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**Article:**

Cartwright, C., Hall, M. and Lee, A.C.K. (2017) The changing health priorities of earthquake response and implications for preparedness: a scoping review. *Public Health*, 150. pp. 60-70. ISSN: 0033-3506

<https://doi.org/10.1016/j.puhe.2017.04.024>

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# **The Changing Health Priorities of Earthquake Response and Implications for Preparedness: A Scoping Review**

## **ABSTRACT:**

### **Objectives:**

Earthquakes have substantial impacts on mortality in low and middle income countries (LMIC). The academic evidence base to support Disaster Risk Reduction activities in LMIC settings is however limited. We sought to address this gap by identifying the health and healthcare impacts of earthquakes in LMICs and to identify the implications of these findings for future earthquake preparedness.

### **Study Design:**

Scoping review.

### **Methods:**

A scoping review was undertaken with systematic searches of indexed databases to identify relevant literature. Key study details, findings, recommendations or lessons learned were extracted and analysed across individual earthquake events. Findings were categorised by timeframe relative to earthquakes and linked to the disaster preparedness cycle, enabling a profile of health and healthcare impacts and implications for future preparedness to be established.

### **Results:**

Health services need to prepare for changing health priorities with a shift from initial treatment of earthquake related injuries to more general health needs occurring within the first few weeks. Preparedness is required to address mental health and rehabilitation needs in the medium to longer term. Inequalities of the impact of earthquakes on health were noted in particular for women, children, the elderly, disabled and rural communities. The need to maintain access to essential services such as reproductive health and preventative health services were identified. Key preparedness actions including identification of appropriate leaders, planning, training of staff. Testing of plans were advocated within the literature with evidence that this is possible in LMIC settings.

### **Conclusions:**

Whilst there are a range of health and healthcare impacts of earthquakes, common themes emerged in different settings and from different earthquake events. Preparedness of healthcare systems is essential and possible, in order to mitigate the adverse health impacts of earthquakes in LMIC settings. Preparedness is needed at the community, organisational and system levels.

**Key words:** Earthquake, Disaster, Resilience, Preparedness, Health

## Introduction

Earthquakes are estimated to account for 36% of all global annual losses from natural hazards, equivalent to US \$113 billion<sup>1</sup>. Between 1980-2009 61 million people were affected by earthquakes with approximately 373,000 killed and 995,000 injured<sup>2</sup>.

Impacts are particularly felt in low and middle-income countries (LMICs). The consequences of earthquakes on resource-constrained countries with limited health services have been clearly demonstrated by the massive death tolls of recent earthquakes in Pakistan (2005)<sup>3</sup>, Haiti (2010)<sup>4</sup> and Nepal (2015)<sup>5</sup> (87000, 160000 and 9000 deaths respectively). Indeed, between 1990 and 2013, 85% of all earthquake mortality occurred in LMICs<sup>1</sup>.

The Sendai Framework for Disaster Risk Reduction<sup>6</sup> emphasises the importance of understanding the 'disaster risk' or potential health and healthcare impacts of hazards in order to be better prepared and thus mitigate impacts of any disaster. Disaster preparedness is a key priority area for action within the framework. However, the evidence base to support this is often from a humanitarian perspective, of a generic nature encompassing all disasters or all settings, or narrowly focussed on very specific areas of health impact.

Thus far, reviews have been carried out identifying immediate post-earthquake priorities in any country regardless of income status<sup>2</sup>, of public health interventions in a humanitarian crisis<sup>7</sup>, of operational humanitarian agencies in a post-earthquake low income country<sup>8</sup>, of acute medical complications associated with earthquakes<sup>9</sup>, of medical rehabilitation after natural disasters<sup>10</sup>, and of health effects associated with relocation after disasters<sup>11</sup>. Many are confined to a specific geographic area<sup>12,13</sup> whilst others have cited the lack of available good quality evidence<sup>10,11</sup>, a common problem encountered in disaster management research<sup>14-17</sup>.

Effective disaster preparedness and response are essential for mitigating the impacts of a disaster<sup>18</sup>. This relies on the availability of information and evidence to inform responders of the expected or actual impact. However, the consequences of disasters can vary significantly from country to country. This is in part likely to be influenced by the degree of resource constraints and type of disasters affecting a country. A better understanding of the anticipated health consequences of a disaster is essential to help inform disaster planning and response. To our knowledge there has been no comprehensive review of the health impacts of earthquakes in LMIC settings. Our scoping review seeks to address this issue and identify possible mitigating factors to guide future earthquake preparedness and response.

## Methods

### Scoping review

A scoping review was carried out using the framework developed by Arksey and O'Malley.<sup>19</sup> This uses a systematic search methodology whilst allowing for the review of a broader, less restrictive, range of evidence. We anticipated that most of the evidence was likely to be short reports<sup>14-17</sup>. Consequently, we intentionally adopted a more inclusive approach to include papers that might have been excluded in a more rigid systematic review format as we wanted to capture the full range of health impacts associated with this type of disaster. Inclusion criteria were developed and tested

prior to screening. We included articles relating to earthquakes from countries within the World Bank criteria for low and lower middle-income countries<sup>20</sup>; published from 1<sup>st</sup> January 1990 onwards to coincide with the International Decade for Natural Disaster Reduction<sup>21</sup>; published in English; with a primary focus on earthquakes and health and/or healthcare. Search strings were developed as detailed in Figure 1.

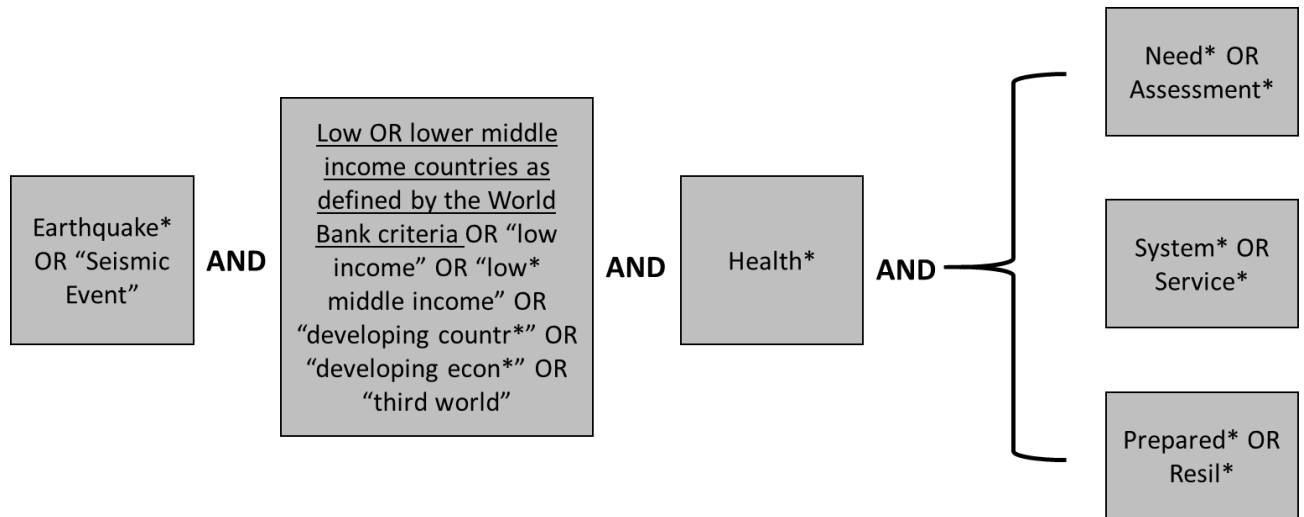


Figure 1 – Search Strings

Exclusion criteria were developed following an initial review of the literature, prior to screening by title and abstract. Articles were excluded where earthquakes were not the main disaster type under consideration, where the primary concern was international personnel, or where they were reporting the viability or suitability of different patient procedures or medical trials.

Searches were undertaken between 22<sup>nd</sup> March and 5<sup>th</sup> April 2016. Indexed databases searched included: CINHAL; EMBASE; Medline; Psycinfo; Scopus; Web of Science (Core Collection); Proquest (ASSIA; PILOTS; International Bibliography of Social Sciences; Dissertations and Theses UK & Eire; Dissertations and Theses A & I; Health and Safety Science Abstracts; COS Conference Papers).

Search results were screened initially by title and abstract, by a single reviewer. Where no abstract was available the record was included for full text review. Full text review was undertaken independently by two reviewers. Consensus was reached through discussion where disagreements occurred. Records which had neither full text nor abstract available were discounted; those with just abstract or conference poster presentation were included.

From the included studies, data was extracted on the time period covered by the study, study type, key findings, and key recommendations or lessons learned. All data was recorded in an Excel database. We analysed the findings, key recommendations or lessons learned from each earthquake event and descriptively coded. These codes were then organised by themes (physical health, mental health and healthcare) and categorised chronologically: preparedness (pre-disaster), 0-2 weeks, 2weeks - 6 months, and beyond 6 months post disaster. We also used the internationally-recognized four-stage disaster cycle (mitigation, preparedness, response and recovery) as the conceptual framework to help organise the codes. Summaries were then produced for each earthquake disaster, compared with each other and consolidated into this review. Extraction and coding were undertaken independently by two reviewers with findings collated and emergent themes identified through discussion. Discrepancies were resolved by discussion.

## Findings

### Study Identification and Selection

The literature search yielded 5831 unique records. After removing duplicates, 1595 were screened by title and abstract. Of these, 476 were selected for full text review for relevance. 152 were included in the final review as illustrated in Figure 2.

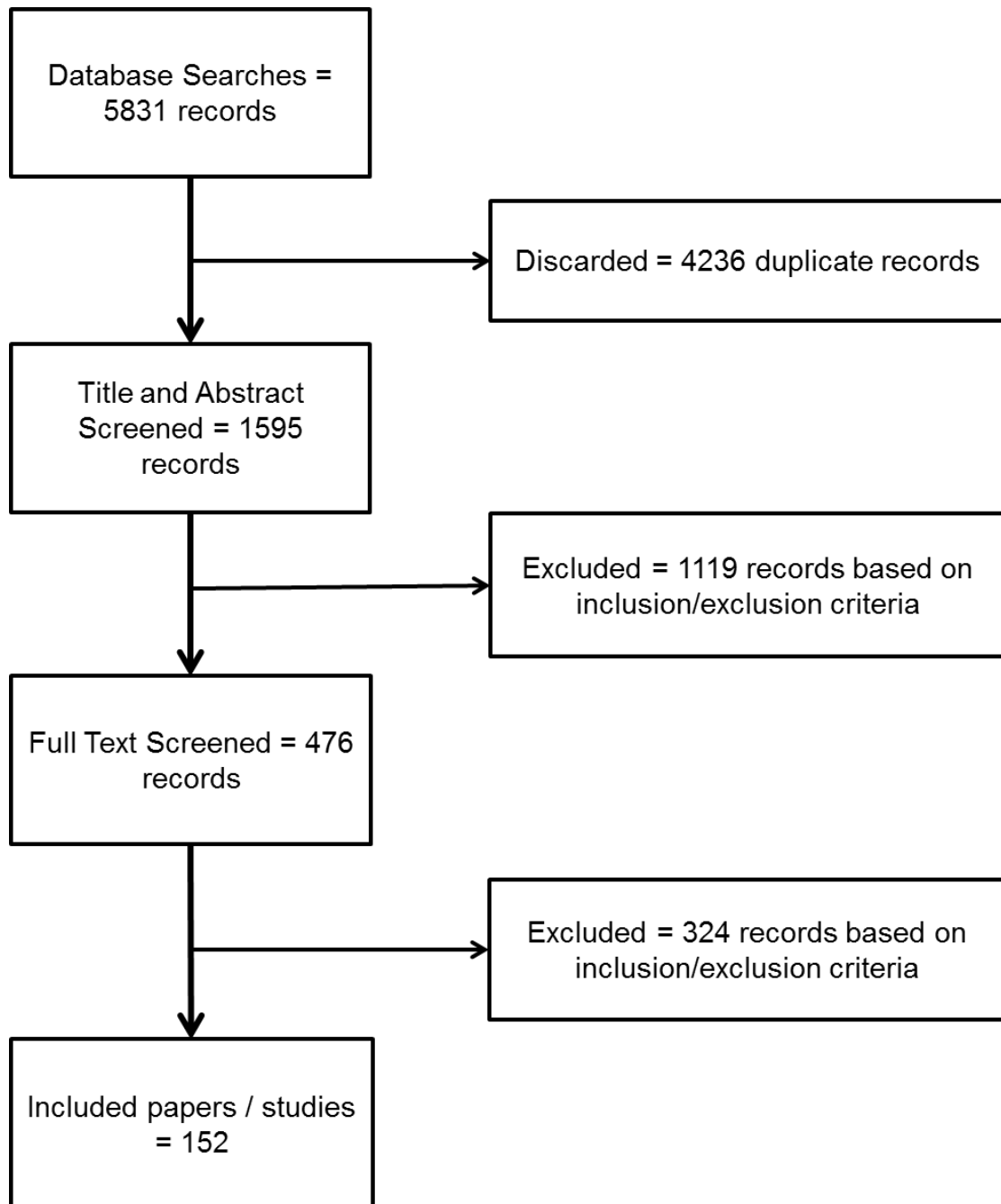


Figure 2: Papers included

### Study Characteristics

Table 1 details the distribution of studies by study design. 73% of all the studies were classed as “other”. They largely consisted of personal accounts and reports from the field. Cross-sectional studies accounted for 17% of total studies.

**Table 1: Breakdown of study characteristics**

<b>Study Design</b>	<b>Number of Studies</b>
Cross Sectional	26
Cohort	1
Ecological	4
Mixed Methods	6
Qualitative	2
Case Control	2
Other	111
<b>TOTAL</b>	<b>152</b>

The Haiti earthquake accounted for 51% of all reports, whilst the Kashmir earthquake (India and Pakistan) accounted for 27%. 63% of all studies covered the initial post-disaster period up to six months. Of the 135 studies reporting health issues (Table 2), over 63% (n=85) reported findings predominantly concerning physical health, 24% (n=32) on mental health and 13% (n=18) on healthcare issues.

### **Thematic analysis**

In the first two weeks there is a predominance of earthquake related injuries and consequent healthcare service demand. After these first few weeks a shift occurs to more routine population health needs emerging alongside ongoing care for those with earthquake related injuries. In the longer term, the health needs centred around rehabilitation, mental health and chronic health conditions (Figure 3).

**Table 2: Distribution of studies by time frame and major health theme**

Event	Total Number of Papers	Distribution of studies across time from earthquake occurrence					Distribution of studies across major themes#		
		Not defined	Pre-event	0 to 2 weeks	2 weeks to 6 months	6 months onwards	Physical Health	Mental Health	Health care
Armenia 1988*	10	-	-	2	2	9	3	7	1
Columbia 1999	1	-	-	1	1	-	1	1	1
El Salvador 2001	3	-	-	-	-	3	1	1	-
Haiti 2010	78	12	7	42	40	18	40	8	20
India (no date)~	1	-	1	-	-	-	-	-	1
India 1993	2	1	-	-	1	-	-	1	1
India 2001*	5	1	-	4	3	2	5	-	1
India 2005 (Kashmir)	4	-	-	1	2	1	3	1	1
Indonesia 2005	1	-	-	1	1	-	-	-	1
Indonesia 2006	4	1	1	1	1	3	1	2	1
Indonesia 2009	5	-	2	1	3	3	4	-	1
Nepal (no date)~	1	-	-	1	1	-	1	-	-
Nepal 1988	1	-	-	1	1	-	1	-	-
Nepal 2015*	4	1	1	1	2	-	1	2	1
Pakistan (Kashmir) 2005	38	7		17	18	12	24	9	8
<b>TOTAL</b>	<b>154</b>	<b>23</b>	<b>12</b>	<b>73</b>	<b>76</b>	<b>51</b>	<b>85</b>	<b>32</b>	<b>18</b>

Note: \* 1 paper covered events in Armenia 1988, India 2001 and Nepal 2015 and is therefore counted three times; ~ refers to preparedness papers therefore not attributed to a specific earthquake event; # the total across major themes is lower than the total number of papers as some papers were general commentary or opinion pieces containing insufficient information to be categorised.

## Earthquake related injury

Trauma injuries, particularly to extremities such as arms and legs<sup>22-29</sup>, dominated reports in the first two weeks following an earthquake. Wound debridement<sup>22, 24, 30-32</sup> comprised a large proportion of procedures undertaken, with general wound infections<sup>30, 33-35</sup>, some specifically related to tetanus<sup>36, 37</sup>, requiring management and ongoing care for up to 8 months<sup>26</sup>. Late presentations of earthquake related injuries were often for complications associated with infections due to the lack of treatment<sup>33, 38</sup>.

Relative to total injuries and presentations, the numbers of spinal cord injuries<sup>24, 39, 40</sup> and amputations<sup>22, 27, 37, 41, 42</sup> reported were low. The medical capacity and expertise to manage such cases was however, often limited and positive outcomes were not assured<sup>3</sup> with one study reporting mortality as the most likely outcome for quadraplegics<sup>43</sup>. Countries had to develop rehabilitation services<sup>39, 44-47</sup> to deliver rehabilitation over the long term<sup>3, 43, 47</sup>.

Issues associated with the quality of care in the initial response were frequently reported. There were infection prevention and control<sup>29, 48, 49</sup> concerns raised as the environment in which healthcare was delivered was often compromised. There was also often a lack of appropriate separation of adult and paediatric patients<sup>35</sup>. The absence of agreed triage protocols led to inconsistent approaches and ethical dilemmas for staff<sup>50</sup> regarding who to treat and when. In some instances prioritisation was by patient need<sup>37, 51, 52</sup>, yet in others through a combination of patient need and the need to make the best use of available resources<sup>40, 50</sup>.

The lack of appropriately trained and skilled staff created problems<sup>29, 40, 44, 53</sup> particularly for certain injury types. Inappropriate pre-hospital<sup>47</sup> and hospital care of spinal cord injury patients led to the development of pressure sores<sup>39, 54</sup> and urinary tract infections<sup>44, 54</sup> whilst the use of interventions inappropriate to the resource setting by some newly arriving international specialist staff led to unnecessary post-operative complications<sup>26, 29</sup>. International staff tended to depart after the initial response leading to difficulties in providing ongoing post-operative care for patients they had treated<sup>26, 55</sup>.

## Changing health priorities

After the initial post-earthquake period, health needs changed from earthquake-related ailments to more routine presentations<sup>35, 41, 56-59</sup>. More infections were seen, in part attributed to living conditions, including respiratory infections<sup>33, 56, 59-61</sup>, gastrointestinal illnesses<sup>56, 59, 62-65</sup>, skin conditions<sup>56, 59, 61, 64</sup>, ocular infections<sup>59</sup> and urinary tract infections<sup>56, 59</sup>. The need for continued delivery of primary healthcare to meet these health needs was repeatedly emphasised<sup>56, 65, 66</sup>. The importance of surveillance systems to identify infectious disease threats were identified<sup>67-69</sup> as was the requirement to ensure safe water supplies in order to prevent further infections<sup>4, 70</sup>. Increases in mortality and morbidity from non-communicable chronic diseases were initially reported amongst earthquake survivors<sup>71</sup>. The need for appropriate management of these chronic diseases<sup>63, 65</sup>, including the ongoing provision of antiretroviral therapy<sup>72, 73</sup>, was highlighted.

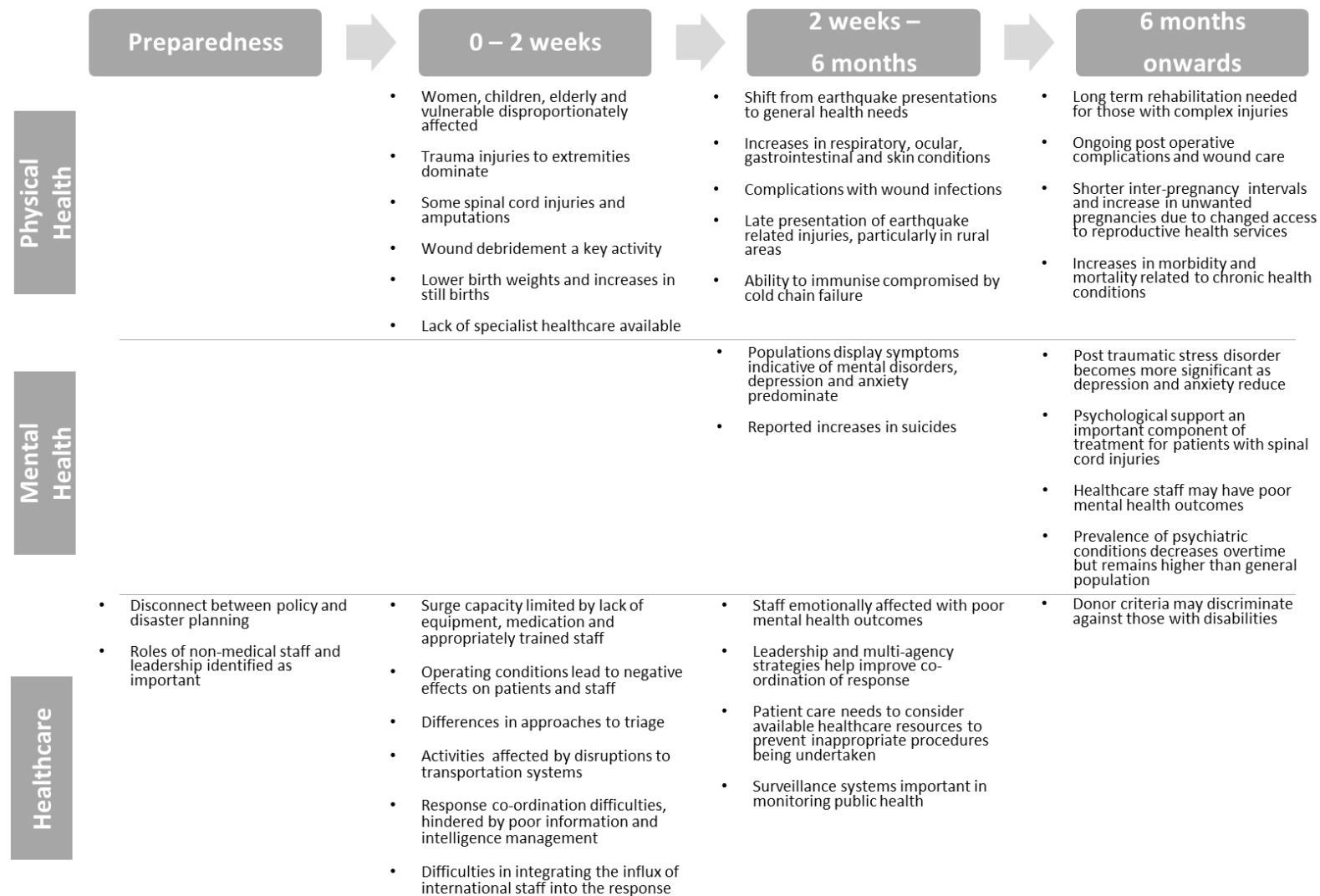


Figure 3 – Summary of Key Findings

## Mental health

Mental health issues increased in prominence following the immediate post-earthquake period<sup>74-77</sup>. Initially, depression and anxiety were predominant<sup>78-80</sup>. However, over time these declined but post-traumatic stress disorder became an increasing issue after the first six months<sup>80, 81</sup>. One study from Nepal reported a 43% increase in recorded suicides in the three months following the earthquake<sup>82</sup>. Longer term studies from Armenia, up to 23 years later, demonstrated a higher prevalence of psychiatric conditions in those exposed to the earthquake compared to those not exposed<sup>83</sup> with conditions such as psychosis and obsessive compulsive disorder being more prevalent<sup>84</sup>. The importance of other services that impact on mental health were also recognised including the value of early re-establishment of education<sup>62</sup> and social networks<sup>81, 85</sup>. The importance of education is highlighted particularly for women and children, with both vulnerable groups often overlooked in the disaster response<sup>86-88</sup>.

## Reproductive health

The immediate impacts reported on reproductive health included lower birth weights<sup>89, 90</sup> and higher proportions of still births<sup>90</sup>. In the medium term, reproductive outcomes continued to be affected with shorter inter-pregnancy intervals<sup>89</sup>, increases in unplanned pregnancies<sup>89, 91</sup> and an overall increase in births<sup>92</sup>. Also reported were reductions in access to reproductive health services as a consequence of the earthquake<sup>91, 93-95</sup>.

## Inequality of impact

Earthquake impacts were not equal. Women, children<sup>96</sup> and the elderly were identified as being more likely to have died at the time of the earthquake<sup>97</sup>. Women<sup>27, 38, 39, 47, 59, 67, 98-102</sup>, children<sup>38</sup>, elderly<sup>38</sup> and those with disabilities<sup>103</sup> were also reported as being disproportionately affected both with regard to earthquake-related injuries as well as other more routine health presentations. This occasionally extended to access to donor support with one study reporting that people with certain disabilities were unable to access some services due to external donor criteria restrictions<sup>103</sup>. Women<sup>85, 104-106</sup>, the elderly<sup>81</sup> and those with a history of exposure to violent events<sup>80</sup> were also reported to be at increased risk of adverse mental health outcomes.

The needs of those outside of official response arrangements, such as those in unofficial displaced persons camps, were also higher due to a lack of comparable health services<sup>63, 107</sup>. More broadly, inequalities between urban and rural populations were also observed with timely care often lacking for the most vulnerable in rural areas<sup>108, 109</sup>.

## Coordination response and logistics

Co-ordination difficulties in the response phase were frequently reported both within and between healthcare services<sup>41, 43, 55, 103, 107, 110</sup>. These difficulties were exacerbated by poor information and intelligence management<sup>35, 51, 103</sup>. As the initial response developed, co-ordination improved<sup>99, 111</sup> with the development of single healthcare response arrangements<sup>35, 51, 64</sup> with master health facilities lists<sup>111</sup> being identified as useful co-ordination tools. Logistical difficulties due to travel disruption hindered the ability to deliver care<sup>25, 46, 108, 112</sup> and transport patients<sup>29, 47</sup>. Patients travelled to functioning healthcare facilities on the periphery of areas most impacted by earthquakes, increasing demands on these services<sup>42, 113</sup>, with some patients travelling great distances to access treatment<sup>61, 113</sup>. The ability to respond immediately following an earthquake, through the provision of surge capacity, was often limited by the availability of physical resources<sup>25, 35, 40, 51, 100, 108</sup> including access to both medications<sup>25, 48, 114, 115</sup> and medical equipment<sup>25, 44, 48, 49, 114</sup>.

## Healthcare systems and staff

Policies requiring the development of health service disaster planning were often not implemented at a local level leading to a preparedness gap<sup>116</sup>. Consequently, in some of the earthquake disasters, health systems experienced multiple disruptions such as cold chain failure that compromised preventative healthcare including tetanus immunisations<sup>40</sup>. Donations of medication and medical equipment were often inappropriate<sup>64, 117, 118</sup>, despite international guidelines being in place to avoid such situations.

As reported earlier, the lack of appropriately trained and skilled staff in the initial response<sup>40, 44, 53, 118</sup> had negative effects on the quality of care. Specialist staff required included specialist paediatric staff<sup>62, 119</sup>, trained non-medical support and administrative staff<sup>90</sup>, physical and occupational therapists<sup>40, 46, 118, 120</sup>, multi-disciplinary teams<sup>51, 99</sup>, medicines management staff and logistics specialists<sup>118, 120</sup>. Rehabilitation staff were also considered to play an important role in facilitating patient discharge<sup>5</sup>. The means to care and support staff were also highlighted as important with reports of staff being negatively affected through both the earthquake and their work in responding to it<sup>53, 75, 76, 115, 121, 122</sup>.

The importance of the role of non-medical staff and non-clinical leadership in co-ordinating and facilitating the disaster response was also highlighted<sup>123</sup>. In addition it was also reported that staff may themselves be emotionally affected by their own personal earthquake experiences<sup>75, 115</sup> and feel ill prepared to respond to patient needs<sup>53</sup>. Indeed, some healthcare staff were reported to have poor mental health outcomes afterwards<sup>76, 122</sup>, particularly those working in public sector healthcare settings<sup>121</sup>.

## **Discussion**

### **Implications for Preparedness**

This review highlights the common health impacts that occur following an earthquake in a LMIC<sup>16</sup>. The findings have important implications for earthquake preparedness at the community, organisational and national levels. Indeed, a large proportion of the reviewed literature recognised the need for pre-planning, preparedness, training and exercising prior to an earthquake. Our chronological thematic analysis naturally aligns to the Disaster Preparedness Cycle (Figure 4) and it is useful to discuss these findings and their implications on preparedness in relation to this cycle. Where applicable these have been linked to existing components of the World Health Organisation toolkit for assessing health system capacity for disasters<sup>124</sup>.

#### *Systems approach to preparedness*

The preparedness cycle applies to all levels of response from community to international. However, in LMICs a disconnect between policy and practice often exists<sup>125</sup> and may manifest through the lack of co-ordinated response planning, organising, exercising and reviewing of disaster response by the different levels of the system. Whether a lack of anticipation of common injury types, the shift from immediate to routine health needs or the need for long term, ongoing mental health support, a system wide, multi-level approach as advocated by WHO<sup>124</sup>, would go some way to enhancing preparedness and thus response to earthquakes.

In addition, disaster preparedness requires effective leadership and management. Leadership does not always mean medical leadership: several studies identified by our review specifically highlight

the need for leadership not to be solely centred within the medical response<sup>123</sup>. Leadership and governance have been highlighted as one of the six key functions by the WHO<sup>124</sup> and identifying suitable situational leadership *at all levels* forms a central part of a systematic approach to disaster preparedness.

#### *Need for systematic planning*

Meticulous planning forms the bedrock of the disaster cycle. If planning is poor, unsystematic or only at a single level, then it is likely that all other aspects of the cycle will also fail. Our review has identified a number of common themes that are important to consider at the planning stage of disaster preparedness. These include identifying the population's pre-existing health needs, the availability and distribution of staff (including specialist, international, and non-health staff), surge planning and changing health priorities. Systematic planning allows for the multi-level systematic identification of areas of need and gaps in service provision or potential vulnerabilities that require particular input or preparation<sup>86</sup>. We would advocate the use of our summary of key themes (Figure 3) alongside the WHO healthcare assessment toolkit<sup>124</sup> to support this planning process. Other issues, such as that of inappropriate medicine donations are also covered by existing WHO guidelines<sup>126</sup> and are important considerations of the planning process.

#### *Importance of developing system capacity and capabilities*

As observed, one common vulnerability identified was the lack of disaster management training for staff<sup>34, 47, 53, 66, 78, 115</sup>. Our review also highlighted a lack of disaster exercise or testing of plans. All elements of preparedness need validating through emergency exercises<sup>34, 47, 49, 64, 123, 127</sup> which can in turn help inform and refine the development of future response arrangements. Experience from Nepal<sup>123</sup> demonstrates that it is possible to conduct such exercises in low resource settings and additionally illustrates the value of identifying previously unanticipated issues.

# Disaster preparedness at the Community, Agency and System Levels

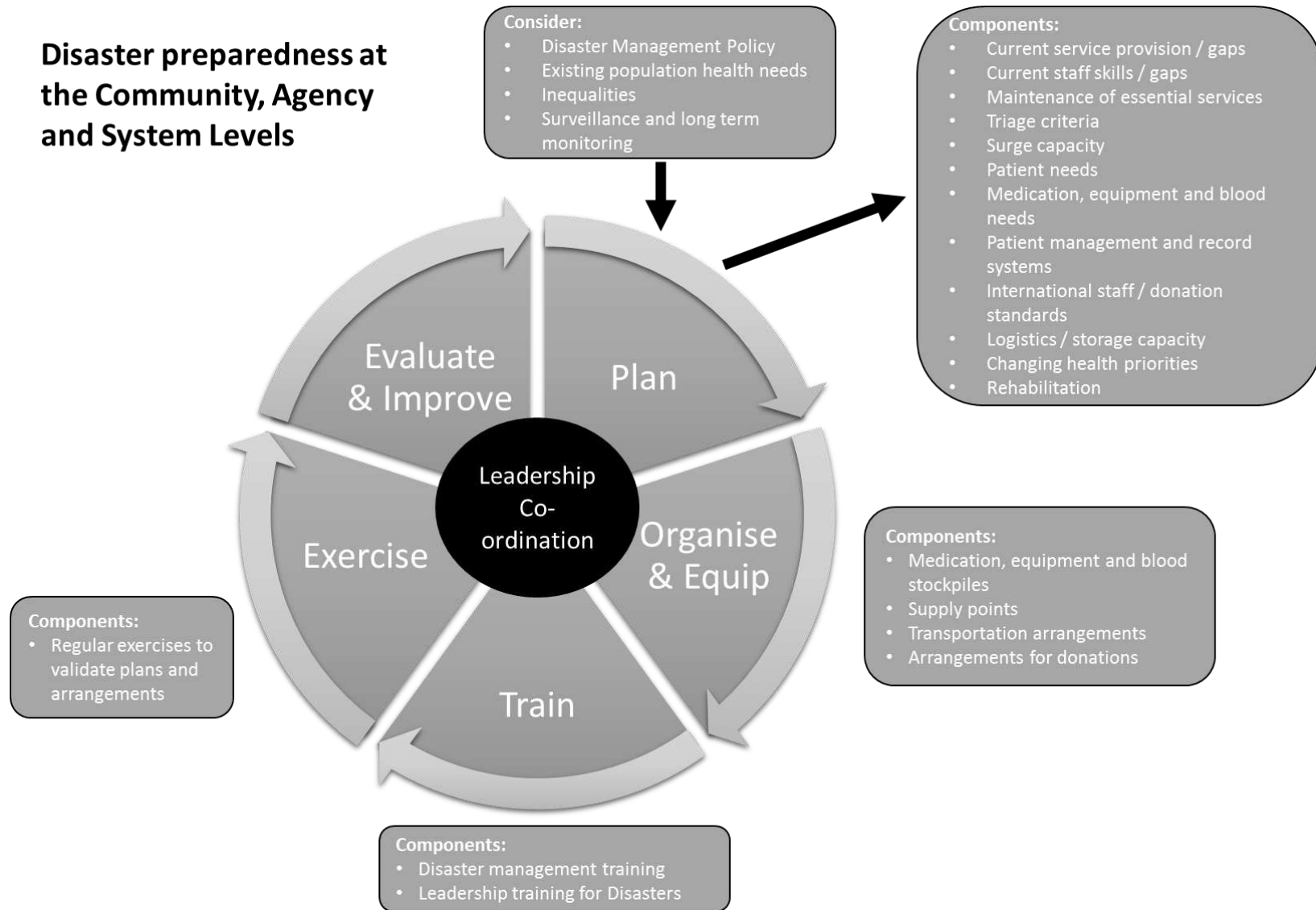


Figure 4 – Implications for Preparedness

### **Implications for research**

While international declarations, frameworks and policies to strengthen disaster preparedness in health systems have been in place for a number of years<sup>124</sup> it is clear from the evidence considered in this review and wider assessments<sup>87</sup> that there remains much to do. The lower quality of studies within this field have previously been reported<sup>16</sup> and our review has identified similar issues. While standards for reporting have been suggested<sup>14</sup> there are no universally agreed quality frameworks to assess such literature. The development of such frameworks would allow a more considered review of the evidence base in the future.

### **Limitations**

One acknowledged limitation of this review is that we only searched for papers in English or that had English translations accompanying them as was the case of several papers from Pakistan. In doing so it is possible some relevant publications may have been excluded. However, the review did use a broad inclusive approach to sampling and through the large number of papers identified it is likely that most if not all emergent insights will have been captured. By virtue of the large volume of literature considered and the consistency of themes identified across different countries and earthquake events suggest that our findings are fairly robust. That said, given that each earthquake event is unique, the value of in-depth analysis of one specific event may be less useful in informing broader, general planning for future events elsewhere and contextualisation of our findings will be required.

## **Conclusion**

Our review has shown that there are a wide range of health and healthcare impacts following earthquakes in LMICs with different manifestations and priority over time. Whilst the settings may differ, there are many common themes emerging from different earthquake events. It is clear, whilst there are significant negative impacts of earthquakes, preparedness is vital to mitigate the impacts of earthquakes.

## **Ethical Approval**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## **Funding**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## **Competing Interests**

Author AL is an associate editor of the journal.

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