The Effect of Choosing a Specific Self Protective Behavior During an Earthquake on Saving Lives and Preventing Injuries

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INTRODUCTION

Earthquakes pose a serious threat to human health. Mitigating the adverse consequences of a future event, in terms of the expected number of casualties, requires a reliable assessment of the traits and vulnerabilities of the exposed population, structures and infrastructures.

Traditionally, casualty modelling is performed using loss-estimation models that base their estimates solely on damage to the built environment(1). However, the interaction between human-related factors which are currently not taken in account, for example choosing a self-protective behavioral strategy during the quake, and the built environment, may exacerbate or mitigate the consequences of a given event(2).

This study sought to integrate behavioral traits of residents in a high risk area in Israel(3) into a traditional and commonly used casualty estimation model (HAZUS) based on engineering methods.

OBJECTIVES

- to estimate the rates of different self protective behaviors expected to be undertaken during earthquakes among the population in Tiberias, Israel.
- to evaluate the relationship between levels of earthquake preparedness, risk perception and previous earthquake experience and reported self protective behaviors.
- to examine the impact of self protective behaviors during an earthquake on the expected number of casualties in a given event.

METHODS

A structured questionnaire was designed to assess expected self protective behavior during an earthquake and additional factors, among the residents of the city of Tiberias in northern Israel:

- Demographic information
- Level of earthquake preparedness (implementing four measures related to home-hazard mitigation)
- Previous earthquake experience
- Risk perception (likelihood of occurrence; perceived effect; concern)

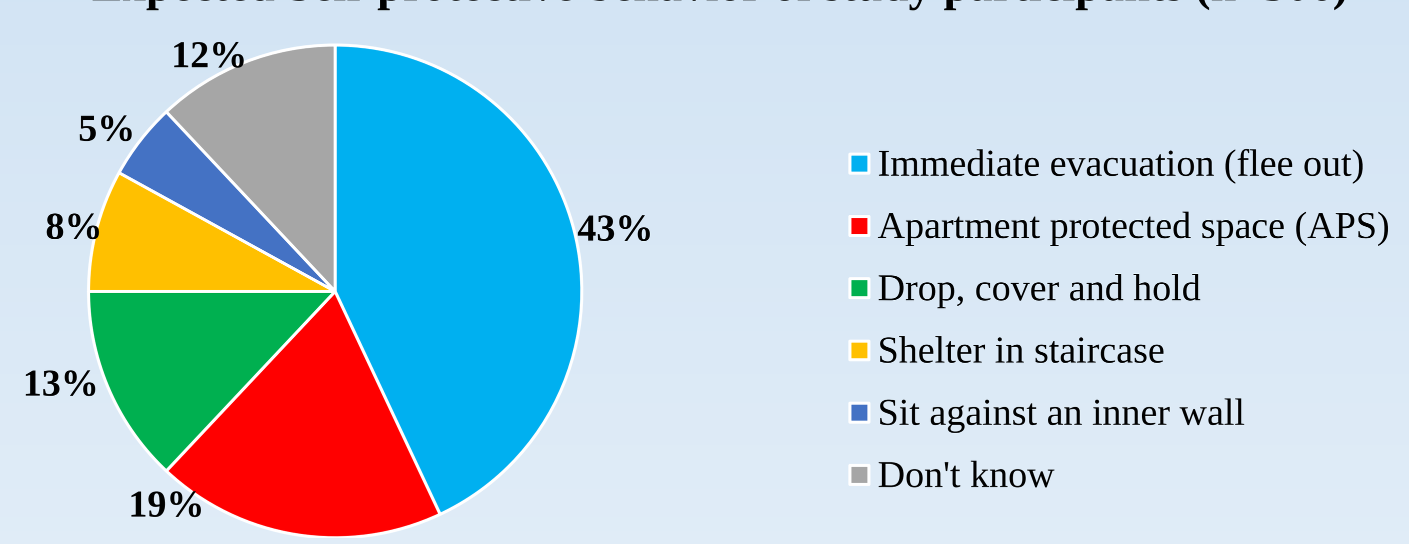
420 households were randomly surveyed in all 12 census tracts of the city to capture the different socioeconomic levels of all city areas.

The results regarding the expected self protective behavior were incorporated to a loss simulation, designed to assess the number of casualties by a massive earthquake in residential areas of Tiberias. The estimated number of individuals present in residential buildings during daytime was derived from census data.

A hypothetical (worst case) scenario was assumed in which all residential dwellings suffered heavy damage and collapse. The simulation was carried in two steps:
a) estimating casualties according to HAZUS original casualty rates, and b) applying a multiplier related to the number of occupants presumed present in the residential buildings according to the reported rates of participants reporting to flee buildings in the survey.

RESULTS

Expected Self-protective behavior of study participants (n=306)



The impact of human behavior on earthquake casualty assessment (HAZUS) - Estimation for total population present within residential dwellings during daytime* in the city of Tiberias.

Number of occupants	Uninjured (25%)	Light injury (40%)	Moderate injury (20%)	Severe injury (5%)	Fatalities (10%)
n=8,111	2028	3244	1622	406	811
Applying a multiplier of expected population behavior: 33%Ψ of the exposed population manage to flee out of building (added to category of uninjured) and only 67% remain indoors					
(0.67)X(n=8,111)= 5,434	4034 (+2007)#	2174 (-1070)#	1087 (-535)#	272 (-134)#	544 (-267)#
** revised rates(%)	50%	27%	13%	3%	7%

* Composed of the unemployed, homeworkers and individuals not part of labor force.

**New casualty matrix after integration of population behavior component.

Ψ The reported rate was 43% but a margin of error was incorporated by subtracting 10% of this figure

\# The value in parentheses represents the difference from the original number of expected casualties (or uninjured) in each injury category.

Multivariate logistic regression model results for predicting who would flee buildings during an earthquake

Nagelkerke R^2=0.21, chi-square$_{(14)}$=42.733, p<0.001, n=257

Variable	B	S.E.	Wald	P	OR	(95% CI) Lower	(95% CI) Upper
Gender (male)	0.296	0.292	1.021	0.31	1.344	0.758	2.384
Age	0.01	0.015	0.429	0.51	1.01	0.981	1.04
Family status (divorced/widowed)			3.46	0.18			
Single	0.422	0.645	0.429	0.51	1.526	0.431	5.404
Married/Common law	0.853	0.551	2.391	0.12	2.346	0.796	6.915
Children residing in household (yes)	0.277	0.307	0.813	0.37	1.319	0.723	2.407
Education	0.088	0.18	0.242	0.62	1.092	0.768	1.554
Income	0.051	0.17	0.088	0.77	1.052	0.753	1.469
Type of Residential building (private house)	1.161	0.306	14.388	.00**	3.193	1.753	5.818
Having a physical disability	-0.294	0.432	0.464	0.5	0.745	0.32	1.737
SEI (Socioeconomic index rank)	0.118	0.101	1.367	0.24	1.125	0.923	1.37
Risk perception	-0.062	0.156	0.158	0.69	0.94	0.693	1.276
Earthquake experience (yes)	0.414	0.401	1.063	0.3	1.512	0.689	3.32
preparedness	0.329	0.156	4.473	.03*	1.39	1.024	1.886
Constant	-5.633	1.575	12.794	0	0.004		

DISCUSSION & CONCLUSIONS

The estimates of models that do not consider human behavior during an earthquake may overestimate the expected number of casualties.

Occupants of multi-story apartment buildings and those with lower levels of earthquake preparedness were less likely to report the recommended self protective behaviors and thus, may be more exposed to earthquake-induced injury and death.

Public health agencies and other community or national organizations can use this information to assess and optimize preparedness plans by raising awareness regarding protective behavioral strategies prior to and during earthquakes and to target these efforts among more vulnerable populations.

REFERENCES:

1. FEMA. HAZUS-MH MR4 Technical Manual: Federal Emergency Management Agency; 2003.
2. Shapira S, Aharonson-Daniel L, Shohet IM, Peek-Asa C, Bar-Dayan Y. Integrating Epidemiological and Engineering approaches in the Assessment of Human Casualties in Earthquakes. Natural Hazards, 2015, 78(2), 1447-1462.
3. Wei HH, Shohat IM, Skibniewski MJ, et al. Economic Feasibility Analysis of Pre-Earthquake Strengthening of Buildings in a Moderate Seismicity / High Vulnerability Area. Paper presented at: 4th International Conference on Building Resilience, 2014; Salford Quays, United kingdom.

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