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REVIEW ARTICLE

Medical Rehabilitation in Natural Disasters: A Review

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Abstract

Objective: To present an evidence-based overview of the effectiveness of medical rehabilitation intervention in natural disaster survivors and outcomes that are affected.

Data Sources: A literature search was conducted using medical and health science electronic databases (PubMed, MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature, Cochrane Library, PsycINFO) up to September 2014.

Study Selection: Two independent reviewers selected studies reporting outcomes for natural disaster survivors after medical rehabilitation that addressed functional restoration and participation.

Data Extraction: Two reviewers independently extracted data and assessed the methodologic quality of the studies using the Critical Appraisal Skills Program's appraisal tools.

Data Synthesis: A meta-analysis was not possible because of heterogeneity among included trials; therefore, a narrative analysis was performed for best evidence synthesis. Ten studies (2 randomized controlled trials, 8 observational studies) investigated a variety of medical rehabilitation interventions for natural disaster survivors to evaluate best evidence to date. The interventions ranged from comprehensive multidisciplinary rehabilitation to community educational programs. Studies scored low on quality assessment because of methodologic limitations. The findings suggest some evidence for the effectiveness of inpatient rehabilitation in reducing disability and improving participation and quality of life and for community-based rehabilitation for participation. There were no data available for associated costs.

Conclusions: The findings highlight the need to incorporate medical rehabilitation into response planning and disaster management for future natural catastrophes. Access to rehabilitation and investment in sustainable infrastructure and education are crucial. More methodologically robust studies are needed to build evidence for rehabilitation programs, cost-effectiveness, and outcome measurement in such settings.

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Disaster is defined by the World Health Organization (WHO) as "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(p6)] In general, disaster can be classified into the following: natural, technologic (eg, nuclear accidents), and complex humanitarian emergencies (eg, wars). A natural disaster is defined as "a 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(p5)] Natural disasters can be classified by etiology (table 1).

Natural disasters may result in significant loss of life and long-term disability from severe injuries, including spinal cord injury

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Table 1 Classification of natural disasters

Subgroup	Definition	Main Type
Geophysical	Events originating from solid earth	Earthquake, volcano, mass movement (dry)
Meteorologic	Events caused by short-lived/small- to mesoscale atmospheric processes (spectrum from minutes to days)	Storm
Hydrologic	Events caused by deviations in the normative water cycle and/or overflow of bodies of water caused by wind setup	Flood, mass movement (wet)
Climatologic	Events caused by long-lived/meso- to macroscale processes (in the spectrum from intraseasonal to multidecadal climate variability)	Extreme temperature, drought, wildfire
Biologic	Disaster caused by the exposure of living organisms to germs and toxic substances	Epidemic, insect infestation, animal stampede

NOTE. Adapted from the Centre for Research on the Epidemiology of Disasters.[2]

(SCI), traumatic brain injury, limb amputation, fracture, peripheral nerve injury, crush injury, and psychological impairment.[3,4] It is estimated that >100,000 lives are lost annually as a result of natural disasters.[5] The incidence of morbidity and mortality because of natural disasters varies based on nature and the amplitude of disasters and various human and environmental factors.[6] Natural disasters create a large socioeconomic burden with significant impact on health care costs, social infrastructure, and the environment.[3,4] The number of severe natural disasters has escalated in recent years, threatening WHO sustainable development and poverty reduction initiatives.[7] Natural disaster—related economic losses have increased 10-fold in the last 4 decades, with estimated costs of >$100 billion annually.[8] Moreover, most natural disasters and disaster-related deaths occur in low-resourced regions (estimated 97%) with significant proportionate economic loss and long-term negative consequences on human development.[4,5]

Saving lives immediately after a natural disaster is an urgent priority. Current data show a significant increase in the numbers of injuries sustained relative to mortality,[6] indicating that medical and nonmedical rehabilitation (ie, restoration of rehabilitation services, infrastructure) are integral to comprehensive disaster management.[9,10] Medical rehabilitation is "a set of measures that assists individuals who experience or are likely to experience disability to achieve and maintain optimal physical, sensory, intellectual, psychological and social functioning in interaction with their environment."[11(p96)] Primary goals of medical rehabilitation are to improve activity and participation within contextual factors (personal, environmental).[12] This includes management of acute injury, optimization of functional capabilities (including cognitive and neuropsychological function), and social reintegration.[3,4] Further, those with preexisting disabilities are at higher risk of mortality and additional comorbidities during natural disasters.[6] With an increasing frequency of natural disasters, there is greater focus on the role of rehabilitation in disaster management. The disaster rehabilitation continuum model (fig 1) includes a response phase based on individual clinical needs for acute and core rehabilitation stages (including community-based rehabilitation [CBR]) and comprises response, recovery, mitigation, and preparation phases.[3] The aim is to enhance community health through an organized system of injury, acute care, and longer-term rehabilitation, fully integrated into the public health system of a local community.[3,6,9]

The role of a rehabilitation medicine physician in any disaster event should be integrated into the multidisciplinary field medical team,[6] which should include nursing and allied health disciplines (box 1).[6,12] The critical role of this team after a disaster is directed toward conservation of body function, activity, and participation domains defined by the WHO's *International Classification of Functioning, Disability and Health* (ICF) framework.[6,13] Rehabilitation technical standards (including foreign medical teams), core standards, and guiding principles should be followed for appropriate care.[14] This process is multidimensional and reflects evolving clinical requirements, transitioning from emergency surgical support in established facilities to less acute rehabilitative input for injuries and complications in the community.[4] There is evidence that patients treated in services with rehabilitation facilities after natural disasters have reduced length of hospital stay, fewer complications, and better clinical outcomes compared with patients in centers with no rehabilitation physician supervision.[6]

Disaster health research encompasses the traditional disaster cycle comprising preparedness, response, recovery, and mitigation phases.[15] Most disaster literature addresses recovery, including rehabilitation service infrastructure.[9] Empirical evidence on medical rehabilitation after natural disasters is increasing, and various studies evaluate effectiveness of rehabilitation in survivors; however, most reports are narratives.[3,6,16] Nevertheless, there is a lack of studies systematically analyzing various rehabilitation interventions in a natural disaster settings. The benefit and harms associated with these interventions need to be established comprehensively to guide disaster management teams and policymakers. This review, therefore, systematically assessed the effectiveness, safety, and cost-efficiency of medical rehabilitation intervention in survivors of natural disasters, focusing on approaches that are effective (type of rehabilitation intervention) and outcomes that are affected (functional activity, participation). This study also explored gaps in evidence for medical rehabilitation in this area.

List of abbreviations:

ADL activities of daily living
CASP Critical Appraisal Skills Program
CBR community-based rehabilitation
CI confidence interval
ICF *International Classification of Functioning, Disability and Health*
MBI Modified Barthel Index
NGO nongovernmental organization
PTSD posttraumatic stress disorder
QOL quality of life
SCI spinal cord injury
WHO World Health Organization

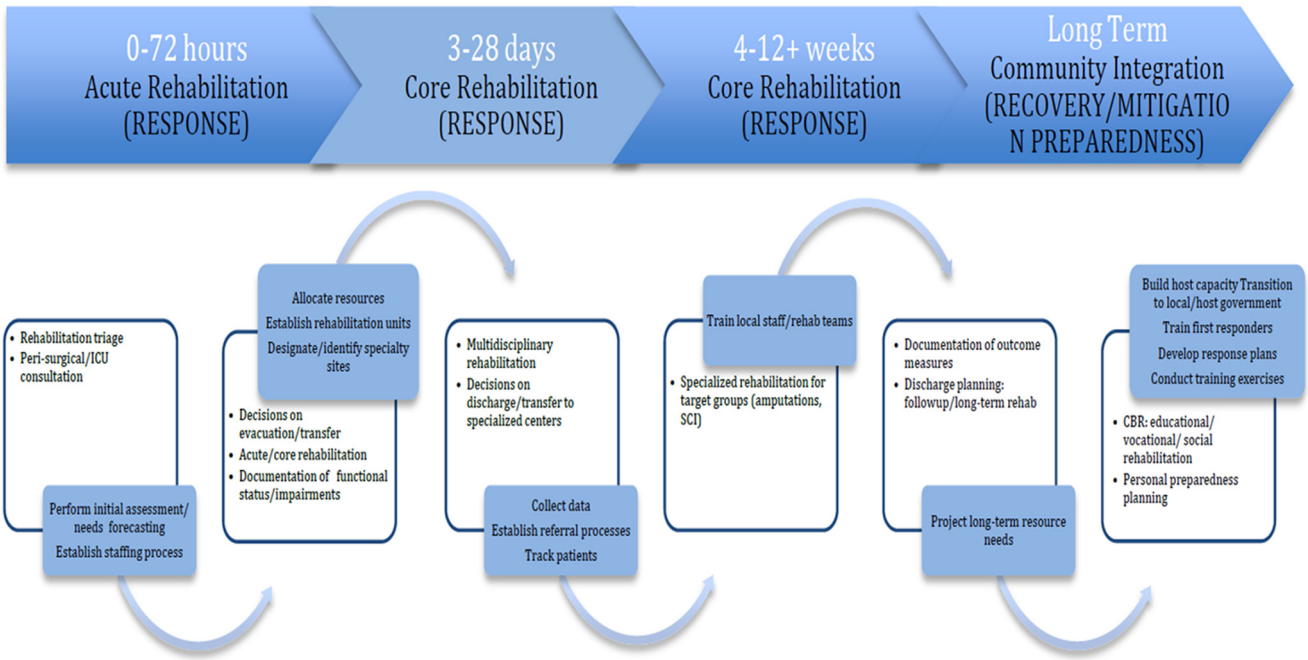

Fig 1 Disaster rehabilitation continuum by time postdisaster and stage (phase). Unshaded regions indicate key clinical activities; shaded regions, nonclinical activities. Abbreviation: ICU, intensive care unit. Adapted from Elsevier.[3]

Methods

A comprehensive, integrated approach was used to review the literature (peer review, gray literature) for medical rehabilitation interventions in natural disasters. A search of the peer-review literature was conducted using medical and health science electronic databases (MEDLINE, PubMed, Embase, Cumulative Index to Nursing and Allied Health Literature, PsycINFO, Cochrane Library) from 2000 to September 2014. The terms natural disaster, disaster management, and rehabilitation interventions, with related phrases, were used. Medical Subject Headings search terms was used for all databases, and a keyword search was used if Medical Subject Headings terms were not available (see appendix 1 for full search details). Publication bias was minimized by sourcing unpublished data where possible.[17] Bibliographies of identified articles were searched, and a manual search was done of relevant journals for additional references. A search of the gray literature was conducted using relevant Internet search engines and websites, including the Center for International Rehabilitation Information and Exchange Database of International Rehabilitation Research, System for Information on Grey Literature in Europe, New York Academy of Medicine Grey Literature Database, WHO Libraries, National Quality Measures Clearinghouse, and Google Scholar. Various health care institutions and governmental and nongovernmental organizations (NGOs) associated with disaster management were also consulted for relevant studies. Authors and known experts in the field were also contacted.

Inclusion and exclusion criteria

All studies that reported medical rehabilitation interventions and associated data in which victims of natural disasters participated were eligible for inclusion, irrespective of study design. Qualifying data included health outcomes (ie, functional restoration, improved symptoms/impairments, participation), health care processes, safety, and economic outcomes (associated costs and resource utilization). Studies involving other disaster

Box 1 Potential roles of a rehabilitation medicine physician after disaster[4,6]

- Coordinate member roles depending on context of the victims' rehabilitation needs and postdisaster environment.
- Participate in victim triage, perioperative, and postoperative consultation.
- Participate in mobile community services, (eg, postoperative follow-up, triage, treating persons with disabling injuries not presenting to hospital facilities).
- Coordination and work with local health care providers, patients, families, and community volunteers in support of community-based rehabilitation programing efforts (eg, prescription and use of assistive devices, mobility aids, adaptive technologies).
- Training team members and local providers in various settings across the care continuum.
- Develop host rehabilitation service provision capacity by supporting establishment of structured training programs.
- Coordinate with host rehabilitation service providers, disaster managers, and health officials to develop additional rehabilitation infrastructure programs for long-term care of disaster victims.
- Planning for rehabilitation infrastructure and response for future disasters.

types in which data for natural disasters were reported were also included.

Studies were excluded if they did not report on medical rehabilitation interventions and evaluated outcomes related to disaster response only or reported medical rehabilitation physical infrastructure or technical developments. Studies reporting epidemiology of injury and disability or the impact of natural disasters on health systems were excluded because these have been reported elsewhere.[6] Non-English language studies, theses, systematic/narrative reviews, editorials, case reports, conference proceedings, and studies conducted before year 2000 were excluded.

Study selection and data extraction

Two reviewers (B.A., F.K.) independently screened all identified study titles and abstracts for inclusion based on the selection criteria. Any disagreements were resolved by consensus discussion. A standard proforma created a priori was used to extract data from studies that met the eligibility criteria, which included study characteristics (publication date and country, study type, sample characteristics, outcome measures) and intervention characteristics (type, intensity, domains, settings, delivery mode and duration). Additional description of rehabilitation interventions was obtained from the study corresponding author where necessary.

Two authors (F.K., B.A.) independently assessed the methodologic quality and grade of evidence of included studies with the Critical Appraisal Skills Program (CASP) tool.[18] The CASP tool uses a systematic approach to appraise different study designs from the following domains: study validity, methodologic quality, presentation of results, and external validity.[18] One item from all CASP checklists (Can the results be applied to the local population?) and another form, cohort/case control studies checklist (Do the results of this study fit with other available evidence?), were not included because the focus of this review was not tied to a specific local population and the purpose was to compare results across studies.[19] The articles were graded independently, and any disagreements were resolved through consensus. Each of the items from the checklists were judged with yes (low risk of bias, score 1), no (high risk of bias), or cannot tell (unclear or unknown risk of bias, score 0). Total scores were used to grade the methodologic quality of each study assessed (maximum score of 10 for cohort studies and randomized controlled trials, maximum score of 9 for case-control studies).[18,19] All outcomes were categorized according to the WHO's ICF framework,[13] and reporting guidelines for systematic reviews were followed.

Results

The combined searches retrieved 2766 published titles and abstracts, of which 2751 were screened after removal of duplicates. Thirty-four abstracts met preliminary inclusion criteria, and full texts of these articles were assessed; 19 of these were excluded because of inappropriate study design (systematic reviews, narrative reviews, commentaries) or because they were not related to natural disasters. Four additional relevant articles were identified from bibliographies. Ten studies (2 randomized controlled trials, 8 observational studies), which reported medical rehabilitation interventions after natural disasters, met the inclusion criteria for this review. The study selection process is summarized in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram (fig 2).

Study characteristics

The characteristics of the 10 included studies are summarized in table 2. Most studies (n=8) were conducted in China and evaluated different cohorts of survivors from the 2008 Sichuan earthquake. Further, 2 studies evaluated survivors of the 2004 tsunami in India and Sri Lanka. Overall, these studies included 2013 participants (range, 22−510; median, 166). Participants' ages ranged from 9 to 76 years, and most were women (1 study included only survivors who were women[20]). Three studies evaluated rehabilitation interventions in cohorts of limb fracture victims,[21-23] 2 included SCI survivors,[24,25] 1 evaluated newly diagnosed posttraumatic stress disorder (PTSD) victims,[26] and 1 included school children.[27]

Rehabilitation interventions and outcome measures description

Table 3 summarizes the rehabilitation interventions in included studies. Institution-based rehabilitation programs were evaluated in 6 studies,[21-26] 3 studies evaluated CBR,[20,27] and 1 study evaluated both institution-based rehabilitation and CBR.[28] The intervention types varied and ranged from comprehensive multidisciplinary rehabilitation programs to structured mental health community programs. Two studies conducted a comparative analysis of early and late rehabilitation interventions with control groups with usual care only.[22,28] Most rehabilitation programs used physical and/or psychological components. Duration and intensity of the interventions varied and ranged from 2 to 12 weeks (4 studies[22-24,28] did not report rehabilitation duration). Follow-up period and outcome measures used also varied between trials. Details of assessment time points and outcome measures in each trial categorized based on ICF framework are tabulated in table 4.

Study quality assessment

Table 5 provides a quality assessment of the included studies using the CASP tool.[18] The methodologic quality of included studies varied, and CASP grade scores ranged from 2 to 8 out of 10. The overall quality of most included studies was low or moderate, with only 1 study[26] categorized as good quality (score, 8/10). There was consensus agreement amongst reviewers regarding methodology used in the studies. All trials had substantial flaws in methodologic design with a high risk of bias related to group allocation procedures, heterogeneous patient characteristics, reporting of interventions, and outcome analysis. Two randomized controlled trials[26,27] did not indicate allocation or blinding procedures sufficiently and were underpowered. The remaining studies were observational studies. Most studies did not provide duration or intensity of therapy. Four studies[24-26,29] had small convenience samples, and 3 studies[24,25,29] lacked a control group. Outcome measurement tools varied among studies, and some tools used were not validated (eg, General and Medical Questionnaire, Assessment of Physical Dysfunction). Three studies[20,27,29] did not provide any ethical statement related to trial process, whereas 3 studies discussed their findings imprecisely.[20,22,29]

Effectiveness of rehabilitation interventions

Data from included studies could not be pooled because of heterogeneity among the trials in terms of study design, type of interventions, outcome measures used, and study population.

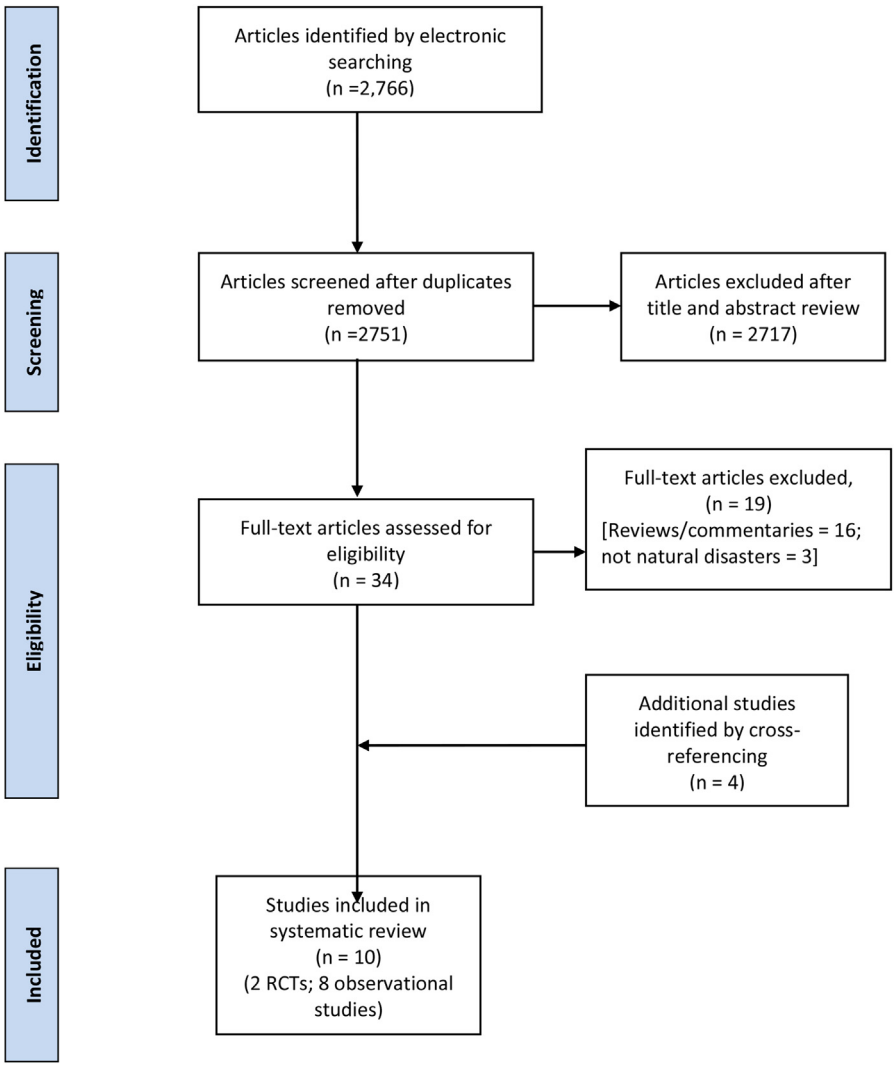

Fig 2 Flow diagram showing selection of articles reviewed. Abbreviation: RCT, randomized controlled trial.

Therefore, a narrative analysis was used for evidence synthesis rather than attempting a meta-analysis (see table 2). A summary of the findings of the included trials is subsequently summarized based on outcomes categorized according to the WHO's ICF framework (see table 4).[13]

Improvement in functional activity

Six studies[22-25,27,28] assessed and reported changes at the level of activity (n=1593). These studies evaluated participants at different time points after the rehabilitation intervention, using different outcome measures (see table 4). Four studies used the Barthel Index to measure functional activity in survivors of the Sichuan earthquake[22,24,25,28] and showed significant improvement in functional activity in those who received medical rehabilitation. Li et al[25] evaluated functional outcomes in SCI earthquake victims and found that 35% of study participants achieved moderate independence in activities of daily living (ADL) and 90% regained some self-care ability prior to discharge. The rehabilitation intervention was found to be the strongest predictor of increased functional gain (using Modified Barthel Index [MBI] scores) by 34 points (95% confidence interval [CI], 28–41).[25] Another study in a similar SCI cohort found substantial functional gain sustained up to 1-year follow-up.[24] The authors reported that compared with discharge data from primary rehabilitation, the MBI and Walking Index for Spinal Cord Injury II scores increased significantly ($P<.05$), indicating improvement in ADL and walking ability.[24]

One study[22] evaluating functional outcomes, health-related quality of life (QOL), and life satisfaction in fracture victims 27 months after the Sichuan earthquake found that ADL and life satisfaction in the intervention groups (both early and late medical rehabilitation) significantly improved compared with the control group ($P<.05$ for both the MBI and Life Satisfaction Questionnaire). Another study[28] demonstrated that a long-term structured rehabilitation services program (comprising NGOs, local health departments, and professional rehabilitation volunteers) in survivors of the Sichuan earthquake significantly improved physical functioning (Barthel Index scores) in both early (baseline: 73.8; 95% CI, 72.5–75.2; follow-up: 90.5; 95% CI, 88.9–92.0; $P<.05$) and late (baseline: 82.2; 95% CI, 76.5–87.8; follow-up: 96.9; 95% CI, 92.4–101.4; $P<.05$) rehabilitation groups at 1-year follow-up, but not in the control group (baseline: 86.8; 95% CI, 83.6–90.1; follow-up: 92.8; 95% CI, 89.7–96.0, $P>.05$). Ni et al[23] in another

Table 2 Summary of included studies (according to hierarchy of study design)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
Zang et al,[26] 2013, China	Evaluate efficacy of NET as a short-term treatment for PTSD in Chinese earthquake survivors (2008 Sichuan)	Randomized waitlist control trial	N=22 11 participants each in the intervention and waitlist control groups Mean age, 55.7±11.7y; range, 37−75y; 77% women; 86% married; 77 had primary or less education; 81% had no fixed income; 36% were injured in the earthquake; 55% experienced >2 times traumatic events	Compared with waitlist control group at posttreatment, the NET group showed significant reductions in PTSD symptoms: IES-R avoidance, intrusion, and hyperarousal subscales ($P<.001$ for all); anxiety and depression: HADS subscales ($P<.001$); general mental stress: GHQ-28 ($P<.0001$); and increased posttraumatic growth: CiOQ ($P<.001$). These changes remained stable for up to a 2-month follow-up. Measures of social support (MSPSS) and coping (SCSQ) did not sustain improvements.	NET is effective in treating postearthquake traumatic symptoms in Chinese earthquake survivors. There was significant positive effect of NET for anxiety, depression, and general mental health. The findings inform future management of PTSD after natural disasters.
Berger and Gelkopf,[27] 2009, Sri Lanka	Evaluate efficacy of a school-based intervention in reducing stress-related symptoms in Sri Lankan children exposed to tsunami	Quasi-randomized controlled trial with waitlist controls	N=166 (elementary school students) Intervention group: n=84; Control group: n=82 Age: 6−18y, 58% women	Tsunami exposure 82.1% of the intervention group and 85.4% of the control group were physically hurt during the tsunami. 66.7% of the intervention group and 53.7% of the control group knew someone close who had died in the tsunami. Other outcomes Significant improvement in the intervention group compared with the control group (interaction time × group): PTSD severity (F=53.52, $P<.001$), functional problems (F=40.73, $P<.001$), somatic complaints (F=44.8, $P<.001$), depression (F=23.55, $P<.001$), and hope (F=54.46, $P\leq.001$) scores. Covariance analysis with baseline measures (as covariance) on each outcome measure showed a distinct time × group × baseline interaction: PTSD severity (F=65.24, $P<.001$), depression (F=58.08, $P<.001$), somatic symptoms (F=51.62; $P<.001$), functional problems (F=132.00, $P<.001$), and hope (F=35.67, $P<.001$). 82% of probable PTSD cases in the intervention group improved compared with 23% in the control group ($P=.0011$).	A universal school-based intervention may be helpful in mitigating posttsunami trauma-related symptoms in children. Those with more severe symptoms benefited most.

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Table 2 (*continued*)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
				Pearson correlation within the intervention group showed higher scores at baseline were related with the differential scores (postassessment −baseline assessment) on the PTSD severity scale (r=.70), depression scale (r=.72), somatic scale (r=.71), functional problem scale (r=.67), and hope scale (r=.56).	
Becker,[20] 2009, India	Effectiveness of a psychosocial program, a community-based mental health initiative for survivors of 2004 tsunami in India	Prospective cohort study	N=200 Intervention group: n=100 (women from an affected village) Control group: n=100 (volunteer women from nearby affected village) Aged 26−45y; 90% married; most had <5y of education	Both the intervention and control groups had experienced some form of loss. At baseline, 32% reported symptoms of severe mental distress, and 22% reported moderate symptoms in the intervention group compared with 34% and 24% respectively, in the control group (SRQ). Significant decrease in total IES scores (P<.001) and subscale IES scores of avoidance (P<.001), intrusion (P<.001), and hypervigilance (P<.001), indicating an improvement in symptoms for the psychosocial intervention group.	Psychosocial intervention is an effective strategy for reducing emotional distress for women tsunami survivors and should be included in disaster response in resource-poor countries.
Zhang et al,[28] 2013, China	Evaluate effectiveness of rehabilitation services program comprised of NGOs, local health departments, and professional rehabilitation volunteers in survivors of 2008 Sichuan earthquake	Longitudinal quasi-experimental study	N=510 (divided into 2 intervention groups: NHV-E: n=298; NHV-L: n=101 and control group: n=111) Mean age, 53.7±16.2y; 65% women; 82.8% had fractures; 5.1% had SCI; mean rehabilitation duration in NHV-E group, 52.6±19.1d and in NHV-L group, 51.5±19d	Physical functioning significantly increased in the NHV-E and NHV-L groups at follow-up but not in the control group after adjustment for sex, age, type of injury, and time to measurement. NHV-E improved BI scores by about 11.3 points at follow-up (95% CI, 9.0−13.7); NHV-L improved by 10.7 points (95% CI, 7.9−13.6). Significant effects were found of both the rehabilitation program (11.14; 95% CI, 9.0−13.3) and spontaneous recovery (5.03; 95% CI, 1.73 −8.34). The effect of NHV-E (11.3; 95% CI, 9.0 −13.7) was marginally greater than that of NHV-L (10.7; 95% CI, 7.9−13.6).	The rehabilitation service program improved physical functioning of earthquake survivors. The rehabilitation program benefited rehabilitation disaster relief planning. Both institution- and community-based programs should be considered for future rehabilitation disaster relief efforts.

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Table 2 (*continued*)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
				Significant differences in baseline and follow-up BI scores in NHV-E (baseline: 73.8, 95% CI, 72.5—75.2; follow-up: 90.5, 95% CI, 88.9—92.0) and NHV-L (baseline: 82.2, 95% CI, 76.5—87.8; follow-up: 96.9, 95% CI, 92.4—101.4), whereas the difference is no longer significant in the control group (baseline: 86.8, 95% CI, 83.6—90.1; follow-up: 92.8, 95% CI, 89.7—96.0). Effectiveness of specific program components could not be determined.	
Hu et al,[24] 2012, China	Compare functional status, QOL, and community integration of earthquake survivors (2008 Sichuan earthquake) with SCI at 12mo postdischarge from institution-based rehabilitation into the community	Prospective cohort study	N=26 Mean age, 52.6±15.8y; range, 20—79y; 57% women; 69% married; 53% had formal education; 46.2% were illiterate; 15% were in paid employment; mean value of annual family income for all survivors, $849±$503	At 1-y follow-up in the community Medical complications All patients reported spasmodic pain; 46% reported a new pressure sore, 53.8% reported neurogenic bladder, and 57.7% reported had urinary tract infection. Functional status Compared with data at discharge from primary rehabilitation, the MBI and WISCI II scores increased significantly ($P<.05$), improved ADL, and improved walking on returning to the community. Pain and depressive symptoms decreased insignificantly ($P=.836$); however, 26.9% required antidepressant treatment and 53.8% required psychological counseling. QOL Improved significantly in the community, total score ($P=.011$), self-ratings of QOL ($P<.001$), general health ($P<.001$), and satisfaction with social relations ($P=.017$). Physical health and psychological health domains improved, whereas satisfaction with the environmental decreased (not statistically significant.)	Functional status, QOL, general health, satisfaction with social relations and some areas of community integration (physical independence, mobility) improved significantly after a year after rehabilitation of SCI earthquake survivors. Rehabilitation should address emotional and cognitive function and re-employment in SCI.

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Table 2 (*continued*)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
				Social participation/community integration Physical independence and mobility improved ($P<.05$), and CHART-SF was higher than at discharge (not significant). No statistically meaningful differences were identified in occupation and actual social integration.	
Li et al,[25] 2012, China	Evaluate functional outcomes of rehabilitation intervention in survivors of the 2008 Sichuan earthquake and assess determinants of rehabilitation effectiveness, medical complications, and outcomes	Prospective cohort study	N=51 Mean age, 38.5±9.6y; range, 11–77y; 58% women; 43.1% had complete SCI at the beginning of rehabilitation. Most patients had lesions at the thoracolumbar level (43%), 29% had thoracic lesions, and 9% had cervical lesions.	Most victims rescued from the debris within 30min of the earthquake (70.6%), and all surviving victims rescued within 9h. 86.3% patients received surgical spinal stabilization; only 7 of these underwent surgery within 5 days after the earthquake. 94.1% of patients began rehabilitation therapy within 4mo. 90% resumed walking using orthoses; 90.2% used a wheelchair. Patient unadjusted/raw MBI scores improved significantly (mean difference, 29±16.9 points) during the rehabilitation program. At the end of therapy, 35% patients achieved moderate ADL independence, and 90.2% regained some self-care ability. Rehabilitation program was the strongest predictor of significantly increased MBI scores (increase of 34 points; 95% CI, 28–41). Complications included: bowel and bladder dysfunction (60.8% and 58.8%, respectively); 63% (pressure ulcers) to 85% (deep vein thrombosis). Earlier rescue and rehabilitation were significant positive predictors of rehabilitation effectiveness.	Earthquake victims with SCI may achieve significantly improved functional rehabilitation outcomes with organized programs.

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Table 2 (*continued*)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
Zhang et al,[22] 2012, China	Evaluate functional outcomes, QOL, and life satisfaction in fracture victims 27mo after the 2008 Sichuan earthquake	Cross-sectional quasi-experimental study	N = 390 (survivors with fractures divided into 2 intervention groups; early intervention group: n = 226; late intervention group: n = 80; and a control group n = 84) Mean age, 53.6±17.1y; most were women; 35% had primary education or were illiterate; 83% were married; 10% had an average level of annual family income; 31% had remunerative employment	ADL and life satisfaction in the intervention groups significantly improved compared with the control group ($P<.05$ for all). HRQOL was higher in early intervention subjects compared with controls ($P=.008$). Group differences in pain level were not significant. Early and late intervention groups found no differences in any measures. Good performance of ADL ($P<.001$) and widowed marital status ($P=.032$) predicted high HRQOL, whereas pain was associated with worse outcomes ($P<.001$). Rehabilitation therapy, remunerative employment, and being a woman were predictors of improved life satisfaction. Participants who received rehabilitation, or were in paid employment or female subjects showed higher life satisfaction.	The findings demonstrate effectiveness of rehabilitation (early and late) on functional outcomes, HRQOL, and life satisfaction in earthquake fracture victims.
Ni et al,[23] 2013, China	Evaluate effectiveness of rehabilitation on physical dysfunction and PTSD in fracture victims at 50mo after the Sichuan earthquake of 2008 and identify PTSD risk factors	Retrospective cohort study	N = 450 Intervention group: n = 245 control group: n = 214 Mean age, 54±17.8y; >63% women; >77% married; most had no or only elementary education; most had above-average household income, but were not providing the main household income	Physical dysfunction Data showed statistically significant differences in favor of the rehabilitation group in physical dysfunction (rehabilitation group: 32.24%, control: 67.76%; $\chi^2=57.65$, $P<.001$); and $P<.01$, respectively. PTSD Unadjusted data showed statistically significant differences in favor of the rehabilitation group (rehabilitation group: mean ± SE, 32.15±0.7; control group: mean ± SE, 34.04±0.7; $t=1.9$; $P<.05$) and for the adjusted group differences ($P<.05$). Being a woman, having average or above-average family income, having witnessed death, and fearfulness were risk factors for PTSD symptoms, 50mo after the earthquake.	Physical dysfunction and PTSD were significantly reduced by the rehabilitation intervention. Future medical rehabilitation strategies should assist survivors in dealing with both physical and psychological effects of natural disasters.

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Table 2 (*continued*)

Study Author, Year, Country	Objectives	Study Type	Participants and Demographic Characteristics	Results/Outcomes	Author's Conclusions
Huang and Wong,[29] 2013, China	Investigate effects of social group work with survivors of the Wenchuan earthquake	Before and after qualitative study	N = 24 Age range, 33–76y; 91% women and married; 9% widowed; 45% had no formal education; and 55% only had primary education	Most participants indicated they did not indulge in thinking about the earthquake, and life became meaningful after joining the group. Participants' social networks were broadened and strengthened after joining the group, and they recognized the importance of mutual understanding and developed a sense of cooperation. After participating in group activities, most women felt happy or that life was more meaningful and their health improved.	Social group work in recreational activities is effective in alleviating disaster survivors' feelings of distress and depression, improves their psychosocial well-being and recovery.
Xiao et al,[21] 2011, China	Analyze factors affecting functional recovery of earthquake survivors with fractures in Sichuan	Case series	N = 174 (survivors with tibial shaft fractures) Mean age, 48.8±14.8y; 57% women; 33% illiterate; 16% positive depressive symptoms; 51.1% received rehabilitation training	51.1% characterized as either excellent or good in functional recovery based on Johner-Wruhs' criteria Functional recovery was positively associated with rehabilitation intervention (OR = 5.3; 95% CI, 2.38–11.67), but it was negatively correlated with the immobilization duration (OR per 10-d increase = .87; 95% CI, .80–.95), age (OR per 10-y increase = .54; 95% CI, .42–.71), and depressive symptomatology (OR = .21; 95% CI, .06–.72).	Functional recovery of postearthquake survivors with fractures is related to availability of rehabilitation treatment, duration of immobilization, depressive symptoms, and age.

Abbreviations: BI, Barthel Index; CHART-SF, Craig Handicap Assessment and Reporting Technique-Short Form; CiOQ, Changes in Outlook Questionnaire; GHQ-28, General Health Questionnaire-28; HADS, Hospital Anxiety and Depression Scale; HRQOL, health-related quality of life; IES-R, Impact of Event Scale-Revised; MSPSS, Multidimensional Scale of Perceived Social Support; NET, narrative exposure therapy; NHV-E, early intervention group; NHV-L, late intervention group; OR, odds ratio; SCSQ, Simplified Coping Style Questionnaire; SRQ, Self-Reporting Questionnaire; WISCI II, Walking Index for Spinal Cord Injury II.

Table 3 Summary of rehabilitation interventions by program content, setting, and duration/intensity (alphabetical by authors)

	Rehabilitation Intervention		
Study	Content	Settings	Duration/Intensity
Becker[20]	Psychological care program: 10 trained community-level workers provided group sessions consisting of 10 participants, based on a train-a-trainer model: a 3-day experimental training program in psychological care (understanding and diagnosis, therapy techniques, stages of reactions and spectrum of care, needs assessments and referral, special needs of vulnerable groups of women, children, and disabled survivors) provided by the National Institute of Mental Health and Neurosciences professional team (psychiatrists, psychiatric social workers, nurses).	Affected community	3 times per week for 2h per session for 3mo
Berger and Gelkopf[27]	Mental health program: a structured program ERASE Stress Sri Lanka: a classroom-based program providing psychoeducational material, cognitive-behavioral skills, meditative practices, and bioenergetic exercises.	Schools in affected community	12 sessions (90-min sessions per week)
Huang and Wong[29]	Social activity program: 2 recreational activity groups were organized by 2 social workers, including various group activities, promotion of harmony among members and fostered group leaders, and communication with other groups outside the community.	Community centers	Once a week (60—90min); 9 total session
Hu et al[24]	Institution-based rehabilitation therapy (details not provided).	Hospital rehabilitation facilities	Details not provided
Li et al[25]	Individualized rehabilitation program provided by multidisciplinary rehabilitation team, comprised of physiatrists, therapists (physical, occupational, traditional modalities), rehabilitation nurses, volunteers, and other consulting medical specialists. Rehabilitation modalities included exercises, muscle strengthening, transfers, training ADL, and mobility training; ultrasound, functional electrical stimulation, electrotherapy, infrared, and lymphatic flow modalities; traditional Chinese therapies (acupuncture, massage); education in management of bladder and bowel continence, skin care, and self-exercise; and assistive devices (prostheses, orthoses) prescribed and provided if indicated.	3 hospitals	Average 3-mo duration
Ni et al[23]	Institution-based comprehensive rehabilitation program, including therapeutic interventions, training and education, and vocational and social rehabilitation (details not provided).	Hospital rehabilitation facilities	Details not provided
Xiao et al[21]	Institution-based rehabilitation interventions delivered by physiotherapists, which included muscle strengthening exercises, joint mobilization and muscle stretching to improve ROM, standing and walking exercises, pain/scar treatment, and other electromagnetic and heat treatments as necessary.	Hospital rehabilitation facilities	Two 40-min sessions per day for >1mo

(*continued on next page*)

Table 3 (*continued*)

Study	Rehabilitation Intervention		
	Content	Settings	Duration/Intensity
Zang et al[26]	Narrative exposure therapy in which the patient, assisted by the therapist, constructed a detailed chronologic report of his/her own biography with a special focus on the traumatic experiences; the narrative was recorded by the counselor and corrected with each subsequent reading. The participants were encouraged to relive emotions while reporting the events.	Hospital rehabilitation facilities	4 therapy sessions (60—90min) for 2wk with 2—4d between each session
Zhang et al[22]	Institutional-based rehabilitation (details not provided).	Hospital rehabilitation facilities	Details not provided
Zhang et al[28]	Rehabilitation program comprised: institutional-based rehabilitation, including muscle strengthening and ROM exercises; training in self-care and mobility activities; education in bladder, bowel, and skin care management; provision of assistive devices; and traditional Chinese therapies (acupuncture, massage). This was followed by CBR, including medical care, rehabilitation, assistive devices, health prevention, and health promotion. Other CBR sectors comprising livelihood, social support, and empowerment were addressed via employment services, personal assistants, and patient self-help peer groups, respectively, among other interventions.	Hospital and community rehabilitation facilities	Details not provided

Abbreviation: ROM, range of motion.

Table 4 Summary of outcome measures and assessment time points in included studies (alphabetical by authors)

Study	Assessment Time Points	Outcome Assessed*			
		Activity	Impairment	Participation	Others
Becker[20]	Baseline, postintervention (3mo)			IES, SRQ	
Berger and Gelkopf[27]	Baseline, 2mo postintervention	CDIS	UCLA PTSD, DPS	Hope questionnaire, BDI	Objective and subjective exposure
Huang and Wong[29]	Postintervention (9wk)				Qualitative transcripts from in-depth interviews
Hu et al[24]	Baseline (discharge from rehabilitation facility) and 1-y follow-up	MBI, WICSI II	AIS, complications, VAS pain	PHQ-9, CHART-SF, WHOQOL-BREF	
Li et al[25]	Discharge from rehabilitation facility (3mo on average)	MBI, ambulation status	AIS		
Ni et al[23]	Retrospective 50mo postearthquake	Subjective assessment of physical dysfunction		PCL-C	Earthquake exposure impact
Xiao et al[21]	15mo postearthquake		VAS pain, fracture healing (Johner-Wruhs' criteria)	CES-D	General and medical questionnaire, anthropometric measurements, leg radiograph
Zang et al[26]	Baseline, post 2-wk treatment, 4wk, and after 2mo		GHQ-28	CiOQ-S, HADS, SCSQ, MSPSS	
Zhang et al[22]	27mo postearthquake	MBI	VAS pain	SF-36	LiSat-9
Zhang et al[28]	27.5—34mo postearthquake	BI			

Abbreviations: AIS, ASIA Impairment Scale; BDI, Beck Depression Inventory; BI, Barthel Index; CDIS, Child Diagnostic Interview Schedule; CES-D, Center for Epidemiologic Studies Depression Scale; CHART-SF, Craig Handicap Assessment and Reporting Technique-Short Form; CiOQ-S, Short Form of the Changes in Outlook Questionnaire; DPS, Diagnostic Predictive Scales; GHQ-28, General Health Questionnaire-28; HADS, Hospital Anxiety and Depression Scale; IES, Impact of Event Scale; LiSat-9, Life Satisfaction Questionnaire; MSPSS, Multidimensional Scale of Perceived Social Support; PCL-C, PTSD Checklist-Civilian Version; PHQ-9, Patient Health Questionnaire depression module; SCSQ, Simplified Coping Style Questionnaire; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; SRQ, Self-Reporting Questionnaire; UCLA PTSD, University of California Los Angeles Post Traumatic Stress Disorder; VAS, visual analog scale; WHOQOL-BREF, World Health Organization Quality of Life-BREF; WISCI II, Walking Index for Spinal Cord Injury II.

* Categorized according to the ICF.[13]

Table 5 Levels of quality of individual studies (CASP approach*)

Randomized Controlled Trials											
Study	Clear Focused Issue	Adequate Randomization Procedure	Participants Properly Accounted	Blinding of Participants/ Assessors	Groups Similar at Start	Groups Treated Equally	Large Treatment Effect	Precise Treatment Effect	Clinically Important Outcomes Considered	Benefits Worth Harms and Costs	CASP Grade†
Zang et al[26]	+	+	+	−	+	+	+	+	+	?	8/10
Berger and Gelkopf[27]	+	−	+	−	?	−	+	+	+	?	5/10

Observational studies											
Study	Clear Focused Issue	Appropriate Method	Appropriate Cohort Recruitment	Exposure Accurately Measured	Outcome Accurately Measured	Important Confounding Factors Accounted	Adequate Follow-Up	Strong Exposure and Outcome Relation	Precise Results	Believe the Results	CASP Grade†
Becker[20]	+	+	?	−	−	−	−	−	?	?	2/10
Zhang et al[28]	+	+	+	+	−	?	+	?	?	?	5/10
Hu et al[24]	+	−	?	?	+	−	+	+	−	?	4/10
Li et al[25]	+	−	+	−	−	−	+	+	−	?	4/10
Zhang et al[22]	+	+	+	?	+	−	+	?	+	?	6/10
Ni et al[23]	+	+	+	−	?	−	+	+	−	?	5/10
Huang and Wong[29]	+	−	−	−	−	?	−	−	−	?	1/10
Xiao et al[21]	+	−	+	−	−	−	+	−	−	?	3/10

Abbreviations: +, yes; −, no; ?, cannot tell.

* CASP critical appraisal tool for qualitative research.[18]

† The judgement of value given for each study is specifically based on the data related to this review.

study retrospectively investigated the effectiveness of the rehabilitation intervention on physical dysfunction and PTSD in fracture victims 50 months after the Sichuan earthquake. The authors reported that physical dysfunction was less prominent in the rehabilitation group than the control group ($P<.01$) postintervention.[23] Another study[27] evaluated a school-based intervention in reducing stress-related symptomatology among Sri Lankan children exposed to the tsunami and found significant reduction in functional problems in the intervention group compared with the waitlist control group ($P<.001$).

Improvement in impairments

Overall, 6 studies[21,22,24-27] assessed symptoms/impairments as an outcome, using different measures (n=829). One study showed significant decrease in somatic symptoms ($P<.001$) after a school-based intervention in reducing stress-related symptoms in children exposed to the tsunami.[27] Zang et al[26] evaluated the efficacy of narrative exposure therapy for PTSD in earthquake survivors and showed significant reductions in mental symptoms (Impact of Event Scale scores, $P<.001$) and general mental stress (General Health Questionnaire scores, $P<.0001$) at 2-months follow-up compared with the waitlist control group. Three studies assessing pain reported some reduction in the visual analog scale pain score; however, these were not statistically significant (see table 2).[22,24,25]

Improvement in participation: psychological outcomes

Overall, 6 studies[20,21,23,24,26,27] assessed psychological outcomes, with 3 studies[20,26,27] evaluating it as a primary outcome (n=1038). Becker[20] showed that a psychological rehabilitation intervention (structured in-community psychological care) delivered by trained community health workers for women survivors of tsunami significantly improved psychosocial symptoms, as measured by the Impact of Event Scale scores (total, $P<.001$; subscale scores: avoidance, $P<.001$; intrusion, $P<.001$; hypervigilance, $P<.001$). The author reported that 82% of probable PTSD cases in the intervention group improved and could no longer be classified as PTSD compared with only 23% in the control group ($P=.001$).[20] Another study[27] evaluating the efficacy of school-based intervention in reducing stress-related symptoms among Sri Lankan children exposed to tsunami found significant improvement in PTSD severity ($P<.001$), depression ($P<.001$), and hope ($P\leq.001$) scores in the intervention group. Zang[26] evaluated the efficacy of narrative exposure treatment for PTSD and showed that compared with the waitlist control group at posttreatment, the intervention group showed significant reductions in PTSD symptoms (Impact of Event Scale-Revised subscales of avoidance, intrusion, and hyperarousal: $P<.001$ for all; Hospital Anxiety and Depression Scale subscales of anxiety and depression: $P<.001$). Hu et al[24] in another study found a small nonsignificant improvement in depression measured by the Patient Health Questionnaire Depression model in the intervention group at 1 year posttreatment ($P=.836$). The authors reported that psychological symptoms were still prevalent, with 26.9% of participants still requiring antidepressant treatment and 53.8% psychological counseling.[24] One study[23] showed a clinically meaningful improvement in PTSD in the intervention group measured by the PTSD Checklist-Civilian Version ($P<.05$) (see table 2).

Improvement in participation: QOL

Overall, 2 studies evaluated QOL as a secondary outcome, using different outcome measures (n=416).[22,24] Hu[24] reported significant improvement in QOL at 1-year follow-up after inpatient rehabilitation intervention using the World Health Organization Quality of Life Scale. Total World Health Organization Quality of Life Scale score ($P=.011$), self-ratings of QOL ($P<.001$) and general health ($P<.001$), and satisfaction with social relations ($P=.017$) improved significantly, whereas the physical health and psychological health domain scores increased but were not statistically significant.[24] Another study[22] showed significant improvement in QOL measured using the Medical Outcomes Study 36-Item Short-Form Health Survey in the early intervention group ($P=.008$) compared with the participants in the control group, but not in the late intervention (after 1y) group ($P=.067$). The authors also found that good performance of ADL and, surprisingly, a widowed marital status predicted higher QOL (see table 2).[22]

Improvement in participation: community integration

Two studies[22,24] evaluated community integration using different outcome measures (n=416). Hu[24] used the Craig Handicap Assessment and Reporting Technique-Short Form scale to compare community integration of earthquake survivors with SCI at the time of discharge from institution-based rehabilitation with scores at 1 year after returning to the community. The authors found a small nonsignificant improvement in Craig Handicap Assessment and Reporting Technique-Short Form scores at 1-year follow-up compared with scores at discharge ($P=.127$). The authors reported that physical independence and mobility increased and cognitive independence decreased significantly ($P<.05$ for both). There was no statistically meaningful difference in occupation and social integration.[24] Zhang et al[22] in another study found no stable effect of the rehabilitation intervention for adequacy of social support from 3 different sources: family, friends, and significant others members (measured by the Multidimensional Scale of Perceived Social Support). There was also no effect of the intervention in improving active and passive coping (measured by the Simplified Coping Style Questionnaire) (see table 2).[22]

Safety

None of the included studies evaluated or reported adverse effects.

Cost-effectiveness

No studies reported any data on cost-effectiveness, investment costs, or resource utilization.

Caregiver-related issues

Caregiver burden was not evaluated in any of the studies.

Discussion

This systematic review provides an evidence-based overview of the effectiveness of various medical rehabilitation interventions used for survivors of natural disasters. A multipronged approach assimilated published literature for currently available evidence by including both qualitative and quantitative studies. The study highlights scarce research and a lack of robust, methodologically strong studies in this area. Most included studies were of poor quality as a result of multiple methodologic flaws (eg, unclear/lack of participant recruitment, group allocation, bias-minimizing procedures). The included studies showed marked heterogeneity in terms of intervention types, measurement tools used (even for

identical outcomes), treatment protocols (for both intervention and control groups), and length of follow-up. Therefore, best evidence synthesis was performed using a narrative approach.

This review includes a total of 10 trials (2 randomized controlled trials, 8 observational studies). Most interventions evaluated in these studies were complex and included >1 active rehabilitation component. The interventions evaluated differed in many aspects, including characteristics, type and intervention goals, number and extent of the intervention components, duration and intensity, and mode of delivery. Most interventions included physical activity and psychosocial care as intervention components. Comparative control interventions varied between studies ranging from no intervention to waitlist groups. The findings from this review suggest that there is some evidence for medical rehabilitation for survivors of natural disasters in producing short- and long-term gains for functional activities (ADL, physical activity, etc), impairments (eg, psychological symptoms), and participation (QOL, social reintegration). There is no evidence for cost-effectiveness of these programs and for the best type/mode/intensity (frequency, duration) of intervention or superiority of one intervention over another.

Natural disasters have become more frequent recently, causing mass casualties and severe physical injuries and psychological disorders impacting QOL of survivors. The critical importance and role of providing rehabilitation services during and after a natural disaster is well-discussed in the literature.[3,4,10,16,30-32] There is also strong opinion among the disaster management experts that medical rehabilitation in any humanitarian disaster should be initiated in the immediate emergency response phase, and as disaster transitions away, it should be continued in the community over the longer term to restore function and enhance participation of survivors.[4,30,31] Improving or restoring physical and psychosocial abilities is a key issue in rehabilitation of disaster victims, and a rehabilitation approach for these people can be helpful.[4,32] Rehabilitation planning includes the following: assessment of evolving and long-term injury patterns, rehabilitation needs, and resource requirements; data collection, management, and analysis; establishment of patient triage, discharge, referral, and tracking systems; collaboration with other rehabilitation and health care service providers; and coordination with emergency systems and host health system and government managers.[3] Long-term rehabilitation planning is critical for community recovery where services should be accessible and includes general health maintenance. Regrettably, however, acute response plans and acute care protocols, which focus on saving lives and treating acute injuries, get much of the attention in any disaster, and rehabilitative needs are often neglected.[3]

The included studies highlight many challenges in implementing and evaluating rehabilitation interventions in natural disaster survivors. First, natural disaster often occurs unexpectedly and precipitously with great magnitude of destruction, resulting in mass casualties and complex disabling injuries requiring multidisciplinary management. Second, the survivors can present with one or a combination of diverse clinical presentations (including medical complications) and with varying levels of disability, requiring an individualized approach. Third, the disaster itself results in severe disruption of local health service infrastructure, including supporting communication and supply/transportation networks, compromising medical response and optimal management of the victims.[3] Moreover, natural disasters mostly occur in developing countries and in remote, resource-scarce regions where rehabilitation services either do not exist or are underdeveloped.[3,16] In most cases, burden of sudden onset and magnitude of traumatic disabling conditions can overwhelm and deplete already overstretched available rehabilitation services and health care infrastructure/resources.[3,16] A lack of understanding of the geographic location, availability of the local health services, and shortage of trained rehabilitation professionals and medical workforce in close proximity can further hinder the comprehensive management.[33] Special needs and management (including evacuation) plans for persons with preexisting disabilities and/or comorbidities generally are often disregarded because the rescuers and planners are mostly unaware of their presence in the community or fail to identify them, placing this vulnerable population at an increased risk of developing additional disabilities, worsening of preexisting disability, and mortality.[3,16]

This review included studies with different research designs in the synthesis of evidence for natural disaster rehabilitation, rather than including only experimental designs. The evidence synthesis highlights the need for systematic data collection in the course of real-life practice and long-term follow-up of outcomes. Selection of feasible and responsive outcome measures and listing of specific interventions (modalities, duration, etc) used in disaster settings is important.

Study limitations

The limitations of methodology used and completeness of this review cannot be ruled out. Despite the extended range of terms used to capture the relevant literature, the search strategy principally encompassed cited literature. Further, the search strategy included searching of reference lists only within the relevant articles for other possible articles missed in electronic searches, which may have introduced a reference bias and may have missed some relevant articles, including negative and unpublished trials. Finally, though the CASP approach used to appraise studies is a robust system for evaluating various trial-based evidences, its sensitivity is still debatable.[34] In this instance, however, its use was appropriate given that studies identified in this review were of mixed methods.

The way forward

Although significant improvements in the coordination and organization of acute care and services in humanitarian catastrophes, including natural disasters, has reduced mortality, this has often not extended to include rehabilitation services. Rehabilitation is an expensive resource, and the evidence to support specific rehabilitation interventions in natural disaster survivors has long been neglected. This review highlights many gaps in the evidence base for medical rehabilitation in natural disaster survivors in terms of the types of rehabilitation interventions, settings, components, modalities, and duration of therapy; lack of effective care pathways; and longer-term outcomes for these survivors, including functional restoration and societal reintegration (participation). Most literature in rehabilitation care in nature disaster survivors exists in silos for isolated conditions (eg, SCI, fractures, psychological conditions). The WHO recently endorsed the *WHO Global Disability Action Plan 2014–2021: Better Health for All People with Disability*,[35] which aims to improve access to health services; strengthen and extend rehabilitation, assistive technology, and support services; and improve data collection and research. The WHO rehabilitation guidelines recommend implementation and access to rehabilitation early during the response phase and

longer-term in the community.[36] The system issues for medical rehabilitation in disaster settings may include the following: expense of setting up these programs, staff expertise, insufficient support for patients along the recovery trajectory with loss of livelihood and productivity, difficulty in access and/or lack of rehabilitation services because of geographic barriers, and lack of social support systems in the longer term.

Implications for practice and research in medical rehabilitation for natural disaster survivors include the need for the following: more methodologically robust studies (ie, well-designed research methods); regular, systematic standardized data collection during disasters; capacity building for disaster management for outcomes in real-life settings; research priority for rehabilitation needs assessment for service delivery planning and delivery[3]; incorporation of perspectives of patients (and/or caregivers) in treatment; outcome measures to reflect the complex constructs using domains of the WHO's ICF; consensus on a battery of measures to capture changes in physical ability and psychosocial adjustment; research on the cost-effectiveness of medical rehabilitation intervention; innovations and models of rehabilitation (eg, telerehabilitation) that offer paradigm shifts in delivery of timely and transparent services and that are cost-effective and patient centered; research on disaster survivors' participatory limitations because of work, family, and social reintegration; more rehabilitation professionals and educating other health care professionals in rehabilitation principles and practice; effective coordination and collaborative research initiatives between international organizations, national and international NGOs in partnership with the local government and health professionals providing rehabilitation services after a disaster[4]; efficient allocation of human and material resources to provide optimal, comprehensive rehabilitative care for the affected population; inclusion of rehabilitation doctors as members of foreign medical teams for rehabilitation input to mitigate disability[33]; development of guidelines and reporting tools for rehabilitation intervention in crisis settings and inclusion in the Consensus Guidelines on Reports of Field Interventions in Disasters and Emergencies[37]; and future studies on professionalizing rehabilitation in resource-poor settings.

Conclusions

This review highlights sparse literature and the lack of high-quality studies in rehabilitation after natural disasters. Assimilation of data from existing studies was difficult because of the diverse content, delivery of rehabilitation, and range of outcome measures used. Although evidence for effectiveness of rehabilitation in natural disaster victims is limited, the gap in current research should not be interpreted as ineffectiveness of rehabilitation in this population. The challenge is to conduct rigorous trials in complex disaster settings to assess outcomes for rehabilitation interventions.

In the current emerging global context of reduced mortality and increased morbidity after natural disasters, the need for rehabilitation will only increase. This review highlights the increasing awareness of medical rehabilitation for effective short- and longer-term management of natural disaster survivors. Medical rehabilitation needs to be incorporated into future response planning and disaster management for improved access to rehabilitation services and investment in sustainable infrastructure, education, and workforce development.

Keywords

Community integration; Disaster survivors, earthquake; Physical functioning; Quality of life; Rehabilitation

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Appendix 1 Search Strategy Applied to Search Medical and Health Databases

1. 'rehabilitation care'
2. 'rehabilitation'
3. "multidisciplinary rehabilitation". ti,ab
4. 'physical activity'
5. 'physiotherapist'
6. 'physiotherapy'
7. 'home care'
8. 'occupational therapy'
9. 'dietitian'
10. nutritional AND services
11. 'counseling'
12. 'educational activities'
13. 'social work'
14. 'cognitive therapy'
15. 'behaviour therapy'
16. 'speech therapy'
17. OR/(1-14)
18. disaster AND management
19. disaster AND response
20. disaster AND mitigation
21. 'international agencies'
22. humanitarian
23. disaster AND information AND system
24. 'international cooperation'
25. OR/(18-24)
26. 'natural disaster'/exp OR 'natural disaster'
27. 'geographic and geological phenomena
28. complex AND emergency
29. "complex emergency".ti,ab
30. 'earthquake'
31. 'volcano'
32. 'fire'
33. 'flooding
34. 'drought'
35. 'tsunami'
36. 'freeze'42,944
37. 'heatwave'
38. tropical AND cyclone
39. 'storm'
40. OR/(26-39)
41. 17 AND 25
42. 41 AND 40

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