



## DISASTER AWARENESS AND EVACUATION PLANS OF RESIDENTS IN AREAS AT RISK FOR TSUNAMIS

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### Abstract

**Background:** In Japan, a Nankai Trough earthquake is estimated to occur with a probability of 70% to 80% within 30 years. The earthquake's epicenter will be at the plate boundary in the south of Japan and its scale may be magnitude 9. In addition, damage from a huge tsunami is expected over a wide area along the Pacific coast. Konohana Ward, Osaka City, located on the western coast of Osaka Prefecture, is one of the areas where tsunami damage is expected. Flooding with a maximum depth of over 4 m is expected for almost the whole ward. Various measures are currently being implemented, such as the development of a district plan for disaster management, the creation of a hazard map, and the designation of buildings to be evacuated during a tsunami. However, the extent of public knowledge of these measures and the risk perception by residents are unknown.

**Objective:** To mitigate the damage caused by such an earthquake, it is necessary to understand residents' awareness and find any issues residents might have. In addition, it is important to determine how many people are taking measures. Therefore, we carried out a questionnaire survey that targeted residents who live in two areas in Konohana district, and we researched the attributes of residents (e.g., sex, age), disaster awareness, and evacuation plans. We analyzed the results and clarified the differences in disaster awareness and evacuation plans by the attributes of residents.

**Results:** We collected 666 questionnaires (recovery rate: 34.7%). The fewest respondents were in their 20s (4.2%) and the most respondents were in their 70s (26.1%). The average age was 62.3 years. For disaster awareness, we used a five-point scale (1 = very applicable, 2 = slightly applicable, 3 = neutral, 4 = not very applicable, and 5 = not applicable at all). For the question about whether the respondent thought that tsunami damage would occur due to a Nankai Trough earthquake, the most common answer was "very applicable" (1) (387 respondents, 59.6%). For the question about whether the respondent was anxious about evacuation, the most common answer was "very applicable" (1) (282 respondents, 44.1%). A total of 390 (62.8%) respondents knew which buildings had been designated by the city administration for evacuation during a tsunami. For the question about the place where the respondent intended to evacuate to after a Nankai Trough earthquake, the most common answer was a shelter (e.g., school) (233 respondents, 42.8%). Respondents who were 65 years old or older tended to know about tsunami shelters more than people who were under 65 years old ( $P = 0.017$ ). Respondents who lived with their families tended to know about tsunami shelters more than people who lived alone ( $P = 0.019$ ). Respondents who thought tsunami damage would occur knew about tsunami shelters ( $P = 0.002$ ) and were more prepared for a disaster.

**Conclusions:** Regarding disaster awareness, many residents were aware of disaster occurrence and the risk of tsunami damage, and they were anxious about evacuation. The trends of preparedness for disaster and evacuation plans depended on age, family size, and disaster awareness.

**Keywords:** disaster awareness; supposition for evacuation; Nankai Trough earthquake; tsunami; disaster management



## 1. Introduction

The tsunami generated by the Tohoku earthquake on March 11, 2011, caused a lot of damage to a wide area in East Japan and revealed the insufficient awareness of the danger of tsunamis and measures for mitigating their damage in Japan. Based on this experience, local disaster management plans have been reviewed and the securing of evacuation sites such as tsunami shelters assigned by local governments has been promoted. However, these measures are insufficient. It is estimated that vast amounts of damage will be caused when a Nankai Trough massive earthquake occurs. It is estimated that such an earthquake will occur with a probability of 70% to 80% within the next 30 years and may be magnitude 9. Tsunami damage is expected in a wide area along the Pacific coast [1]. To reduce damage caused by a tsunami, the federal government and local governments are taking various measures [2]. In addition, it is important for individuals to evacuate quickly when an earthquake occurs to ensure their safety. It is thus necessary for residents to properly recognize the tsunami risk [3].

Many studies have been conducted on evacuation behavior and risk perception regarding natural disasters in Japan. For example, in a study based on an attitude survey about the Miyagi-Oki earthquake in 2003, Katada discussed factors that affected decision-making and the relationship between evacuation behavior and risk perception [4]. Oikawa found that the perception of inundation risk affects crisis awareness and that preparedness for disasters affects early response during a disaster [5]. Previous research found factors that affect evacuation behavior and pointed out the importance of correct risk recognition and preparedness for disasters. Recent studies pointed out that the definition of risk perception varies from study to study, and thus the results are not always correct and consistent [6]. In addition, few studies have been conducted about concern and measures regarding a specific high-risk disaster. To mitigate damage by a Nankai Trough massive earthquake, it is necessary to clarify the awareness trend of residents, the effect of measures being implemented, and any issues, and to find more effective measures and disaster responses.

The purpose of the present research is to understand the state of preparedness and disaster awareness in the study area and clarify residents' issues and trends in their evacuation plans. We conducted a questionnaire survey in Konohana Ward, Osaka City, Osaka, where there is a risk of tsunami damage after a Nankai Trough massive earthquake, and analyzed the results. We expect that the results will be useful for finding more effective measures, improving local disaster management plans, and promoting appropriate responses and evacuation behavior during a disaster.

## 2. Research Method

### 2.1 Study Area

The study area is Konohana Ward, Osaka City, located on the coast of Osaka Bay (Fig. 1). Konohana has 31,462 households and a population of 65,112. Most of the area is below sea level, and thus huge tsunami damage after a Nankai Trough massive earthquake is expected. According to a government report, it is estimated that inundation with a maximum depth of above 4 m, the collapse of at most 6,571 houses, and a maximum death toll of 9,264 will be caused by the tsunami [7]. Based on these estimates, the local government has implemented various measures, including the securing of tsunami shelters, the creation of hazard maps, and the staging of events to promote disaster awareness. However, the measures may not be working. According to a survey on disaster management conducted throughout Osaka Prefecture, 57.8% of respondents answered that they are aware of natural disasters and 31.6% of respondents answered that they are not taking any measures; the survey also showed that interest in disaster management is insufficient [8]. In Konohana, which has a high risk of tsunami damage, it is urgent to investigate the current situation and improve residents' awareness. Measures that take into account the issues raised by residents should also be considered. Konohana is thus a suitable study area for the present research.



Fig. 1 - Location of Konohana Ward

In particular, this study focused on two areas (named “area A” and “area B”) in Konohana Ward (Fig. 2). These areas are expected to have huge damage and have few tsunami shelters. Therefore, it will be difficult for all residents to complete evacuation if a Nankai Trough massive earthquake occurs. The local government expects that healthy people will evacuate to tsunami shelters outside areas A and B, but it does not know whether the residents know about this plan. In addition, because evacuation is expected to take a relatively long time, the residents must have high disaster awareness and appropriate evacuation plans.

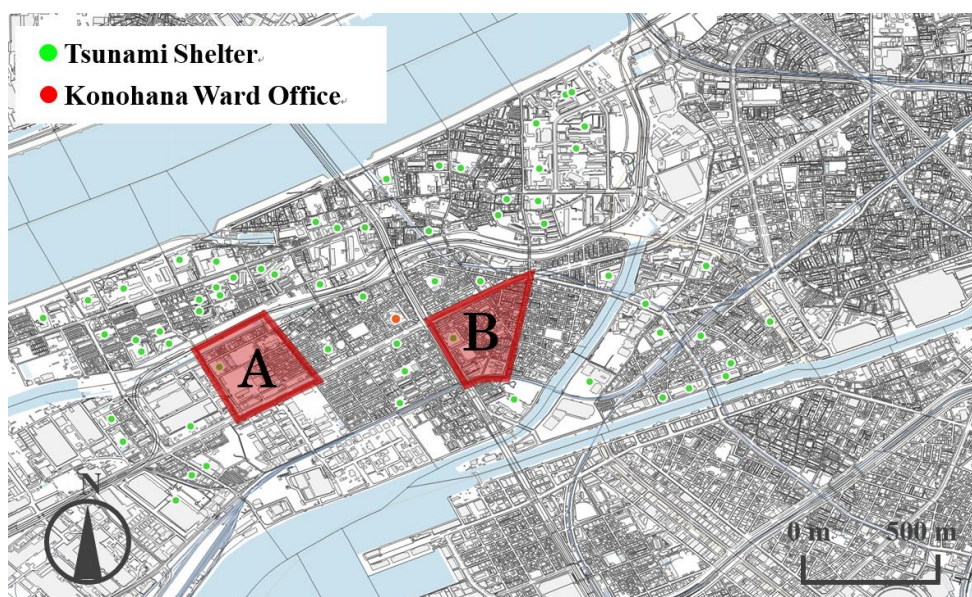


Fig. 2 - Study areas



## 2.2 Outline of Questionnaire Survey

This is a quantitative and descriptive study. The survey items were designed to understand disaster awareness, recognition of measures implemented by the local government, individual measures taken, and individual evacuation plans. The survey was jointly conducted by the Konohana Ward Office and the Center of Education and Research for Disaster Management at Osaka City University in March 2019. The office distributed the questionnaire to all households in the study areas (area A: 530 households; area B: 1,387 households) and collected them. The head of household or another household member was asked to complete the questionnaire.

## 2.3 Questionnaire Survey Items

The questionnaire survey is composed of four fields: basic attributes, risk perception, implementation status of preparedness for disaster, and evacuation plan for a Nankai Trough massive earthquake. The details of the survey items are given below.

**Basic attributes:** This field is composed of residential area, sex, age, whether there are vulnerable family members, family size, daytime location, and floor of residence. In this research, we define vulnerable people as those who meet the criteria for support from Osaka City [9].

**Risk perception:** This field is composed of recognition of the possibility of tsunami damage, awareness of disaster occurrence, anxiety about evacuation, and estimated tsunami arrival time and inundation depth after a Nankai Trough massive earthquake. The first three items were rated on a five-point Likert scale (1 = very applicable, 2 = slightly applicable, 3 = neutral, 4 = not very applicable, and 5 = not applicable at all).

**Implementation status of preparedness for disaster:** This field is composed of measures being implemented and reasons for not taking measures. We extracted 18 measures based on previous research [10, 11]. For each measure, the choice of answer is either “Implemented” or “Not implemented”.

**Evacuation plan for a Nankai Trough massive earthquake:** This field is composed of recognition of tsunami shelters, information sources, evacuation sites, and evacuation direction. We aimed to clarify the trend of evacuation plans based on the results of “evacuation site” and “evacuation direction”.

## 3. Trends of Disaster Awareness and Individual Measures Taken

666 questionnaires were collected (recovery rate: 34.7%). Details of the results are given below.

### 3.1 Basic Attributes

Table 1 shows the results for basic attributes. A total of 244 respondents lived in area A and 409 respondents lived in area B. The response rates were 46.0% in area A and 29.5% in area B. Most respondents were in their 70s (174 respondents, 26.4%), followed by those in their 60s (156 respondents, 23.6%). The average age was 62.4 years (standard deviation: 16.53 years); the answers were thus mostly from elderly people. Regarding family size, there were many small-scale households, including those living alone (225 households, 35.4%) or living with one other person (238 households, 37.4%). One hundred respondents (18.4%) had vulnerable family members and 358 respondents (83.1%) answered that they were in Konohana Ward during the daytime. A total of 265 respondents (41.5%) lived on the first or second floor and 373 respondents (58.5%) lived on the third or higher floor.

In section 4, age is classified as “under 65” and “65 and over” and family size is classified as “alone” and “two or more people”. Age and family size are treated as variables.



Table 1 - Basic attributes

Attribute		Number	Rate
Place of residence	Area A	244	37.4%
	Area B	409	62.6%
Sex	Male	346	52.3%
	Female	315	47.7%
Age	≤20s	28	4.2%
	30s	54	8.2%
	40s	70	10.6%
	50s	88	13.3%
	60s	156	23.6%
	70s	174	26.4%
	≥80s	90	13.6%
Family size	1	225	35.4%
	2	238	37.4%
	3	93	14.6%
	4	45	7.1%
	5	24	3.8%
	6	6	0.9%
	≥7	5	0.8%
Vulnerable family members	Yes	100	15.6%
	No	543	84.4%
Daytime location	Konohana Ward	358	83.1%
	Outside Konohana Ward	73	16.9%
Floor of residence	First or second	265	41.5%
	Third or higher	373	58.5%

### 3.2 Risk Perception

Table 2 shows the results for risk perception. For recognition of the possibility of tsunami damage by a Nankai Trough massive earthquake, the most common answer was “very applicable” (1) (387 respondents, 59.6%), indicating that many residents are aware of the danger of tsunami damage. For awareness of disaster occurrence, the most common answer was “slightly applicable” (2) (293 respondents, 45.4%). Disaster awareness in the study areas is higher than that for the whole area in Osaka Prefecture [8]. For anxiety about evacuation, the most common answer was “very applicable” (1) (282 respondents, 44.1%). More than 80% of the respondents are concerned about evacuation. The results show that many residents in the study areas are aware of the danger of a disaster and are anxious about evacuation.

Table 2 - Risk perception

	Very applicable	Slightly applicable	Neutral	Not very applicable	Not applicable at all
Recognition of the possibility of tsunami damage	387	160	85	15	2
N = 649	59.6%	24.7%	13.1%	2.3%	0.3%
Awareness of disaster occurrence	175	293	135	35	8
N = 646	27.1%	45.4%	20.9%	5.4%	1.2%
Anxiety about evacuation	282	236	82	30	9
N = 639	44.1%	36.9%	12.8%	4.7%	1.4%



In section 4, for the three items in risk perception, “very applicable” (1) and “slightly applicable” (2) are grouped into “Yes”, and “neutral” (3), “not very applicable” (4), and “not applicable at all” (5) are grouped into “No”. These items are treated as variables.

To determine whether the residents’ knowledge about the disaster is correct, we asked for their estimates of tsunami arrival time and inundation depth after a Nankai Trough massive earthquake. The results of tsunami arrival time from respondents who thought that a tsunami would arrive (446 respondents, 69.8%) indicate that many residents estimate the tsunami to arrive much earlier than the official estimated time (approximately 110 minutes after an earthquake) (Table 3). The most common inundation depth estimated by respondents who thought that their area would be flooded in a disaster (405 respondents, 64.5%) was 6.0 m or more (183 respondents, 45.3%). This indicates that residents estimated excessive flooding (Table 3). The results show that the residents are aware of the danger of a disaster, but many of their assumptions are wrong.

Table 3 - Estimated tsunami arrival time and inundation depth

Time (min)	Number	Rate (%)	Depth (m)	Number	Rate (%)
Under 15	78	17.2%	Under 1.5	11	2.7%
15 – 29	78	17.2%	1.5 – 1.9	9	2.2%
30 – 44	120	26.4%	2.0 – 2.9	48	11.9%
45 – 59	17	3.7%	3.0 – 3.9	52	12.9%
60 – 89	78	17.2%	4.0 – 4.9	19	4.7%
90 – 119	40	8.8%	5.0 – 5.9	82	20.3%
120 – 179	35	7.7%	6.0 and over	183	45.3%
180 and over	8	1.8%			

### 3.3 Implementation Status of Preparedness for Disaster

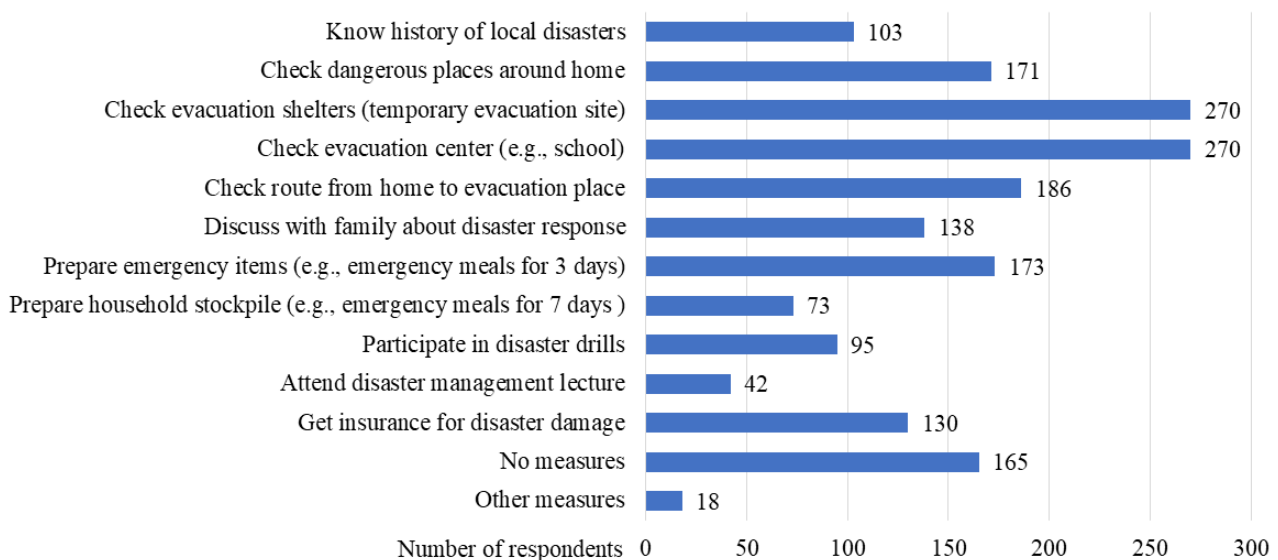


Fig. 3 - Implementation status of preparedness for disaster



To determine the measures taken by residents, we asked about the measures being implemented using multiple-answer questions. A total of 634 people answered (Fig. 3). No single measure had a high rate overall. “Check evacuation shelters (temporary evacuation site)” and “Check evacuation center (e.g., school)” had the highest implementation rates (270 respondents, 42.6%). The rate was different for each measure. “No measures” was given by 165 respondents (26.0%), indicating insufficient promotion of risk perception and measures. Figure 4 shows the reasons for not taking these measures. Common answers are “I end up putting it off” (252 respondents, 48.6%), “I don't know what to do” (209 respondents, 40.3%), and “I feel somehow safe” (130 respondents, 25.0%). These results indicate that the main reasons for not taking measures are low awareness of a crisis and a lack of understanding of what to do.

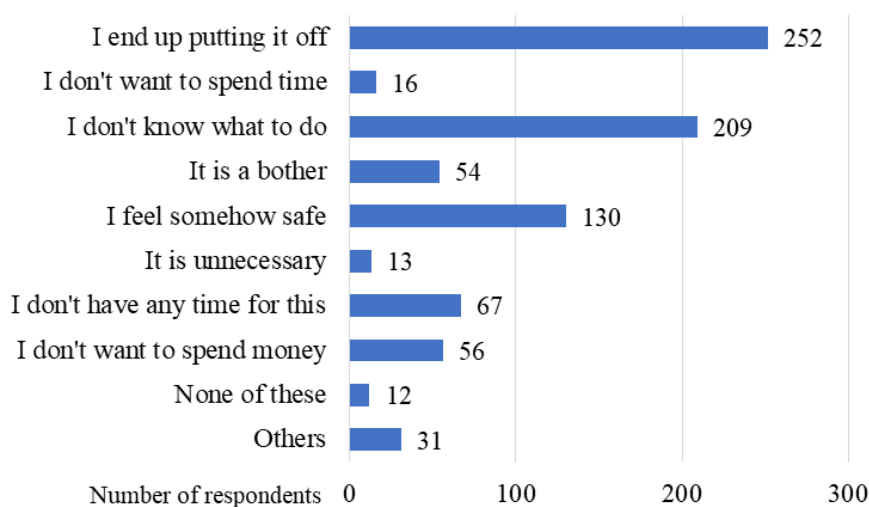


Fig. 4 - Reasons for not taking measures

### 3.4 Evacuation Plans for Nankai Trough Massive Earthquake

Figure 5 shows that the results for recognition of tsunami shelters designated by the local government as evacuation sites for a tsunami. A total of 390 respondents (62.8%) answered “I know one site or more” and 47 respondents (7.6%) answered “I have never heard about this”, indicating that recognition of tsunami shelters is insufficient. For information sources (Fig. 6), common answers are “TV” (486 respondents, 74.4%) and “mail or notification (smartphone or mobile)” (455 respondents, 69.7%). These are the two main sources of information for residents.

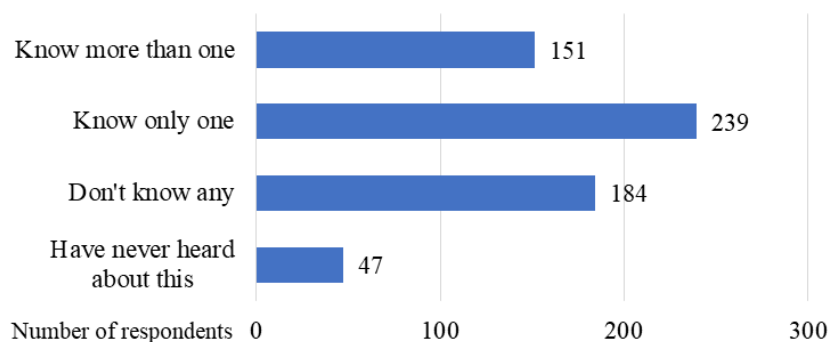


Fig. 5 - Recognition of tsunami shelters

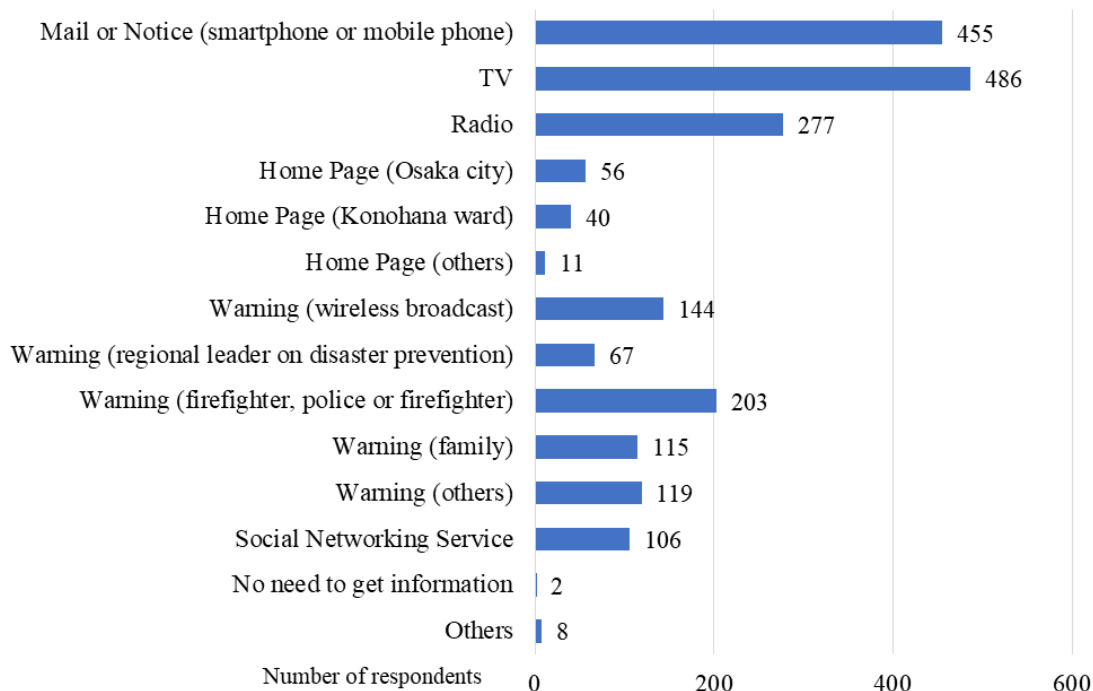


Fig. 6 - Information source during disasters

In section 4, for recognition of tsunami shelters, “Yes” and “No” represent knowing and not knowing about tsunami shelters, respectively.

The results for evacuation plans are shown below. Table 4 shows the results for planned evacuation sites. The most common answer was “evacuation center (e.g., school)” (233 respondents, 42.8%) and the second most common was “home (including top floor)” (168 respondents, 30.8%). Twenty-three respondents (4.2%) stated that they would evacuate to a tsunami shelter. This result is below the local government’s expectation. For planned evacuation direction (Table 4), the most common answer was “residential area” (486 respondents, 92.4%). These results indicate that most residents will go to an evacuation site near their homes.

Table 4 - Planned evacuation sites and direction

Evacuation site	Number	Rate (%)	Evacuation direction	Number	Rate (%)
Home (including top floor)	168	30.8%	Residential area	486	92.4%
Acquaintance's house	24	4.4%	Northern area	3	0.6%
Evacuation center (e.g., school)	233	42.8%	Eastern area	8	1.5%
Public facility	16	2.9%	Southern area	3	0.6%
Tsunami shelter	23	4.2%	Western area	10	1.9%
Other building	20	3.7%	I don't know	7	1.3%
Overhead structure of National Route 43	4	0.7%	Other	9	1.7%
I don't know	7	1.3%			
Other	50	9.2%			



#### 4. Relationship between Attributes and Evacuation Plans

We analyzed the results in section 3 to clarify the trend of residents' evacuation plans using bivariate analysis. We used R 3.5.1 for the analysis and set the significance level to 5%. We used the chi-squared test and Fisher's exact test for statistical tests.

##### 4.1 Characteristics Related to Recognition of Tsunami Shelters

We determined the attributes related to recognition of tsunami shelters. Based on the variable "recognition of tsunami shelters", we input "place of residence", "sex", "age", "family size", "vulnerable family members", "daytime location", "floor of residence", "recognition of the possibility of tsunami damage", "awareness of disaster occurrence", and "anxiety about evacuation" as cross variables. Table 5 shows the results. There is a significant association between recognition of tsunami shelters and place of residence, age, family size, recognition of the possibility of tsunami damage, and awareness of disaster occurrence. Residents in area A tended to know more about tsunami shelters compared to residents in area B (73.4% vs. 56.4%,  $P < 0.001$ ), elderly people aged 65 and over tended to know more about tsunami shelters compared to those aged under 65 (68.0% vs. 57.2%,  $P = 0.017$ ), and families with two or more people tended to know more about tsunami shelters compared to people who lived alone (67.0% vs. 57.0%,  $P = 0.019$ ). People who recognized the possibility of tsunami damage tended to know most about tsunami shelters (64.9% vs. 47.3%,  $P = 0.002$ ) and people who were aware of disaster occurrence tended to know most about tsunami shelters (67.2% vs. 50.6%,  $P < 0.001$ ). The results suggest that improving disaster awareness and giving people a sense of crisis lead to specific and realistic expectations of evacuation and promote understanding about tsunami shelters.

Table 5 - Characteristics related to recognition of tsunami shelters

Variable		Recognition of Tsunami shelters				P-value
		Yes		No		
		N	%	N	%	
Place of residence	Area A	163	73.4	59	26.6	<0.001
	Area B	219	56.4	169	43.6	
Sex	Male	203	62.3	123	37.7	0.897
	Female	183	63.1	107	36.9	
Age	Under 65	166	57.2	124	42.8	0.017
	65 and Over	221	68.0	104	32.0	
Vulnerable family members	Yes	56	62.9	33	37.0	0.952
	No	273	64.0	154	36.0	
Family Size	Two or more people	258	67.0	127	33.0	0.019
	Alone	122	57.0	92	43.0	
Daytime location	In Konohana Ward	203	59.7	137	40.3	0.295
	Outside Konohana Ward	37	52.1	34	47.9	
Floor of residence	First or second	160	64.0	90	36.0	0.903
	Third or higher	223	63.2	130	36.8	
Recognition of possibility of tsunami damage	Yes	339	64.9	183	35.1	0.002
	No	43	47.3	48	52.7	
Awareness of disaster occurrence	Yes	301	67.2	147	32.8	<0.001
	No	84	50.6	82	49.4	
Anxiety about evacuation	Yes	307	61.6	191	38.4	0.48
	No	72	66.1	37	33.9	

Variables that meet the significance level of 5% are shown in bold.



## 4.2 Characteristics Related to Planned Evacuation Sites

The attributes related to planned evacuation sites were determined. Based on the variable “planned evacuation site”, we input the variables mentioned above. Table 6 shows the results. There is a significant association between supposition of evacuation sites and place of residence, age, existence of vulnerable family members, daytime location, and floor of residence. Residents in area A were more likely to evacuate to an evacuation center (e.g., school) (54.9% vs. 44.3%) or a tsunami shelter (7.4% vs. 3.3%) and they were less likely to evacuate to their home (including top floor) (28.0% vs. 38.5%,  $P = 0.030$ ). Elderly people aged 65 and over were more likely to evacuate to their home (including top floor) (37.4% vs. 31.5%) or an evacuation center (e.g., school) (51.2% vs. 44.5%) and they were less likely to evacuate to a tsunami shelter (2.5% vs. 8.0,  $P = 0.009$ ). Families with vulnerable members were more likely to evacuate to their home (including top floor) (41.6% vs. 31.8%), but were less likely to evacuate to other sites, such as an acquaintance’s house, an evacuation center (e.g., school), a public facility, or and a tsunami shelter. Table 6 also shows that “daytime location” and “floor of residence” affected planned evacuation sites.

Table 6 - Characteristics related to planned evacuation sites

Variable		Evacuation site												P-value
		Home (including top floor)		Acquaintance's house		Evacuation center (e.g., school)		Public facility		Tsunami shelter		Other building		
		N	%	N	%	N	%	N	%	N	%	N	%	
Place of residence	Area A	49	28.0	7	4.0	96	54.9	3	1.7	13	7.4	7	4.0	0.030
	Area B	115	38.5	16	5.3	133	44.3	13	4.3	10	3.3	13	4.3	
Sex	Male	89	34.9	11	4.3	122	47.8	10	3.9	11	4.3	12	4.7	0.876
	Female	79	35.1	12	5.3	109	48.4	6	2.7	12	5.3	7	3.1	
Age	Under 65	63	31.5	14	7.0	89	44.5	7	3.5	16	8.0	11	5.5	0.009
	65 and Over	105	37.4	9	3.2	144	51.2	8	2.8	7	2.5	8	2.8	
Vulnerable family members	Yes	32	41.6	2	2.6	34	44.2	1	1.3	2	2.6	6	7.8	<0.001
	No	103	31.8	21	6.5	158	48.8	12	3.7	18	5.6	12	3.7	
Family size	Two or more people	112	36.7	16	5.2	143	46.9	5	1.6	15	4.9	14	4.6	0.062
	Alone	43	27.4	7	4.5	83	52.9	10	6.4	8	5.1	6	3.8	
Daytime location	Konohana Ward	78	30.6	8	3.1	136	53.3	7	2.7	13	5.1	13	5.1	<0.001
	Outside Konohana Ward	26	52.0	6	12.0	14	28.0	3	6.0	0	0.0	1	2.0	
Floor of residence	First or second	38	17.1	11	5.0	114	51.4	6	2.7	8	3.6	9	4.1	<0.001
	Third or higher	121	40.1	12	4.0	114	37.7	8	2.6	15	5.0	11	3.6	
Recognition of possibility of tsunami damage	Yes	138	34.2	21	5.2	192	47.5	12	3.0	23	5.7	18	4.5	0.243
	No	26	38.2	3	4.4	35	51.5	3	4.4	0	0.0	1	1.5	
Awareness of disaster occurrence	Yes	121	34.4	20	5.7	163	46.3	12	3.4	20	5.7	16	4.5	0.568
	No	41	33.9	4	3.3	65	53.7	4	3.3	3	2.5	4	3.3	
Anxiety about evacuation	Yes	117	31.1	21	5.6	187	49.7	11	2.9	20	5.3	20	5.3	0.057
	No	38	43.2	3	3.4	40	45.5	4	4.5	3	3.4	0	0.0	

Variables that meet the significance level of 5% are shown in bold.

## 5. Discussion

Regarding disaster awareness, although many of the residents in the study areas are aware of the risk of a tsunami, their estimates of the arrival time and inundation depth are incorrect. This suggests that it is necessary to educate the public because excessive anxiety and incorrect estimations may lead to delayed evacuation and panic. Regarding designated tsunami shelters, about 40% of residents do not know their locations and it turns out that tsunami shelters are not well known. This highlights the need for securing shelters and making them more recognizable. The local government expects residents to evacuate to tsunami



shelters, whereas many respondents stated that they will evacuate to an evacuation center (e.g., school). This indicates that some residents may not be able to evacuate after a Nankai Trough massive earthquake because evacuation centers will be full. In addition, because most residents plan to evacuate to a site in their area of residence, it is necessary to secure evacuation sites to accommodate more people and promote evacuation to more distant sites.

The results of the bivariate analysis on recognition of tsunami shelters indicate that residents who live in area A, are over 65 years old, live with someone, recognize the possibility of tsunami damage, are aware of disaster occurrence and tend to know most about tsunami shelters. These results suggest that the recognition of measures implemented by the local government differs depending on the basic attributes of residents and risk perception. Especially, it is important to educate younger and indifferent generations who have a lower recognition rate of tsunami shelters.

The results of bivariate analysis on planned evacuation sites suggest that the place of residence, age, existence of vulnerable family members, daytime location, and floor of residence affect planned evacuation sites. The results also indicate that many elderly people (68.0%) know about tsunami shelters, but few of them plan to evacuate to the shelters. Moreover, families with vulnerable members may evacuate too late if a tsunami larger than expected occurs because they do not plan to evacuate outside their home. The supposition of evacuation sites depends on attributes, suggesting the necessity of creating evacuation plans and implementing measures suitable for individuals.

## 6. Limitations

There are some limitations in this research. One limitation is the limited generalization of the obtained results to other areas in Japan that are at risk of tsunami damage after a Nankai Trough massive earthquake because the topography, estimation of tsunami inundation depth and arrival time, attributes of residents, and measures taken differ from region to region. Another limitation is that the disaster awareness of all residents may not have been measured sufficiently. In this study, questionnaires were distributed to all households in the study areas to determine the overall awareness trend; however, the recovery rate for young people was low. The results may thus have been greatly influenced by the trend of elderly people.

## 7. Conclusion

This study used questionnaire surveys and analyses to determine disaster awareness and measures taken in areas at risk of a tsunami, and clarified the trends and issues regarding planned evacuation behavior. It is necessary for residents to understand specific risks, such as tsunami arrival time and inundation depth, about a Nankai Trough massive earthquake in their area of residence, identify any issues, and take measures themselves. Based on the results of this research, it is important not only to promote current measures more, but also to develop ways to encourage individuals to think about and take measures against disasters. This would mitigate human casualties during a disaster.

## 8. Acknowledgment

This work was supported by JSPS KAKENHI Grant Number JP18K02243. We wish to thank the Konohana Ward Office for creating, distributing, and collecting the questionnaires. We also wish to thank the residents of the study areas for answering our questionnaire.

## 9. References

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