



## Review Article

Ann Rehabil Med 2023;47(4):237-260  
eISSN: 2234-0653  
<https://doi.org/10.5535/arm.23071>

# Disaster Response and Management: The Integral Role of Rehabilitation

Bhasker Amatya, MD, MPH, DMedSc<sup>1,2,3</sup>, Fary Khan, AM, MBBS, MD, FAFRM (RACP)<sup>1,2,3</sup>

<sup>1</sup>Department of Rehabilitation Medicine, Royal Melbourne Hospital, Parkville, Australia

<sup>2</sup>Department of Medicine (Royal Melbourne Hospital), University of Melbourne, Parkville, Australia

<sup>3</sup>Australian Rehabilitation Research Centre, Royal Melbourne Hospital, Parkville, Australia

**Received:** June 14, 2023

**Accepted:** July 3, 2023

**Correspondence:** Bhasker Amatya  
Department of Rehabilitation Medicine,  
Royal Melbourne Hospital, Royal Park  
Campus, 34–54 Poplar Road, Parkville,  
Victoria 3050, Australia.  
Tel: +61-3-8387-2037  
Fax: +61-3-8387-2222  
E-mail: Bhasker.amatya@mh.org.au

With the increasing frequency of disasters and the significant upsurge of survivors with severe impairments and long-term disabling conditions, there is a greater focus on the importance of rehabilitation in disaster management. During disasters, rehabilitation services confront a greater load due to the influx of victims, management of persons with pre-existing disabilities and chronic conditions, and longer-term care continuum. Despite robust consensus amongst the international disaster response and management community for the rehabilitation-inclusive disaster management process, rehabilitation is still less prioritised. Evidence supports the early involvement of rehabilitation professionals in disaster response and management for minimising mortality and disability, and improving clinical outcomes and participation in disaster survivors. In the last two decades, there have been substantial developments in disaster response/management processes including the World Health Organization Emergency Medical Team (EMT) initiative, which provides a standardized structured plan to provide effective and coordinated care during disasters. However, rehabilitation-inclusive disaster management plans are yet to be developed and/or implemented in many disaster-prone countries. Strong leadership and effective action from national and international bodies are required to strengthen national rehabilitation capacity (services and skilled workforce) and empower international and local EMTs and health services for comprehensive disaster management in future calamities. This narrative review highlights the role of rehabilitation and current developments in disaster rehabilitation; challenges and key future perspectives in this area.

**Keywords:** Disaster, Rehabilitation, Disability, Impairment

## INTRODUCTION

Disaster is a “serious disruption of functioning of a community or a society causing widespread human, material, economic or environmental losses which exceeds the ability of the affected community or society to cope using its own resources” [1]. Disaster can be classified into:

- Natural (e.g., earthquakes, storms)
- Technological or man-made - events caused deliberately by humans (e.g., armed conflicts, terror attacks and other situations of violence) or by human negligence (e.g., industrial or transport accidents)
- Complex humanitarian emergencies - events from several different hazards or a complex combination of both natural

and man-made disasters with different causes (e.g., food insecurity, epidemics/pandemics, displaced populations).

This review will focus on natural disasters which are defined as “*situation or event caused by nature, which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering*” [2]. Natural disasters can be sub-classified into different categories based on their etiology (Table 1) [3].

All types of natural disasters are increasing globally. According to the Centre for Research on the Epidemiology of Disasters (CRED), between 2000 and 2019, 7,348 natural disaster events were recorded worldwide, which has almost doubled since 1998–1999 [4]. This is mainly attributed to a rise in the number

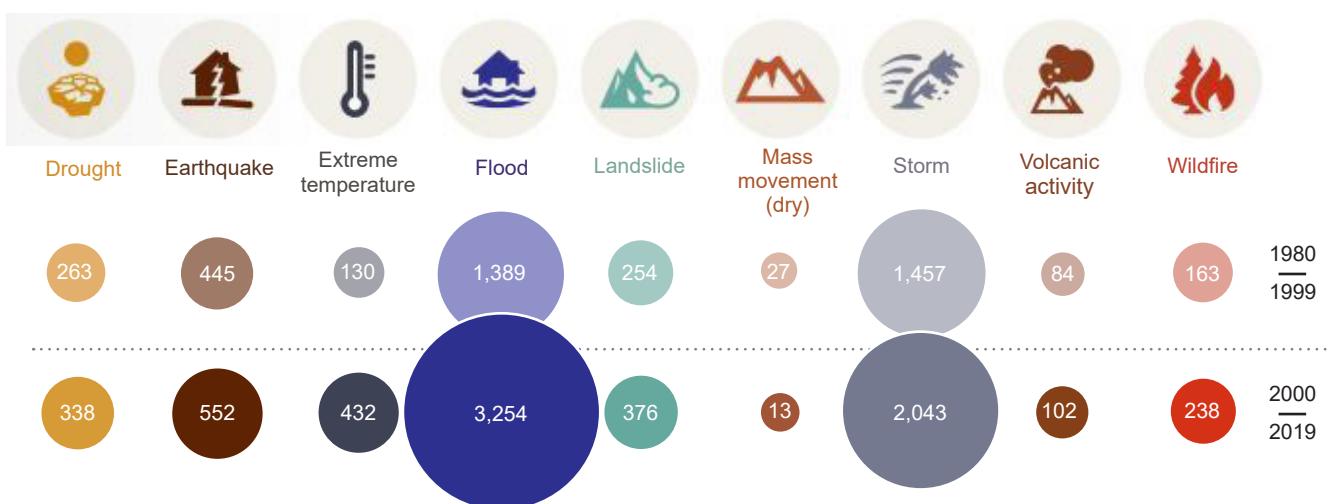
of climate-related disasters (floods, storms, heatwaves, etc.), accounting for over three fourth of the total natural calamities (6,681 climate-related disasters between 2000 and 2019) (Fig. 1) [4]. Floods are the most common type of disaster (accounting for 44% of total events), followed by storms (28%), earthquakes and volcanic activity (9%), extreme weather events (6%), droughts (5%), and wildfires (3%) [4].

Natural disasters occur disproportionately and the majority occur in the low-resourced regions of the world. Asia-Pacific is the most disaster-prone region accounting for over 40% of the world's disasters in the past decade [4,5]. This is largely due to seismic fault lines and landscapes in the region that represent a high risk of natural hazards, such as river basins, flood plains [6]. Between 2000 and 2019, overall, eight of the top 10 countries by disaster events were in Asia, with China experiencing the most

**Table 1.** Classification of natural disasters

Subgroup	Definition	Main type
Geophysical	Events originating from solid earth	Earthquake, volcano, mass movement (dry) (rockfall, landslide, avalanche, subsidence)
Meteorological	Events caused by short-lived/small to meso scale atmospheric processes (spectrum from minutes to days)	Storm (tropical cyclone, extra-tropical cyclone, local storm)
Hydrological	Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up	Flood, mass movement (wet) (rockfall, landslide, avalanche, subsidence)
Climatological	Events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)	Extreme temperature (heat wave, cold wave, extreme weather condition), drought, wildfire (forest fire, land fire)
Biological	Disasters caused by the exposure of living organisms to germs and toxic substances	Epidemic (viral/bacterial/parasite/fungal/prion infectious disease), insect infestation, animal stampede

Adapted from Below et al. Centre for Research on the Epidemiology of Disasters (CRED); Munich Reinsurance Company [3].



**Fig. 1.** Total natural disasters by type 1980–1999 vs. 2000–2019. Source: Centre for Research on the Epidemiology of Disasters (CRED); United Nations Office for Disaster Risk Reduction (UNISDR) (<https://cred.be/sites/default/files/CRED-Disaster-Report-Human-Cost2000-2019.pdf>) [4].

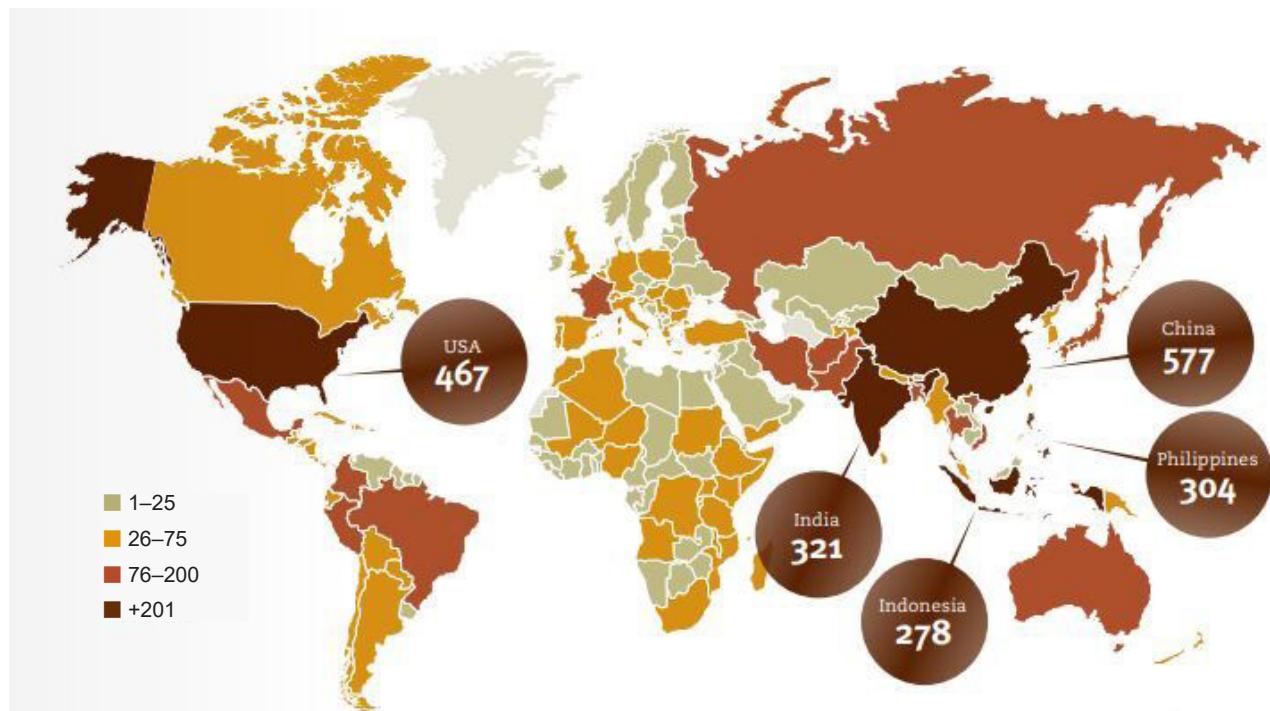
number of events (over 500 events) (Fig. 2) [4]. Further, Pacific Island Countries (PICs) are classified among the world's top 30 most vulnerable nations to natural disasters, with approximately 41 tropical cyclones occurring each year [7].

## IMPACT OF NATURAL DISASTERS

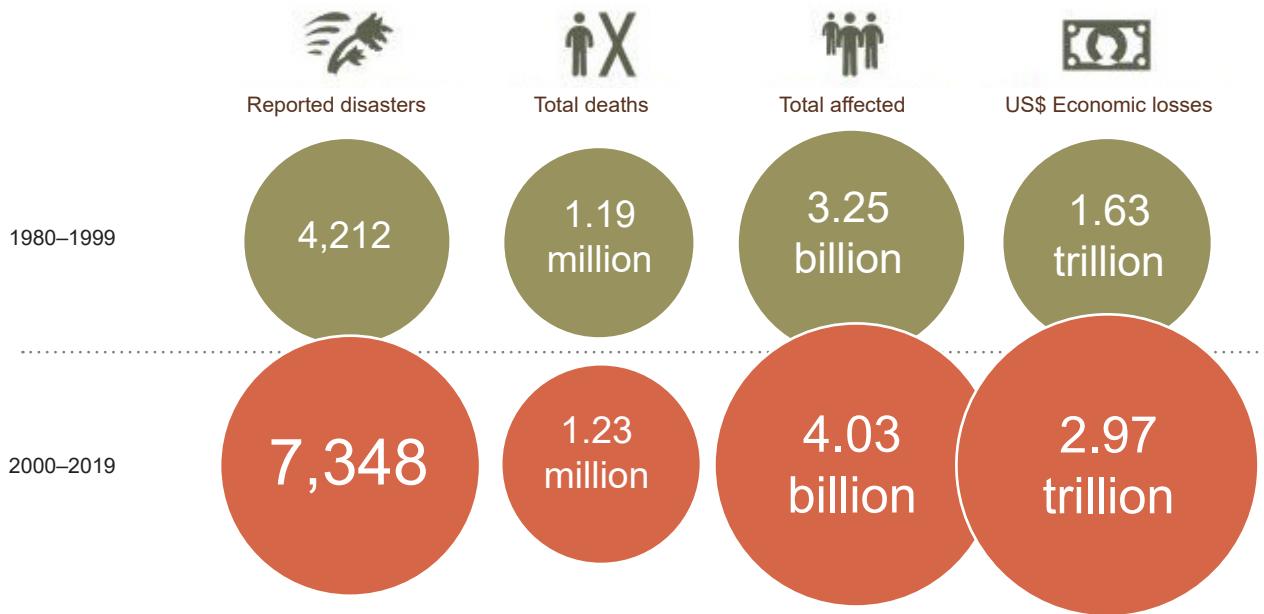
Natural disasters result in significant loss of life and long-term disability from severe injuries. Depending on the nature and scale of disasters, the impacts on population, health, and infrastructure may differ, however, the outcomes to a large extent could be similar [8]. Between 2000 and 2019, the natural disaster claimed approximately 1.23 million lives (an average of 60,000 deaths per annum) and affected over 4 billion people (an average of 200 million per year) [4]. These have led to approximately USD 2.97 trillion in economic losses (almost doubled since 1980–1999) (Fig. 3). In recent years, there is a sustained rise in climate- and weather-related events (floods, storms, heatwaves, wildfires in particular) accounting for 41% of total deaths and over 3.9 billion affected in the period 2000–2019 [4]. Geophysical disasters (earthquakes including tsunamis) are

associated with the highest impact on the human toll among all other types of disasters put together (accounting for 59% of all disaster-related deaths) [4]. In 2022 alone, 387 natural disasters worldwide killed over 30,700 people, affecting 185 million others and costing above USD 223.8 billion [9]. Fig. 3 shows the human impact of disasters comparing 1980–1999 with two decades ahead (2000–2019).

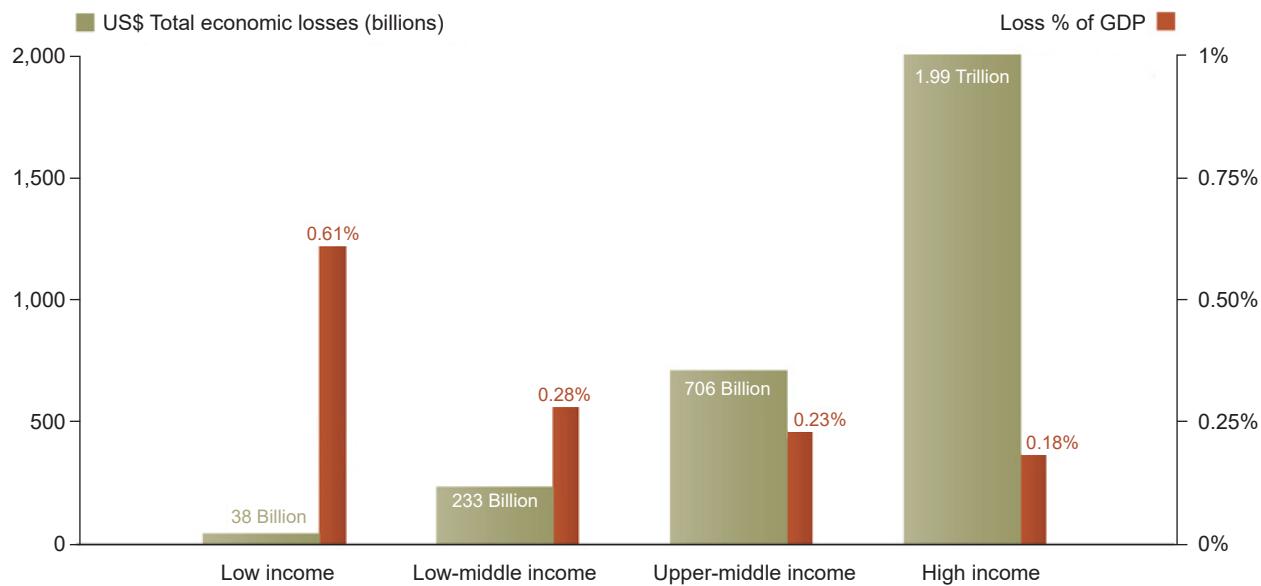
High-income countries experienced more disasters compared to low-income countries, and tend to have the most total economic losses. However, these countries have lower numbers of people affected and killed by disaster events, relatively due to better risk governance, infrastructure, surveillance systems, and reduced exposure to natural hazards. Low-income countries account for 23% of total disaster deaths and the highest average number of deaths per disaster event (284 per event) [4]. This is accompanied by a significant proportionate economic loss and long-term negative consequences on human development in these countries (3 times higher gross domestic product [GDP] losses compare to high-income countries) (Fig. 4) [4]. For example, PICs bear, combined disaster damages of more than USD 280 million on average every year, costing some countries



**Fig. 2.** Total number of disasters reported per country/territory (2000–2019). Source: Centre for Research on the Epidemiology of Disasters (CRED); United Nations Office for Disaster Risk Reduction (UNISDR) (<https://cred.be/sites/default/files/CRED-Disaster-Report-Human-Cost2000-2019.pdf>) [4].



**Fig. 3.** Impact of natural disaster between 1980–1999 vs. 2000–2019. Source: Centre for Research on the Epidemiology of Disasters (CRED); United Nations Office for Disaster Risk Reduction (UNISDR) (<https://cred.be/sites/default/files/CRED-Disaster-Report-Human-Cost2000-2019.pdf>) [4].



**Fig. 4.** Economic losses in absolute value (USD) compared to losses as a percentage of gross domestic product (GDP) by World Health Organization income group (2020). Source: Centre for Research on the Epidemiology of Disasters (CRED); United Nations Office for Disaster Risk Reduction (UNISDR) (<https://cred.be/sites/default/files/CRED-Disaster-Report-Human-Cost2000-2019.pdf>) [4].

up to 6.6% of their GDP [10]. The total value of economic damage and losses caused by the 2010 Haiti earthquake was estimated at USD 7.8 billion, surpassing the country's GDP in 2009, which could delay the country's economic development by 10 years [11]. Further, there was a substantial impact on health services with 30 out of 49 hospitals damaged or destroyed during this event [11].

## REHABILITATION NEEDS IN DISASTER SETTINGS

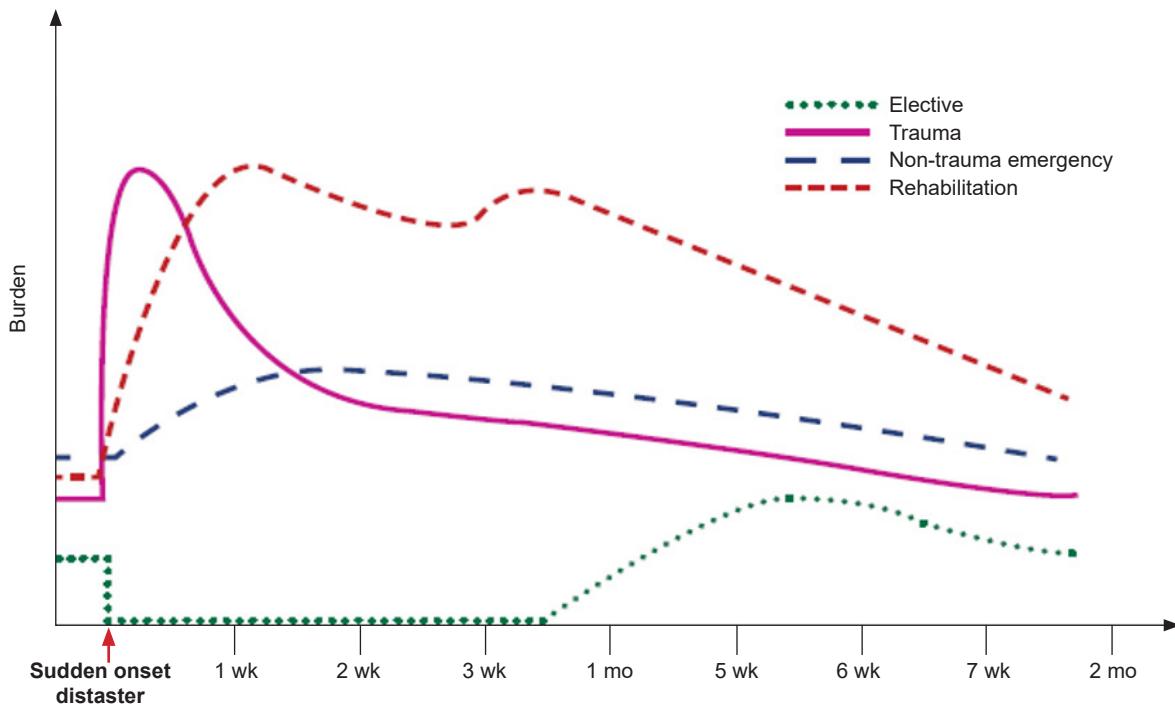
Despite saving lives immediately following disasters being an urgent priority, current advances in disaster response and management, have resulted in a significant increase in survivors compared to mortality. This includes an upsurge in survivors with complex impairments and disability (temporary or permanent) from common injuries, such as musculoskeletal (bone fractures, limb amputations, crush injuries), spinal cord and/or traumatic brain injury, soft tissue and peripheral nerve injury, burns, etc. [12]. Overall injury patterns are poorly studied in natural disasters, and the type and severity of injuries vary according to various factors including the type of disasters and geological factors (disaster magnitude and intensity, epicentral distance, etc.), human/individual factors (demographics, physical location, and capabilities, behavior, etc.), and built environment (quality of building and infrastructure, population density, etc.) [13]. The most common type of injuries specifically in earthquakes, which contributes to the highest disaster-related mortality and morbidities, were reported to be orthopedic (87%), with lower extremities fractures being most prevalent (42%) [14,15]. Further, there is a substantial increase in the number of victims with exacerbation of non-communicable diseases (NCDs) (e.g., cardiovascular disease, cancer, chronic respiratory diseases, diabetes, etc.), psychological impairment (such as post-traumatic stress disorder [PTSD], depression, and other mental disorders) [16,17]. The common barriers reported to healthcare access during disasters included: limited and/or disrupted healthcare services, centralized healthcare infrastructure (mostly located in the metropolitan area), financial difficulties, access to transport, affordability of treatment and devices, displacement, and illiteracy [16]. Huang et al. [18] exploring the association of ischemic heart disease (IHD) with natural disasters in 193 countries reported an independent association between the IHD mortality rate (2.3 deaths per 100,000 population) and years of life lost (YLL, 31.1 years per 100,000), and

occurrence of natural disasters ( $p<0.05$  for both). Further, those with pre-existing disabilities are at risk of higher mortality rates and additional co-morbidities/ impairments, especially those with mobility impairments [12]. These signify the important role of medical rehabilitation in the comprehensive disaster management plan.

The critical importance of rehabilitation during and after a natural disaster for the survivors is well-documented and the World Health Organization (WHO) recognizes that "*rehabilitation is one of the core functions of trauma care systems in regular health care and, as such, Emergency Medical Team (EMT) should have specific plans for the provision of rehabilitation services to their patients post sudden onset disaster*" [19,20]. The rehabilitation need and demand can have different patterns in emergencies, and may also differ over time [20]. However, based on clinical needs rehabilitation is required at all stages of the disaster management cycle: in the initial acute stage when there is the influx of trauma and non-trauma emergencies; in the post-acute period as complications arise and patients are prepared for discharge; and in the long-term in the community for those with complex, and permanent disabilities [20-22]. Demand for rehabilitation can peak in the first 3 weeks post-disaster and can increase over time, as triaging and discharge of patients (even those who are medically stable) can be problematic, due to the destruction or damage of their homes and livelihood. Further, demand for outpatient and community rehabilitation can spike post-disaster with added care requirements of persons with pre-existing disabilities and chronic conditions, creating additional service needs [20]. Thus, these indicate that rehabilitation services confront the greatest care burden during disasters. Fig. 5 indicates trends in the rehabilitation burden in disasters [21].

## ROLE OF REHABILITATION PROFESSIONALS IN DISASTERS

The global health authorities emphasize that medical rehabilitation should be initiated acutely during the emergency disaster response and should be continued in the community over a longer-term [22-24]. The WHO World Report on Disability accentuates that "*rehabilitation services are essential services to be provided by foreign aid for humanitarian crises*" (p. 108) [25]. The "Sphere Project," in its handbook "*Humanitarian Charter and Minimum Standards in Humanitarian Response*," further reinforces the importance of rehabilitation and states that surgery provided during a humanitarian crisis without any immediate

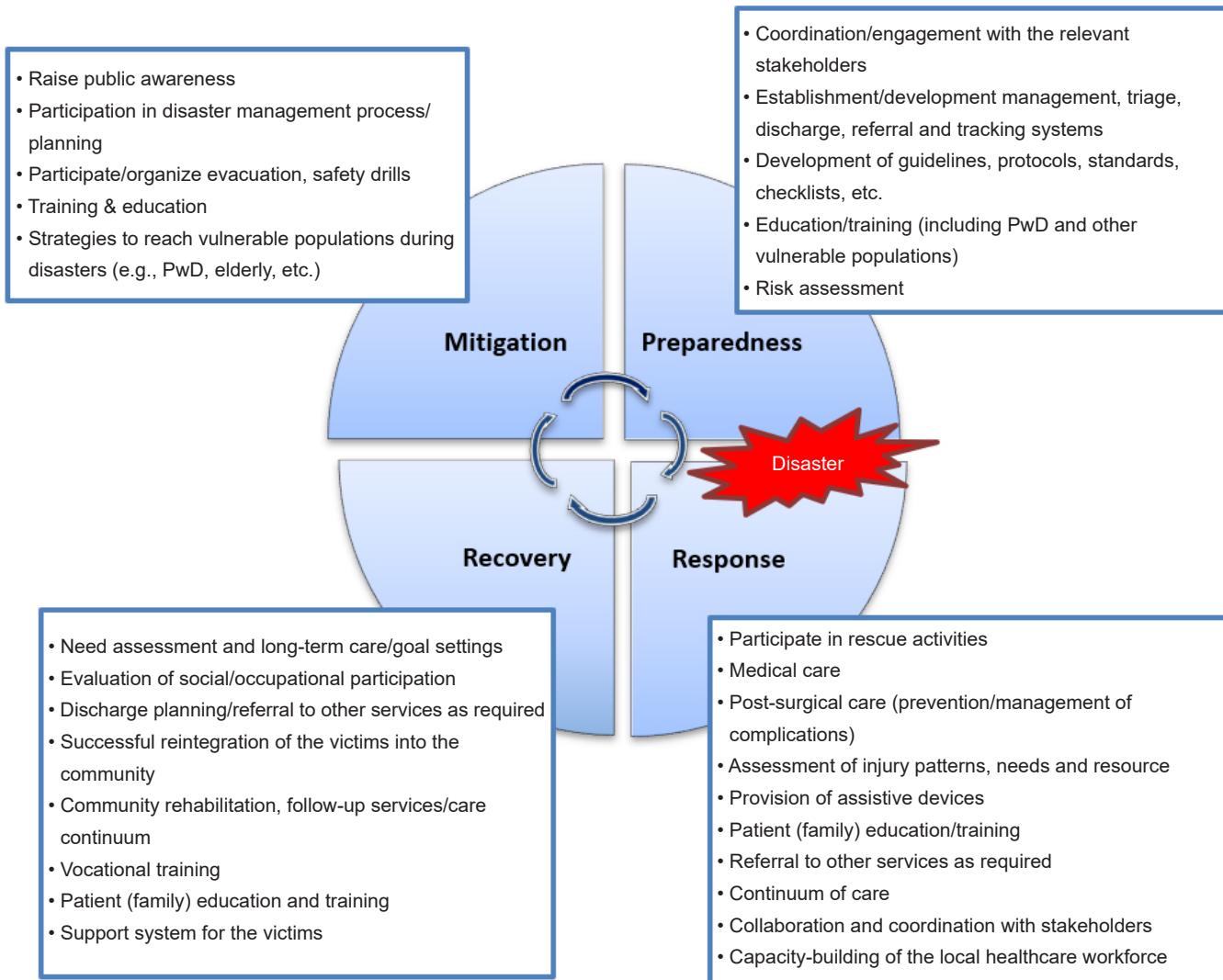


**Fig. 5.** Trends in the rehabilitation burden in sudden-onset disasters. Adapted from World Health Organization (Emergency medical teams:minimum technical standards and recommendations for rehabilitation; 2016) [20].

rehabilitation can result in poorer patient outcomes [26]. This implies that rehabilitation service is required at all phases of the disaster management continuum, which comprises mitigation/prevention, preparation, response, and recovery phases [22,23,27]. It presents holistic patient-centered care for disaster victims delivered by an interdisciplinary team (medical, nurses, and allied health professionals) developed within available resources, to optimize function, improve activity and participation within contextual factors (personal and environmental) [28]. The role of rehabilitation professionals can be complex and requires a multi-faceted mix of skills and training in disaster continuum phases, including diagnostic, clinical management, educational and advocacy capabilities [23,29]. At times rehabilitation professionals will be required to stretch beyond the roles they are trained for to meet the complex needs of the overwhelming number of disaster victims. Some of the potential roles of rehabilitation personnel in the disaster management cycle are listed in Fig. 6.

The number of international and local EMTs from governmental or non-governmental sources deployed to the disasters are steadily increasing. In many past disasters, deployment of

EMTs was not solely based on the assessed needs of the affected state, and wide variations in their capacities, competencies and adherence to professional ethics can be noted [30]. For example, during the 2010 Haiti earthquake, the international humanitarian response was catastrophic, with the influx of a large number of unregistered EMTs who were unfamiliar with the international emergency response systems and standards, or coordination mechanisms [11]. The WHO EMT initiative now sets the core standards and guidance for EMTs within defined coordination mechanisms in this area [20]. Various guidelines and protocols have been developed including rehabilitation guidelines during disasters, launched in 2016. It provides minimum standards/requirements for all EMTs during deployments to disasters, regarding workforce, field hospital environment, rehabilitation equipment/consumables and information management (Appendix 1-3) [20]. It is recommended that the EMT needs to establish an action plan in consultation with the WHO EMT secretariat, local healthcare authorities, International Society of Physical and Rehabilitation Medicine (ISPRM), and appropriate experts [31]. The following important themes are required for consideration:



**Fig. 6.** Potential role of rehabilitation personnel in the disaster management cycle. PwD, persons with disabilities.

- Analysis: study the situation, risk assessments, requirements, etc.
- Objectives: set up key objectives, roles, and responsibilities
- Planning: team configurations, resources (finance, equipment), transportation, accommodation, logistics
- Execution: medical care, response, and management to achieve objectives
- Communication: briefing, reports, support activity, consultation
- Safety: patient and healthcare personal safety
- Transition: handover, care continuum of victims, local capacity building, foster partnership

- Research: evaluation, data collection, and dissemination, identify gaps/challenges, knowledge/information sharing

## EVIDENCE OF REHABILITATION INTERVENTIONS IN DISASTER SETTINGS

Table 2 provides a summary of published studies evaluating various rehabilitation interventions in disaster settings. Early involvement in rehabilitation can result in better clinical outcomes, and improve participation and quality of life (QoL) of disaster victims [6,29,32,33]. Evidence from past disasters

**Table 2.** Summary of studies evaluating rehabilitation interventions in disaster settings

References	Study type	Interventions	Key findings	Conclusion
Hospital-based rehabilitation program				
Xiao et al. 2011 [40], China Disaster: 2008 Sichuan earthquake	Case series N=174 survivors with tibial shaft fractures	Institution-based rehabilitation interventions delivered by PT	•Functional recovery was positively associated with rehabilitation intervention (OR, 5.3; 95% CI, 2.38–11.67), but negatively correlated with immobilization duration (OR, 0.87; 95% CI, 0.738–0.947), age (OR [per 10 yr increase], 0.54; 95% CI, 0.418–0.707) & depressive symptomatology (OR, 0.21; 95% CI, 0.063–0.716)	Rehabilitation was associated with functional recovery of post-earthquake survivors with fractures
Zhang et al. 2012 [42], China	Cross-sectional quasi-experimental study N=390 survivors with fractures	Institution-based rehabilitation (details not provided)	•Significant improvement in ADLs and life satisfaction (p<0.05) •HRQoL improved higher in early intervention subjects compared with controls (p=0.008) •Good performance of ADL (p<0.001) and widowed marital status (p=0.032) predicted high HRQoL, while pain was associated with worse outcomes (p<0.001) •Rehabilitation therapy, remunerative employment & female gender were predictors of improved life satisfaction	Rehabilitation (early and late) significantly improved functional outcomes, HRQoL, and life satisfaction in earthquake fracture victims
Hu et al. 2012 [35], China Disaster: 2008 Sichuan earthquake	Prospective cohort study N=26 (SCI survivors)	Institution-based rehabilitation therapy (details not provided)	•Significant improvement in functional status (ADLs, mobility, walking) •Decrease in pain and depressive symptoms •Significant improvement in QoL in the community (p=0.011), self-ratings of QoL (p<0.001), general health (p<0.001), and satisfaction with social relationships (p=0.017) •Improvement in physical health and psychological health improved (not statistically significant)	Significant improvements in: functional status, QoL, general health, satisfaction with social relationships & some areas of community integration (physical independence, mobility)
Li et al. 2012 [32], China Disaster: 2008 Sichuan earthquake	Prospective cohort study N=51 (SCI survivors)	Individualized rehabilitation program provided by MD rehabilitation team (physician, allied health therapist (PT, OT, traditional modalities), nurses, volunteers & other medical specialists)	•Thirty-five percent patients achieved moderate ADLs independence and 90.2% regained self-care ability •Rehabilitation program was the strongest predictor of a significant increase in functional scores •Earlier rescue and rehabilitation were significant positive predictors of rehabilitation effectiveness	Significantly improved functional rehabilitation outcomes with organized programs
Ni et al. 2013 [39], China Disaster: 2008 Sichuan earthquake	Retrospective cohort study N=450 survivors with fractures	Institution-based comprehensive rehabilitation program (therapeutic interventions, training/education, and vocational and social rehabilitation (details not provided))	•Significant improvement in physical dysfunction (p<0.001) •Significant improvement in PTSD symptoms (p<0.05) •Females, average or above family income, having witnessed death and fearfulness were risk factors for PTSD symptoms, 50 mo after the earthquake	Physical dysfunction and PTSD were significantly reduced by rehabilitation intervention

(Continued to the next page)

**Table 2.** Continued

References	Study type	Interventions	Key findings	Conclusion
Li et al. 2015 [37], China Disaster: 2008 Sichuan earthquake	Prospective cohort study N=72 amputees	Institution-based rehabilitation to prevent joint contracture, desensitization, shaping of the residual limbs, joint mobilization, muscle strength training, PT, OT & psychotherapy	<ul style="list-style-type: none"> <li>•Significant improvement in physical functioning (p=0.016) and decrease in pain scores (p&lt;0.001)</li> <li>•No significant changes in QoL and life satisfaction subscales</li> <li>•Higher rates of literacy associated with better physical and mental health status</li> <li>•Higher age associated with decreased satisfaction with leisure activities &amp; relationships</li> </ul>	Significant improvement in functioning and pain over time, however, no change in QoL & life satisfaction
Wu et al 2019 [49], Taiwan Disaster: 2015 Dust explosion disaster, Formosa Fun Coast	Prospective observational study N=16 hand burn victims; 8 participants in both groups	LMC (virtual reality) video games 20 min after 40 min traditional OT Control group: traditional OT for 60 min 2 day/wk for 4 mo	<ul style="list-style-type: none"> <li>•Significant improvements in hand function in the LMC group (p&lt;0.05) compared to control group</li> <li>•In LMC-trained hand, thumb IP joint ROM &amp; pinch strength increased, whereas the scar thickness over first dorsal interossei muscle decreased (p&lt;0.05)</li> </ul>	Leap motion training could help patients with hand burns to increase finger ROM, decrease scar thickness, and improve hand function
Zhang et al. 2013 [43], China Disaster: 2008 Sichuan earthquake	Mixed (hospital-and community-based) rehabilitation model China Longitudinal quasi-experimental study (3-arm); N=510 Early intervention group (NHV-E); 298; late intervention group (NHV-L); 101; control group: 111	NHV rehabilitation program - institutional-based rehabilitation followed by CBR comprised of: NGOs (N), local health departments (H), professional volunteers (V)	<ul style="list-style-type: none"> <li>•Significant improvement in physical functioning (Barthel Index) in the both NHV-E and NHV-L intervention groups but not in the control group (11.14 points; 95% CI, 9.0–13.3)</li> <li>•Significant effects on spontaneous recovery (5.03 points; 95% CI, 1.73–8.34)</li> <li>•Effect of NHV-E (11.3 points; 95% CI, 9.0–13.7) was marginally greater than that of NHV-L (10.7 points; 95% CI, 7.9–13.6)</li> </ul>	Significantly improved physical functioning of earthquake survivors
Li et al. 2019 [38], China Disaster: 2008 Sichuan earthquake	Cross-sectional study N=17 bilateral limb amputees	MD rehabilitation program – StandTall (exercise and education)	<ul style="list-style-type: none"> <li>•Subjects with bilateral through-knee or transtibial amputations had less activity restriction (p&lt;0.01) &amp; higher mobility (p=0.03)</li> <li>•Subjects using prostheses &gt;50% of waking time had better general adjustment (p=0.02) &amp; less functional restriction (p=0.01)</li> <li>•StandTall program were associated with higher mobility (p=0.06) &amp; mental quality of life (p=0.09)</li> </ul>	MD rehabilitation program (Stand-Tall) was associated with positive functional and psychological outcomes in disaster survivors with complex needs (bilateral knee amputees)
Becker 2009 [44], India Disaster: 2004 tsunami	Prospective cohort study N=200	Community-based psychological program (group sessions)	<ul style="list-style-type: none"> <li>•Significant improvement in psychosocial symptoms IES scores: total (p&lt;0.001) &amp; avoidance (p&lt;0.001) (p&lt;0.001), hypervigilance (p&lt;0.001)</li> </ul>	Effective in reducing emotional distress for women tsunami survivors
Berger and Gelkopf 2009 [45], Sri Lanka Disaster: 2004 tsunami	Quasi-RCT with wait-list controls N=166 elementary school students	School-based mental health program	<ul style="list-style-type: none"> <li>•Significant improvement in PTSD severity in psychosocial symptoms (p&lt;0.001), functional problems (p&lt;0.001), somatic complaints (p&lt;0.001), depression (p&lt;0.001), and hope (p≤0.001) scores</li> </ul>	Helpful in mitigating post-disaster-related symptoms in children, and those with more severe symptoms benefited most

(Continued to the next page)

**Table 2.** Continued

References	Study type	Interventions	Key findings	Conclusion
Zang et al. 2013 [41], China Disaster: 2008 Sichuan earthquake	RCT with wait-list controls N=22	NET	•Significant reductions in PTSD symptoms: avoidance, intrusion & hyper-arousal subscales (p<0.001 for all); anxiety & depression (p<0.001), general mental stress (p<0.0001) & increased posttraumatic growth (p<0.001)	Significant positive effect on psychological symptoms & general mental health
Jiang et al. 2014 [36], China Disaster: 2008 Sichuan earthquake	RCT with usual care controls N=49, intervention group: 27	12 weekly sessions of IPT, 1 h for 12 wk	•At 3 mo, compared to control group significant reduction IPT is a promising treatment for in the IPT group: PTSD (3.4% vs. 51.9%), major depressive diagnoses (3.4% vs. 30.1%) •Treatment gains were maintained at 6 mo for the IPT group	Effective in alleviating disaster survivors' feelings of distress & depression, & improves their psychosocial well-being and recovery
Huang and Wong 2013 [47], China Disaster: 2008 Wenchuan earthquake	Before and after qualitative study	Recreational activity groups N=24	•Participants' social networks broadened and strengthened •Participant recognised the importance of mutual understanding and developed a sense of cooperation •After participating in group activities, most women felt life was more meaningful or happy •Participants' health improved	Effective in alleviating disaster survivors' feelings of distress & depression, & improves their psychosocial well-being and recovery
Tsuji et al. 2017 [17], Japan Disaster: Great East Japan Earthquake/tsunami 2011	Prospective observational study	Group exercise and regular walking N=3,567 older survivors	At 3 yr post-disaster: •Depressive symptoms slightly improved, mean change in GDS score increased by 0.1 point (95% CI, -0.003 to 0.207) •Frequency of group exercise participation & daily walking time increased by 1.9 day/yr & 1.3 min/day, respectively •After adjusting for all covariates, including personal experiences of disaster, increases in the frequency of group exercise participation (p=0.003) & daily walking time (p=0.054) were associated with lower GDS scores	Participation in group exercises or regular walking may mitigate the worsening of depressive symptoms
Alkyama et al. 2018 [46], Philippines Disaster: 2013 Typhoon Haiyan	Quasi-experimental trial	N=293 students from 3 schools, including 1 intervention school (n=51 students)	MAC: a coaching education program on sports activities •MAC intervention showed a significant change in self-esteem, with the mean score increasing from 20.2 to 21.1 (p=0.02) •Neither school in the control group showed a significant change	Results showed the feasibility and a positive effect of sports activity with the MAC post-disaster

(Continued to the next page)

**Table 2.** Continued

References	Study type	Interventions	Key findings	Conclusion
Kuroda et al. 2018 [48], Japan Disaster: Great East Japan Earthquake/tsunami 2011	Prospective cohort study N=115; exercise class group: 159 usual care control group: 1,000	Group exercises (1 h twice a month for 1 yr)	<ul style="list-style-type: none"> <li>• 4-yr post-disaster incident functional disability reported in 24.2% (280 cases); 196 (70%) mild, 84 (30%) severe</li> <li>• Participants who scored negative compared to those who scored positive in BCL: for the "Physical function" domain HR=2.04 (95% CI, 1.54–2.69) for incident functional disability; for "Cognitive function" HR=1.37 (95% CI, 1.06–1.77); for "Depression" HR=1.60 (95% CI, 1.24–2.08)</li> <li>• Both low- and high-participation exercise groups had a significantly lower rate of incident functional disability compared to non-participating group (HR=0.27, 95% CI, 0.16–0.46; HR=0.30, 95% CI, 0.12–0.74, respectively)</li> </ul>	Pre-disaster BCL domains were useful to identify individuals at risk of functional disability Group exercise therapy showed a significant reduction in incident functional disability
Fahmida et al. 2022 [50], Indonesia Disaster: 2018 East Lombok earthquake	Quasi-experimental trial (N=480 children <5 years old) Intervention group (n=240); usual service control group (n=240)	Community-based comprehensive nutrition rehabilitation, based on the holistic integrated early child development concept	<ul style="list-style-type: none"> <li>• Significant reduction in depression in mothers in the intervention group (6.1% vs. 43% post-intervention, p&lt;0.001); no change in control group (43% vs. 40%, p=0.272)</li> <li>• Child morbidity (cough) lower and dietary diversity (+1) in 6–23-month-old children, &amp; weight-for-age Z-score (+0.26) &amp; social-emotional score (+10 points) in 24-month-old children were higher in intervention group</li> </ul>	Nutrition rehabilitation intervention has a positive effect on the growth & development of children

N, total number; PT, physiotherapists; OR, odd ratio; 95% CI, 95% confidence interval; ADL, activity of daily living; HRQoL, health-related quality of life; SCI, spinal cord injury; QoL, quality of life; MD, multidisciplinary; OT, occupational therapist; PTSD, post-traumatic stress disorder; LMC, leap motion control; IP, interphalangeal; ROM, range of motion; CBR, community-based rehabilitation; NGO, nongovernmental organization; IES, Impact of Event Scale; RCT, randomized controlled trial; NET, narrative exposure therapy; IPT, interpersonal psychotherapy; GDS, Geriatric Depression Scale; MAC, Mastery Approach to Coaching; BCL, Basic Checklist; HR, hazard ratio.

suggests that victims treated in centers with rehabilitation physician supervision had a reduced length of hospital stay, fewer complications and better clinical outcomes compared with patients without such provision [33,34].

**Box 1.** Summary of the desk review of the evidence of rehabilitation interventions in disaster settings

A rapid desktop review was conducted to update the evidence from our previous review published in 2015 [23] evaluating the effectiveness of medical rehabilitation intervention in natural disaster survivors. This comprehensive review included 10 studies (2 randomized controlled trials [RCTs] and 8 observational studies) that investigated a variety of medical rehabilitation interventions for natural disaster survivors, ranging from comprehensive multidisciplinary rehabilitation to community educational programs. This review highlighted the lack of high-quality evidence to support rehabilitation interventions used for disaster survivors. The gaps identified in the literature included the types of rehabilitation settings, modalities and duration of therapy, lack of effective care pathways, and long-term functional outcomes. A similar multipronged approach was used to search the literature (peer review, grey literature from the date of the last search date till May 2023) including search of the peer-review literature using medical and health science electronic databases (MEDLINE, PubMed, Embase, Cumulative Index to Nursing and Allied Health Literature, PsycINFO, Cochrane Library); manual search of bibliographies of relevant articles and journals; and search of grey literature using relevant Internet search engines and websites of prominent health care institutions, governmental and nongovernmental organizations associated with disaster management and rehabilitation.

The combined searches retrieved a total additional 260 published titles and abstracts. Twelve abstracts met preliminary inclusion criteria, and the full texts of these articles were assessed. In addition to the 10 articles included in our previous review [23], a further 8 articles (1 RCT, 2 controlled clinical trials, and 5 observational studies) which reported medical rehabilitation interventions after natural disasters were included (Table 2).

The published literature indicates that a wide variety of medical rehabilitation modalities are trialed in natural disaster survivors both in hospital and community settings. The evaluated interventions were heterogeneous (type, duration and mode of delivery) and specifically included, comprehensive multidisciplinary rehabilitation, physical modalities, psychological programs, community programs, and others. The majority included physical activity and psychosocial intervention as rehabilitation components. The study population group also differed in many facets.

The findings suggest that despite the lack of high-quality evidence for the effectiveness of many of the evaluated rehabilitation interventions, there is distinct evidence for the beneficial effect of medical rehabilitation for survivors of natural disasters in producing short and long-term gains for functional activities (activities of daily living, physical activity, etc.), impairments (e.g., psychological symptoms), and participation (QoL, social reintegration) [6,32,33]. Institution-based and community rehabilitation interventions provided by the multidisciplinary team to 2008 Sichuan earthquake victims in China were associated with significant improvement in functional outcomes, decrease symptoms and improved health-related QoL [32,35-43]. The rehabilitation interventions were the strongest predictor of increased and sustained functional gains and improved QoL in these patients [32]. Further, other studies demonstrated the beneficial effect of hospital-based and/or community-based rehabilitation programs in improving psychological issues such as anxiety, PTSD symptoms, distress and depression [17,36,39,41,44,45]. Zhang et al. [43] evaluated a long-term structured and coordinated rehabilitation services model that provided both comprehensive hospital and community-based rehabilitation, comprising nongovernmental organizations (NGOs), local health departments (H) and volunteers (V) for earthquake survivors in China. The findings suggest that the NHV comprehensive rehabilitation program benefitted the individual and society with significant improvement in long-term physical functioning [43]. Another study showed psychological rehabilitation intervention (structured in-community psychological care) significantly improved psychosocial symptoms (PTSD, depression, stress, etc.) in post-tsunami victims [44]. Group and social activities post-disaster were found to enhance victims' societal participation and improve psychosocial well-being [17,46-48]. Wu et al. [49] demonstrated that modern technological intervention (virtual reality videogames) adjunct to traditional occupational therapy interventions can

have better improvement in function, scar management, and hand function in patients with severe hand burns. In another study, Fahmida et al. [50] showed that integrated community-based nutrition rehabilitation intervention can have benefits in reducing maternal stress, child morbidity and in improving the growth and development of children in post-disaster conditions. However, there was no evidence for the best type mode/intensity (frequency, duration) of these interventions or the superiority of one intervention over another. There is a limited number of robust studies in this area, which reflects various ethical, methodological and logistical challenges in conducting research in disaster situations.

## CURRENT DEVELOPMENTS

Since the catastrophic disaster management process during the 2010 Haiti earthquake, there was a strong consensus amongst the international medical and humanitarian communities for a stringent approach to emergency response in future disasters in terms of governance, coordination, organisation, evaluation, professionalism and accountability. In the last decade, there have been many much-needed developments in disaster response and management (including rehabilitation) in international, regional and national collaboration and management capacities. The WHO's EMT initiative is fundamental in this area to improve the timeliness and quality of health services provided by EMTs and enhance the capacity of national health systems in leading the activation and coordination of rapid response capacities aftermath of a disaster, outbreak and/or other emergencies. It adopts a rigorous and systematic approach to EMT registration, deployment, and response. It has set out benchmark requirements and standards for all EMTs and classifies all medical teams according to their capability into 4 main types (Appendix 1) [19]. The WHO-EMT initiative highlights that rehabilitation is one of the core components of regular health care and, as such, all EMTs (both national and international) should have specific and coordinated medical response plans for the provision of rehabilitation services to their patients [20]. Minimum technical standards and recommendations for rehabilitation for EMTs are published in collaboration with the ISPRM, and global rehabilitation experts (Appendix 2) [20]. It is a mandatory requirement that all EMTs, including specialized care teams comply and adhere to these principles and standards. The efficacious coordination, leadership and governance role of the EMT initiative was demonstrated in various natural

disasters such as the 2013 typhoon Haiyan in the Philippines, the 2015 tropical cyclone Pam in the Pacific region, 2015 Nepal earthquakes, and others [30,51]. A comprehensive registration system for all EMTs was initiated (since July 2015), which enables the establishment of a global EMT registry for future deployment (Appendix 3) [19]. To date, 37 acute medical/surgical teams (Type 1: 21, Type 2: 12, Type 3: 2 and 1 Specialized cell) from different parts of the world have progressed to full verification and many more teams have commenced the mentorship and quality assurance process. However, currently, any rehabilitation specialized cell is yet to be verified. Further various reports and guidelines, including specific clinical practice guidelines from different sources, are now published [52-54] and e-learning [55] professional development courses in disaster management are being developed (<https://www.disasterready.org/>).

Some of the key global initiatives related to disaster rehabilitation are summarised in Table 3 [20,26,51,56-67].

## CHALLENGES AND FUTURE PERSPECTIVES

Despite all aforementioned developments and significant improvements in emergency response and care, in many previous disasters rehabilitation services are less prioritised [12]. Further, many vulnerable cohorts, such as persons with disabilities and/or with pre-existing NCDs, etc., are often overlooked throughout the disaster management cycle. The United Nations Office for Disaster Risk Reduction (UNDRR) estimates that 71% of persons with disabilities do not have an individual preparedness plan for disasters and almost 85% have not participated in community disaster management and risk reduction processes in their communities [68]. Regrettably, significant disparities and gaps still exist among the countries, with those with high disaster risk having a low-coping capacity and scarce resources (infrastructure, skilled workforce, etc.) to address the challenges of the increasing frequency of disasters and their impact [6]. In many disaster-prone countries, rehabilitation-inclusive disaster management plans are absent and rehabilitation services are generally inadequate or underdeveloped [6,7,69]. For example, the density of skilled rehabilitation professionals in many low- and middle-income countries (LMICs) is estimated to be 10 per 1 million population [70] and the unmet need is across many specialized rehabilitation services such as rehabilitation medicine, physiotherapy, occupational therapy, prosthetics and orthotics, and others [70]. There are also contrasts and imbalanc-

**Table 3.** Key global disaster rehabilitation-related initiatives

Initiative/strategy	Key features	Comments
Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, UNDRR 2005 [56]	<ul style="list-style-type: none"> <li>Comprehensive global blueprint for disaster risk reduction adopted by 168 UN member states at the World Conference on Disaster Risk Reduction in Kobe, Japan, in 2005</li> <li>Key 5 priorities for action <ul style="list-style-type: none"> <li>- Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation</li> <li>- Identify, assess and monitor disaster risks and enhance early warning</li> <li>- Use knowledge, innovation and education to build a culture of safety and resilience at all levels</li> <li>- Reduce the underlying risk factors</li> <li>- Strengthen disaster preparedness for effective response at all levels</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Voluntary and non-binding</li> <li>• Embraced by central and local governments, the private sector and civil society groups</li> <li>• In 2015, Hyogo Framework focal points in 191 countries and 85 platforms for disaster risk reduction, and 141 countries have carried out at least one review of their efforts to implement this Framework for action</li> </ul>
GFDRR, 2006 [57]	<ul style="list-style-type: none"> <li>Key initiative to assist developing countries, reduce their vulnerability to natural hazards, with a global partnership of over 45 countries and international organisations</li> <li>Conducts post-disaster needs assessments and support in recovery and reconstruction, to reduce costs</li> <li>Implements programs in partnership with national, regional, and other international agencies, in accordance with the SFDRR, the Paris Agreement on Climate Change, and the UN SDGs</li> </ul>	<ul style="list-style-type: none"> <li>• Include rehabilitation and reconstruction, aligns with the SFDRR priorities and disaster-risk management activities</li> <li>• No details of programs focused on building capacity in rehabilitation medicine</li> </ul>
EMT Initiative, WHO 2016 [51]	<ul style="list-style-type: none"> <li>Provides coordination of national &amp; international disaster responders</li> <li>Provides flexible mechanisms for registration &amp; accreditation of rapid-response EMTs</li> <li>Published guidelines for EMTs: "Classification and Minimum Standards for EMTs" (Updated 2021)</li> <li>Sets minimum standards required for all EMTs by classifying teams according to their capability</li> <li>Acknowledges rehabilitation as an integral aspect of medical response &amp; patient-centred care in disaster settings</li> </ul>	<ul style="list-style-type: none"> <li>• Categorised EMTs into 4 types</li> <li>• Registration system (2015) to enable the establishment of a global registry of EMTs to improve the quality of medical team response in disasters</li> <li>• Demonstrates a systematic organized approach for the deployment of EMTs in disasters</li> </ul>
SFDRR 2015-2030, UNDRR 2015 [58]	<ul style="list-style-type: none"> <li>Successor instrument to the Hyogo Framework and introduces innovations and emphasises on disaster risk management as opposed to disaster-management</li> <li>Key 4 priorities for action: <ul style="list-style-type: none"> <li>-Understanding disaster risk</li> <li>-Strengthen disaster risk governance to manage disaster risk</li> <li>-Investing in disaster risk reduction for resilience</li> <li>-Enhancing disaster preparedness for effective response, &amp; to "Build Back Better" in recovery, rehabilitation &amp; reconstruction</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Broadens disaster risk reduction significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks</li> <li>• Specified term "rehabilitation," (in Priority 4), however, more inclined towards the rehabilitation of infrastructure</li> </ul>

(Continued to the next page)

**Table 3.** Continued

Initiative/strategy	Key features	Comments
Sphere Project Handbook, Greaney et al. 2018 [26]	<ul style="list-style-type: none"> <li>Sets common principles and universal minimum standards for the delivery of quality humanitarian response</li> <li>Published handbook "Humanitarian Charter and Minimum Standards in Humanitarian Response"</li> <li>Includes minimum standards in key response sectors: Water Supply, Sanitation and Hygiene Promotion (WASH); Food Security and Nutrition; Shelter and Settlement; &amp; Health</li> <li>Specifies the importance of timely access to rehabilitation services for restoring functional capacities, improving survival, QoL &amp; social reintegration of victims</li> </ul>	<ul style="list-style-type: none"> <li>Voluntary initiative initiated by a group of humanitarian NGOs &amp; the Red Cross and Red Crescent Movement in 1997</li> <li>Specifies: medical teams with inpatient capacity must be able to provide early rehabilitation</li> </ul>
EMT rehabilitation guidelines, WHO 2016 [20]	<ul style="list-style-type: none"> <li>Titled: "EMTs: minimum technical standards and recommendations for rehabilitation"</li> <li>Developed by the Rehabilitation Working Group under the EMT initiative</li> <li>Sets out the core standards for rehabilitation</li> <li>Provide the minimum standards for all EMTs regarding workforce, field hospital environment, rehabilitation equipment/consumables and information management</li> <li>One of the key ISPRM committees promoting the ISPRM's policy statement for the response to sudden onset disasters and to support its humanitarian mission</li> </ul>	<ul style="list-style-type: none"> <li>Key minimum standards:           <ul style="list-style-type: none"> <li>≥1 Rehabilitation professional per 20 beds at time of initial deployment, with further recruitment as required</li> <li>Allocation of purpose-specific rehabilitation space of ≥12 m<sup>2</sup> for all type 3 EMTs</li> <li>Deployment of EMTs with at least the essential rehabilitation equipment/ consumables</li> </ul> </li> <li>Coordinate activities on disaster rehabilitation with ISPRM National Societies (&gt;70 with over 7,000 members) and the WHO-ISPRM Liaison Committee</li> </ul>
Disaster Rehabilitation Committee, ISPRM 2021 [59]	<ul style="list-style-type: none"> <li>Advocate the rehabilitation medicine perspective in minimizing disability and optimizing functioning and HRQoL in disaster victims</li> <li>Collaborates with the WHO Liaison Committee on WHO disaster-related disability initiatives</li> <li>Provides technical resources and expertise to relevant stakeholders including WHO, UN, local governments, NGOs, disability organisations, national PRM Societies &amp; others</li> <li>Capacity building through education/training</li> <li>Generate evidence through research &amp; knowledge dissemination</li> </ul>	<ul style="list-style-type: none"> <li>17 SDGs setting a global agenda to build a sustainable disability-inclusive community with equitable healthcare</li> <li>SDG 3: "Ensure healthy lives and promote well-being for all at all ages" specifically emphasises rehabilitation as the key health strategy</li> <li>Disaster risk reduction is at the forefront of the SDGs</li> <li>Develop policies to enhance the quality of life by improving rehabilitation services</li> <li>Uphold the rights, ensure full inclusion &amp; equitable healthcare for PwD</li> </ul>

(Continued to the next page)

**Table 3.** Continued

Initiative/strategy	Key features	Comments
"Rehabilitation 2030: A call for action," WHO 2017 [61,62]	<ul style="list-style-type: none"> <li>Launched: "Rehabilitation in health systems" for evidence-based recommendations for governments &amp; stakeholders in developing/extending rehabilitation services equitably at all levels of health systems</li> <li>Focus on coordinated action &amp; joint commitments by all stakeholders to raise the profile of rehabilitation, improve rehabilitation management &amp; investment, build rehabilitation workforce &amp; services, and enhance data and research</li> <li>Aligned with rehabilitation in the context of the global agenda as specified in SDG 3 and of the second goal of GDAP</li> <li>Goal: to improve access to high-quality affordable assistive products globally as a part of UHC</li> <li>WHO partnership with stakeholders who represent international organizations, donor agencies, professional organizations, academia, and user groups</li> <li>Focusing on five interlinked areas (5P): people, policy, products, provision, and personnel</li> </ul>	<ul style="list-style-type: none"> <li>Input from rehabilitation stakeholders from health policy, clinical practice, users, funders, academia, and development experts from 46 countries</li> <li>Highlights the critical work to enhance access to rehabilitation, particularly in LMICs</li> </ul>
Global Cooperation on Assistive Technologies (GATE), WHO 2018 [63]	<ul style="list-style-type: none"> <li>Vision: highest possible standard of health and well-being for all people who are at risk of emergencies, and stronger community &amp; country resilience, health security, UHC and sustainable development</li> <li>Core principle: risk-based approach, comprehensive emergency management, all-hazard approach, inclusive, multisectoral &amp; multidisciplinary collaboration, whole-of-health system based and ethical consideration</li> <li>Provide overview on: policies, strategies &amp; legislation; planning &amp; coordination; human &amp; financial resources; information &amp; knowledge management; risk communications; health infrastructure &amp; logistics; community capacities; monitoring &amp; evaluation</li> </ul>	<ul style="list-style-type: none"> <li>Focus on infectious disease outbreaks, emergencies due to natural, technological and societal hazards</li> <li>More inclined towards infrastructure rehabilitation</li> </ul>
Health Emergency and Disaster Risk Management Framework, WHO 2019 [64]	<ul style="list-style-type: none"> <li>Vision: every country has the capacity to respond rapidly and effectively to national emergencies</li> <li>Key priorities: <ul style="list-style-type: none"> <li>Strength effective partnership, leadership &amp; operational governance</li> <li>Provide comprehensive, accessible and quality health service</li> <li>Implement and scale up strategies for standardization and quality assurance</li> <li>Strengthen information system, evidence and research</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Developed in response to WHO's Strengthening the Global Architecture for Health Emergency Preparedness, Response and Resilience, 2022</li> <li>Launched at the 5th EMT Global meeting, Armenia, 2022</li> </ul>
EMT 2030 Strategy, WHO 2022 [65]	<ul style="list-style-type: none"> <li>WHO global network of stakeholders whose mission is to support the implementation of the Rehabilitation 2030 Initiative through advocacy activities</li> <li>Objectives: to conduct evidence-based advocacy activities that increase awareness and demand for rehabilitation, networking and knowledge-sharing and for creating a shared understanding and narrative around rehabilitation</li> <li>Focuses on promoting rehabilitation as an essential health service that is integral to UHC and to the realization of SDG Goal 3; ensure healthy lives and promote well-being for all at all ages</li> </ul>	<ul style="list-style-type: none"> <li>Launched in 2022</li> <li>Consists 5 workstreams: workforce, primary care, research, emergencies, and external relations</li> </ul>
World Rehabilitation Alliance (WRA), WHO 2023 [66]		(Continued to the next page)

**Table 3.** Continued

Initiative/strategy	Key features	Comments
Resolution on "Strengthening rehabilitation in health system" WHO 2023 [67]	<ul style="list-style-type: none"> <li>The resolution calls for expanding and integrating rehabilitation in health systems as part of UHC, emphasizing the importance of rehabilitation in primary care and as part of emergency preparedness and response</li> <li>Aims to support member states in prioritizing rehabilitation within their health systems, promoting equitable access to rehabilitation services, and improving the lives of individuals with disabilities, injuries, and chronic health conditions</li> <li>Key points: Broad definition of rehabilitation, recognition of the role of rehabilitation, health system strengthening, equity and human rights, data and research, collaboration and partnership</li> </ul>	<ul style="list-style-type: none"> <li>• Adopted in 27th World Health Assembly</li> <li>• Support the implementation of "Rehabilitation 2030"</li> </ul>

UN, United Nations; GFDRR, Global Facility for Disaster Reduction and Recovery; SFDRR, Sendai Framework for Disaster Risk Reduction; SDG, Sustainable Development Goal; EMT, Emergency Medical Team; WHO, World Health Organization; UNDRR, United Nations Office for Disaster Risk Reduction; NGO, nongovernmental organization; QoL, quality of life; ISPRM, International Society for Physical Rehabilitation Medicine; HRQoL, health-related quality of life; PRM, physical and rehabilitation medicine; PwD, persons with disabilities; GDAP, global disability action plan; LMIC, low- and middle-income country; UHC, universal health coverage.

es within operational healthcare systems in many countries in terms of policies, funding structure/infrastructure, capacity, human and physical resources, technology, etc. Further, in large-scale disasters, even the world's best healthcare systems can be overwhelmed due to damage and/or disruptions of local existing health service infrastructure and an influx of new victims. The coronavirus disease 2019 pandemic is such an example that has tested the resilience of robust health systems of most developed countries, like the United States, Australia, France, Italy, Spain, the United Kingdom, etc [71]. Moreover, various barriers and gaps still exist in the comprehensive rehabilitation-inclusive disaster management process, which includes poor awareness, insufficient leadership and governance, inadequate coordination, financial constraints, limited political, etc [31,72].

Global healthcare authorities acknowledge the important role of rehabilitation within the context of overarching disaster management systems and lack and/or limited rehabilitation services/workforce capacity can compromise outcomes. There is a need for effective action from national and international bodies for comprehensive rehabilitation-inclusive disaster responses to strengthen national capacity, and foster an environment of self-empowerment of rehabilitation medical personnel/teams for sustainable long-term care. This requires strong leadership from governing organizations and 'shared' responsibility from all actors in the field [31]. Various perspectives need to be considered for effective future disaster management, which include (but are not limited to):

- Strengthen robust collaboration and governance from healthcare organisations
- Strengthen political commitment and allocation of adequate resources at the highest level to rehabilitation inclusive disaster management process
- Emphasise on disaster risk reduction and climate change mitigation
- Accelerate capacity building and training for skilled interdisciplinary rehabilitation workforce
- Increase public awareness and education
- Persistent and timely communication with the public, healthcare workers, government agencies, and industry
- Training and educational programs for healthcare professionals regarding rehabilitation-inclusive disasters management
- Embrace a system-wide approach for rehabilitation-inclusive disaster planning, with active participation/inclusion

- of disaster survivors/family, persons with disabilities, other stakeholders and the community at large
- Strengthen access to rehabilitation services including assistive devices
  - Develop effective strategies for reaching/supporting vulnerable population cohorts during disasters (e.g., persons with disabilities)
  - Development of innovative interventions and various alternative methods of service delivery including, telerehabilitation, rehabilitation in the home, mobile clinics
  - Promote task shifting and coordination between international EMTs, local healthcare authorities and humanitarian actors
  - Strengthen community-based rehabilitation and provision of long-term needs/support of disaster survivors
  - Formulate a formal registry of accredited rehabilitation professionals for deployment to disaster settings
  - Recognition of social and cultural barriers within the disaster settings
  - Improve communication (information gathering, sharing and disseminating)
  - Development of standardized assessment and monitoring tools, and injury-specific rehabilitation guidelines in disaster settings
  - Strengthen research and data collection

## CONCLUSION

Rehabilitation is an essential part of the disaster management and recovery process. It involves restoring the physical, psychological, and social functioning of affected individuals and can help to mitigate the long-term impacts of disasters (disabilities, health complications, mental health), improve QoL and provide an effective pathway to recovery and successful reintegration of the victims into the community, and reduce the burden on healthcare systems. While there is no one-size-fits-all approach to disaster rehabilitation, there is evidence suggesting various interventions/strategies that can be employed to ensure that the process is effective and efficient. It can be a complex and often lengthy process and requires all-inclusive planning and coordination approaches including strong governance and coordination, engaging with stakeholders (including vulnerable population cohorts such as persons with disabilities), developing a plan of action, and focusing on a long-term continuum of care.

There is strong consensus amongst global health authorities

that medical rehabilitation should be initiated in the immediate emergency response phase and should be continued post-disaster over a longer term. Despite this, rehabilitation services are often neglected in previous disasters and many disaster-prone countries still have low coping capacity and limited rehabilitation resources. The current endorsement of the landmark resolution by the World Health Assembly: "Strengthening Rehabilitation in Health Systems," the WHO aims to support member states in prioritizing rehabilitation within their health systems, promoting equitable access to rehabilitation services, and integrating rehabilitation and assistive technology in its EMTs including addressing the long-term rehabilitation needs of people affected by emergencies. Further, the WHO-EMT initiative and now set out a structure and standardization for future medical team deployments (including rehabilitation) to ensure that quality care is provided to those in need. There are still lots of challenges ahead and successful and effective rehabilitation-inclusive disaster management will depend on the proficient leadership of the governing bodies (international and national), and the willingness and commitment of countries to build systematic advance planning and preparedness, and building local rehabilitation capacities (skilled workforce, infrastructure, funding) to ensure that effective and timely services are available to vulnerable communities at risk in future calamities.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

## FUNDING INFORMATION

None.

## ACKNOWLEDGEMENTS

We acknowledge the Disaster Rehabilitation Committee, of the International Society of Physical and Rehabilitation Medicine (ISPRM) and Disaster Rehabilitation Special Interest Group, Rehabilitation Medicine Society of Australia and New Zealand (RMSANZ) for their support. The views expressed in this article are of the authors only and not of the above-mentioned committee.

## AUTHOR CONTRIBUTION

Conceptualization: Amatya B. Methodology: Amatya B. Formal analysis: Amatya B, Khan F. Project administration: Amatya B. Visualization: Amatya B, Khan F. Writing – original draft: Amatya B. Writing – review and editing: Amatya B, Khan F. Approval of final manuscript: all authors.

## ORCID

Bhasker Amatya, <https://orcid.org/0000-0003-4793-1104>

Fary Khan, <https://orcid.org/0000-0003-2232-6493>

## REFERENCES

1. United Nations Office for Disaster Risk Reduction (UNISDR). 2009 UNISDR terminology on disaster risk reduction. UNISDR; 2009.
2. Guha-Sapir D, Hoyois P, Below R. Annual disaster statistical review 2015: the numbers and trends. Centre for Research on the Epidemiology of Disasters (CRED); 2016.
3. Below R, Wirtz A, Guha-Sapir D. Disaster category classification and peril terminology for operational purposes. Centre for Research on the Epidemiology of Disasters (CRED); Munich Reinsurance Company; 2009.
4. Centre for Research on the Epidemiology of Disasters (CRED); United Nations Office for Disaster Risk Reduction (UNISDR). Human cost of disasters. An overview of the last 20 years 2000–2019 [Internet]. UNISDR; 2020 [cited 2023 Feb 24]. Available from: <https://cred.be/sites/default/files/CRED-Disaster-Report-Human-Cost2000-2019.pdf>.
5. Brassard C, Howitt AM, Giles DW. Natural disaster management in the Asia-Pacific: policy and governance. Book series: disaster risk reduction methods, approaches and practices. Springer Japan; 2015.
6. Khan F, Amatya B, Rathore FA, Galea MP. Medical rehabilitation in natural disasters in the Asia-Pacific region: the way forward. *Int J Natural Disaster Health Secur* 2015;2:6-12.
7. Amatya B, Khan F. Overview of medical rehabilitation in natural disasters in the Pacific Island countries. *Phys Med Rehabil Int* 2016;3:1090.
8. Guha-Sapir D, Vanderveken A. CRED CRUNCH: 2016 preliminary data: Human impact of natural disasters (Issue No. 45). Centre for Research on the Epidemiology of Disasters (CRED), December 2016.
9. Centre for Research on the Epidemiology of Disasters (CRED). 2022 Disasters in numbers [Internet]. CRED; 2023 [cited 2023 Mar 14]. Available from: [https://cred.be/sites/default/files/2022\\_EMDAT\\_report.pdf](https://cred.be/sites/default/files/2022_EMDAT_report.pdf).
10. Okuyama Y, Sahin S. Impact estimation of disasters: a global aggregate for 1960 to 2007. World Bank; 2009.
11. de Goyet CDV, Sarmiento J, Grünewald F. Health response to the earthquake in Haiti January 2010: lessons to be learned for the next massive sudden-onset disaster. Pan American Health Organization (PAHO); 2011.
12. Amatya B, Galea M, Li J, Khan F. Medical rehabilitation in disaster relief: towards a new perspective. *J Rehabil Med* 2017;49:620-8.
13. Ramirez M, Peek-Asa C. Epidemiology of traumatic injuries from earthquakes. *Epidemiol Rev* 2005;27:47-55.
14. Bortolin M, Morelli I, Voskanyan A, Joyce NR, Ciottone GR. Earthquake-related orthopedic injuries in adult population: a systematic review. *Prehosp Disaster Med* 2017;32:201-8.
15. MacKenzie JS, Banskota B, Sirisreetreerux N, Shafiq B, Hasenboehler EA. A review of the epidemiology and treatment of orthopaedic injuries after earthquakes in developing countries. *World J Emerg Surg* 2017;12:9.
16. Ngaruiya C, Bernstein R, Leff R, Wallace L, Agrawal P, Selvam A, et al. Systematic review on chronic non-communicable disease in disaster settings. *BMC Public Health* 2022;22:1234.
17. Tsuji T, Sasaki Y, Matsuyama Y, Sato Y, Aida J, Kondo K, et al. Reducing depressive symptoms after the Great East Japan Earthquake in older survivors through group exercise participation and regular walking: a prospective observational study. *BMJ Open* 2017; 7:e013706.
18. Huang KS, He DX, Huang DJ, Tao QL, Deng XJ, Zhang B, et al. Changes in ischemic heart disease mortality at the global level and their associations with natural disasters: a 28-year ecological trend study in 193 countries. *PLoS One* 2021;16:e0254459.
19. World Health Organization (WHO). Classification and minimum standards for emergency medical teams. WHO; 2021. p. 1-147.
20. World Health Organization (WHO). Emergency medical teams: minimum technical standards and recommendations for rehabilitation. WHO; 2016.
21. von Schreeb J, Riddez L, Samnegård H, Rosling H. Foreign field hospitals in the recent sudden-onset disasters in Iran, Haiti, Indonesia, and Pakistan. *Prehosp Disaster Med* 2008;23:144-51. discussion 152-3.
22. Rathore FA, Gosney JE, Reinhardt JD, Haig AJ, Li J, DeLisa JA. Medical rehabilitation after natural disasters: why, when, and how? *Arch Phys Med Rehabil* 2012;93:1875-81.
23. Khan F, Amatya B, Gosney J, Rathore FA, Burkle FM Jr. Medical rehabilitation in natural disasters: a review. *Arch Phys Med Rehabil*

- 2015;96:1709-27.
24. Landry MD, McGlynn M, Ng E, Andreoli A, Devji T, Bower C, et al. Humanitarian response following the earthquake in Haiti: reflections on unprecedented need for rehabilitation. *World Health Popul* 2010;12:18-22.
  25. World Health Organization (WHO); World Bank. *World report on disability*. WHO; 2011.
  26. Greaney P, Pfiffner S, Wilson D. *The Sphere Project: humanitarian charter and minimum standards in humanitarian response*. Practical Action Publishing; 2011.
  27. Gosney JE Jr. *Physical medicine and rehabilitation: critical role in disaster response*. *Disaster Med Public Health Prep* 2010;4:110-2.
  28. World Health Organization (WHO). *Rehabilitation in health systems: guide for action*. WHO; 2019.
  29. Ganchoon F, Bugho R, Calina L, Dy R, Gosney J. *Philippine Academy of Rehabilitation Medicine emergency basic relief and medical aid mission project (November 2013–February 2014): the role of physiatrists in Super Typhoon Haiyan*. *Disabil Rehabil* 2018;40:2217-25.
  30. World Health Organization (WHO); International Federation of Red Cross and Red Crescent Societies (IFRC). *The regulation and management of international emergency medical teams*. WHO; IFRC; 2017.
  31. Amatya B, Lee SY, Galea MP, Khan F. *Disaster rehabilitation response plan: now or never*. *Am J Phys Med Rehabil* 2020;99:170-7.
  32. Li Y, Reinhardt JD, Gosney JE, Zhang X, Hu X, Chen S, et al. Evaluation of functional outcomes of physical rehabilitation and medical complications in spinal cord injury victims of the Sichuan earthquake. *J Rehabil Med* 2012;44:534-40.
  33. Rathore FA, Farooq F, Muzammil S, New PW, Ahmad N, Haig AJ. Spinal cord injury management and rehabilitation: highlights and shortcomings from the 2005 earthquake in Pakistan. *Arch Phys Med Rehabil* 2008;89:579-85.
  34. Mallick M, Aurakzai JK, Bile KM, Ahmed N. Large-scale physical disabilities and their management in the aftermath of the 2005 earthquake in Pakistan. *East Mediterr Health J* 2010;16 Suppl: S98-105.
  35. Hu X, Zhang X, Gosney JE, Reinhardt JD, Chen S, Jin H, et al. Analysis of functional status, quality of life and community integration in earthquake survivors with spinal cord injury at hospital discharge and one-year follow-up in the community. *J Rehabil Med* 2012;44:200-5.
  36. Jiang RF, Tong HQ, Delucchi KL, Neylan TC, Shi Q, Meffert SM. Interpersonal psychotherapy versus treatment as usual for PTSD and depression among Sichuan earthquake survivors: a randomized clinical trial. *Confl Health* 2014;8:14.
  37. Li L, Reinhardt JD, Zhang X, Pennycott A, Zhao Z, Zeng X, et al. Physical function, pain, quality of life and life satisfaction of amputees from the 2008 Sichuan earthquake: a prospective cohort study. *J Rehabil Med* 2015;47:466-71.
  38. Li WS, Chan SY, Chau WW, Law SW, Chan KM. Mobility, prosthesis use and health-related quality of life of bilateral lower limb amputees from the 2008 Sichuan earthquake. *Prosthet Orthot Int* 2019;43:104-11.
  39. Ni J, Reinhardt JD, Zhang X, Xiao M, Li L, Jin H, et al. Dysfunction and post-traumatic stress disorder in fracture victims 50 months after the Sichuan earthquake. *PLoS One* 2013;8:e77535.
  40. Xiao M, Li J, Zhang X, Zhao Z. Factors affecting functional outcome of Sichuan-earthquake survivors with tibial shaft fractures: a follow-up study. *J Rehabil Med* 2011;43:515-20.
  41. Zang Y, Hunt N, Cox T. A randomised controlled pilot study: the effectiveness of narrative exposure therapy with adult survivors of the Sichuan earthquake. *BMC Psychiatry* 2013;13:41.
  42. Zhang X, Hu XR, Reinhardt JD, Zhu HJ, Gosney JE, Liu SG, et al. Functional outcomes and health-related quality of life in fracture victims 27 months after the Sichuan earthquake. *J Rehabil Med* 2012;44:206-9.
  43. Zhang X, Reinhardt JD, Gosney JE, Li J. The NHV rehabilitation services program improves long-term physical functioning in survivors of the 2008 Sichuan earthquake: a longitudinal quasi experiment. *PLoS One* 2013;8:e53995.
  44. Becker SM. Psychosocial care for women survivors of the tsunami disaster in India. *Am J Public Health* 2009;99:654-8.
  45. Berger R, Gelkopf M. School-based intervention for the treatment of tsunami-related distress in children: a quasi-randomized controlled trial. *Sychother Psychosom* 2009;78:364-71.
  46. Akiyama T, Gregorio ER Jr, Kobayashi J. Youth sports activity and young people's well-being after a disaster: a trial with the Mastery Approach to Coaching (MAC) in the Philippines. *BMC Res Notes* 2018;11:747.
  47. Huang Y, Wong H. Effects of social group work with survivors of the Wenchuan earthquake in a transitional community. *Health Soc Care Community* 2013;21:327-37.
  48. Kuroda Y, Iwasa H, Orui M, Moriyama N, Suemoto CK, Yashiro C, et al. Risk factor for incident functional disability and the effect of a preventive exercise program: a 4-year prospective cohort study of older survivors from the Great East Japan Earthquake and nuclear disaster. *Int J Environ Res Public Health* 2018;15:1430.
  49. Wu YT, Chen KH, Ban SL, Tung KY, Chen LR. Evaluation of leap motion control for hand rehabilitation in burn patients: an expe-

- rience in the dust explosion disaster in Formosa Fun Coast. Burns 2019;45:157-64.
50. Fahmida U, Hidayat AT, Oka AASI, Suciyantri D, Pathurrahman P, Wangge G. Effectiveness of an integrated nutrition rehabilitation on growth and development of children under five post 2018 earthquake in East Lombok, Indonesia. *Int J Environ Res Public Health* 2022;19:2814.
  51. World Health Organization (WHO). Emergency Medical Teams Initiative. WHO; 2016 [cited 2023 Mar 14]. Available from: <https://extranet.who.int/emt/>
  52. World Health Organization (WHO). Emergency medical team initiative. Guidelines and publications [Internet]. WHO; 2023 [cited 2023 Mar 15]. Available from: <https://extranet.who.int/emt/guidelines-and-publications>.
  53. Lathia C, Skelton P, Clift Z. Early rehabilitation in conflicts and disasters [Internet]. Humanity & Inclusion UK; 2020 [cited 2023 Mar 14]. Available from: [https://www.hi.org/sn\\_uploads/document/36199-Humanity--Inclusion-Clinical-Handbook-web\\_1.pdf](https://www.hi.org/sn_uploads/document/36199-Humanity--Inclusion-Clinical-Handbook-web_1.pdf).
  54. Humanity & Inclusion UK. Responding internationally to disasters: a do's and don'ts guide for rehabilitation professionals [Internet]. Humanity & Inclusion UK; 2016 [cited 2023 Mar 14]. Available from: [https://www.humanity-inclusion.org.uk/sn\\_uploads/uk/document/responding-disasters-dos-and-donts-guide-rehabilitation-professionals-april-2016.pdf](https://www.humanity-inclusion.org.uk/sn_uploads/uk/document/responding-disasters-dos-and-donts-guide-rehabilitation-professionals-april-2016.pdf).
  55. DisasterReady. Develop your skills, maximize your impact [Internet]. DisasterReady; 2023 [cited 2023 Mar 10]. Available from: <https://www.disasterready.org/>.
  56. United Nations Office for Disaster Risk Reduction. Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters. UNDRR; 2005.
  57. Global Facility for Disaster Reduction and Recovery (GFDRR). Bringing resilience to scale. GFDRR; 2016.
  58. United Nations Office for Disaster Risk Reduction (UNISDR). Sendai framework for disaster risk reduction 2015-2030. UNISDR; 2015.
  59. International Society for Physical Rehabilitation Medicine (ISPRM). Disaster Rehabilitation Committee (DRC) [Internet]. ISPRM; 2021 [cited 2023 Feb 25]. Available from: <https://www.isprm.org/collaborate/drc/>.
  60. United Nations. Sustainable Development Goals: knowledge plat-
  - form [Internet]. United Nations; 2017 [cited 2023 Feb 25]. Available from: <https://www.un.org/sustainabledevelopment/>.
  61. World Health Organization (WHO). Rehabilitation in health systems. WHO; 2017.
  62. World Health Organization (WHO). Rehabilitation: key for health in the 21st century. WHO; 2017.
  63. World Health Organization (WHO). Global Cooperation on Assistive Technology (GATE) [Internet]. WHO; 2018 [cited 2023 Feb 14]. Available from: [https://www.who.int/initiatives/global-cooperation-on-assistive-technology-\(gate\)](https://www.who.int/initiatives/global-cooperation-on-assistive-technology-(gate)).
  64. World Health Organization (WHO). Health emergency and disaster risk management framework. WHO; 2019.
  65. World Health Organization (WHO). Emergency medical team strategy 2030 [Internet]. WHO; 2022 [cited 2023 Feb 10]. Available from: <https://www.who.int/news/item/04-10-2022-who-launches-the-emergency-medical-teams-2030-strategy-at-global-meeting-to-strengthen-rapid-response-amid-emergencies-worldwide>.
  66. World Health Organization (WHO). World Rehabilitation Alliance (WRA) [Internet]. WHO; 2023 [cited 2023 Jul 4]. Available from: <https://www.who.int/initiatives/world-rehabilitation-alliance>.
  67. World Health Organization (WHO). Strengthening rehabilitation in health systems [Internet]. WHO; 2023 [cited 2023 Jul 4]. Available from: [https://apps.who.int/gb/ebwha/pdf\\_files/EB152/B152%2810%29-en.pdf](https://apps.who.int/gb/ebwha/pdf_files/EB152/B152%2810%29-en.pdf).
  68. United Nations Office for Disaster Risk Reduction (UNISDR). UN 2013 global survey explains why so many people living with disabilities die in disasters [Internet]. UNISDR; 2013 [cited 2023 Feb 25]. Available from: <https://www.unisdr.org/news/un-2013-global-survey-explains-why-so-many-people-living-disabilities-die-disasters>.
  69. Economic and Social Commission for Asia and the Pacific (ESCAP). Disasters in Asia and the Pacific: 2014 year in review. United Nations; 2015.
  70. World Health Organization (WHO). The need to scale up rehabilitation. WHO; 2017.
  71. Amatya B, Khan F. COVID-19 in developing countries: a rehabilitation perspective. *J Int Soc Phys Rehabil Med* 2020;3:69-74.
  72. Khan F, Amatya B, Lee SY, Vasudevan V. Rehabilitation in disaster relief. *Phys Med Rehabil Clin N Am* 2019;30:723-47.

**Appendix 1.** Emergency Medical Team classification

Type	Description	Minimal benchmark indicators (per day)	Minimum length of stay
Type 1 (mobile)	Provides daylight hours care for stabilization of acute trauma and nontrauma presentations, referrals for further investigation or inpatient care & community-based primary care with the ability to work in multiple locations over the period of a deployment	At least 50 outpatients	2 wk
Type 1 (fixed)	Provides daylight hours care for acute trauma and non-trauma presentations, referrals, and ongoing investigation or care & community-based primary care in an outpatient fixed facility	100 outpatients	2 wk
Type 2 Inpatient surgical emergency care	Provides Type 1 services plus general and obstetric surgery for trauma & other major conditions as well as inpatient acute care	>100 outpatients; 1 operating theatre with a minimum of 20 inpatients beds/operating table; 7 major or 15 minor operations	3 wk
Type 3 Inpatient referral care	Provides Type 2 services plus complex referral and intensive care capacity	>100 outpatients and >40 inpatients; at least 2 operating tables & 40 inpatient beds (20 beds/operating table) 15 major or 30 minor operations; at least 4 intensive care beds	4 wk
Specialized care team	Additional specialized care teams that can be embedded in local healthcare facilities or Type 2 or Type 3 unless specified otherwise, can provide the following services: outbreak, surgical, rehabilitation, mental health, reproductive and newborn care, interdisciplinary, interhospital and technical support.	Teams offering care embedded into existing facilities & able to provide the equipment and consumables related to the services they are offering for the entire period of their deployment	Variable

Adapted from World Health Organization (Classification and minimum standards for emergency medical teams; 2021. p. 1-147) [19].

**Appendix 2.** Summary of technical standards for rehabilitation specialized team

	Minimum technical standards	Requirements for verification
Team configuration	Team should be comprised of $\geq 3$ rehabilitation professionals, should be multidisciplinary and include at least one PT & other rehabilitation discipline(s): OT, rehabilitation physician, nurse, others	Team can provide $>3$ professionals representing at least 2 rehabilitation disciplines (one of which is PT), who are available for rapid deployment
Qualification & experience	Rehabilitation professionals should have at least bachelor's degree or equivalent in their respective discipline, $\geq 3$ yr experience in trauma injury rehabilitation $\geq 1$ Team member (preferable the team leader) should have experience in emergency response & all team members should have undergone training in working in austere environments	Team can provide copies of professional qualifications and declarations of at least three years clinical experience in trauma injury rehabilitation
Rehabilitation equipment <sup>a)</sup>	Team should have capability to rapidly provide necessary equipment for deployment	Team can present either a stockpile of the rehabilitation equipment, or documentation of an arrangement to have the equipment rapidly provided (including financial and logistical capability) in the event of the team's deployment
Length of stay	Team that embeds into an EMT should stay for the minimum length of stay of that EMT (3 wk for Type 2; 4–6 wk for Type 3) A team that embeds into a local facility should plan to stay for $\geq 1$ mo	Team should declare its intended length of stay (no $< 3$ wk), to facilitate appropriate placement with an EMT or local facility if deployed

Adapted from World Health Organization [20].

PT, physiotherapists; OT, occupational therapists; EMT, Emergency Medical Team.

<sup>a)</sup>List of rehabilitation equipment is detailed in the guidelines (<https://extranet.who.int/emt/guidelines-and-publications>).

**Appendix 3.** Eight-step pathway of the global EMT classification process. Adapted from World Health Organization (Classification and minimum standards for emergency medical teams; 2021. p. 1-147) [19]. EMT, Emergency Medical Team; SOPS, Standard Operating Procedures; DG WHO, Director-General World Health Organization.

