptive transport models, including helicopter emergency medical services (HEMS), motorcycle ambulances (motorlances), and taxi dispatch (Mishra *et al.*, 2020; Stassen, Alkzair and Kurland, 2020; Apiratwarakul *et al.*, 2022; Pule, Hodgkinson and Hardcastle, 2022). These approaches were implemented to improve access to PEC for patients with time-sensitive conditions (Apiratwarakul *et al.*, 2022). Among these approaches, evidence from South Africa suggests that HEMS was deployed selectively for patients with severe trauma requiring advanced trauma care, rather than serving as a routine first-line transport modality (Pule, Hodgkinson and Hardcastle, 2022). However, other studies report no clear

superiority of HEMS over ground-based transport in terms of response time or mortality outcomes (Stassen, Alkzair and Kurland, 2020; Stassen, Tsegai and Kurland, 2023). By contrast, motor-lances in Thailand achieved shorter response times than conventional ambulances. They enabled rapid delivery of automated external defibrillators (AEDs) for out-of-hospital cardiac arrest in areas where AEDs were otherwise unavailable (Apiratwarakul *et al.*, 2022). Similarly, simulation modeling from India suggested that integrating dispatcher-coordinated taxis into the existing ambulance fleet could reduce response times, shorten travel distances, and expand emergency service coverage (Mishra *et al.*, 2020).

Development of organized EMS

Studies describing formal EMS development focused on strengthening institutional capacity through workforce training and the establishment of organized ambulance systems. In Sierra Leone, the implementation of a nationwide ambulance-based EMS was associated with a 43% increase in hospital admissions, with most patients transported by the national ambulance service (Caviglia *et al.*, 2021). Similarly, organizational redesign of EMS service delivery in South Africa demonstrated the potential to strengthen locally responsive prehospital care, although sustainability remained dependent on supportive organizational and contextual factors (Brady *et al.*, 2024). At the workforce level, a capacity-building initiative in Laos focused on developing EMS leadership and operational competencies, with participants reporting increased self-confidence in dispatch, medical oversight, disaster management, and EMS system management following training (Apiratwarakul *et al.*, 2021).

Enhancing the performance and quality of existing systems

Three studies described system quality improvement initiatives within prehospital emergency care systems through performance measurement, clinical practice guideline implementation, and workforce training. One study developed a performance measurement framework that identified operational gaps related to communication, protocol adherence, equipment management, and documentation, and reported reductions in collapse-in-ambulance cases following implementation (Idris *et al.*, 2025). Another study explored challenges in implementing prehospital clinical practice guidelines. It proposed priority actions, including the development of national end-user guidance, alignment of recommendations with local practice, transparent decision-making, and clear implementation strategies (McCaul *et al.*, 2020). The remaining study evaluated a workplace-based rapid training strategy to implement a prehospital trauma care bundle, reporting high implementation effectiveness and improvements in providers' knowledge, skills, and attitudes. However, patient clinical outcomes did not differ significantly between groups (Mould-Millman *et al.*, 2023).

The following sections discuss the implications of these findings within the broader context of PEC strengthening in LMICs. This review interprets how LMIC settings are progressing toward more resilient and sustainable emergency care systems, emphasizing the role of community engagement, appropriate technologies, and enabling policy environments. Rather than presenting isolated interventions, these findings collectively illustrate system-level adaptations to resource constraints. These findings should be interpreted in light of the methodological heterogeneity of the included studies, most of which were conducted in real-world service settings rather than controlled trial conditions. To facilitate interpretation, the identified strategies are summarized in Figure 2.

Community-based response as an entry point to PEC strengthening in LMICs

The findings of this review suggest that the involvement of laypersons as first responders is not merely a stopgap measure, but a structurally important component of PEC in resource-limited settings, reflecting a pragmatic response to persistent workforce constraints. In contexts where

formal EMS systems remain limited, early care is frequently initiated by community members, effectively shaping the first link in the prehospital emergency care continuum (Mohan et al., 2021; Jackson et al., 2022; Brown et al., 2023). This approach aligns with WHO recommendations on integrated emergency care systems, particularly in resource-constrained settings (Hansen et al., 2020; WHO, 2025a).

The programs identified in this review generally reflect a shift toward targeted, high-yield capacity building, prioritizing essential skills that can be rapidly deployed in emergencies, particularly in high-burden conditions such as trauma (Eisner et al., 2020; Jackson et al., 2022). These programs enable laypersons to actively participate in early emergency care, not only through initial first aid but also by facilitating timely access to higher-level care (Jackson et al., 2022; Drake et al., 2024). Importantly, the observed improvements in knowledge and confidence suggest that effectiveness is achievable across heterogeneous populations, reinforcing the scalability of this approach (Eisner et al., 2020; Mohan et al., 2021). However, sustaining long-term knowledge retention remains a challenge, underscoring the need for ongoing training and reinforcement mechanisms (Eisner et al., 2020; Mohan et al., 2021).

Conceptually, delegating tasks to laypersons represents an adaptive strategy to strengthen the early phase of PEC in low-resource contexts (Eisner et al., 2020; Sakeah et al., 2021). However, this approach should not be viewed as a substitute for formal EMS systems. Its effectiveness and sustainability depend on integration within broader health systems, supported by appropriate governance, policy legitimacy, and context-sensitive incentive structures (Eisner et al., 2020; Sakeah et al., 2021; Brown et al., 2023). Therefore, lay responder models should be positioned as an entry point into the emergency care continuum, rather than as a low-cost replacement for professional EMS capacity.

Digital systems as coordination tools across the prehospital care pathway

In the context of fragmented communication and coordination systems, LMICs are progressively leveraging digital technologies as integrative tools to connect components of PEC systems. Evidence from the included studies indicates a shift toward more coordinated dispatch architectures, in which emergency call handling, ambulance deployment, and referral pathways are functionally integrated rather than operating in isolation. Such integration appears to enhance system responsiveness by improving information continuity and reducing delays across the care pathway (Ononge et al., 2023; Rafaqat et al., 2025). These findings highlight the role of digital technologies as system-level enablers of coordination and information flow, particularly in settings where formal EMS systems remain underdeveloped.

However, the effectiveness of digital integration is closely linked to underlying infrastructure and system capacity (Friesen, Kharel and Delaney, 2024). Persistent challenges include digital inequities, limited internet connectivity, and mismatches between digital system expansion and the capacity of physical service delivery (Ononge et al., 2023; Reynolds et al., 2024; Rafaqat et al., 2025). Taken together, these findings suggest that digital integration can catalyze improving coordination and early-response readiness in prehospital systems. However, its effectiveness ultimately depends on contextual alignment with infrastructure, operational capacity, and the overall maturity of the health system (Reynolds et al., 2024; Delaney et al., 2025).

Context-sensitive transport models for improving emergency access

LMICs are increasingly adopting adaptive transport strategies to address geographic and operational constraints in PEC delivery. The included studies demonstrate that transport modalities cannot be used interchangeably, but instead fulfill distinct, context-dependent functions within the system (Apiratwarakul et al., 2022; Pule, Hodgkinson and Hardcastle, 2022). These approaches

reflect deliberate system adaptations aimed at preserving accessibility and response capacity under structural limitations, rather than merely serving as logistical alternatives.

However, investment in advanced transport technologies such as HEMS does not inherently improve system performance and may introduce inefficiencies when not supported by appropriate system design. Without timely activation, efficient coordination, and appropriate triage mechanisms, HEMS may even increase total prehospital time compared with ground transport. This highlights that technological sophistication alone is insufficient without alignment with operational workflows and decision-making processes. Consequently, the effectiveness of transport interventions depends on their integration into a broader systems framework, in which coordination, triage accuracy, and resource allocation are optimized to achieve meaningful impact (Stassen, Alkzair and Kurland, 2020; Stassen, Tsegai and Kurland, 2023).

Development of formal EMS systems

The included studies suggest that establishing integrated, formal EMS systems is an important component of strengthening PEC in LMICs. Variations in system maturity across settings underscore that EMS development is an incremental and context-dependent process, requiring coordinated investments in workforce development, legal and regulatory frameworks, infrastructure, and sustainable financing (Apiratwarakul et al., 2021; Caviglia et al., 2021; Sun, de Vries and Mould-Millman, 2024). Accordingly, efforts to establish formal EMS should be framed as system-wide capacity building rather than limited to the provision of ambulances or physical infrastructure.

Despite their potential to improve access to emergency care, the implementation of formal EMS systems remains constrained by multiple structural and contextual challenges (Caviglia et al., 2021). These challenges extend beyond resource limitations to include safety concerns, organizational culture, and governance fragmentation, all of which can undermine system functionality and sustainability (Brady et al., 2024). In addition, limited leadership capacity and weak intersectoral coordination further restrict effective system integration and scale-up (Denu et al., 2022; Joiner et al., 2023). Taken together, these findings indicate that strengthening formal EMS requires not only technical and operational improvements, but also deeper organizational and governance reforms, supported by stable multisectoral collaboration (Burkholder, Osei-Ampofo and Bonney, 2024).

Standardization and quality improvement of existing services

Alongside efforts to strengthen formal EMS systems, several LMICs have focused on improving service quality by standardizing clinical and operational practices. Evidence from multiple settings indicates that implementing performance indicators and clinical practice guidelines (CPGs) reinforces consistency in care delivery and strengthens system performance (McCaul et al., 2020; Idris et al., 2025). By reducing unwarranted variation in clinical decision-making and operational processes, standardization contributes to more predictable and reliable care delivery, potentially improving patient safety (Kannan et al., 2020; McCaul et al., 2020).

However, the implementation of standardization and quality improvement (QI) initiatives in LMICs continues to face persistent challenges. Common barriers include limited resources, variable adherence to standard operating procedures, suboptimal communication, and weaknesses in system governance (McCaul, Young and Clarke, 2021; Idris et al., 2025). These constraints suggest that standardization alone is insufficient without the supporting structures required for effective implementation and sustainability. Consistent with the WHO Emergency Prehospital Care Framework, these findings highlight that quality improvement must be approached as a continuous, system-wide process spanning the entire care continuum, from activation and dispatch to patient transport and handover, and supported by robust infrastructure, effective communication systems,

and data-driven performance monitoring (Kannan et al., 2020; Burkholder, Osei-Ampofo and Bonney, 2024).

Implications

Implications for clinical practice:

Strengthening PEC in LMICs requires integrated, context-sensitive approaches rather than isolated interventions. Lay responders, dispatch systems, transport mechanisms, and receiving facilities should be linked through clear protocols, reliable communication pathways, supervision, and referral mechanisms. Digital tools and adaptive transport models should be embedded into routine workflows and aligned with local infrastructure, workforce capacity, geography, and facility readiness.

Implications for health policy:

Effective strengthening of PEC in LMICs depends on policy frameworks that enable system integration and formally recognize the role of lay responders. Clear governance, regulatory support, and cross-sector coordination are essential to sustain adaptive service models in resource-limited contexts.

Implications for future research:

Future research should prioritize evaluating clinical outcomes, including mortality and morbidity, to better assess the effectiveness of layperson-led interventions. Furthermore, research should extend beyond isolated interventions to examine the long-term implementation and system-level effects of integrated strategies across the continuum of care.

Limitation

This review has several limitations. First, the included studies were methodologically heterogeneous, consisting mainly of quasi-experimental, descriptive, qualitative, simulation-based, mixed-methods, and program implementation studies, with no randomized controlled trials identified. As a result, the findings are better interpreted as evidence of implementation feasibility, contextual adaptation, and system-level learning rather than as definitive evidence of effectiveness on mortality, morbidity, or long-term patient outcomes. Second, the included studies were conducted across diverse LMIC contexts, meaning that the strategies identified may not be directly transferable across settings without careful consideration of local infrastructure, workforce capacity, governance, and financing. Finally, although a systematic search strategy was applied, relevant grey literature, policy documents, or locally published reports may not have been captured.

Conclusion

This scoping review identified five complementary system-level strategies to strengthen prehospital emergency care (PEC) in low- and middle-income countries (LMICs): community-based first response through task shifting, digital coordination and dispatch systems, adaptive transport models, formal emergency medical services (EMS) development, and standardization with continuous quality improvement. Collectively, these strategies demonstrate that strengthening PEC in LMICs requires integrated, context-sensitive approaches that address multiple components of the prehospital care continuum rather than isolated technical interventions.

Although the findings were derived from methodologically heterogeneous studies conducted across diverse LMIC settings, they consistently highlight the importance of aligning service delivery models with local health system capacity, available resources, and contextual needs. Policymakers

and health system planners may use these findings to support the development of integrated dispatch systems, structured lay first-responder programs, context-appropriate transport models, and continuous quality improvement initiatives as part of broader PEC system-strengthening efforts. Future research should evaluate the long-term implementation, sustainability, cost-effectiveness, and patient outcomes of integrated system-level strategies to strengthen PEC across diverse resource-limited settings.

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