

The October 2005 Earthquake in Northern Pakistan: Pattern of Injuries in Victims Brought to the Emergency Relief Hospital, Doraha, Mansehra

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Abstract

Objective: Knowledge of injuries of earthquake victims is important to plan relief efforts. This cross-sectional study was conducted following the 08 October 2005 earthquake in Northern Pakistan to determine the pattern of injuries sustained and their relationship with age and gender in order to identify the medical needs in an earthquake-affected zone.

Methods: The study was conducted between 13 October and 23 October 2005 at the Emergency Relief Hospital, Doraha, Mansehra. From the 1,700 patients registered in the hospital, 310 were sampled randomly for the study. Demography and details of the patients' injuries were noted by history and physical examination. Twelve cases were omitted due to incomplete data.

Results: Of the cases, 54% were female. Children ≤ 10 years old formed the largest age group. Isolated bone injuries were present in 41%, soft tissue injuries in 36%, and mixed injuries in 23% of the patients. The most common bone injury was lower limb fracture (52%), while the most common non-bone injury was non-infected, soft tissue wounds on the limbs (33%). Among patients with soft tissue injuries, gangrenous wounds were present in 9%, and grossly infected wounds in 30% (20% on limbs and 10% on rest of the body).

Conclusions: The population injured during the earthquake showed a higher proportion of females and children ≤ 10 years old, and lower limb bone injuries. The data highlight the need to address orthopedic, pediatric, and women's health issues, and for logistic arrangement of relevant diagnostic and therapeutic facilities at the initial stages of relief activities after earthquakes.

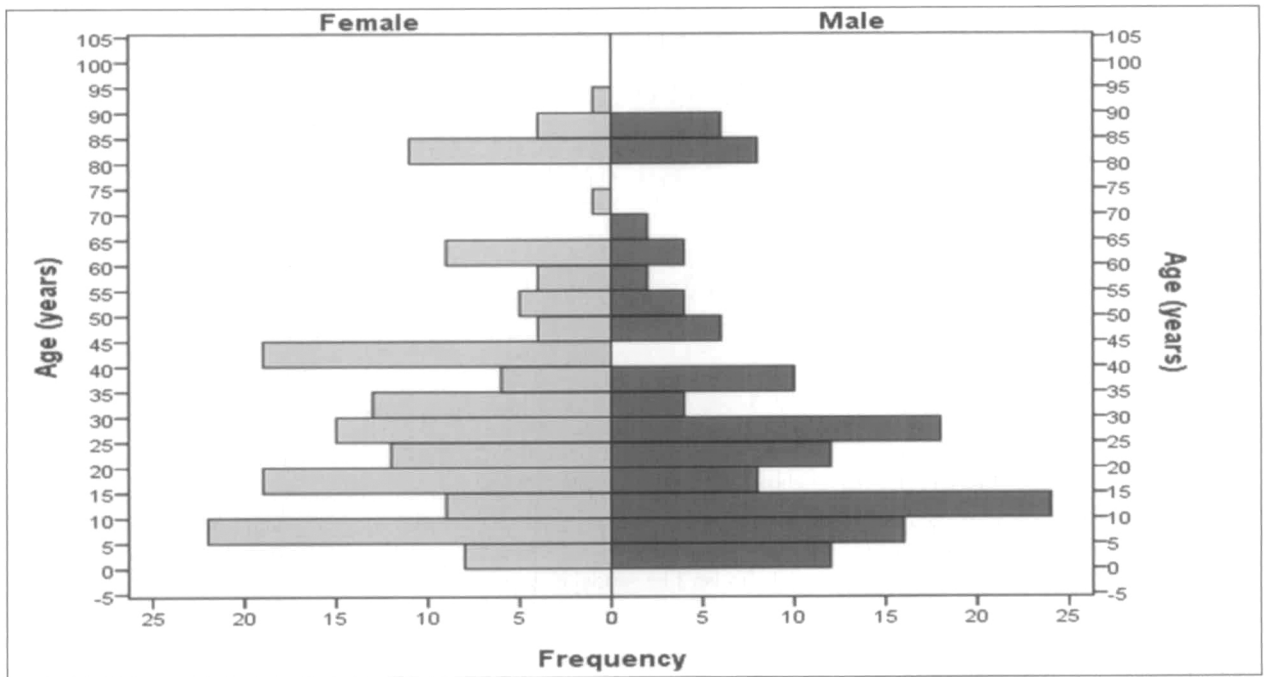
Sami F, Ali F, Zaidi SHH, Rehman H, Ahmad T, Siddiqui MI: The October 2005 earthquake in northern Pakistan: Pattern of injuries in victims brought to the emergency relief hospital, Doraha, Mansehra. *Prehosp Disaster Med* 2009;24(6):535–539.

Introduction

Due to release of energy accumulated along the geological faults or volcanic activity, vibrations called seismic waves are generated and travel both through the earth and along its surface. These seismic waves cause the movement known as earthquakes.¹ Only around 3,000 earthquakes are perceptible by humans out of approximately 500,000 earthquakes documented every year. Of the former, an average ranging from seven to 11 result in substantial loss of lives, but in the last few years this average has increased.^{2–4} Total deaths resulting from major earthquakes ranges from fewer than five to more than 240,000.⁵

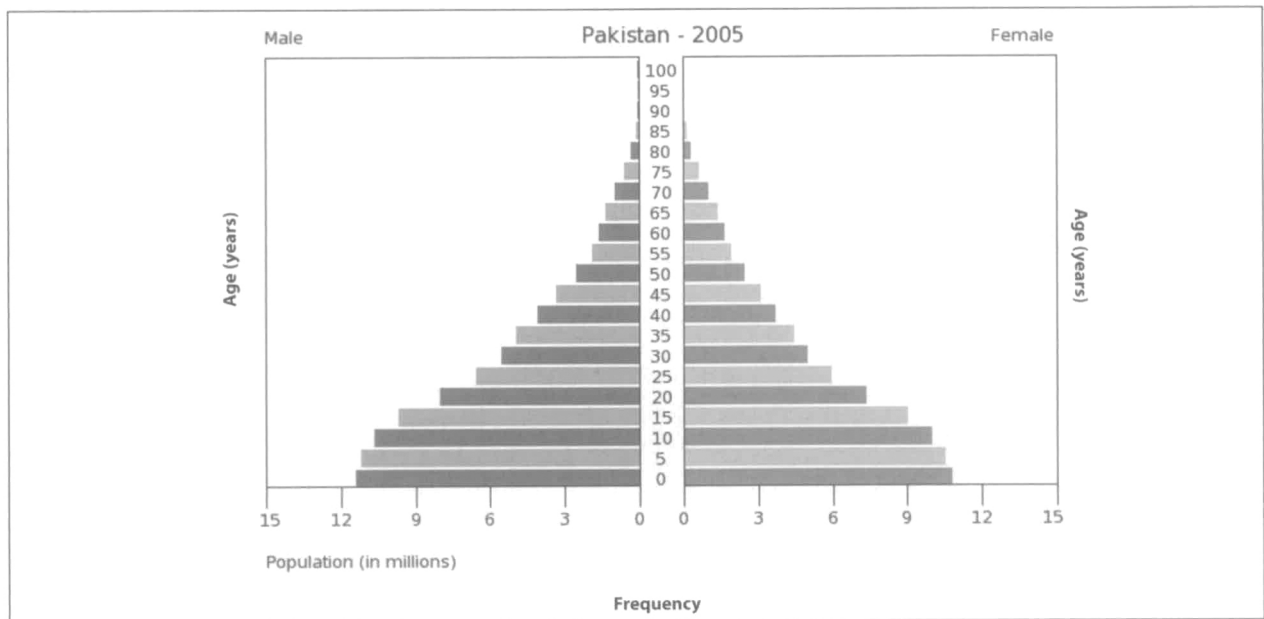
Of every two large cities in the developing world, one is vulnerable to disasters due to natural hazards. Notably, out of the 20 largest cities in the world, 17 are in low-resource countries. An estimated 80% of the world's population will reside in developing countries by 2025.^{6,7} Thus, studies on disasters due to natural hazards are of paramount importance in developing countries. There is a dearth of published studies on such disasters in Pakistan.

On the morning of 08 October 2005, at 08:50 h Pakistan Standard Time, an earthquake measuring 7.6 on the Richter Scale struck the mountainous northern region of Pakistan, affecting an area of about 28,000 km². More than 73,000 people died and around 69,000 were seriously injured.⁸ Twenty-six



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Figure 1A—Age and gender distribution. Patients injured in October 2005 earthquake



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Figure 1B—Age and gender distribution. Patients injured in October 2005 earthquake compared to the Population pyramid of Pakistan, 1998

Adapted from: Population Association of Pakistan. <http://www.pap.org.pk/statistics/population.htm> Accessed 27 May 2008

hospitals and 600 clinics also were destroyed.⁹ Teams from Hamdard University also participated in relief activities in the earthquake-affected areas.

A survey was conducted to determine the pattern of injuries in earthquake victims and their variations with age and gender. Such data are expected to aid in future planning of relief efforts during such disastrous situations when they occur in similar geographic areas, and identification of the most relevant specialties, teams, and facilities could be made available to best manage the situation.

Methods

This study was a cross-sectional survey conducted at Emergency Relief Hospital, Doraha, Mansehra. The hospital site was a post-graduate college converted into an emergency relief hospital after the 08 October incidence. It began functioning on the first day following the earthquake. The laboratories and lecture halls were converted into operation theatres and intensive care units. Initially, the services were going on the inside of the building pending the launching of the field camps, which were set-up by the second day after

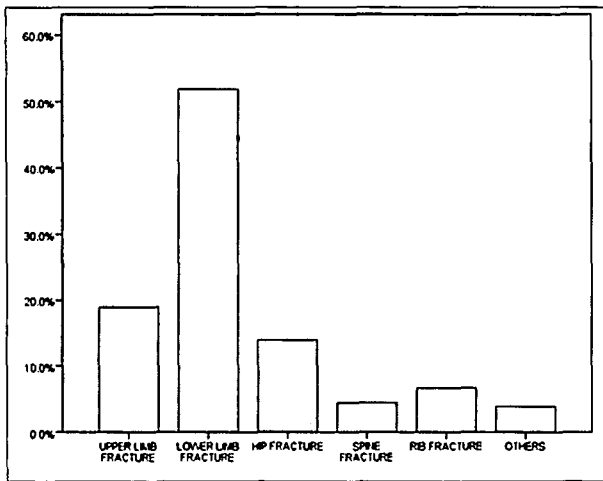


Figure 2—Pattern of bony injuries

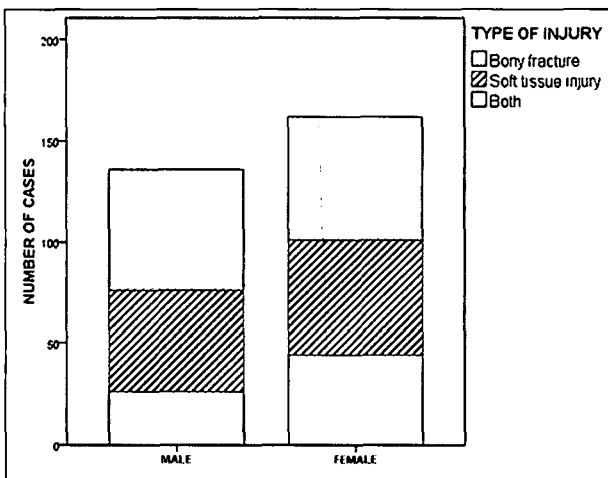


Figure 3—Distribution of type of injury by gender

the event by Italian, Korean, Saudi, and Taloo Trust teams. Later, these field camps were used as surgical and medical wards. The emergency relief hospital was the safest place to work and the closest location to the earthquake-affected areas, located at a distance of approximately 40 km from the epicenter. It also was approachable via motor vehicles and helicopters, which carried the patients from the remote areas. Their relatives, volunteers, and Pakistan army soldiers who were helping to control patient flow during the disastrous situation also carried patients. The affected region is so uneven and mountainous, that the authors did not anticipate any proper triage system was being used in the field. Many of the affected areas remained inaccessible by the rescue teams, even a week after the earthquake.

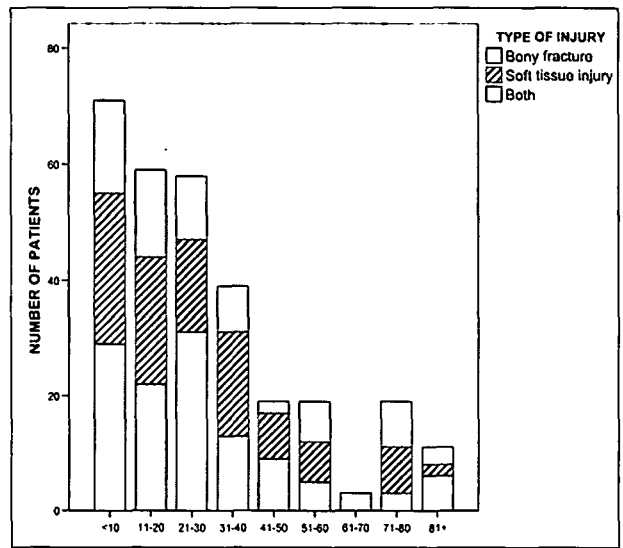
By 20 October, 1,700 patients were registered in the hospital and all of them were considered in this study. Using simple random sampling through a random numbers table, 310 cases (~20%) were selected and subsequently interviewed and examined. Data collection was completed by 26 October.

To make the extremely diverse pattern of injuries more comprehensive and analyzable, all of the injuries were grouped under three broad categories: (1) bone injuries; (2) soft tissue

Grossly infected wounds	Limbs	Infected Gangrenous	20% 9%
	Face and trunk		10%
Not grossly infected wounds	Limbs	Face	33% 12%
	Miscellaneous*		15%

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Table 1—Types of soft tissue injuries * Injuries to head, chest, abdomen, and pelvis, and crush injuries



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Figure 4—Distribution of type of injury by age groups

injuries; and (3) mixed (soft tissue and bone) injuries. Patients also were classified into age groups, each consisting of a single decade and the last one consisting of all of those >81 years of age. Those who sustained injury prior to the earthquake or sustained an injury related to events other than the earthquake were excluded.

Some biases were anticipated due to the setting and nature of the data. Of the 310 cases identified, 12 were omitted due to incomplete data, i.e., missing case records, discharged patients, or patients transferred to other hospitals for further care. Moreover, patients who were dead on arrival were not enlisted in the hospital register, hence the nature of injuries sustained by them could not be ascertained. Furthermore, as the earthquake-affected mountainous region has a gross disruption of transport facilities, many patients with injuries may not have been able to arrive in the hospital during the study period. Thus, injuries in those patients could not be assessed.

Results

Of the 298 cases studied, 54% were female. Two-thirds of the injured were ≤30 years of age (63%), indicating that people in their productive years of life are most affected (Figure 1A). Among the different age groups, children up to 10 years of age formed the largest group (24%) sustaining injuries. Forty percent of boys were under 15 years of age as compared to 27% of girls (*p* <0.05). Moreover, there

were almost twice as many women between 30 and 45 years of age as men in the corresponding age groups ($p < 0.01$). Furthermore, there appears to be a disproportionately higher number of elderly (age >75 years) people in comparison to the country's population pyramid (Figure 1B).

Bone injuries were present in 41% of the patients, soft tissue injuries in 36%, and mixed injuries in 23% (Figure 2). Lower limb fractures were the most commonly sustained bone injuries (52%).

The soft tissue injuries were further classified as grossly infected, non-grossly infected, and miscellaneous (Table 1). Wounds on limbs which were not grossly infected were most common (33%), followed by grossly infected wounds (30%). Of the latter, 19.8% were present on the limbs and 10.2% were present on rest of the body parts. Gangrenous wounds formed 9% of all soft tissue injuries.

The pattern of injuries was similar among males and females. Although females sustained mixed (combined bone and soft tissue) injuries more commonly (27%) than males (19%) (Figure 3), the difference was not statistically significant. Across the different age groups, the proportions of patients with bone, soft tissue, or mixed injuries was similar (Figure 4).

Discussion

A higher proportion of females, a high number of children ≤ 10 years old, and a high incidence of lower limb bony injuries in earthquake victims were found during this study. A higher number of females injured during earthquakes also has been reported in other studies,¹⁰⁻¹² perhaps due to the fact that women are working indoors relatively more than men (the male:female ratio in that area is 0.9813). As the time of the earthquake was ~09:00 hours, school-going children and working men were expected to be gone from their homes, while the small children and women, who were mostly housewives, remained in their homes.

Previous studies also have shown that children form the most affected age group.^{14,15} However, some studies show no significant difference regarding age distribution.¹⁶ Others show the elderly population as the most affected population¹⁷ where as some show a bimodal pattern and propose that both the young and old are affected most.¹⁸ In this study, although a clear bimodal pattern is not apparent (Figure 1A), there is a progressive decline in the number of patients in each age group up to age 70 years, followed by a small rise.

Therefore, health care after earthquakes in developing countries such as Pakistan must cater to the higher proportion of women and children. Apart from general and trauma surgeons, pediatric surgeons and pediatricians, as well as arrangements for immunizations, pediatric drug and food preparations, appropriate surgical supplies, and provision for catering to women's health issues, must have priority.

Among the different types of injuries, fractures in general, and lower limb fractures in particular, were the most frequent injuries sustained. The higher frequency of lower limb fractures has been documented in other studies;¹⁹ however, some studies show that soft tissue injuries are more common than are fractures.²⁰ As for soft tissue injuries, grossly infected and gangrenous wounds in the

limbs were the most frequent, and these required urgent medical and surgical attention. According to a survey, in this disaster an estimated 1,000 to 1,300 amputations were performed, and >700 people suffered para- or quadriplegia.²¹ These patients are permanently handicapped from loss of their limb function, and require nursing care, wheel chairs, walking aids, prostheses, and physiotherapy as well as psychological support.²² Similar to other reports on this earthquake, in this study, spinal fractures accounted for 4% of the bone injuries (Figure 2).¹⁹ Moreover, crush syndrome is also one of the leading causes of mortality in earthquake disasters,²³ meaning nephrologists, dialysis units, and other measures must be made available. A limitation of this study is that fatal injuries were not included, because patients who were dead on arrival were not enlisted in the in-patient register. Moreover, routine autopsies were not performed on the dead cases. Thus, no data concerning the nature of their injuries or cause of death was available. However, this study does show the pattern of injuries in the surviving patients, for whom health care must be provided.

In order to stratify patients according to their medical needs, an effective triage system is of paramount importance for the appropriate delivery of health care. Other countries, such as Iran, have introduced a "screening tunnel" for their earthquake victims. In a screening tunnel, every patient is segregated and referred to the appropriate centers for minor, moderate, or major injury management.²⁴ Such a system should be introduced in Pakistani field hospitals. Additional evidence suggests that many post-event visits to hospital emergency departments are for medical conditions other than injuries.²⁵ Some studies indicate that the populations affected by disasters also have to cope with depression, anxiety, and post-traumatic stress for several months. Experience also suggests that during the post-earthquake period, psychiatrists, infectious diseases specialists, and physiotherapists are required.²⁶

For research in disaster-affected areas, several randomized, probability-sampling techniques have been developed, such as cluster sampling techniques during and following hurricanes, floods, etc. However, in an earthquake-stricken area, use of such techniques is liable to produce biased results. During an earthquake, damage varies widely depending on factors such as local soil and terrain conditions, the distance, rate and duration of ground-shaking attenuation from the epicenter, and the quality of building constructions. Thus, randomized, probability sampling would not only be difficult, but also not reliable. Hence, most studies done following such events employ non-probability techniques for rapid assessment.⁶ This study was conducted in an isolated center; thus, use of simple random selection was a suitable method. Although a broad generalization cannot be made from such studies due to the biases inherent in such hospital-based studies, a rough estimate about the probable nature of injuries can be made before going into the earthquake-affected areas in the future. For the assessment of the whole geographically affected area, appropriate methods must be designed.

Earthquakes will continue to strike, and healthcare responders must be prepared to overcome the situation by anticipating consequences and planning accordingly.

Conclusions

This study has shown that the population injured during the earthquake is comprised of a higher proportion of females, a high number of children ≤ 10 years old, and a high incidence of lower limb bone injuries. In the light of

these observations, the mainstay of medical care at the early stage of relief efforts should address trauma/orthopedic, pediatric, and women's health issues, and logistic arrangements for the relevant diagnostic and therapeutic facilities must be made.

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Editorial Comments—October 2005

Earthquake in Northern Pakistan: Pattern of Injuries in Victims Brought to the Emergency Relief Hospital, Doraha, Mansehra

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To date, the October 2005 earthquake in Pakistan is the third most deadly natural disaster in the world since the 1976 earthquake in China that reportedly killed 255,000 people.¹ This issue of *Prehospital and Disaster Medicine* includes a report of the pattern of injuries in victims brought to the emergency relief hospital in Doraha, Mansehra. The manuscript presents a unique glimpse into the role of a relief emergency hospital and provides important information that can help plan future response for such events. Mountainous areas everywhere, are a challenge to rescue activities, especially in developing countries in which devastation was massive and resources were stressed beyond their limits.

When reading this paper, it is important that the reader remembers the context in which it was written—The Emergency Relief Hospital, Doraha, Mansehra actually was a post-graduate college converted into an emergency relief hospital after the earthquake. It began functioning on the first day following the earthquake. The laboratories and lecture halls were converted into operation theatres and intensive care units. Only later, field camps were set-up. This scenario is somewhat similar to the 2001 earthquake in Gujarat, India, where most hospitals collapsed and military hospitals provided initial preliminary care in tents until field hospitals arrived about five days later.²

The facility described in the manuscript authored by Fahad *et al* was approximately 40 km from the epicenter, and was approachable via motor vehicles and helicopters carrying the patients from the remote areas.³ Patients also were transported by their relatives, volunteers, and Pakistan army soldiers who were helping to control the situation. The affected region was so uneven and mountainous, that many of the affected areas remained inaccessible by the rescue teams, even a week after the earthquake, and resulted in dire medical consequences.

Beyond these barriers to care, many obstacles further impede the ability to conduct quality scientific research in the aftermath of a disaster. Earthquakes, possibly more than any other event, have the ability to disrupt the lives of a large population due to the physical destruction of homes, clinics, hospitals, schools, roads, water reservoirs, and more. Affected countries often lack the ability and interest in portraying these injuries as all of their resources are consumed by treating the wounded and rebuilding their communities. For this reason, there is great importance in this manuscript, despite several limitations, as a first-hand documentation of casualties arriving to receive care. Questions about the overall epidemiologic profile of the disaster, such as what happened to those who died on the way to the hospital, or how many died on the scene because they could not be evacuated, remain to be answered elsewhere. Nevertheless, the current study sheds light on various issues, among them are complications due to delay in care of survivors who made it to the hospital. When comparing the results of the current study to studies of other earthquakes, it is important to remember the difference in the population described. The selectiveness of the treated population in this study hinders the ability to say whether the general findings of this study, in terms of the distribution of injured population and their injuries, are similar to those reported for other known earthquake disasters.

This study reports that children in the first decade of life formed the largest age group. This finding could reflect the tendency of parents to worry about the care that their children receive before they take care of themselves. However, it also could be a result of the fact that 40% of the population in Pakistan is below the age of 14 years.

Fahad *et al* mention that there appears to be a disproportionately higher number of elderly (age >75 years) people in comparison to the country's population pyramid. Chan, in a later analysis of the 2005 earthquake in Pakistan, identifies the need to sensitize relief and health workers about older people's health needs during a disaster.⁴ The fact that 54% of the cases were female is surprising, not only because it is quite different from reports elsewhere,⁵ but also because the proportion of women in the Pakistani population is lower than the males.

The health outcomes of an earthquake are associated closely with the earthquake intensity, but also are affected by several major contributing factors such as the density of the population, the type of buildings, the time of day, and the ease of evacuation. A typical example for such effects on injury is the Tangshan earthquake in China, still the most devastating earthquake in the last century, where people were sleeping in their homes that were built on soft land. Homes collapsing and people being trapped resulted in the development of the crush syndrome and traumatic paraplegia in many patients.⁶ Reports from a large earthquake disaster in Gujarat, India in 2001 mention deficiencies in the pre-earthquake healthcare system as a factor worsening the outcome. The difficulty in access to care described in Pakistan resulted in one of the important findings of this study—infected and gangrenous wounds. Among patients

with soft tissue injuries, gangrenous wounds were present in 9% and grossly infected wounds in 30% (20% on the limbs and 10% on the rest of the body). Similar reports are not found in the literature apart from recent mention of a small number of cases related to the Wenchuan earthquake in China in 2008.^{7–8} Findings on wound infections in Pakistan have recently been elaborately described elsewhere.⁹

Along with the crucial importance of aid provided by national and international field hospitals during disasters, suitable triage of casualties and preparedness of tertiary referral centers in unaffected regions also play an important role in providing medical care to disaster victims. During these situations, the number of victims cannot be predicted accurately, and sufficient medical care, particularly for orthopedic problems, can be provided by referral centers.⁵

This study aimed to determine the pattern of injuries in earthquake victims and their variations with age and gender with the ultimate goal of aid in future planning of relief efforts in such disastrous situations in similar geographic areas. If one is aware of the various limitation of the population that was surveyed, and aware of those left behind, this manuscript is an important essay. The results of this study are especially important and relevant for planning and preparing an *ad hoc* erected field hospital that is aimed to settle in a mountainous earthquake zone, or in an isolated island, in developing countries where there is a low density of medical facilities and insufficient evacuation resources.

We congratulate the authors for their important effort to conduct research in these difficult conditions and encourage other researchers to overcome the difficulties in conducting research in such a difficult situation in order to enhance human knowledge of disaster medicine.

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