



## Tsunami Evacuation Risk Evaluation of the Elderly Person based on the Questionnaire Survey

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### Abstract

Two of the issues facing tsunami evacuation planning include availability of refuge facilities and evacuation time of residents. In the current study, We investigated the awareness of residents seeking tsunami refuge by a questionnaire survey and evaluated the tsunami evacuation risks of elderly and non-elderly residents.

A questionnaire survey was carried out to investigate the refuge actions of non-elderly and elderly residents of A Elementary School District, Osaka City, and to compare evacuation times. Refuge action was analyzed according to area, individual attribute, and behavior before the refuge action. Survey participants responded in either of two categories: “I escaped immediately” (1.6%) or “I escaped after performing some kind of action” (98.2%). Reasons for evacuation included “televised evacuation information” (25.2%) and “appeals from other persons” (35.9%), indicating warnings from neighborhood residents are more likely to promote tsunami evacuation behavior.

Tsunami evacuation risk was evaluated based on the results of the questionnaire survey. A total of 4,697 non-elderly (estimated number of evacuees was 4,418) and 952 elderly (estimated number of evacuees was 886) residents were subjects for risk evaluation. Time elapsed and evacuation completion rate is determined by the number of evacuees, and residents able to reach tsunami refuge facilities were considered to be safe. The mean evacuation time of everyone was 58.5 minutes (estimated executing rate of evacuation was 94.1%) and the time of elderly was 63.9 minutes (estimated executing rate of evacuation was 93.0%). Maximum evacuation time of the non-elderly and elderly was 111 minutes and 118 minutes, respectively. Evacuation time consists of time of action before start of evacuation and travel time. The average travel time to the tsunami refuge facility was 8.2 minutes for the elderly, evacuation time had increased up to 109.8 minutes by the action before evacuation.

Many residents were aware of tsunami refuge facilities and were found to be able to evacuate on their own. However, the number of residents that evacuated immediately was small. Elderly residents, in particular, were found to wait for televised evacuation information. In addition, elderly residents had a higher tendency to bring valuables and personal belongings than non-elderly residents. It is necessary to improve early evacuation measures to reduce their evacuation time by understanding characteristics of behavior.

**Keywords:** tsunami evacuation, elderly person, questionnaire survey, evacuation behavior



## 1. Introduction

Since there is no high ground in Osaka, securing facilities for evacuation from the tsunami caused by the Nankai Trough earthquake has been promoted. However ward that can ensure the evacuation possible number of people is in the 3rd district in the 10th arrondissement. Since the spatial distribution of tsunami evacuation facility there is a bias, some residents can not be evacuated safely.

In addition, about 60% of the drowning person of the Great East Japan Earthquake is a 60-year-old or older, in order to evacuate safely in time of up to tsunami, taking into account the secure situation and evacuation route of tsunami evacuation facility elderly it is necessary to arrange the evacuation system.

The tsunami evacuation plan of the current situation is a problem there are two aspects. First to the problem as seen from the sphere of evacuation facilities such as evacuation distance, which is a problem as seen from the evacuation of residents, such as the choice of timing and evacuation destination of evacuation in the second.

In this study, to investigate the intention for the tsunami evacuation of residents from the survey. It is an object to evaluate the tsunami evacuation risk from the survey results.

## 2. Questionnaire Survey

### 2.1 Purpose

This study is intended to investigate the evacuation of residents at the time of tsunami occurrence and rivers flooding intended for Osaka Suminoe-ku A elementary school district. It is an object to grasp the evacuation particular residents needed in evaluating evacuation risk in A elementary school district.

### 2.2 Method

In order to grasp the evacuation behavioral characteristics of residents, we conducted a survey to study as a target the 500 households of the households that subscribe to the residents' association in the A Elementary School District. 500 households were distributed at random. The survey summary is shown in Table 1. The survey, respondents asked to answer on the assumption such as "if the Nankai Trough earthquake has occurred, which is to be occurring in the future", the perception of shelter, evacuation means, those asking about evacuation intention, such as evacuation routes it is.

### 2.3 Content

The survey content shown in Table 1. Personal attributes, household attributes, awareness of disaster, awareness of evacuation, corresponding to the rivers flood, and a item of responding to the tsunami.

Table 1 – Survey Content

Individual attribute	address, gender, age, occupation, whether the residents' association officer, vulnerable people in disasters
Household attribute	head of household whether or not, household size, with or without family / housemate, family / housemate is vulnerable people in disasters or not
Housing attribute	type, rank, structure, residence life, year built
Awareness of the disaster	disaster experience (house damage), disaster experience (injury), anxiety to the disaster, most worry to that disaster, the perception of shelter, you can escape on their own, or shelter at night, or at night to allow evacuation to shelter , disaster preparedness, particularly those to focus on when a disaster has occurred
Response to river flooding	timing of the evacuation, evacuation information available means, disaster information available means, shelter, until the evacuation



	location time, whether there is a dangerous place in the evacuation route, triggered the evacuation, evacuation means, evacuation before action, belongings at evacuation
Response to Tsunami	recognition of the tsunami evacuation building, recognition of the above sea level height, if they were included in the anticipated inundation area, time until the tsunami, the timing of the evacuation, evacuation information available means, disaster information available means, shelter, until the evacuation place time, is there a dangerous place in the way to shelter, one of which is at home and tsunami evacuation building above sea level is high, the chance of evacuation, evacuation means, evacuation before action, what do we have the time of evacuation, evacuation routes

### 3. Results and Discussion

The number of valid responses total of 436 cases, consisted of men 184, women 250 cases, gender unknown was 2. The average age of the respondents was 63.2 years old.

#### 3.1. Consciousness, knowledge, and preparedness for disaster

Answer the question of whether there is anxiety in the disaster, people who answered "some pretty", "there is little" is 361 people (86.2 percent), almost residents are feeling an anxiety to disaster.

Answer the question of whether you know a shelter near home, people who answered "know more than one" or "know one," was 379 people (90.7 percent). More than 90% of the residents are aware of the shelter.

Answer of the question of whether it is possible to go to a shelter by yourself when needed, people who answered "can evacuate by self" was 283 people (66.3 percent). Then, it has become the person who answered the 123 people many with (28.8%), "can evacuate by self but there is anxiety", about 30% of the people are having anxiety to evacuation.

At any stage When you start to escape at tsunami is shown in Figure 1. People who answered to evacuate as soon as the 124 people (28.2%), the person who answered to evacuate from out some kind of evacuation information such as evacuation advisory was 266 people (60.6 percent).

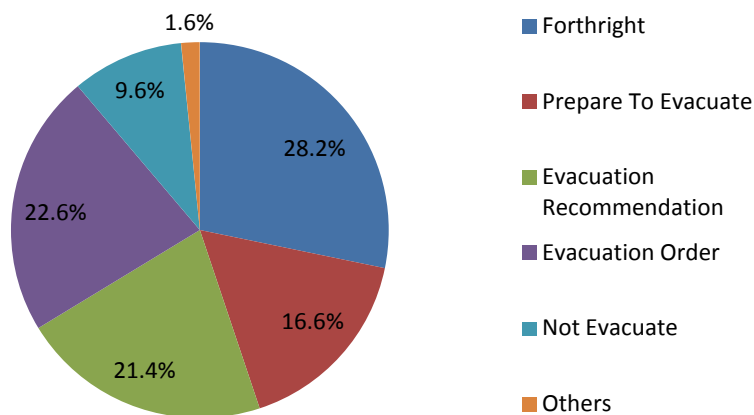


Figure 1 – Timing of evacuation



Answer the question of where to evacuate when tsunami, people who answered A primary school is the most 214 people (39.6 percent). Then 70 people A junior high school (12.9%) in many cases. Evacuation travel time people are answered within 5 minutes was more than half.

In what of the question of what to do before evacuation started, most 323 people dressed for the evacuation (74.1%) have been selected. Then taking out of valuables has become many and 244 people (56.0 percent).

### 3.2. Comparison Noneldery and Eldery

#### 3.2.1. Timing of Evacuation

Table 2 shows the results of cross-tabulation of the timing of the evacuation and age. The percentage of people of non-elderly about the timing has answered to evacuate as soon subsided shaking of the evacuation there were many. As a result of further subjected to chi-square test, significant difference for the evacuation order and age was observed. Therefore, the elderly can be said that there is a tendency to begin evacuation from waiting for evacuation information.

Table 2 – Timing of evacuation (comparison noneldery and eldery)

	noneldery (N=186)		eldery (N=232)		
	Evacuate	%	Evacuate	%	
Forthright	50	26.74%	48	19.35%	n.s.
Prepare to Evacuate	44	23.53%	64	25.81%	n.s.
Evacuation Recommendation	51	27.27%	56	22.58%	n.s.
Evacuation Order	34	18.18%	65	26.21%	< .05
Not Evacuate	8	4.28%	15	6.05%	n.s.

#### 3.2.2. Action before evacuation

Figure. 2 is a result of cross-tabulation of the evacuation before behavior and age. Taking out of dressing and valuables for evacuation has a high proportion of the elderly. Considered from anxiety to escape life in the shelter has led to such a result. In relation to evacuation before action and age significant difference with respect to the "confirmation family of safety" and "pick of the family" it was observed. From this result, the non-elderly is an emphasis on "mutual assistance behavior of the family."

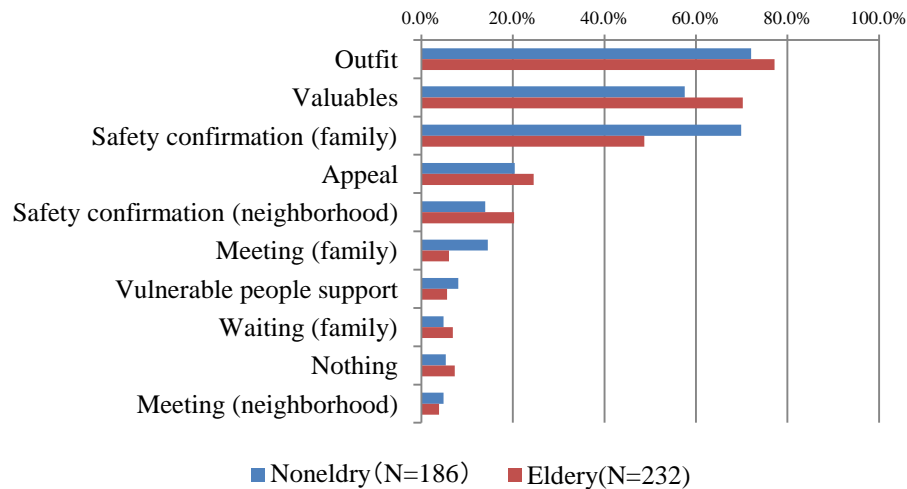


Figure 2 – Action before evacuation (comparison noneldery and eldery)

### 3.3. Evacuation Risk Assessment

To evaluate the evacuation risk from the results of the questionnaire survey. In this study, we assumed that the safety if it is possible to evacuees to reach the tsunami evacuation facility, to evaluate the evacuation risk.

#### 3.3.1. Settings

- Evacuee

To set the evacuees the residents who live in apartment buildings of single-family, tenement-1, 2-story. Evacuation implementation rate of the residents of the third floor above the apartment was calculated based on the results of the questionnaire.

- Timing of evacuation

With respect to the question of whether to start the evacuation at any stage if an earthquake has occurred, to calculate the evacuation implementation rate for each small area. The timing of each of the evacuation information is issued, after 15 minutes from the earthquake If you have answered "shaking soon subsided", after the evacuation preparation information 30 minutes, after the evacuation of 60 minutes, evacuation order after 90 minutes It was assumed to evacuate.

- Action before evacuation

Classify the evacuation before action, they were aggregated for each small area. Evacuation 0 minutes after the duration of the action before each of the evacuation, evacuation preparation 5 minutes after errands, evacuation assistance 10 minutes after errands, have set up a refuge called for 7 minutes after errands.

- Evacuation Shelter

Using the results of the questionnaire to fill out the route and the distance to the shelter, it was average evacuation distance calculation of the refuge of the aggregate for each small area. Evacuees was assumed to follow the average evacuation distance and town-chome, another refuge of the composition ratio. Moving means is assumed to walk, evacuation rate is the 1m / s if the evacuation speed of the non-elderly, in the case of the elderly was set to 0.5m / s. Evacuation distance in the case of evacuation within their home of the upper floor was 0m.

### 3.3.2. Evacuation Risk Assessment

Residents evaluated is living in A Elementary School District, non-elderly is 4,697 people (assuming of which 4,418 people to evacuate), the elderly 952 (assuming of which 886 people to evacuate) people were supposed to evacuate. Determine the time elapsed and the evacuation completion rate from the evacuation is complete number of people, shows the transition in Figure 3. Non-elderly average evacuation time is 58.5 minutes, the elderly was 63.9 minutes. Maximum evacuation time of the non-elderly is 111 minutes, maximum evacuation time of the elderly was up to 118 minutes. The average travel time to the shelter is a 8.2-minute case of the elderly, evacuation time by the evacuation had increased up to 109.8 minutes. It is considered necessary to run early evacuation to reduce the evacuation time than this.

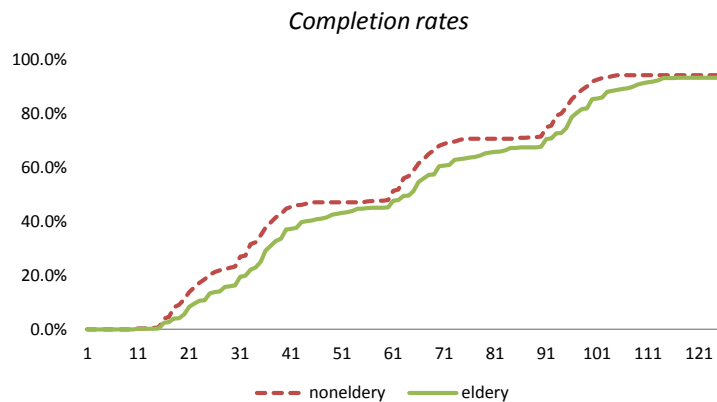


Figure 3 – Time and evacuation completion rate

## 4. Conclusions

In this study, we aimed to evaluate the tsunami evacuation risk of elderly people in consideration of the evacuation, conducted a questionnaire survey of Osaka City A Elementary School District, it was to clear the evacuation intention of residents. Many of the residents have been aware of the shelter, also was found to be able to evacuate on their own. However, residents to start the evacuation immediately is small, it has been found that take various actions before the start of evacuation. Especially as the elderly, it has been found that waiting for information on Evacuation. In addition, the elderly tend to bring the valuables and personal belongings of goods about than younger people.

Based on these results, we were evacuated risk assessment. As a result, compared with young people is longer evacuation time, it was found that by performing the early evacuation as the elderly are effective in reducing risk.

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