Research Article

Video-Based Postural Hazard Identification during Flood Victim Evacuation

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Abstract

Several inappropriate postures have been adopted in the evacuation of disaster victims, which is the important procedure in emergency life-saving responses. Despite safety for the victims, these responses may become the major cause of musculoskeletal injuries among staff. The purpose of this study was to identify lifting and handling postures during disaster and to explore risks of musculoskeletal injuries during flood victim evacuation. A retrospective review of snapshots from video recordings of the 2011 Flood in Thailand was conducted. The Rapid Entire Body Assessment technique was used to assess risk of musculoskeletal injuries during manual handling and lifting.

The most common method used during flood evacuation was manual handling. More than 50% of lifting postures were medium to very high risk. Potential causes of injury included general characteristics of staff, victims, handling methods, equipment, and environment.

Conclusion: These findings revealed baseline data for future disaster risk management related to musculoskeletal injuries. Harmful postures were identified during evacuation activities. Safety practices and proper evacuations are paramount for emergency staff to prevent injuries during evacuation in flooding and other disaster situations.

Keywords: Public health preparedness; Musculoskeletal injury; Emergency responder; Ergonomics; Flood

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1. Introduction

Flood disasters cause economic lost, injury and death worldwide [1] and occur widespread in scope and severity [2]. Many Asian countries have sustained severe flood damage, including Bangladesh, China, India, Japan, Laos, Viet Nam, Cambodia, the Philippines, and Thailand [3]. More than 65 provinces and millions of people were affected by 2011 Flood disaster in Thailand [3]. Emergency staff are crucial for life-saving. Several activities are performed during emergency evacuation such as lifting, lowering and transferring flood victims, in which unsafe conditions are unadvoidable [4,5]. The staff have been exposed to a variety of occupational injuries [6-8] in particular the risk of back pain [5,9]. Several studies indicated that manual handling of people is associated with back injuries in the health care sector [10-12] and in emergency situations [5,6,13-15]. Emergency staff seem to have greater musculoskeletal problems when compared to other populations [16]. A previous report demonstrated disaster unpreparedness, staff shortage and inadequate equipment [17]. Manual lifting and handling of flood victims has been adopted. However, physical demands and adverse events present during emergency operation may lead to injuries among staff and victims [4,18]. Prolonged flexed and twisted trunk may significantly increase the risk of low back injury among staff [13].

The identification of hazards is the first step of risk assessment [19,20]. Postural analysis is not only a powerful technique for assessing work activities but also a major factor for implementing changes [15]. Lifting and handling of flood victims is an unpredictable activity. Existing guidelines are available mainly for safe patient handling and usually limited to the health care sector [15,22,23]. Only a few recommendations extend to specifically deal with emergency tasks [15,23,24,25]. Musculoskeletal injuries (MSI) as a result of handling people in emergency or during crisis have not been well addressed [5,15,25]. Injury prevention strategies in different healthcare settings, such as home care and during crisis, must be explored and considered within the context of emergency care work [26,27].

The aim of this study is to identify lifting and handling postures and to explore the hazards of musculoskeletal injuries during flood victim evacuation. This information will provide baseline data to support the improvement of evacuation preparedness and responses.

2. Materials and Methods

A retrospective snapshots review of the 2011 Thailand Flood crisis situation from July to December was implemented. The footages were obtained from one Thai broadcasting station. The sample of snapshots was chosen from captured victim evacuation which was operationally defined as the situation in which a helper was lifting or handling a victim during transferring from one place to another safe place.

Lifting and handling postures of individual helpers were assessed. These were chosen from common postures adopted in manual handling of people including lifting, lowering, and transferring. The moving or supporting of a body part of a victim without assistive devices were also included [13]. The Rapid Entire Body Assessment (REBA) technique was used in postural analysis. The classification of postures is derived from two groups of body part diagrams. Postural score increases when posture diverged from the neutral position. Group A includes trunk, neck, and legs, while group B includes upper and lower arms and wrist. There are five action levels for risk estimation (0 = negligible, 1 = low, 2 = medium, 3 = high and 4 = very high) [15]. High reliability of the REBA technique has been reported (ICC=0.90) [28,29]. The current study addressed only adult manual handling. Right and left arms were assessed separately and data was analyzed using descriptive statistics.

3. Results

The final snapshot sample consisted of 191 pictures mostly in the carrying and lifting phase. Most helpers were men (82.20%), in which almost half were military (41.90%). Most flood victims were adults (62.30%) with the majority of women (44.50%), followed by infants and small children (37.70%) (Table 1).

Evacuation consisted of walking in water, picking up a victim to an ambulance/ a military truck, a boat, and down stairs. Manual handling was found to be the most common method used for lifting victims (72.30%). Of all sampled snapshots, the most common manual handling for an adult was taken by one helper (18%) (Table 2).

Several manual handling methods of flood victim have been demonstrated and categorized by the number of helpers. There were three methods by one helper, two methods by two helpers, and three methods by three helpers (Figure 1).

The 91 postures of adult manual handling were completely evaluated using the REBA. No difference was found between the grand REBA score performed by the right and left sides of individual helpers. In all methods adopted, the risk of injury was medium to very high as shown in Figures 2-4.

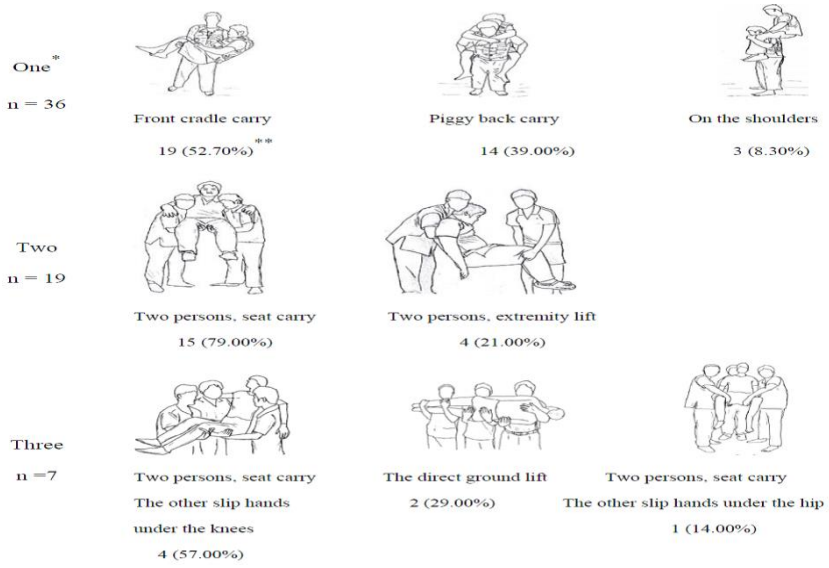
Table 1. Characteristics of helpers and flood victims from 191 pictures.

Characteristic	n	%
Helpers		
Sex		
Female	34	17.80
Male	157	82.20
Occupation		
Emergency medical technicians/ paramedics	54	28.30
Residents	57	29.80
Military	80	41.90
Flood victims		
Sex (Adult)		
Female	85	71.00
Male	34	29.00
Age group		
Infants/small children	72	37.70
Adults	119	62.30

Table 2. Situation, methods of evacuation and number of helpers**.**

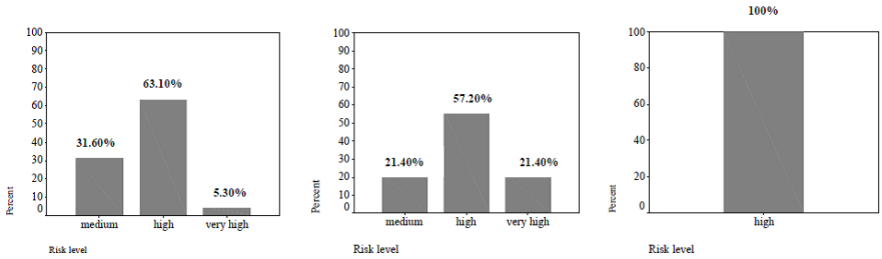
Characteristic	n	%
Situation of victim evacuation (n=191)		
Pick up a victim to a boat	9	4.70
Transport a victim down stairs	7	3.70
Pick up a victim to an ambulance/a military truck	65	34.00
Walking in water	110	57.60
Methods for lifting and handling (n=191)		
With equipment/devices (e.g. chair, stretcher)	53	27.70
Manual (without equipment/ devices)	138	72.30
The number of helpers and victim category (n=191)		
One helper handling an infant or a small child	72	38.60
One helper handling an adult	36	18.00
Two helpers handling an adult	19	9.90
Three helpers handling an adult	14	7.30
Four or more helpers handling an adult	50	26.20

n = number of snapshots



* Number of helpers
** Number of snapshots (percentage)

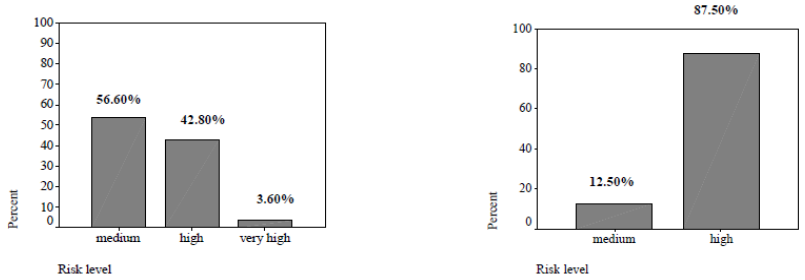
Fig.1. Methods of victim manual handling categorized by the number of helpers.



Front cradle carry (n=19) Piggy back carry (n=14) On the shoulders (n=3)

n = Number of helpers

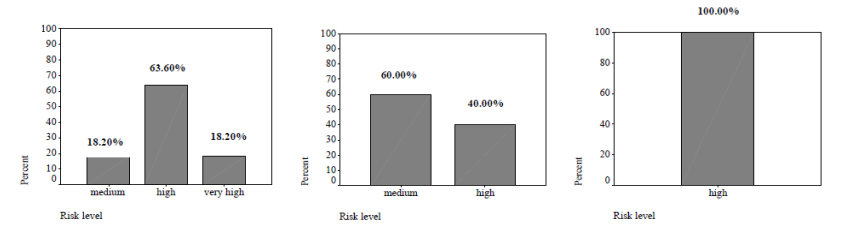
Fig.2. Percentage of risk level (REBA) of manual handling methods by one helper.



Two persons extremity lift (n=28) Two persons seat carry (n=8)

n = Number of helpers

Fig.3. Percentage of risk level (REBA) of manual handling methods by two helpers.



Two persons seat carry, the other slip hands under the knees (n=11)

The direct ground lift (n=5)

Two persons seat carry, the other slip hands under the hip (n=3)

n = Number of helpers

Fig.4. Percentage of risk level (REBA) of manual handling methods by three helpers.

4. Discussion

The results of this study revealed harmful postures when operating flood victim handlings whether by one or more helpers. More than 50 % of handling postures were found to be at medium to very high risk, necessitating further assessments and changes. Inappropriate working postures have been identified as the cause of injuries and considered to be unacceptable tasks [9,11]. Similarly, some studies have demonstrated that manual handling of people in emergency situation were at risk of MSI due to awkward postures [5,13,15,18,28]. Harmful postures which were found during the evacuation attributed to musculoskeletal injury exposure required corrective measures [25,29].

From the analysis of risk level in this study, existing working postures during evacuation is not recommended for lifting and handling people. These methods have also been prohibited and considered inappropriate such as the drag lift, cradle lift, and shoulder lift [30,31]. Despite harm, the most common method used was manual handling by one helper. This finding demonstrated the lack of effective evacuation preparedness and responses to crisis in Thailand. Similar to disaster reports in previous studies in Thailand [17] and in Japan [32], in which the lack of evacuation planning in staff operation and equipment preparation was evidenced. Several hazardous factors among staff involved awkward and asymmetrical postures during lifting and handling. The current study demonstrated that characteristics of the staff, flood victims, tasks or methods and conditions, in which flood victim handling activities became hazardous and increased exposure to the risk of injury [33]. Postures are influenced by task, workstation, tool design, and the anthropometric characterictics of workers [9]. Emergency staff including emergency medical services, paramedics, military and other volunteers are considered at risk given that they rescue and carry victims in unpredictable environments [34]. In addition, rescuers may experience mental burden during an emergency which is different from manual material handling in industrial sectors [35]. Staff whom are untrained to cope with disaster evacuation may not be able to respond durring an evacuation promptly and appropriately [17,32].

Paramedics are usually directly involve in patient transfer in their annual training. They are trained with information and proper human lifting and handling techniques [17]. In 2011 flooding situation, most helpers were military who might be untrained for proper manual handling of people. Therefore, they are likely to be expose to injury risk during performing evacuation tasks. Moreover, not only repetitive liftings of people is performed but also lifting furniture and sand bags. Unlike health care workers, these military staff transported flood victims in various unfamiliar environmental conditions such as picking up victims to boats, ambulances and military trucks. The limitation of equipment usage in crisis led to inconvenient and inappropriate emergency procedures [36]. These tasks might contribute to unavoidable awkward positions and overexertion among these staff [37].

Small children and older people were the main group of victims rescued by emergency staff in the 2011 Thailand Flood. Combative or unrest victims may create extra loads on the helper's spine [38]. Therefore, prior to emergency responses, staff should be well-informed and trained for safe evacuation procedures confining resident/victim characters, especially the vulnerable group [32]. Implementation of proper lifting methods and assistive devices to reduce the manual handling and awkward posture is crucial for not only the staff, but also for the safety and comfort of the residents or victims being rescued [39,40].

There are some limitations in the current study. Reviewed film data were supplied by only one broadcast station. However, these lifting and handling postures

were considered the representatives of the most common practice.

5. Conclusion

Harmful postures were adopted during flood victims handling. Common methods of victim manual handling during flood evacuation were found. These included front cradle carry by one helper; two persons, seat carry by two helpers; and two persons, seat carry, the others slip hands under the knees by three helpers. These methods were at high risk level. It is necessary to control not to use awkward postures in emergency tasks to prevent musculoskeletal injuries. Lifting team members should be trained and proper equipment should be used for victim transfer. There is a need for designing proper evacuation procedure both in flooding preparedness and responses. The findings from the current study would be useful for promoting safety awareness among operators. Further investigation as well as the implementation of ergonomic interventions are required to prevent musculoskeletal injuries during resident evacuation in flooding and other crisis situations.

6. Acknowledgements

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7. References

[1] World Health Organization, FLOODS - Technical Hazard Sheet - natural Disaster Profile., 2013 Available Source: http://www.who.int/hac/techguidance/ems/floods/en/, April 19, 2015.

[2] Pauline Mwaniki, Lessons Learned WASH Response During Rural Flood Emergencies, 2009, Available Source: http://www.humanitarianreform.org/Default.aspx?tabid=770, April 19, 2015.

[3] Global Information and Early Warning System on Food and Agriculture (GIEWS). *Southeast Asia flood up date*, 2011, Available Source: http://www.fao.org/giews/english/shortnews/seasia21102011.pdf, April 4, 2014.

[4] Wang H.E., Weaver M.D., Abo B.N., Ambulance Stretcher Adverse Events, Quality Safety in Health Care, Vol.,18, pp. 213-236, 2009.

[5] Gentzler, M., and Stader S., Posture Stress on Firefighters and Emergency Medical Technicians (EMTs) Associated with Repetitive Reaching, Bending, and Pulling Tasks., Work. Vol. 37, pp. 227-239, 2010.

[6] Sommerich, C.R., Lavender, S.A., Umar R.Z., A Biomechanical and Subjective Assessment and Comparison of Three Ambulance Cot Design Configurations, Ergonomics., Vol. 55, pp. 1350-1361,2012.

[7] Weiler, M.R., Lavender, S.A., and Crawford J.M., Identification of Factors that Adoption of an Ergonomic Intervention among Emergency Medical Service Workers, Ergonomics., Vol. 55, pp. 1362-1372, 2012.

[8] Jahnke, S.A., Poston, W.S., and Haddock C.K., Injury among a Population Based Sample of Career Firefighters in the Central USA, Injury Prevention., Vol. 19, pp. 393-398, 2013.

[9] Vieira E.R. and Kumar, S., Working posture: A Literature Review, Journal of Occupational Rehabilitation., Vol. 14, pp. 143-159, 2004.

[10] Manesh, A.M., Angthong, C. and Pangma A., Hospital Evacuation; Learning from the Past, Flooding of Bangkok 2011, British Journal of Medicine & Medical Research., Vol. 4, pp. 395-415, 2014.

[11] Reichard, A.A. and Jackson, L.L., Occupational Injuries among Emergency Responders, American Journal of Industrial Medicine., Vol. 53, pp.1-11, 2010.

[12] Prairie, J. and Corbeil, P., Paramedics on the Job: Dynamic Trunk Motion Assessment at the Workplace, Applied Ergonomics., Vol. 45, pp. 895-903, 2014.

[13] The International Organization for Standardization., Ergonomics-Manual Handling of People in the Healthcare Sector (ISO/TR 12296) CH 211:Geneva, 2012.

[14] Hignett, S., Fray, M. and Battevi, N., International Consensus on Manual Handling of People in the Healthcare Sector : Technical Report ISO/TR 12296, International Journal of Industrial Ergonomics., Vol. 44, pp.191-195,2014.

[15] Hignett, S. and McAtamney, L., Rapid Entire Body Assessment (REBA), Applied Ergonomics., Vol. 31, pp. 201-205, 2000.

[16] Hignett, S., Posture Analysis of Nursing Work, Applied Ergonomics., Vol. 21, pp. 171-176. 1996.

[17] Marras, W.S., Davis, K.G. and Kirking, B.C., A Comprehensive Analysis of Low Back Disorder Risk and Spinal Loading During the Transferring and Repositioning of Patients Using Different Techniques. Ergonomics., Vol. 42, pp. 904-926, 1999.

[18] Freitag, S., Ellegast, R. and Dulon M., Quantitative Measurement of Stressful Trunk Postures in Nursing Professions. Annual of Occupational Hygine., Vol. 51, pp. 385–395,2007.

[19] Lavender, S.A. and Corard, K.M., Reichelt PA., Postural Analysis of Paramedics Simulating Frequently Performed Strenuous Work Tasks, Applied Ergonomics., Vol. 31, pp. 45-57, 2000.

[20] Whitby, L., Preventing Injury When Moving Patients in a Emergency. HFESA 47th. Annual Conference 2011, Ergonomics Australia- Special Edition, pp. 1-4, 2011.

[21] Sterud, T., Ekeberg, O. and Hem, E., Health Status in the Ambulance Services: a Systematic Review. BMC Health Services Research, Vol.6, pp. 1-10, 2006.

[22] Li, J., wolf, L., Evanoff B., Use of Mechanical Patients Lifts Decreased Musculoskeletal Symptoms and Injuries among Health Care Workers, Injury Prevention., Vol. 10, pp. 212-216, 2004.

[23] Conrad, K.M., Reichelt, P.A. and Lavender SA., Designing Ergonomic Interventions for EMS Workers: Concept Generation of Patient – Handling Devices, Applied Ergonomics., Vol. 39, pp. 792-802,2008.

[24] Massad, R. and Gambin, C., Duval., The Contribution of Ergonomics to the Prevention of Musculoskeletal Lesions among Ambulance Technicians, Proceeding of the IEA 2000/HFES 2000 Congress, pp. 201-204, 2000.

[25] Ferreira, J. and Hignett, S., Review Ambulance Design for Clinical Efficiency and Paramedic Safety, Applied Ergonomics., Vol. 36, pp. 971-975, 2005.

[26] Collins, J.W., Wolf, L. and Bell, J., An Evaluation of a Best Practices Musculoskeletal Injury Prevention Program in Nursing Homes, Injury Prevention., Vol. 10, pp. 206-211, 2004.

[27] Lim, H, Black, T.R. and Shah, S.A., Evaluating Repeated Patient Handling Injuries Following the Implementation of a Multi-factors Ergonomics Intervention Program among Health Care Workers, Journal of Safety Research., Vol. 42, pp. 185-191, 2011.

[28] Kee, D., A Comparison of Three Observational Techniques for Assessing Postural Loads in Industry, International Journal of Occupational Safety and Ergonomics., Vol. 13, pp. 3-14, 2007.

[29] Syahril, F. and Sonjaya, E., Validity, Sensitivity, and Reliability Testing by Ergonomics Evaluation Methods for Geothermal Task., Proceeding World Geothermal Congress, Melbourne, Australia, 2015.

[30] Lavender, S.A., Conrad, K.M. and Reichelt P.A., Designing Ergonomics Interventions for EMS Workers – part I: Transporting Patients Down the Stairs, Applied Ergonomics., Vol. 38, pp. 71–81, 2007.

[31] Doormall, M.T., Physical Workload of Ambulance Assistants, Ergonomics., Vol. 38, pp. 361-376, 1995.

[32] Owen, B.D., Magnitude of the problem. In: Charney, W & Hudson, A. (eds). Back Injury among Health Care Workers, pp. 5-13. New York: Lewis Publishers, 2004.

[33] Lakin, S.B. and Clarkson, R., When the Patient Handlers Become Patients, Health Trek, Willis North America, pp. 1-8, 2008.

[34] Nakahara, S., Lessons Learnt from the Recent Tsunami in Japan: Necessity of Epidemiological Evidence to Strengthen Community-based Preparation and Emergency Response Plans, Injury Prevention., Vol. 17, pp. 361-364, 2011.

[35] Occupational Safety and Health Administration (OSHA), Patient Handling Techniques to Prevent MSDs in Health Care, 2007, Available Source: http://www.osha.eu/en/publications/e-facts/efact28, February 20, 2014.

[36] Punakallio, N., Lusa, S. and Luukkonen, R., Musculoskeletal Pain and Depressive Symtoms as Predictors of Trajectories in Work Ability among Finnish Firefighters 13-year Follow-up, Journal of Occupational and Environmental Medicine., Vol. 54, pp. 367-375, 2014.

[37] Hignett, S., Intervention Strategies to Reduce Musculoskeletal Injuries Associated with Handling Patients a Systematic Review, Occupational and Environment Medicine., Vol. 60, pp. 1-8, 2003.

[38] Collins J.W., Musculoskeletal Disorders and Emergency Issue. In: NIOSH, Identification of Research Opportunities for the next Decade of NORA, No. DHH. 8, pp. 141-147. Publication No. 2009-139, 2009.

[39] Nelson, A., Patient Handling in Health Care.In: Marras, W. S., & Karwowski, W, (eds), Intervention, Control, and Application in Occupational Ergonomics New York, CRC Press, 2006.

[40] Water, T.R., When is it Safe to Manually Lift a Patient? The American Journal of Nursing., Vol. 107, pp. 53-58, 2007.

[41] Kjellberg, K., Lagerstro, M. and Hagberg M., Patient Safety and Comfort During Transfers in Relation to Nurses' Work Technique. Journal of Advanced Nursing., Vol. 47, pp. 251–259. 2004.

[42] Zhuang, Z., Stobbe, T.J. and Collins, J.W., Psychophysical Assessment of Assistive Devices for Transferring Patients/residents, Applied Ergonomics., Vol. 31, pp. 35-41, 2000.