UNDERSTANDING HUMAN BEHAVIOR DURING AND IMMEDIATELY FOLLOWING EARTHQUAKE SHAKING

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ABSTRACT

To reduce earthquake casualties, it is important to understand how human behavior, during and immediately following earthquake shaking, exposes an individual to increased risk of injury. Little research has analyzed the immediate human responses to earthquake shaking, mostly due to data constraints and/or ethical considerations. To better understand the relationship between human behavior and injury, researchers need a robust and repeatable methodology. We analyzed human behavior and injury data from the Canterbury Earthquake Sequence (Mw7.1 Darfield 2010; Mw6.3 Christchurch 2011), New Zealand and Mw9.0 Hitachi Earthquake, Japan to determine behavior, injury patterns and their causes. We identified three main influences on human behavior during earthquake shaking. The first influence is the environment that an individual is located in during the earthquake, such as inner-city building, in bed at home, or outside. Second, who an individual is with at the time of the earthquake will affect their behavior. For example, an adult with a small child will behave differently than an adult alone. Third, an individual’s behavior during shaking is also influenced by their age, gender, previous earthquake experience, and the earthquake’s attributes, including intensity and duration of shaking. Further research is needed to better understand the relationships between these key factors.

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Understanding human behavior during and immediately following earthquake shaking

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Introduction

Developing guidelines for human behavior that minimize risk of injury during earthquake shaking will save lives. Currently, little is known about human reactions during earthquakes. A recent

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report demonstrated that without guidance human actions can increase risk of injury [1]. In contrast, freezing and not taking protective action has led to death and serious injuries in other earthquakes [1,2]. Another study revealed that most people do not follow recommended safety behavior guidelines during earthquake shaking [3]. Other studies are limited by the quality of the participant's memory or (perceived) realism of a simulation. Therefore, to better understand the relationship between human behavior and injury, a robust and repeatable methodology is required that will accurately determine what major behaviors during shaking influence injury. This paper reviews four recent studies that evaluated context and causes of injury and adherence to safety guidelines during several earthquakes using comprehensive injury data and CCTV footage [1-5].

**Study 1**

The aim of study 1 was to investigate causes of injury during the Darfield (4 September 2010) and Christchurch (22 February 2011) earthquakes [1]. Data was sourced from the New Zealand Accident Compensation Corporation. The total injury burden was analyzed for demography, context of injury, causes of injury, and injury type. Injury context was classified as direct (immediate shaking of the primary earthquake or aftershocks causing unavoidable injuries), action (movement of a person during the primary earthquake or aftershocks causing potentially avoidable injuries), and secondary (cause of injury after shaking ceased). The analysis of the data showed that three times as many people were injured in the Christchurch earthquake as in the Darfield earthquake (7171 vs 2256). The primary shaking caused approximately two-thirds of the injuries from both quakes. Actions during the main primary shaking and aftershocks led to many injuries (51.3% Darfield and 19.4% Christchurch). Primary direct caused the highest proportion of injuries during the daytime Christchurch quake (43.6%). Many people were injured after shaking stopped in both events: 499 (22.1% Darfield) and 1881 (26.2% Christchurch). Most of these people were injured during clean-up. In both earthquakes, more females than males (1453 vs 803 Darfield; 4646 vs 2525 Christchurch) were injured. This study demonstrated that where people were, and their actions during and after earthquakes, influenced their risk of injury.

**Study 2**

This study examined people’s immediate responses to earthquakes in 2011 in Christchurch, New Zealand and Hitachi, Japan [2, 3]. Data collected from 257 respondents in Christchurch and 332 respondents in Hitachi revealed notable similarities between the two cities in people’s emotional reactions, risk perceptions, and immediate protective actions during the shaking. Respondents’ physical, household, and social contexts were quite similar, but Hitachi residents reported somewhat higher levels of emotional reactions and risk perception than did Christchurch residents. Contrary to the recommendations of emergency officials, residents’ most frequent responses in both cities was to freeze. Christchurch residents were more likely than Hitachi residents to drop and take cover, whereas Hitachi residents were more likely than Christchurch residents to immediately evacuate the building they were in. There were relatively small correlations of immediate behavioral responses with demographic characteristics, previous earthquake experience, and physical, social, or household context.
Study 3

Study 3 was concerned with developing a systematic process and coding scheme to analyze earthquake video footage of human behavior during strong earthquake shaking [4]. The coding scheme was developed in a two-part process, combining a deductive and inductive approach. Previous research studies of human behavioral responses during earthquake shaking provided the basis for the coding scheme [see references in 4]. This was then iteratively refined by applying the coding scheme to a broad range of video footage of people exposed to strong shaking during the Canterbury 2010-2011 earthquake. The scheme was developed to assist future researchers understand how to categorize people’s responses to earthquakes using video footage.

Study 4

The coding methodology developed in study 3 was applied to security video data captured during the 22 February 2011 (Mw6.3) ‘Christchurch’ earthquake event at the Christchurch Hospital (Christchurch, New Zealand). The shaking intensity was MM9 and lasted 12–15s [5]. That study applied the coding methodology to determine demography, trans-event behavioral responses, post-event behavioral responses, influence of social context on behavior, and influence of behavior on injuries. A total of 213 individuals from 31 different camera views were analyzed. Sixty-six per cent of the individuals were adult-aged females. The primary trans-event responses were to hold (26%) onto furniture, walls, and/or other people close to them and to look around (30%). No individuals were observed to perform all ‘Drop, Cover, Hold’ actions, the recommended actions during strong earthquake shaking in New Zealand. Post-event behavior included: running, walking, providing assistance, moving towards others, visual communication, and some individuals gave instructions. Social contextual behavior varied depending on the role of the adult. There were no serious injuries linked to behavior. The results of this initial study indicated that the coding methodology can record the distribution of and variation in human behaviors. Therefore, objective observation of earthquake video data can provide a useful quantitative measure of human behavior. Significantly, this method will enable researchers to look more closely at behaviors, as well as the social and physical contexts associated with injury risk during and immediately following earthquake shaking.

Conclusions

To reduce earthquake casualties, it is important to understand how human behavior, during and immediately following earthquake shaking, exposes the individual to risk of injury. The various research projects reviewed here have identified the main influences on injury occurrence. These include: the environment where the individual is during the earthquake, who the individual is with at the time of the earthquake, individual characteristics such as age, gender, previous earthquake experience, and an earthquake’s attributes: intensity and duration of earthquake shaking. Further research on the efficacy of protective behaviors is needed to better understand the relationships between these key factors.
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References


