

## Review Article



# Earthquake Risk and Preparedness in Bangladesh: The Indispensable Role of Rehabilitation Medicine

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### Abstract

**Background:** Bangladesh is located within a seismically active region influenced by the interactions of the Indian, Eurasian, and Burmese tectonic plates, making the country vulnerable to potentially damaging earthquakes. Despite this geological risk, earthquake preparedness in Bangladesh has historically received limited attention, largely due to the country's greater exposure to floods and cyclones and the absence of a catastrophic earthquake in recent decades. This relative seismic quiescence has contributed to low public risk perception and inadequate prioritization of earthquake-specific preparedness. In contrast, neighboring South Asian countries have experienced multiple devastating earthquakes, resulting in substantial mortality and a high burden of long-term disability.

**Materials and Methods:** This article is a narrative review synthesizing existing evidence on earthquake risk and preparedness in Bangladesh, with emphasis on the role of Rehabilitation Medicine in disaster management. Relevant literature was identified through searches of PubMed, Google Scholar, and selected grey literature from national and international disaster management and health agencies. Search terms included earthquake, Bangladesh, South Asia, disaster preparedness, rehabilitation, and physiatry. Sources were selected based on relevance to seismic risk, injury patterns, rehabilitation needs, and disaster rehabilitation models, and findings were synthesized thematically. Formal systematic review procedures were not applied.

**Results:** Evidence from South Asia consistently demonstrates that earthquakes result in significant long-term disability, predominantly due to musculoskeletal trauma, spinal cord injuries, and neurological impairments. However, current preparedness frameworks in Bangladesh insufficiently integrate rehabilitation services, workforce planning, and continuity of care across the disaster management continuum.

**Conclusion:** Rehabilitation must be recognized as a core component of earthquake preparedness in Bangladesh. Systematic integration of physiatrist-led rehabilitation teams within disaster management systems is essential to reduce long-term disability, optimize functional outcomes, and strengthen national health system resilience against future seismic events.

**Key words:** Earthquake, Bangladesh, Disaster preparedness, Rehabilitation, Physiatrist, South Asia

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### Introduction

Earthquakes are not only mass-casualty events rather they are mass-disability events. They remain among the most devastating natural hazards worldwide, causing sudden mass casualties, infrastructural collapse, and long-term disability. Globally, geophysical disasters account for the highest proportion of disaster-related mortality and morbidity, particularly in low- and middle-income countries (LMICs).<sup>1,2</sup> Bangladesh, although widely recognized for its vulnerability to floods and cyclones, is also exposed to significant seismic risk due to its tectonic setting

at the junction of major lithospheric plates.<sup>3</sup> Notably, Bangladesh has not experienced a catastrophic earthquake during the past century, a factor that has contributed to limited public risk perception and relatively low prioritization of earthquake preparedness. In contrast, neighboring South Asian countries including India, Pakistan, Nepal, and Myanmar have suffered multiple devastating earthquakes with extensive loss of life and long-term disability.<sup>4-7</sup> The 2001 Gujarat earthquake, the 2005 Kashmir earthquake, and the 2015 Nepal earthquake vividly demonstrated that survival from seismic events is frequently

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accompanied by complex musculoskeletal injuries, spinal cord injuries, traumatic brain injuries, amputations, and psychosocial impairments. Despite the absence of a catastrophic earthquake in Bangladesh over the past century, recent moderate seismic events have highlighted the country's persistent seismic vulnerability and the need for improved preparedness.<sup>8,9</sup> Advances in disaster response, including improved search-and-rescue operations and emergency medical care, have significantly reduced earthquake-related mortality in many settings. However, this success has paradoxically resulted in a growing population of survivors living with temporary or permanent disabilities.<sup>10,11</sup> Evidence consistently shows that early and coordinated rehabilitation interventions can reduce complications, shorten hospital stays, and improve long-term functional outcomes following earthquakes.<sup>12-14</sup> Nevertheless, rehabilitation remains one of the most under-prioritized components of disaster management, particularly in LMICs. Against this backdrop, this narrative review examines earthquake risk and preparedness in Bangladesh, contextualized by regional South Asian seismic experiences, and underscores the imperative for rehabilitation-inclusive preparedness. Particular emphasis is placed on the indispensable role of physiatrist-led disaster management frameworks in reducing long-term disability and strengthening health system resilience.

## Materials and Methods

This article is a narrative review synthesizing existing evidence on earthquake risk and preparedness in Bangladesh, with emphasis on the role of Rehabilitation Medicine in disaster management. A narrative approach was chosen to allow contextual interpretation of regional seismic experiences, policy frameworks, and rehabilitation preparedness. Literature was identified through searches of PubMed, Google Scholar, and relevant grey literature from national and international organizations, including disaster management and health agencies. Search terms included earthquake, Bangladesh, South Asia, disaster preparedness, rehabilitation, and physiatry. Selection of sources was based on relevance to seismic risk, injury patterns, rehabilitation needs, and disaster rehabilitation models. Findings were synthesized thematically. Formal systematic review procedures were not applied, as the objective was to provide a contextual and thematic synthesis of evidence relevant to regional seismic risk, policy frameworks, and rehabilitation preparedness, consistent with established guidance on narrative reviews.<sup>15</sup>

## Results

**Seismic Risk and Structural Vulnerability in Bangladesh.** Bangladesh is exposed to significant seismic risk due to its location near the convergent boundary of the Indian, Eurasian, and Burmese plates (Figure-1). Geological investigations identify several active fault systems, including the Dauki Fault and the Indo-Burma subduction zone, capable of producing moderate to large earthquakes with widespread impact.<sup>16</sup> Although Bangladesh has not experienced a catastrophic earthquake in recent decades, historical events such as the 1885 Bengal earthquake demonstrate the region's capacity for destructive seismic activity.<sup>17</sup> Contemporary seismological studies suggest that recurrent low-magnitude tremors and micro

seismic activity reflect ongoing tectonic strain accumulation, increasing concern about the potential for a future high-impact earthquake following prolonged seismic quiescence.<sup>18</sup>



**Figure 1:** Seismic Risk in Bangladesh

(Figure 1) Tectonic setting of Bangladesh showing its position near the convergent boundary of the Indian, Eurasian, and Burmese plates, with major seismic structures including the Dauki Fault and the Indo-Burma subduction zone. The figure is schematic and intended to illustrate regional seismic vulnerability. Rapid and largely unplanned urbanization has substantially amplified this geological vulnerability. Dhaka, one of the most densely populated megacities globally, is characterized by extensive non-engineered construction, inadequate enforcement of seismic building codes, ageing infrastructure, and limited open spaces for evacuation.<sup>19</sup> Similar structural vulnerabilities are present in other major urban centers, including Chattogram and Sylhet. Importantly, the occurrence of a recent moderate-magnitude earthquake in Bangladesh that resulted in multiple fatalities underscores that seismic risk is not merely theoretical but poses an immediate threat even in the absence of a major event. Modelling and risk-assessment studies further indicate that even a moderate-magnitude earthquake could result in mass casualties, overwhelm emergency medical services, and generate extensive long-term rehabilitation needs.<sup>20</sup>

### Regional Earthquake Experiences in South Asia

Earthquake experiences from neighboring South Asian countries provide critical insights relevant to Bangladesh. The 2001 Gujarat earthquake in India,<sup>4, 21</sup> the 2005 Kashmir earthquake,<sup>6, 10</sup> and the 2015 Gorkha earthquake in Nepal,<sup>5,13</sup> resulted in hundreds of thousands of injuries, with a substantial proportion of survivors sustaining permanent or long-term disabilities. Across these disasters, orthopedic injuries particularly fractures and crush injuries accounted for the majority of earthquake-related morbidity.<sup>23</sup> Spinal cord injuries, traumatic brain injuries, peripheral nerve injuries, and amputations, although less frequent, contributed disproportionately to long-term disability and dependency.<sup>24</sup>

**Table I:** Major South and Southeast Asian Earthquakes: Injury Patterns, Disability Burden, and Rehabilitation Implications.

Earthquake (Country, Year)	Reported Human Impact	Predominant Injuries	Disability & Functional Consequences	Rehabilitation-Relevant Insights
<b>Gujarat, India (2001)</b> <sup>4, 21</sup>	>20,000 injured; large survivor population	Fractures, crush injuries, soft -tissue trauma	Persistent limb disability, reduced mobility and work capacity	Delayed rehabilitation increased long -term impairment and dependency
<b>Kashmir, Pakistan (2005)</b> <sup>6, 22</sup>	>80,000 injured; thousands with permanent disability	Orthopedic trauma, SCI, amputations	Long-term dependency, unemployment, and social exclusion	Limited early rehabilitation capacity worsened disability outcomes
<b>Gorkha, Nepal (2015)</b> <sup>5, 13, 26</sup>	>22,000 injured	Fractures, crush injuries, TBI	Chronic functional limitation; reduced quality of life	Early rehabilitation improved outcomes, but post - acute access gaps persisted
<b>Sagaing– Mandalay, Myanmar (2025)</b> <sup>7</sup>	>4,000 injured	Fractures, head injuries, polytrauma	High risk of long -term disability due to trauma and disrupted care	Large injury burden underscores urgent need for early and sustained rehabilitation

Importantly, regional evidence demonstrates that earthquake impact should be assessed not only in terms of mortality but also in terms of disability burden. Studies from Nepal and Pakistan reveal that many survivors experience prolonged functional impairment, reduced quality of life, unemployment, and social exclusion when structured rehabilitation services are unavailable or delayed.<sup>13, 25, 26</sup>

### Rehabilitation Needs and Disability Burden Following Earthquakes

Earthquakes generate predictable patterns of injury that result in extensive rehabilitation demand. Survivors frequently sustain complex musculoskeletal trauma, spinal cord injuries, and neurological impairments that require prolonged multidisciplinary rehabilitation.<sup>27, 28</sup> In the absence of timely rehabilitation, secondary complications such as joint contractures, pressure injuries, chronic pain, and psychological disorders are common.<sup>10</sup> Evidence from low- and middle-income countries indicates that these complications substantially increase long-term disability and healthcare costs.<sup>29</sup>

Multiple studies consistently demonstrate that early and coordinated rehabilitation interventions reduce medical complications, shorten hospital stays, and improve long-term functional outcomes following earthquakes.<sup>30, 31</sup> Early mobilization, functional assessment, and provision of assistive devices are repeatedly identified as critical determinants of recovery.<sup>32</sup>

### Current Gaps in Disaster Preparedness in Bangladesh

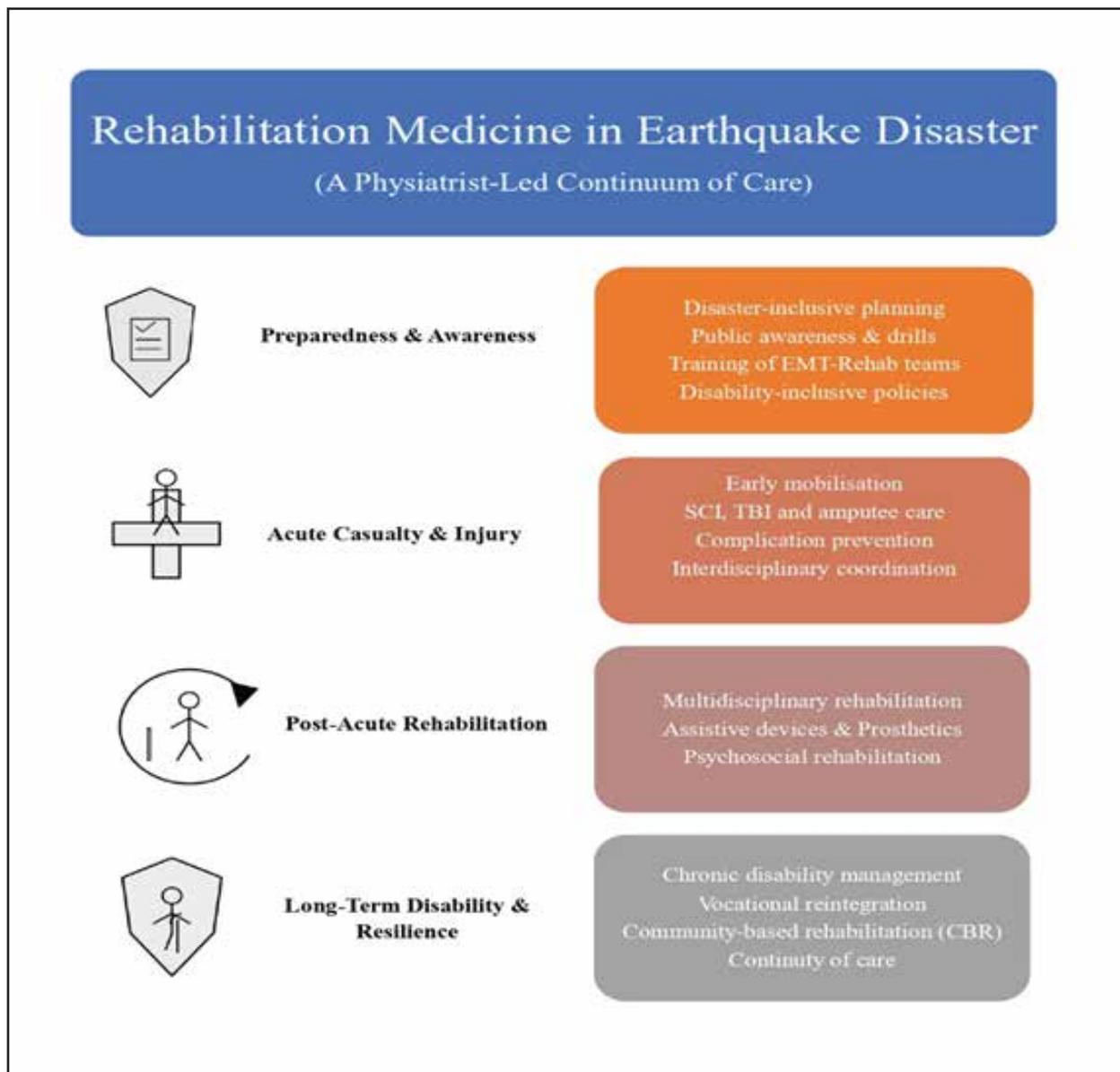
Despite clear evidence of the disability burden associated with

earthquakes, preparedness frameworks in Bangladesh insufficiently integrate rehabilitation services. National disaster management policies primarily emphasize emergency response and relief, with limited operational planning for post-acute rehabilitation and long-term recovery.<sup>33, 34</sup> Although seismic zoning and building codes exist, enforcement remains inconsistent, and rehabilitation workforce planning is largely absent from earthquake preparedness strategies.<sup>35, 36</sup>

Community-level preparedness for earthquakes is also limited compared with flood and cyclone preparedness.<sup>37</sup> Public education, simulation drills, and disability-inclusive preparedness planning remain inadequate, increasing vulnerability among older adults and persons with pre-existing disabilities.<sup>38</sup>

### Role of Rehabilitation Medicine and Physiatrists

International consensus recognizes rehabilitation as an essential component of disaster management across all phases: preparedness, response, and recovery.<sup>31, 39, 40</sup> Physiatrists play a central role in functional triage, interdisciplinary coordination, prevention of secondary impairments, and long-term recovery planning (Figure 2). Evidence from disaster-affected settings demonstrates that physiatrist-led rehabilitation programmes are associated with improved functional outcomes, reduced complications, and better continuity of care.<sup>41</sup> Without systematic integration of rehabilitation medicine into disaster preparedness, the long-term disability burden following a major earthquake in Bangladesh is likely to remain substantial.<sup>42</sup>



**Figure 2:** Conceptual framework showing the central role of physiatrist-led Rehabilitation Medicine across the earthquake disaster continuum

**Discussion**

This narrative review highlights that earthquake should be reframed not solely as acute mass-casualty events but as major contributor to long-term disability with profound implications for health systems, particularly in low- and middle-income countries (LMICs).<sup>40</sup> International experience consistently demonstrates that improvements in emergency response and trauma care have increased survival after earthquakes, yet this has been accompanied by a growing population of survivors with complex and enduring rehabilitation needs.<sup>31,32,43</sup> For Bangladesh, international and regional experience indicates that disaster preparedness frameworks prioritizing rescue, relief, and acute medical care alone risk systematically underestimating the true earthquake burden unless rehabilitation is

embedded as a core pillar of disaster risk management and health-system preparedness.<sup>44,45</sup>

Evidence from multiple seismic events across South Asia and Asia shows a strikingly consistent injury profile following earthquakes. Orthopedic trauma especially fractures and crush injuries accounts for the majority of morbidity, while spinal cord injury, traumatic brain injury, peripheral nerve injury, and amputations contribute disproportionately to long-term disability and dependence.<sup>4,7,46</sup> Systematic reviews and epidemiological analyses from diverse settings confirm that musculoskeletal and neurological impairments dominate post-earthquake disability burden, often persisting for years when rehabilitation is delayed or inadequate.<sup>47</sup> These findings reinforce that disabil-

ity outcomes are not inevitable consequences of earthquakes but are strongly influenced by the timeliness, coordination, and quality of rehabilitation services.

Comparative experiences from Nepal (2015 Gorkha earthquake), Pakistan (2005 Kashmir earthquake), India (2001 Gujarat earthquake), China (2008 Wenchuan earthquake), and Turkey provide particularly relevant lessons for Bangladesh. In Nepal and Pakistan, delayed rehabilitation and limited specialist capacity were associated with higher rates of long-term functional limitation, unemployment, and social exclusion among survivors. Conversely, longitudinal studies from China following the Wenchuan earthquake demonstrated that structured, sustained rehabilitation programmes significantly improved long-term physical functioning and participation outcomes over several years.<sup>32</sup> These contrasts illustrate that early rehabilitation is not a luxury but a cost-effective intervention that mitigates secondary complications, reduces dependency, and supports socioeconomic recovery.

From a policy perspective, international guidance increasingly recognizes rehabilitation as an essential component of health emergency preparedness and response. The World Health Organization's Emergency Medical Teams standards and subsequent policy briefs emphasize that rehabilitation should be integrated across the disaster continuum from preparedness and acute response to recovery and resilience.<sup>48,49</sup> Physiatrists and multidisciplinary rehabilitation teams are uniquely positioned to conduct functional triage, guide early mobilization, prevent secondary complications such as contractures and pressure injuries, and coordinate long-term recovery pathways.<sup>50</sup> Studies from disaster-affected settings consistently show that physiatrist-led or rehabilitation-integrated models are associated with improved functional outcomes, reduced length of hospital stay, and better continuity of care.<sup>45,50</sup>

In Bangladesh, however, rehabilitation remains insufficiently integrated into earthquake preparedness frameworks. National disaster management policies have historically prioritized emergency response, relief distribution, and infrastructure protection, with limited operational planning for post-acute rehabilitation and long-term functional recovery. While Bangladesh has developed strong institutional capacity for cyclone and flood preparedness, similar investments in earthquake-specific rehabilitation planning are largely absent. This gap is particularly concerning given rapid urbanization, high population density, and widespread non-engineered construction in cities such as Dhaka and Chattogram, which modelling studies suggest could generate overwhelming numbers of injured survivors even after a moderate-magnitude earthquake.<sup>20,51</sup>

The Bangladesh context also highlights broader systemic challenges common to LMICs, including limited rehabilitation workforce density, uneven geographic distribution of services, and barriers to access for vulnerable populations. Evidence from South Asia and other LMIC settings shows that people with pre-existing disabilities, older adults, and socioeconomically disadvantaged groups are disproportionately affected by disasters when rehabilitation and disability-inclusive planning are neglected. Without proactive integration of rehabilitation

into preparedness plans, earthquakes risk exacerbating existing inequities and creating a prolonged disability burden that strains families, communities, and the national economy.<sup>52</sup>

Importantly, lessons from regional and international experience suggest feasible and scalable strategies for Bangladesh. These include incorporating rehabilitation professionals into disaster preparedness committees, developing national guidelines for post-earthquake rehabilitation pathways, strengthening surge capacity through training of general physicians and therapists in basic disaster rehabilitation principles, and ensuring continuity of care through community-based rehabilitation and referral networks. Aligning national strategies with international frameworks such as the Sendai Framework and WHO rehabilitation guidance would further support a shift from reactive to resilience-oriented disaster management.<sup>31,39,40</sup>

In summary, global and regional evidence unequivocally demonstrates that rehabilitation is a determinant of long-term outcomes following earthquakes. For Bangladesh, the absence of a recent catastrophic earthquake should not be interpreted as reassurance but as an opportunity to prepare proactively. Integrating physiatrist-led rehabilitation into earthquake preparedness is essential to reduce avoidable disability, promote functional recovery, and strengthen health system resilience. Failure to do so risks repeating the costly lessons observed across South Asia, where delayed rehabilitation translated into long-term human, social, and economic loss.<sup>53</sup>

## Limitations

This narrative review is subject to selection bias and does not provide quantitative estimates of rehabilitation burden specific to Bangladesh. Further research is needed to model injury patterns and rehabilitation demand following hypothetical earthquake scenarios.

## Conclusion

Bangladesh faces a credible earthquake threat despite the absence of a recent catastrophic event. Lessons from South Asia clearly demonstrate that earthquakes generate substantial long-term disability, necessitating early and sustained rehabilitation. Integrating physiatrist-led rehabilitation preparedness into disaster management frameworks is essential to minimize disability, enhance functional recovery, and build national resilience. Rehabilitation should no longer be viewed as an adjunct but as a core pillar of earthquake preparedness in Bangladesh.

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