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REVIEW ARTICLE

PARTICIPATION AND QUALITY OF LIFE OUTCOMES AMONG INDIVIDUALS WITH EARTHQUAKE-RELATED PHYSICAL DISABILITY: A SYSTEMATIC REVIEW

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Objective: **A literature review to evaluate quality of life and participation outcomes of individuals with earthquake-related physical injury.**

Data sources: **A systematic review was performed using National Health Service (NHS) Centre for Reviews and Dissemination (CRD) guidelines. MEDLINE, Embase, PsychINFO, CINAHL and AMED electronic databases were searched from 1966 to January 2014.**

Study selection: **Studies that measured quality of life or participation outcomes among individuals who acquired a physical disability as a result of an earthquake injury were included, with no limits on research design.**

Data extraction: **The search yielded 961 potentially relevant articles after removal of duplicates. Of these, only 8 articles met the inclusion criteria. Studies were rated for quality using the Critical Appraisal Skills Programme (CASP) guidelines.**

Data synthesis: **A narrative synthesis was performed due to the heterogeneity of the included studies.**

Results: **Injured earthquake survivors in developing countries experience diminished participation and reduced quality of life. Small sample sizes and lack of uniformity in outcome measurement limit generalizability. No studies from developed countries were identified.**

Conclusion: **To maximize our understanding of quality of life and participation in injured earthquake survivors, future research should consider both the functional consequences of the injury and the environmental impact of the earthquake. The research should be based on representative samples of the injured earthquake survivors and use validated condition-specific outcome measures that are clearly defined within the publications. In addition, research should include all countries that are affected by earthquakes.**

Key words: consumer participation; earthquakes; quality of life; review.

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INTRODUCTION

Earthquakes occur throughout the world at an average of 2 every minute, totalling more than a million earthquakes a year (1, 2). In the past 25 years over 530,000 deaths have been reported from earthquakes around the world, (3, 4). In 2011, approximately 14,629 people were injured in earthquakes (5).

The profile of people injured in earthquakes differs from non-earthquake trauma in terms of aetiology, sex and health service response. First, earthquake injuries result mainly from individuals being trapped under collapsed buildings or being hit by falling objects (1, 6). Secondly, more injuries occur in women, irrespective of age, (7) in earthquakes compared with non-earthquake trauma, which is seen mostly in young men. Finally, earthquakes produce mass casualties that often overload local health facilities. These health facilities frequently do not have the resources to treat and rehabilitate the large number of people injured in an earthquake. Consequently, individuals who sustain earthquake injuries may require transportation to out-of-area facilities, and experience different health service provision.

With improvements in initial earthquake responses, knowledge of earthquake-related injuries, and surgical techniques, earthquake-related mortality decreases, but the number of injured survivors is prone to increase (8, 9). In the developed world, improvements in medical care have resulted in increased survival rates from trauma; however, mere survival following trauma no longer reflects successful health intervention. Instead, the focus has shifted toward health and rehabilitation outcomes, such as participation and quality of life (QOL). QOL is defined by the World Health Organization Quality of Life (WHOQOL) Group (10) as "an individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns". This is just one conceptualization of QOL which has multiple meanings. Participation is defined by the World Health Organization (WHO) as "an individual's involvement in a life situation"; for example, employment (11). However, these outcome domains are not always addressed when professionals from developed countries travel to provide assistance in developing countries following an

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earthquake. Many western medical teams respond generously during the initial response period when preservation of life is paramount, but are conspicuously absent from rehabilitation of the injured (12).

In recent years, there has been a growing evidence-base documenting the initial outcomes of individuals injured in earthquakes (3, 13–20), but little investigation of longer-term outcomes expressed through participation and QOL. The aim of this review was to address this gap by determining what is known about participation and QOL outcomes for people with physical impairment resulting from earthquake-related injuries.

METHODS

Data sources

The review methodology was based on guidelines from National Health Service (NHS) Centre for Reviews and Dissemination (CRD) (21). A computerized literature search was conducted using Ovid on MEDLINE, Embase, PsycINFO, CINAHL, and AMED databases using a search strategy developed in consultation with an experienced health librarian. All study designs were included in the search strategy. The search was limited to articles written in English, and included all publications from the start date of the individual database to 31 January 2014.

Study selection

To be included in the review, the study had to meet 3 criteria. First, the study had to include adult participants (the definition of children being in line with that offered by the authors of the paper) with physical injuries sustained in an earthquake or related to an earthquake measuring 5.0 or more on the Richter scale, a threshold that can cause significant damage to poorly constructed buildings. Secondly, "physical disability" was narrowed to injury resulting in orthopaedic impairment affecting the musculoskeletal system or neurological impairment, such as spinal cord injury (SCI) or brain injury. Hence, the review did not include psychological disorders as a primary diagnosis. In instances where studies involved both injured and non-injured participants, at least 75% of the participants had to have sustained physical injuries. Thirdly, the outcomes of the study included a QOL, return to work (RTW) or another measure of participation as defined by the WHO International Classification of Functioning, Disability and Health (ICF) (11). The full search strategy is shown in Appendix I.

The lead author reviewed all titles and abstracts, and then 2 co-authors independently reviewed 10% of the search results to check for reliability. Any differences were resolved by discussion between the authors. Secondly, where the abstract review was inconclusive, a full-text assessment was carried out by 2 authors, to check that articles met the inclusion criteria. All articles eligible for inclusion were quality appraised by 2 of the authors using the Critical Appraisal Skills Programme (CASP) Guidelines from the NHS (22). This was chosen as a measure as it had different evaluation forms suitable for all types of research design. This was particularly important in this review due to the range and type of studies included in the search. The CASP framework approaches research in 3 steps, looking at the methodological quality, validity including clinical importance, and application of results to the original question. Following independent review of the articles using CASP guidelines, consensus agreement was made on the quality and inclusion of each paper.

Data extraction

For each study, 2 of the authors abstracted study aims, interventions used, study methods used including study design, characteristics of study participants (e.g. age, sex, ethnicity, socio-economic status, injury, injury severity, inclusion of people with co-morbidities), study setting (e.g. geographical location, earthquake), outcome measures used, and reported findings. An Excel spreadsheet was used to record study data and EndNote citation manager to store bibliographic data. Given the limited number of articles, their different approaches and methodological limitations, a narrative assessment and synthesis of the data was performed.

RESULTS

A total of 961 potentially relevant articles were identified once the duplicates were removed (Fig. 1). Using the selection criteria for this review, 920 articles were excluded based on title and abstract review. Forty-one full-text articles were retrieved for further review and of them 33 were excluded, as they were not earthquake related, or did not include QOL, participant measures, or injured earthquake survivors, or because they involved children. The remaining 8 articles met the selection criteria for this review. One further article was excluded based on research design; however, there were some methodological limitations in the remaining papers.

The 7 papers reviewed reported outcomes from the following 5 earthquakes:

- 2001 Gujarat earthquake, India (23).
- 2008 Wenchuan earthquake, China (also known as the Sichuan earthquake) (24–26).
- 2005 Kashmir earthquake, Pakistan (27).
- 2009 Padang earthquake, Indonesia (28).
- 2010 Port-au-Prince earthquake, Haiti (29).

A summary of these articles is presented in Table I.

The studies included a range of study populations, and participants sustained different physical disabilities from the earthquakes. Three papers reported the outcomes of individuals who sustained a spinal cord injury (SCI) (25–27), 1

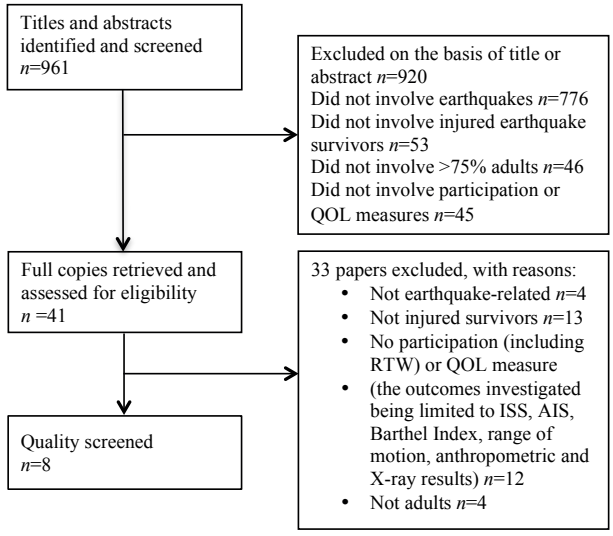

Fig. 1. Systematic review flow chart. RTW: return to work; QOL: quality of life; ISS: injury Severity Score; AIS: ASIA Impairment Scale.

Table I. *Summary of studies included in review*

Study, year, earthquake, country, design	Participants	Measurement time interval	Participation outcome measure	QOL outcome measures	Main outcomes	Quality
Hu et al. (26), 2008 Wenchuan Earthquake, China Prospective cohort	26 participants with SCI	Hospital discharge and 1 year post-injury	Employment rates	WHOQOL-BREF	Total QOL score, general health and satisfaction with social relationships improved significantly in community compared with hospital discharge ($p<0.05$) Increases in physical health, psychological health, community re integration at 1 year, but not significant. Satisfaction with environment decreased, but not significantly Scores in physical independence and mobility improved significantly ($p<0.05$) Cognitive independence decreased significantly ($p<0.05$) Paid employment 15.4%	Small sample size No information on inpatient services
Zhang et al. (24), 2008 Wenchuan Earthquake, China Cross-sectional quasi-experimental design	390 participants with fractures	2.25 years post-injury	Employment rates	LiSat-9 SF-36	Life satisfaction significantly improved in intervention group compared with control LiSat better in those who received rehabilitation therapy, were in paid employment and female SF-36 higher in early intervention than control Improved ADL and widowed marital status positive predictors of HRQOL	No classification of fracture type, or severity No details of the rehabilitation received or why participants received early, late or no rehabilitation
Tasiemski et al. (25), 2008 Wenchuan Earthquake, China Prospective cohort	14 wheelchair user SCI participants	1.5 years post-injury	Objective – Education, Vocational activity, Subjective - LiSat-9	Objective – housing and time to rehab centre	Objective Vocational – 76.8% unemployed, 85% lower income than average 7.1% had no income Housing 21.4% lived in fully adapted housing 50% had accessible accommodation 28.6% un-adapted houses Time to rehabilitation centre – participants had to travel on average 1 h (SD = 0.36) Subjective LiSat Most satisfying Partnership least Vocational situation and sexual life. 64% participants did not fully complete LiSat-9 (did not answer question on sex life)	Small sample Inappropriate outcome measures Non-validated rehabilitation measure Incomplete questionnaires
Sudaryo et al. (28), 2009 Pedang earthquake, Indonesia Prospective cohort	184 injured participants 84 control group participants	Baseline, 3 months and 6 months starting 4 months from earthquake	None	QOL – Indonesia Health Related Quality of Life Questionnaire 1–37	QOL reduced in injured group at all time points $p<0.0005$ QOL lower in injured group even when adjusted for co-morbidities Lowest scores Pain, depression and anxiety	Control group had very different demographics QOL measure was modified and adapted for disaster setting
Irshad et al., (27) 2005 Kashmir earthquake, Pakistan Qualitative	73 participants with paraplegic SCI	3 years post-injury	Qualitative	Qualitative	Women with paraplegia were socially, economically and financially disadvantaged as they were not able to resume gender roles and it was culturally inappropriate for them to undertake paid employment	Lacks information on participant selection and analysis
Roy et al. (23), 2001 Gujarat earthquake, India Retrospective review	133 participants injured from non-urban areas	2 years post-injury	Employment rates	None	51% resumed previous occupation only 30% stated they had recovered economically QOL improved between year 1 and 2 but low	Subjective inferences made but unsupported by the results

Table I. *Contd.*

Study, year, earthquake, country, design	Participants	Measurement time interval	Participation outcome measure	QOL outcome measures	Main outcomes	Quality
Delauche et al. (1), 2010 Haiti Earthquake Prospective cohort	305 participants living in Port-au-Prince with lower limb surgery resulting in amputation or limb preservation	1 and 2 years post-injury	Employment rate	SF-36	QOL impacted in all SF-36 domains improved over time but mental health remained lower in amputees Two years after the earthquake, 23.5% of participants were still living in a tent, 30% were working	Participants recruited via specific agencies increased percentage of amputees in study 24% dropout rate

QOL: quality of life; HRQOL: health-related quality of life; SCI: spinal cord injury; ADL: activities of daily living; WHOQOL-BREF: World Health Organization Quality of Life instrument abbreviated version; LiSat: life satisfaction questionnaire.

paper included participants with fractures (24), one included limb trauma and amputees (29), and 2 included a mixed injury group that included participants with fractures, amputations and paralysis (23, 28). In addition, the studies reported a mixture of QOL and participation measures. Four papers included both QOL and participation measures (24–26, 29), one reported QOL only (28) and 2 participation only (23, 27). Many of the papers presented additional outcomes in their results; however, these are not being reported as they fall outside the aim of this review. For clarity the 2 topics, QOL and participation, are covered separately in the following sections.

Quality of life following earthquake injury

Five studies measured QOL following earthquake injury from 2 separate earthquakes, using a variety of outcome measures and different time-points (Table I). Hu et al. (26), Tasiemski et al. (25) and Zhang et al. (24) reported outcomes from survivors of the Sichuan earthquake. Hu et al. (26) used the WHOQOL-BREF, a 26-item QOL scale devised by the WHO with domains on physical, psychological, social relationships and the environment (10). Higher scores are indicative of higher QOL. Tasiemski et al. (25) measured educational level, income and housing, and distance to the rehabilitation centre, describing these as objective QOL indicators, and used the LiSat-9, a life satisfaction measure to test for subjective QOL. The LiSat-9 measures a number of domains, including leisure, vocational situation and family life (30). Zhang et al. (24) also used the LiSat-9 in conjunction with the Short Form 36 (SF-36), a 36-item health-based QOL measured across 8 domains including role limitations and social functioning (31).

As shown in Table I, Hu et al. (26) found significant improvements in total QOL, self-rated QOL, general health and satisfaction with social relationships in 26 people with SCI one year after discharge compared with hospital discharge. Tasiemski et al. (25) reported a high rate of unemployment (76.8%), and low rate of housing adaptations for their participants, with only 21% of the participants living in fully adapted accommodation. The participants reported an average travel time to a rehabilitation centre of an hour. The LiSat-9 scores of the participants indicated their life was between "rather satisfying" and "rather dissatisfying". However, as 64% of the small sample of 14 participants refused to answer the question on sexual life in the LiSat-9, the validity of the overall scores are compromised. Vocational and sexual life received the lowest scores and partnership relationships the highest.

Zhang et al. (24) compared SF-36 outcomes in 390 participants with fractures, which were retrospectively grouped into 1 of 3 groups: an early intervention group, who had received rehabilitation in 2008 at 1 rehabilitation facility, a late intervention group who had their rehabilitation at a different facility in 2009; and a control group who had received no institutional-based rehabilitation. They found the highest QOL scores in the early intervention group, but both intervention groups had higher QOL than the control group. Comparison of the results between groups was limited because no information was provided on the injuries of the participants in the different groups, or on why the groups received different levels of rehabilitation.

Delauche et al. (29) also used the SF-36 and showed improved QOL in the injured survivors of the Haiti earthquake between the first and second years, although participants with amputations scored lower on the mental health scores than participants with preserved lower limbs. They also compared the SF-36 score from their participants with Swedish participants with Anterior Cruciate Ligament (ACL) repairs, and found that earthquake survivors had lower QOL than the individuals in Sweden who had ACL repairs (29). Furthermore, participants were identified from specific databases and recruited by phone and, as such, they may not be representative of the larger group of individuals with lower limb trauma or amputation as a result of earthquake injury.

Sudaryo et al. (28) compared injured and non-injured survivors of the Pedang earthquake using the Indonesia Health Related Quality of Life Questionnaire. This questionnaire was developed by one of the authors and modified for the study; it addresses 10 QOL aspects, including social activities, hearing, and food tasting, with a higher score correlating with higher QOL. They found QOL was consistently lower in the injured group compared with the non-injured group across all time-points tested. Due to the large demographic differences across the 2 groups (which may also have influenced the QOL differences between the groups), and the fact that the QOL questionnaire was modified for the disaster situation limits comparisons with other research.

In general there were improvements in QOL after discharge from the hospital, QOL was better in people who had received rehabilitation, but overall remained lower than the non-injured earthquake survivors.

Participation outcomes following earthquake injury

Six studies measured participation outcomes (23–27, 29) (Table I). The most commonly reported participation measure was RTW. None of these studies had RTW as the main focus and reported RTW rate as a percentage, without including a definition of RTW (23–26, 29). The reported RTW rates ranged from 15.4%, (26) to 51% (23) (Fig. 2). Zhang et al. (24) found statistically significant higher life satisfaction in subjects who had completed rehabilitation therapy, were in paid employment, and were female.

Hu et al. (26) used a general participation measure with their SCI-injured participants, the Craig Handicap Assessment and Reporting Technique (CHART). The CHART is a measure of participation based on the WHO International Classification of Impairments, Disability and Handicap (ICIDH) (32). It includes questions on self-care, transportation, how people spend their time and who they spend their time with. Hu et al. (26) reported modest improvements in CHART scores from hospital discharge, to 1-year post discharge in the community, although the difference in overall CHART scores were not statistically significant. While this study had only 26 participants, and whilst the use of standardized measures facilitates comparisons with other published research, there was little exploration of the differences in the CHART that were a result of the post-earthquake environment rather than the injury.

Irshad et al. (27) studied gender differences among rural paraplegic survivors of the Pakistan earthquake using an ethnographic qualitative methodology. They found gender differences in the experience of recovery quite different. Following injury, families of the men with paraplegia remained with them, whereas the majority of women with paraplegia had been abandoned by their husbands within 3 years. For these women, this not only denied them the ability to resume their homemaker roles, but as employment outside the home was viewed as inappropriate for women in their culture, they were unable to take on any employment outside the home. A strength of this research was the range of methods and number of participants included; however, the authors did not specifically note their recruitment, the credibility of the findings, or the rigour of the study methods.

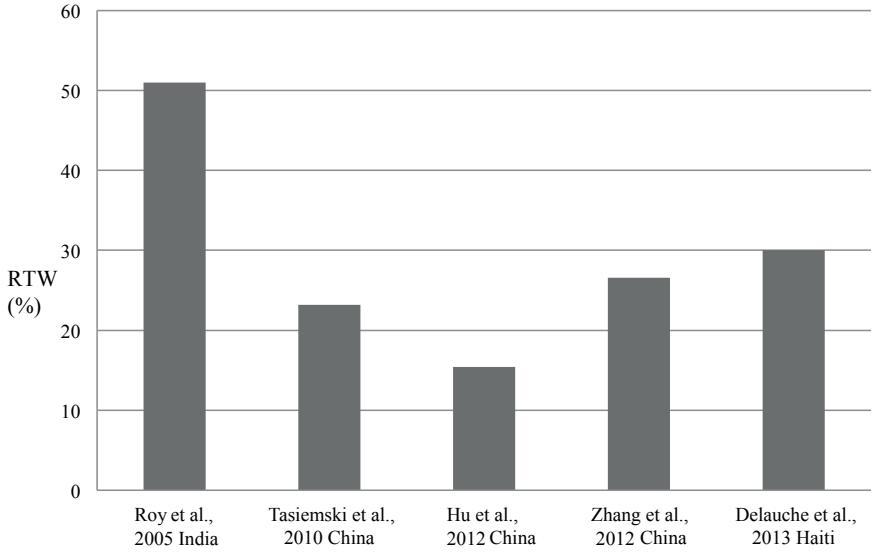

Fig. 2. Reported rates of return to work (RTW).

RTW rates are low in injured earthquake survivors, leading to financial hardship. Participation outcomes improve slightly between discharge and the community. There is some evidence that men and women may have different experiences after an earthquake.

DISCUSSION

This review of the published literature on QOL and participation outcomes following earthquake-related physical injury identified a small number of studies investigating long-term outcome. The included studies report findings from a small proportion of injured earthquake survivors from specific hospital or regions, injured in 5 separate earthquakes, all in developing countries.

QOL remains a difficult construct to measure (33–35). The choice of QOL measure varied widely across the papers, with health, life satisfaction, vocation, education and travel distance to rehabilitation all used as indicators of QOL. Both the use of different proxy measures of QOL, and the variety in the choice of instruments used to measure QOL made direct comparisons across studies impossible. In addition, there were problems with the use of non-validated instruments (28) and missing data. For example, specific questions addressing sexual life in the LiSat-9 questionnaire were not completed by the majority of the participants in the study by Tasiemski et al. (25). The different population groups and injury severities studied also made comparisons difficult. Zhang et al. (24) explored QOL using both the LiSat and the SF-36 in a population of survivors with fractures. However, as they did not characterize type of fracture, severity of injury, or the rehabilitation received, it was difficult to draw inferences or generalize the findings. QOL is multifactorial, and gender, cultural and environmental differences between the countries may explain some of the differences. The comparison of QOL outcomes between countries has been acknowledged as difficult (6). As most QOL research comes from developed countries and the research on QOL following earthquake injury was all from the developing world, extrapolating results from these studies to the developed world is challenging.

Earthquakes cause widespread damage, making it difficult to distinguish the impact of physical injury on QOL from secondary consequences of the earthquake; for example, housing issues, changes in the community or changes in family circumstances. Only the study by Sudaryo et al. (28) included a non-injured comparison group; however, there were notable demographic differences in age, gender and marital status between the 2 groups that limited the inferences that investigators were able to make. The specific factors that influence QOL following earthquake trauma remain inconclusive and require further research.

The most common participation measure reported in this review was RTW. RTW is frequently used as a proxy measure for participation because it is more easily and objectively measured than other aspects of participation, such as recreational and community life. However, RTW is multifaceted and can be measured in multiple ways (36, 37). Comparison across the papers was difficult, as the specific RTW criteria used as the measurement of employment was not clearly defined in any of the studies. The reported RTW rate varied across the studies reviewed, the highest RTW rate being 51% in a mixed injury cohort in India described by Roy et al. (23). This rate was higher than the employment rate of 41% reported in a study of non-earthquake injured SCI individuals from across India by Gupta et al. (38). In contrast with the participants in the study by Roy et al, who were non-urban earthquake survivors living in their own homes, all the employed participants in Gupta et al.'s study were residing in specialized SCI centres, run by the armed forces or non-governmental agencies, rather than living independently in the community. Therefore, the 2 groups of participants may not be comparable. Other participation outcomes investigated in the studies were gender roles and community re-integration. Irshad et al. (27) provided valuable insight into the outcomes of females with paraplega in Pakistan. They highlight how injury following an earthquake can heighten pre-existing gender inequalities and that well-meaning donations may not reach the intended target. In this case the stipend for the injured female survivors was intercepted and used by their husbands. Developing countries typically have fewer legislative and financial supports available for people with disabilities, resulting in diminished employment opportunities compared with their counterparts in developed countries (39). Societal expectations of individuals with disabilities are often lower and environmental barriers are often higher than in developed countries, both of which factors are magnified by cultural and gender role norms that already limit participation, especially for women (39).

Hu et al. (26) were the only group that used a community reintegration measure. They showed improvement in CHART scores between hospital setting and community; however, these results were unsurprising, as the hospital environment automatically limits a person's ability to participate in the community. Adding an additional post-discharge time-point measurement or a non-injured comparison group score may have yielded more informative results. In fact the authors indicated that longer term follow-up was planned.

As data from only 5 countries were found in this review, it is difficult to generalize our findings to other countries. Nonetheless, these studies provide useful information for health and rehabilitation professionals working in developing countries, and for professionals who may themselves face a disaster situation in their own country, or assist post-disaster in the developing world. Initial international assistance after natural disasters is typically generous, but very time limited (12); aid and support tends to be reduced significantly or withdrawn before the injured survivors face their most difficult challenge, i.e. returning to life in an earthquake-damaged community. Effective rehabilitation is required, not only to maximize functional outcomes after injury, but also to address participation, such as RTW (8). However, the rehabilitation provided post-earthquake in developing countries is often delivered with limited resources. Rehabilitation is not always

timely and either misses crucial intervention timeframes or is not of adequate duration (8). Zhang et al. (24) showed that rehabilitation improved QOL outcomes following fracture, although they did not provide details of the content of rehabilitation. Irshad et al. (27) noted that both men and women with paraplegia were keen to work, but felt they had received no vocational input to help them achieve their employment goals. In developed countries, the different delivery of health services may negate the need for studies comparing early and late rehabilitation outcomes, as developed countries tend to have better resources to cover rehabilitation needs. In disaster situations the recording and reporting of medical data is often secondary to life-saving care, and missing or inadequate data was a concern in several of the studies (23, 28).

To improve the outcomes of earthquake survivors in developing countries, well-timed local intervention appears vital to ensure that aid is distributed in a culturally appropriate way, to reach the intended population without unintentionally disadvantaging vulnerable groups or exacerbating pre-existing gender inequalities. International organizations are improving efforts to educate health professionals in developing countries prone to natural disasters to improve local capacity not only to respond to future disasters (12, 40), but to also enhance the treatment of trauma patients irrespective of the cause of injury and to deal with the rehabilitation needs of individuals with disabilities from previous disasters.

Research from developing countries has indicated that outcomes of earthquake-related trauma may be different from the outcomes of non-earthquake related trauma. However, earthquakes are not restricted to developing countries; this review highlights a lack of information about QOL and participation outcomes for injured earthquake survivors in developed countries. It is important that this type of research is performed in developed countries, where higher expectations of care and rehabilitation coupled with increased financial support and legislation may be more effective in pinpointing the differences in participation and QOL related specifically to earthquake effects, and not just the injury. Research from earthquakes in the developed world, such as the 1994 Northridge earthquake in the USA, has focused on mortality and injury rates (41, 42), or psychological outcomes (43) rather than participation and QOL outcomes of injured survivors. This may, in part, be due to the lower incidence of high magnitude earthquakes experienced in developed countries. However recent earthquakes in New Zealand and Japan have highlighted the very real risk of significant earthquakes in the developed world.

Earthquakes are unpredictable events and, inevitably, all post-earthquake research is reactive in nature and time limited. As a consequence there are often methodological issues in the resultant studies. Care is needed in future events to ensure that post-earthquake research is of the highest possible quality. As a result, we recommend that the following outcome criteria be mandatory in all future studies evaluating QOL outcomes and RTW.

- Future research should include a wider range of outcomes based on a conceptual framework, such as the ICF (11), to include both the injury and environmental consequences of earthquake injuries. Mixed methods research including a qualitative exploration of the issues may be useful to understand the full effects of participation and QOL issues after earthquake injury.
- Although achieving consensus on a single QOL or participation measure to use is fraught with difficulty, future research should use validated condition-specific outcome measures to provide better opportunities to compare QOL and participation outcomes post-earthquake on a worldwide scale.
- Clear definitions of the outcome measures used should be made explicit in publications, especially around employment outcomes where the metric used needs to be clearly stated, e.g. return to work rate or return to employment-specific hours.
- Ideally research into outcomes of injured earthquake survivors should use representative samples of the whole group of injured earthquake survivors. Where this is not possible, comparisons with the wider group of injured survivors should be made.
- Research on participation and QOL issues after earthquake injury should be undertaken in all countries that experience earthquakes.

Study limitations

Although this review followed guidelines for systematic reviews, it has some limitations. The search strategy was designed to be inclusive, but the review was limited to peer-reviewed articles published in English, which, considering the location of the earthquakes, may have limited the number of studies reviewed.

Conclusion

This review indicates that there is limited evidence to suggest that earthquake-injured survivors in developing countries experience participation and QOL limitations as a result of their injuries. In addition, cultural and gender-role issues as a result of earthquake injuries may be magnified by the increased number of female injuries. However, it is difficult to generalize outcomes between studies, because the studies are few, with small sample sizes, they lack uniformity in outcome measurement, and there is an absence of studies from developed countries.

In order to maximize future research on QOL and participation in injured earthquake survivors, studies should consider both the functional consequences of the injury and the environmental impact of the earthquake. Research should be based on representative samples of the injured earthquake survivors and use validated condition-specific outcome measures that are clearly defined within the publications and include all countries that are affected by earthquakes.

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REFERENCES

1. Noji EK. Medical consequences of earthquakes: coordinating medical and rescue response. Disaster Management 1991; 4: 32–40.
2. Naghii MR. Public health impact and medical consequences of earthquakes. Rev Panam Salud Publica 2005; 180: 216–221.
3. Ramirez M, Peek-Asa C. Epidemiology of traumatic injuries from earthquakes. Epidemiol Rev 2005; 27: 47–55.
4. Word Health Organization Collaborating Centre for Research on the Epidemiology of Disasters. EM-DAT: the OFDA/CRED International Disasters Data Base. 2011 [cited 2011 Nov 16]. Available from: http://www.emdat.be/.
5. Vervaeck A, Daniel J. CATDAT Damaging Earthquakes Database 2011 – annual review. 2012. Available from: http://earthquake-report.com/2012/01/09/catdat-damaging-earthquakes-database-2011-annual-review/.
6. Briggs MS. Earthquakes. Surg Clin North Am 2006; 86: 537–544.
7. Urquhart DM, Edwards ER, Graves SE, Williamson OD, McNeil JJ, Kossmann T, et al. Characterisation of orthopaedic trauma admitted to adult level 1 trauma centres. Injury 2006; 37: 120–127.
8. Reinhardt JD, Li J, Gosney J, Rathore FA, Haig AJ, Marx M, et al. Disability and health related rehabilitation in international disaster relief. Glob Health Action 2011; 4: 7191–7199.
9. Guha-Sapir D, Vos F, Below R, Ponserre S. Annual disaster statistical review 2011: the numbers and trends. Brussels: CRED; 2012.
10. The WHOQOL Group. Development of the World Health Organization WHOQOL-BREF Quality of Life Assessment. Psychol Med 1998; 28: 551–558.
11. World Health Organisation. International Classification of Functioning, Disability and Health. Geneva: World Health Organization; 2001.
12. Burns AS, O'Connell C, Rathore FA. Meeting the challenges of spinal cord injury care following sudden onset disaster – lessons learned. J Rehabil Med 2012; 44: 414–420.
13. Ardagh M, Richardson SK, Robinson V, Than M, Gee P, Henderson S, et al. The initial health-system response to the earthquake in Christchurch, New Zealand, in February, 2011. Lancet Neurol 2012; 379: 2109–2115.
14. Carr VJ, Lewin TJ, Webster RA, Kenardy JA, Hazell PL, Carter GL. Psychosocial sequelae of the 1989 Newcastle earthquake: II. Exposure and morbidity profiles during the first 2 years post-disaster. Psychol Med 1997; 27: 167–178.
15. Centers for Disease Control Prevention. Post-earthquake injuries treated at a field hospital – Haiti, 2010. Morbidity and Mortality Weekly Report 2011; 59: 1673–1677.
16. Chatterjee P. One year after the Gujarat earthquake. Lancet 2002; 359: 327–337.
17. Chen R, Song Y, Kong Q, Zhou C, Liu L. Analysis of 78 patients with spinal injuries in the 2008 Sichuan, China, earthquake. Orthopedics 2009; 32: 322–326.
18. Gautschi OP, Cadosch D, Rajan G, Zellweger R. Earthquakes and trauma: review of triage and injury-specific, immediate care. Prehospital Disaster Med 2008; 23: 195–201.
19. Jian HS, Lü ZM, Li YY. Epidemiological investigation on Wenchuan earthquake-struck trauma patients admitted to two hospitals of Chongqing. Chin J Traumatol 2010; 13: 101–102.
20. Mulvey JM, Awan SU, Qadri AA, Maqsood MA. Profile of injuries arising from the 2005 Kashmir Earthquake: the first 72 h. Injury 2008; 39: 554–560.
21. Centre for Reviews and Dissemination. Systematic reviews: CRD's guidance for undertaking reviews in health care. University of York: Centre for Reviews and Dissemination; 2009.
22. Public Health Resource Unit. Critical appraisal skills programme: making sense of evidence 2012. Available from: http://www.sph.nhs.uk/what-we-do/public-health-workforce/resources/critical-appraisals-skills-programme.
23. Roy N, Shah H, Patel V, Bagalkote H. Surgical and psychosocial outcomes in the rural injured – a follow-up study of the 2001 earthquake victims. Injury 2005; 36: 927–934.
24. Zhang X, Hu X, Reinhardt J, Zhu H, Gosney J, Liu S, et al. Functional outcomes and health-related quality of life in fracture victims 27 months after the Sichuan earthquake. J Rehabil Med 2012; 44: 206–209.
25. Tasiemski T, Nielsen S, Wilski M. Quality of life in people with spinal cord injury - earthquake survivors from Sichuan province in China. Asia Pacific Disabil Rehabil J 2010; 21: 28–36.
26. Hu X, Zhang X, Gosney JE, Reinhardt JD, Chen S, Jin H, et al. Analysis of functional status, quality of life and community integration in earthquake survivors with spinal cord injury at hospital discharge and one-year follow-up in the community. J Rehabil Med 2012; 44: 200–205.
27. Irshad H, Mumtaz Z, Levay A. Long-term gendered consequences of permanent disabilities caused by the 2005 Pakistan earthquake. Disasters 2012; 36: 452–464.
28. Sudaryo MK, Besral, Tias Endarti A, Rivany R, Phalkey R, Marx M, et al. Injury, disability and quality of life after the 2009 earthquake in Padang, Indonesia: a prospective cohort study of adult survivors. Glob Health Action 2012; 5: 1–11.
29. Delauche MC, Blackwell N, Le Perff H, Khallaf N, Muller J, Callens S, et al. A prospective study of the outcome of patients with limb trauma following the Haitian earthquake in 2010 at one- and two- year (the SuTra2 Study). PLoS Currents 2013; (ecurrents.dis.931c4ba8e64a95907f16173603abb52f).
30. Fugl-Meyer AR, Bränholm I-B, Fugl-Meyer KS. Happiness and domain-specific life satisfaction in adult northern Swedes. Clin Rehabil 1991; 5: 25–33.
31. Ware JE, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36): I. Conceptual framework and item selection. Med Care 1992; 30: 473–483.
32. World Health Organization. International Classification of Impairments, Disabilty and Handicap (ICIDH). Geneva: World Health Organization; 1980.
33. Dijkers M. Measuring quality of life: methodological issues 1. Am J Phys Med Rehabil 1999; 78: 286–300.
34. Dijkers M. Individualization in quality of life measurement: instruments and approaches. Arch Phys Med Rehabil 2003; 84: S3–S14.
35. Dijkers M. "What's in a name?'' The indiscriminate use of the "quality of life'' label, and the need to bring about clarity in conceptualizations. Int J Nurs Stud 2007; 44: 153–155.
36. Young AE, Roessler RT, Wasiak R, McPherson KM, Van Poppel MNM, Anema JR. A developmental conceptualization of return to work. J Occup Rehabil 2005; 15: 557–568.
37. Young AE, Wasiak R, Rossler RT, McPherson KM, Anema JR, van Poppel MNM. Return-to-work outcomes following work disability: stakeholder motivations, interests and concerns. J Occup Rehabil 2005; 15: 543–556.
38. Gupta N, Solomon J, Raja K. Employment after paraplegia in India: a postal survey. Spinal Cord 2011; 49: 806–811.
39. World Health Organization. World report on disability. Geneva: World Health Organization; 2011. Available from: http://www.who.int/disabilities/world_report/2011/report.pdf.
40. Burns AS, O'Connell C. The challenge of spinal cord injury care in the developing world. J Spinal Cord Med 2012; 35: 3–8.
41. McArthur DL, Peek-Asa C, Kraus JF. Injury hospitalizations before and after the 1994 Northridge, California earthquake. Am J Emerg Med 2000; 18: 361–366.
42. Peek-Asa C, Kraus JF, Bourque LB, Vimalachandra D, Yu J, Abrams J. Fatal and hospitalized injuries resulting from the 1994 Northridge earthquake. Int J Epidemiol 1998; 27: 459–465.
43. McMillen JC, North CS, Smith EM. What parts of PTSD are normal: intrusion, avoidance, or arousal? Data from the Northridge, California, earthquake. J Trauma Stress 2000; 13: 57–75.

APPENDIX I. Systematic review search strategy

MEDLINE (Ovid)
1. Fracture$.mp.
2. Exp injuries/
3. Exp orthopaedic$
4. Exp Trauma/
5. Exp multiple trauma/
6. Lower extremity injur*.mp.
7. Upper extremity injur*.mp.
8. Spinal Cord injury.mp.
9. Exp Spinal Cord Injuries/
10. Brain injury.mp.
11. Exp Brain injury/
12. Disab$.mp.
13. exp Amputation/
14. exp Amputation, Traumatic/
15. amputation.mp.
16. 1–15
17. Exp earthquake$
18. Earthquake$.mp.
19. Seismic.mp.
20. Disaster$.mp.
21. Exp disaster$/
22. Or/ 17–21
23. Exp Work/
24. Exp Employment/
25. Return to work.mp. or Return-to-work.mp.
26. Return to employment.mp.
27. Exp Absenteeism/
28. Unemployment.mp.
29. Sick leave.mp.
30. Sick$ absence.mp.
31. Sick list$.mp.
32. Time off work.mp.
33. Workloss.mp.
34. Work loss.mp.
35. Work resumption.mp.
36. Work disability
37. Or/ 23–36
38. Participation.mp.
39. function$.mp.
40. Exp Quality of Life/
41. health outcomes.mp.
42. health related quality of life.mp.
43. SF 36.mp.
44. Whoqol.mp.
45. Or/38–44
46. 16 and 22 and 37 and 45
47. Limit to English language only
48. Limit to humans