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ARTICLE

Factors Affecting Behaviors that Precede Evacuation at the Onset of a Heavy Rainstorm in Japan

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Abstract There exist certain behaviors that people tend to do in disaster situations before evacuation. Such behaviors include warning confirmation behavior (for example, seeking information) and family-oriented behavior (for example, contacting one's family). Identifying factors that affect these behaviors is of particular importance in building a better understanding of why people often fail to respond quickly to evacuation orders. For this purpose, the present study employed some of the established factors affecting evacuation behavior as predictor variables along with the timing of an evacuation order. A total of 518 participants took part in a 12-item online questionnaire survey that contained a hypothetical disaster scenario. The results of ordinal logistic regression analyses revealed that only risk area residence and disaster preparedness were associated with warning confirmation behavior, while gender, age, disaster preparedness, and risk perception had some associations with family-oriented behavior. Also, the participants were not more likely to engage in these behaviors in the morning and the afternoon than the evening in the hypothetical scenario. These findings imply the possibility that people engage in warning confirmation behavior and family-oriented behavior before evacuation regardless of individual characteristics and the circumstances surrounding them.

Keywords Disaster preparedness · Disaster psychology · Evacuation behavior · Evacuation order · Japan · Rainstorm

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1 Introduction

Evacuation is an essential behavior that humans can engage in to survive in the event of a disaster triggered by natural hazards. In particular, early evacuation—moving to a safer place from potentially dangerous areas before people and/or their properties are seriously affected by a disaster—is vital for people living in areas and countries that are prone to water-related disasters such as floods, rainfall-induced landslides, rainstorms, and tsunamis. Japan is one of such countries, as several water-related disasters strike the country every year. For example, heavy rain hit the southern part of Japan, particularly Kumamoto Prefecture in Kyushu Island, in July 2020, resulting in the deaths of 84 people with thousands of houses destroyed or damaged (Cabinet Office 2021). In 2019, Typhoon Hagibis killed 95 people and inflicted fatal damage on thousands of houses in the northern and central parts of Japan (Cabinet Office 2019). The year 2018 also saw devastating typhoons and heavy rainfalls, among which the 30 July Heisei floods caused more than 220 deaths due to massive floods and landslides (Fire and Disaster Management Agency 2019).

In these disasters, many victims were thought to have failed to evacuate even after evacuation orders were issued (Sankei Shimbun 2018; Mainichi Newspapers 2019, 2020; Asahi Shimbun 2021). However, people's reluctance to immediately evacuate in emergency situations is not only unique to the Japanese. Whenever and wherever a major storm makes landfall or disastrous rainfall is predicted, there are a substantial number of people who choose not to immediately evacuate to safer places even when they need to do so. Indeed, it has been well-known in the disaster literature that in general people are not quick to respond to evacuation orders (Quarantelli and Dynes 1972). This undesirable tendency has also been observed during

disasters in developing countries, such as Bangladesh (Paul 2012; Saha and James 2017; Saha and Pittock 2021) and the Philippines (Walch 2018).

Over the past decades, disaster researchers have been exploring factors that contribute to evacuation in emergency situations. Huang et al. (2015) performed a meta-analysis on 38 actual hurricane studies and 11 hypothetical evacuation studies. They found that official warnings, peers evacuating, expected personal casualties, mobile home residence, and risk area residence were significantly positively associated with evacuation behavior, while some common variables, such as gender, age, and previous hurricane experience, were not found to be significant predictors of evacuation. Thompson et al. (2017) also looked into 83 published research articles on evacuation in emergency situations, and they found that risk perception was one of the most robust predictors of evacuation behavior. In their study, female gender, the presence of children, having an evacuation plan, mandatory evacuation orders, and prior evacuation behavior were also found positively associated with evacuation behavior, whereas older age and the presence of pets had negative effects on evacuation.

In developing countries, factors that contribute to evacuation in emergency situations seem slightly different from those found in developed countries. Based on evacuation behaviors observed in India and the Philippines, Walch (2018) found that the lack of traumatic disaster experience coupled with a low trust in municipality could result in non-evacuation, implying that the opposite factors (traumatic disaster experience coupled with a high trust in municipality) can help people evacuate early. In another study, trust in warning messages was found to be the most important determinant in evacuation, when the category 4 Cyclone Sidr struck the southwestern coast of Bangladesh in 2007 (Paul 2012). In a similar vein, the availability of a shelter in one's neighborhood (for example, whether or not there is a cyclone shelter available in the vicinity of one's home, how far a cyclone shelter is from one's home) can also affect Bangladeshis' decision making in evacuation (Paul 2012; Saha and Pittock 2021).

As for the evacuation-enhancing factors found in developed countries, evacuation orders have consistently been found to have facilitatory effects on evacuation behavior and intentions (Gladwin et al. 2001; Sherman-Morris 2013; Huang et al. 2015; Thompson et al. 2017; Meyer et al. 2018). That is, people are likely to evacuate to safer places when ordered to do so. However, as mentioned earlier, even when people have received an evacuation order, they may not immediately start moving to safer places in an emergency situation. People could end up evacuating after an evacuation order, but it seems that they engage in certain behaviors before evacuation. The objective of the present study is to shed light on factors that affect such behaviors, which could contribute to enhancing early evacuation in future disasters.

1.1 Behaviors that Precede Evacuation in Emergency Situations

People's responses to past disasters clearly indicate that there exist some behaviors that precede evacuation even in emergency situations. For instance, Okayama Prefecture, one of the most affected prefectures in the 30 July 2018 Heisei floods, performed a questionnaire survey on 2,310 affected local residents, asking about what they did after the evacuation order was issued at the time of the disaster (Okayama Prefecture 2019). Among 12 behavior options, "collecting information about the disaster from TV" was indicated by the highest proportion of the respondents (43.5%), while the second highest was "going to the evacuation center" (28.2%). This implies that even when people have received an evacuation order, many of them may prioritize information collection over evacuation. Other behaviors, such as "preparing emergency goods such as a flashlight" (27.1%), "contacting one's family and relatives" (26.1%), and "preparing for evacuation" (25.8%), were also performed by many of the affected local residents after the evacuation order.

In an interview survey on survivors of the 2011 Great East Japan Earthquake, 42% of 870 respondents were found to have not evacuated immediately after the initial earthquake despite a major tsunami warning being issued for their residential areas (Central Disaster Prevention Council 2011). These respondents did not immediately evacuate to higher ground after the earthquake, because they "went back home" (22%), "tried to pick up their families" (21%), and "tried to make sure that their families were safe" (13%). In other words, these people placed the family-related behaviors above their own evacuation. Based on the results of these surveys, it seems that certain behaviors, such as information collection and making contact with family, are likely to precede evacuation even in emergency situations.

Behaviors that precede evacuation in emergency situations are certainly not new to the literature. For instance, Perry (1979) claimed that when an evacuation warning has been issued, people try to confirm the warning message regardless of the mode and source of the warning. Such warning confirmation behavior includes surveying the environment, observing others' behavior, talking to friends or relatives, and contacting official sources. Deriving information from modern information technologies such as the Internet and social networking services (SNSs) should also be included in warning confirmation behavior along with traditional mass media (for example, television, the radio). Perry also asserted that people tend not to evacuate if they fail to confirm a warning message. Thus, warning confirmation

behavior is likely to precede evacuation behavior whenever a waring message is issued in an emergency situation.

Another common tendency often seen in emergency situations is that people evacuate with their family members together (Drabek and Boggs 1968). This family-oriented behavior implies that people need to reunite their family members before evacuating. In fact, as seen in the 2011 Great East Japan Earthquake survey mentioned above, quite a few affected local residents tried to reunite their family members even after the major tsunami warning was issued for their areas (Central Disaster Prevention Council 2011). Perry (1979) also argued that reunion of separated family members may not be necessary as long as they can communicate with each other through some communication means. Owing to recent technological advances in information and communication technologies, people in modern society can confirm whether their family members are safe in an emergency situation through mobile phones, e-mail, and SNSs provided communication lines stay intact. Consequently, people in modern society may not necessarily actually see their families as long as they can contact them after an evacuation order.

Warning confirmation behavior and family-oriented behavior have been found not only in Japan or other developed countries, but such behaviors seem observable in developing countries. For instance, many local residents affected by the 2017 Cyclone Mora in Bangladesh did not evacuate to cyclone shelters, because the affected people thought "the weather was good despite warnings" (Saha and Pittock 2021). In this particular disaster, only 21.6% of the 250 surveyed local residents (54) evacuated to the shelters. Out of these 54, 39 (72.2%) evacuated with all family members, while 15 (27.8%) did so with some of their family members. Saha and James (2017) also argued that non-compliance with cyclone evacuation orders in Bangladesh is partly due to warning confirmation-related factors (for example, disbelief in the warning) as well as to family-related factors (for example, male members were not at home, husband was too old to walk the long way). Therefore, warning confirmation behavior and family-oriented behavior may be robust wherever a disaster strikes.

1.2 Factors Affecting Warning Confirmation Behavior and Family-Oriented Behavior

Given that people engage in warning confirmation behavior and/or family-oriented behavior before evacuation, the same factors affecting evacuation could also have effects on these two behaviors. For example, prior evacuation behavior is thought to be a robust predictor of future evacuation behavior (Thompson et al. 2017; Meyer et al. 2018). Thus, people with previous evacuation experience may be quicker to survey the environment and seek additional information about the disaster than those with no such experience after an evacuation order is issued. In the same vein, these experienced people could also be more likely than their counterparts to try to contact their families in emergency situations.

Risk area residence has been positively associated with evacuation behavior (Baker 1991; Huang et al. 2015; Lazo et al. 2015; Golshani et al. 2019). Consequently, people living in areas with high risks of flood may be more likely to survey the environment, seek additional information about the disaster, and try to contact their families than those living in low-risk areas after an evacuation order. In addition to that, because having an evacuation plan is found to be a positive predictor of evacuation (Lazo et al. 2015; Thompson et al. 2017), people who are well-prepared for potential disasters and have done evacuation planning may be able to engage in warning confirmation behavior and family-oriented behavior sooner than those less prepared for disasters. Higher risk perception is also thought to be a robust predictor of future evacuation behavior (Baker 1991; Lindell and Perry 2012; Huang et al. 2015; Thompson et al. 2017; Meyer et al. 2018). Therefore, those who are aware that an approaching disaster will impact them are more likely than less aware people to confirm warning messages as well as to try to make contact with their families before they evacuate.

Besides the above-mentioned factors possibly affecting warning confirmation behavior and family-oriented behavior, there is one more variable that may affect these two behaviors as well as the onset of evacuation: That is the timing of an evacuation order. Disaster occurs at any time of the day or night. Therefore, evacuation orders can also be issued at any time of the day. Fu et al. (2007) looked into the impact of evacuation notices issued at different times of the same day. They found that the impact of evacuation notices on evacuation behavior diminishes as night approaches. Huang et al. (2012) also found that more people evacuated in the morning and the afternoon than during the evening and nighttime hours before the landfall of the 2008 Hurricane Ike in Texas, the United States. Given that people are more likely to evacuate when an evacuation order is issued in the morning or the afternoon than in the nighttime, it is also possible to assume that people are more likely to engage in warning confirmation behavior and family-oriented behavior in the morning and the afternoon than in the nighttime.

1.3 Research Design and Hypothesis of this Study

Up to the present, little research, if any, has examined factors affecting behaviors that precede evacuation, namely warning confirmation behavior and family-oriented behavior, when an evacuation order is issued in an emergency situation. However, identifying such factors is of particular importance in building a better understanding of why people often fail

to respond quickly to evacuate orders. Therefore, the present study is designed to fulfill this purpose.

Employing a hypothetical rainstorm scenario in an online questionnaire survey, this study examined factors that affect warning confirmation behavior and family-oriented behavior. The study took several established factors found to affect evacuation in previous research, such as prior evacuation experience and risk perception, as well as unestablished factors, such as the timing of an evacuation order. The first hypothesis predicts that people with prior evacuation experience, risk area residence, higher disaster preparedness, and higher risk perception will be more likely to engage in warning confirmation behavior and family-oriented behavior than those without such characteristics. The second hypothesis predicts that people will be more likely to engage in warning confirmation behavior and family-oriented behavior in a hypothetical rainstorm scenario when an evacuation order is issued in the morning and the afternoon than the evening.

2 Method

This study was performed as a part of a larger study on evacuation behavior in water-related disasters. The study employed an online survey method to collect data across Japan. All participants were randomly selected from a panel of 1.2 million online respondents held by a large Japanese online survey company.

2.1 Participants

A total of 518 Japanese participants (259 men and 259 women) aged from 16 to 82 ($M = 46.31$, $SD = 14.15$) took part in the study. With regard to age distribution, 1.0% of the participants were in their 10s, 10.8% in their 20s, 21.8% in their 30s, 26.6% in their 40s, 20.5% in their 50s, and 19.3% were aged over 60. The percentage distribution of participants by their region of residence is shown in Table 1. All participants were asked to take part in the study in exchange for participation points, which can be used as a cash voucher on the survey company's affiliated online websites.

Table 1 Percentage distribution of participants by region of residence

No.	Region	*n*	%	Actual % of Population[a]
1	Hokkaido and Tohoku	54	10.4	11.0
2	Kanto and Koshin-etsu	208	40.2	36.9
3	Tokai and Hokuriku	57	11.0	15.9
4	Kinki	112	21.6	16.3
5	Chugoku and Shikoku	47	9.1	8.7
6	Kyushu and Okinawa	40	7.7	11.3
Total		518	100.0	100.0

[a]Statistics Bureau of Japan (2020)

2.2 Materials

In total, 12 questions were composed for this study. The first two questions were about participants' gender and age. The rest of the 10 questions are as follows.

2.2.1 Evacuation Experience (one question)

A three-choice question was prepared for measuring participants' evacuation experience. The participants were asked whether they had ever evacuated to another safer place in an actual disaster ("Have you ever evacuated to another safer place in the event of a water-related disaster (for example, the government-designated evacuation center, the second floor of your own house, your relative's house, the community center in the neighborhood)?"). Participants were instructed to choose one of "yes," "no," and "not sure" answers in this three-choice question (all three-choice questions described below were answered in the same fashion).

2.2.2 Risk Area Residence (three questions)

Three three-choice questions were designed to ask whether participants lived in a high risk area. The first question asked participants whether they lived in the sediment disaster-prone area ("Do you currently live in the designated sediment disaster-prone area?"), whereas the second question was about the flood-prone area ("Do you currently live in the designated flood-prone area?"). These disaster-prone areas are officially designated by the central and local governments in Japan, and people can find whether they live in these areas with the hazard map issued by their local governments. Participants were also asked in the third question whether their house had two or more stories ("Does your house have two or more stories (if you live in an apartment building, do you live on the second or a higher floor)?"), as people could safely evacuate to a higher floor of their own house/apartment in a water-related disaster like floods. The sum of "yes" responses in these three questions, ranging from 0 to 3, were deemed as a score of risk area residence (the third item was a reverse-scored item).

2.2.3 Disaster Preparedness (four questions)

Four three-choice questions were designed to measure participants' preparedness for potential disasters in their neighborhood during non-disaster times. One item asked whether participants were aware of potential disaster risks in their neighborhood ("Have you ever checked the hazard map

to see if there is any potential disaster risk (for example, floods, landslides) in your neighborhood?"). The other three questions were intended to measure participants' preparedness for emergency situations ("Do you have emergency stocks (for example, bottles of water, emergency food, the emergency radio, the emergency toilet)?"; "Do you regularly participate in emergency evacuation drills organized by your local community, workplace, and/or school?"; and "Have you ever talked with your family members about emergency evacuation in case of water-related disasters?"). "Yes" responses in the four questions were summed up into a score of disaster preparedness ranging from 0 to 4. Participants with high scores were thought to be more prepared for potential disasters and have done evacuation planning than those with low scores.

2.2.4 Perceived Risk in a Hypothetical Rainstorm Scenario (one question)

A hypothetical rainstorm scenario was created to measure participants' perceived risk and their assumed responses to an evacuation order in a rainstorm. In Japan, evacuation orders are issued by municipal governments for the general population as Warning Level 4, although evacuation is not mandatory but is on a voluntary basis. Also, meteorological warning messages are issued by the Japan Meteorological Agency (JMA) whenever severe meteorological disasters are forecast. There are four types of meteorological warning messages issued by the JMA for each meteorological phenomenon (for example, heavy rain, storm, storm surges): probability of warnings, advisories, warnings, and emergency warnings. Municipal governments generally decide whether they should issue an evacuation order, when a "warning" for a certain meteorological phenomenon has been issued by the JMA. The JMA may issue an "emergency warning" if the phenomenon has been recognized as far worse than initially predicted. Therefore, municipal governments normally issue Level 4 warning (evacuation order) sometime between the JMA's warning and emergency warning for a certain meteorological phenomenon.

Based on the above-mentioned nuts and bolts of Japan's disaster warning system, three conditions were prepared for the hypothetical rainstorm scenario: morning, afternoon, and evening. Participants were randomly assigned to one of the three conditions in which the evacuation order and meteorological emergency warning were issued in their neighborhood due to a heavy rainstorm. In the example of the morning condition, the scenario was described as: "Approximately at 4:00 a.m. on a weekday, Warning Level 4 has been issued in your neighborhood. Approximately at 5:00 a.m., one hour after the evacuation order, an emergency warning for heavy rainfall has also been issued in your neighborhood." Differences between the three conditions were the times at which the evacuation order and warning message were issued. The afternoon condition had the evacuation order at 0:00 p.m. and the emergency warning for heavy rainfall at 1:00 p.m., whereas the evening condition had the former at 8:00 p.m. and the latter at 9:00 p.m. After reading the assigned hypothetical scenario, participants in all the three conditions were asked to rate how dangerous the assigned situation would be to them, including their family members, on a five-point scale ranging from 1 (not dangerous at all) to 5 (very dangerous).

2.2.5 Assumed Responses to Evacuation Order (One Question)

After rating the perceived risk, participants in all the three conditions were also asked to choose assumed responses that they would take in the assigned situation. There were 11 response choices: five kinds of warning confirmation behavior ("surveying the environment (for example, checking how intensely it is raining, whether the roads have been inundated)," "seeking information on TV and/or the Internet," "contacting the local government office, the fire department, and/or the police office," "contacting community residents (for example, neighbors, members of the community association/community disaster response organization)," and "contacting other people (for example, friends, acquaintances, school, workplace)"), one family-oriented behavior ("contacting family members (including confirmation of their safety)"), two responses related to evacuation ("preparing for evacuation (including other family members and pets)" and "evacuating to a safer place (for example, the second floor of your house, the designated evacuation center, your relative's house)"), and three other responses ("doing nothing," "not sure," and "other behavior (open-ended)"). Participants were instructed to choose at least three responses from the list in chronological order, while two more responses could be chosen if desired (up to five responses). These responses were numerically scored according to their chosen orders ranging from 5 (the 1st response) to 1 (the 5th response) with unchosen responses given a score of 0.

2.3 Procedures

Potential participants first received an e-mail invitation randomly distributed by the online survey company. Participants who had agreed to take part in the study were asked to visit a survey website, on which they were randomly assigned to one of the three conditions before they started answering the questions (86 men and 87 women in the morning condition, 86 men and 86 women in the afternoon condition, and 87 men and 86 women in the evening condition). Participants were instructed to complete the 12-item questionnaire on the survey website at their convenience during a three-day

survey period. Participant recruitment was terminated, when the desired sample size of each gender (more than 250 for each gender) was reached on a first-come-first-served basis.

3 Results

All statistical tests were performed at the 0.05 significance level. Descriptive statistics of evacuation experience, risk area residence, disaster preparedness, and perceived risk are shown in Table 2. Among these variables, only perceived risk was condition-sensitive.

Table 3 presents the results of the assumed responses in the hypothetical rainstorm scenario. The most chosen response participants assumed they would first take in the rainstorm scenario was "surveying the environment" (51%). "Seeking information" was the most chosen in the second assumed response (44%), while "contacting family" was chosen most often in the third (32%). "Preparing for evacuation" was the most chosen in the fourth assumed response

Table 2 Descriptive statistics of the responses

No.	Items	Morning		Afternoon		Evening	
		Men ($n = 86$)	Women ($n = 87$)	Men ($n = 86$)	Women ($n = 86$)	Men ($n = 87$)	Women ($n = 86$)
1	Evacuation Experience	8 (9%)	6 (7%)	9 (10%)	11 (13%)	10 (11%)	9 (10%)
2	Risk Area Residence	0.47 (0.70)	0.31 (0.54)	0.30 (0.51)	0.33 (0.58)	0.44 (0.60)	0.35 (0.59)
3	Disaster Preparedness	1.50 (1.20)	1.62 (1.28)	1.70 (1.36)	1.51 (1.23)	1.48 (1.28)	1.78 (1.23)
4	Perceived Risk	3.69 (1.16)	3.92 (1.01)	3.71 (0.99)	4.08 (0.96)	3.90 (1.13)	4.20 (0.73)

The "Evacuation Experience" row indicates the numbers of "yes" responses with percentages of "yes" in parentheses, while the other rows show means of answers to each question with standard deviations in parentheses

Table 3 Results of assumed responses to the evacuation order

No.	Response choice	Order of assumed responses[a]						Mean score[b]
		1st	2nd	3rd	4th	5th	Total	
1	Surveying the environment	265 (51%)	84 (16%)	34 (7%)	10 (3%)	4 (2%)	397 (77%)	3.45 (2.04)
2	Seeking information	168 (32%)	228 (44%)	36 (7%)	6 (2%)	5 (2%)	443 (86%)	3.62 (1.64)
3	Contacting local government	5 (1%)	6 (1%)	11 (2%)	9 (3%)	4 (2%)	35 (7%)	0.20 (0.81)
4	Contacting community residents	4 (1%)	10 (2%)	15 (3%)	18 (6%)	11 (4%)	58 (11%)	0.29 (0.91)
5	Contacting Other People	0 (0%)	6 (1%)	20 (4%)	23 (7%)	18 (7%)	67 (13%)	0.29 (0.81)
6	Contacting family	31 (6%)	94 (18%)	168 (32%)	11 (3%)	13 (5%)	317 (61%)	2.07 (1.78)
7	Preparing for evacuation	10 (2%)	37 (7%)	110 (21%)	104 (32%)	28 (11%)	289 (56%)	1.47 (1.49)
8	Evacuating	6 (1%)	18 (3%)	64 (12%)	76 (23%)	92 (36%)	256 (49%)	1.04 (1.28)
9	Doing nothing	9 (2%)	12 (2%)	28 (5%)	35 (11%)	41 (16%)	125 (24%)	0.56 (2.33)
10	Not sure	18 (3%)	23 (4%)	32 (6%)	33 (10%)	39 (15%)	145 (28%)	0.74 (2.98)
11	Other behaviors	2 (0%)	0 (0%)	0 (0%)	1 (0%)	3 (1%)	6 (1%)	0.03 (0.33)

[a]The 1st, 2nd, and 3rd responses were mandatory (n = 518), whereas the 4th and 5th responses were optional (n = 326 for the 4th, n = 258 for the 5th)

[b]The order of assumed responses is converted into a response score: 1st response = 5, 2nd = 4, 3rd = 3, 4th = 2, 5th = 1, and unranked response = 0

(32%), and "evacuating to a safer place" was the most frequently chosen in the fifth response (36%). The "Total" column of Table 3 indicates that most participants chose seeking information (86%) and surveying the environment (77%), while approximately half of them also assumed that they would contact family members (61%), prepare for evacuation (56%), and evacuate (49%) in the given scenario. The other six response choices (contacting local government, contacting community residents, contacting other people, doing nothing, not sure, other behavior) were not so common among the participants.

The rightmost column of Table 3 shows mean scores of the assumed responses. A repeated measures one-way ANOVA was performed on the scores of the five most chosen responses (surveying the environment, seeking information, contacting family, preparing for evacuation, evacuating). The results indicate that there were statistically significant differences between the five responses, F (3.61, 1866.98) = 248.41, $p < 0.001$, $\eta_p^2 = 0.33$. A post hoc Bonferroni analysis revealed that scores of seeking information and surveying the environment were higher than scores of the other three responses (all pairs at $p < 0.001$), while no significant difference was found between these two warning confirmation behaviors ($p = 0.96$). Moreover, there were statistically significant differences between contacting family members, preparing for evacuation, and evacuating (all pairs at $p < 0.001$). These results indicate that warning confirmation behavior (surveying the environment, seeking information) and family-oriented behavior (contacting family members), as well as evacuation preparation (preparing for evacuation), preceded evacuation behavior (evacuating) even in a hypothetical disaster scenario.

Finally, in order to examine factors affecting behaviors that precede evacuation, ordinal logistic regression analyses were performed on the data. Scores of the four response choices that had been assumed to be taken prior to evacuation in the hypothetical scenario were employed as outcome variables, which consisted of two warning confirmation behaviors (surveying the environment, seeking information on TV and/or the Internet), one family-oriented behavior (contacting family members), and evacuation preparation (preparing for evacuation). Predictor variables were gender, age, evacuation experience, risk area residence, disaster preparedness, perceived risk, and the two disaster conditions (the morning and evening conditions with the afternoon condition set as default).

Table 4 shows correlations of the predictor variables, with no predictor variable strongly correlated with another ($r < 0.40$). Table 5 summarizes the results of the ordinal logistic regression analyses. With regard to surveying the environment, only risk area residence was found significantly negatively associated with the outcome variable ($\beta = -0.40$, $p < 0.01$). Disaster preparedness was significantly positively associated with seeking information ($\beta = 0.16$, $p < 0.05$). Gender ($\beta = 0.48$, $p < 0.01$), disaster preparedness ($\beta = 0.24$, $p < 0.001$), and perceived risk ($\beta = 0.17$, $p < 0.05$) were found significantly positively associated with contacting family members, while age ($\beta = -0.01$, $p < 0.05$) and the morning condition ($\beta = -0.48$, $p < 0.05$) had significant negative associations with this outcome variable.

Disaster preparedness ($\beta = 0.21$, $p < 0.01$), perceived risk ($\beta = 0.46$, $p < 0.001$), and the evening condition ($\beta = 0.44$, $p < 0.05$) were all found to have significant positive associations with preparing for evacuation. Evacuation experience was not found significantly associated with any of the four outcome variables. Overall, all the predictor variables of the present study accounted only for 1 to 4% of the variances in the outcome variables.

4 Discussion

The results of the present study indicate that only two of the predictor variables (disaster preparedness and risk perception) were found to affect warning confirmation behavior and

Table 4 Correlations between predictor variables

	Variables	1	2	3	4	5	6
1	Gender (1 = male, 2 = female)	–					
2	Age	− 0.33***	–				
3	Evacuation experience (0 = No, 1 = yes)	− 0.01	− 0.04	–			
4	Risk area residence	− 0.06	− 0.01	0.18***	–		
5	Disaster preparedness	0.03	0.08	0.04	0.07	–	
6	Perceived risk	0.15***	− 0.12**	0.09*	0.02	0.17***	–
7	Morning (0 = no, 1 = yes)	0.00	− 0.02	− 0.05	0.03	− 0.02	− 0.08
8	Evening (0 = no, 1 = yes)	− 0.00	0.04	0.02	0.03	0.02	0.09*

N = 518

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 5 Results of ordinal logistic regression analyses

No.	Predictor variables	Surveying the environment			Seeking information			Contacting family			Preparing for evacuation		
		β	*SE*	Exp (β)	β	*SE*	Exp (β)	β	*SE*	Exp (β)	β	*SE*	Exp (β)
1	Gender (1 = Male, 2 = Female)	0.22	0.18	1.25	− 0.32	0.18	0.73	0.48**	0.18	1.62	0.05	0.18	1.05
2	Age	0.01	0.01	1.01	− 0.01	0.01	1.00	− 0.01*	0.01	0.99	0.01	0.01	1.01
3	Evacuation Experience (0 = No, 1 = Yes)	0.24	0.28	1.27	0.04	0.27	1.04	− 0.05	0.27	0.95	0.13	0.27	1.14
4	Risk Area Residence	− 0.40**	0.14	0.67	− 0.07	0.15	0.93	0.01	0.14	1.01	− 0.06	0.14	0.94
5	Disaster Preparedness	0.08	0.07	1.08	0.16*	0.07	1.18	0.24***	0.07	1.27	0.21**	0.07	1.23
6	Perceived Risk	− 0.02	0.09	0.98	0.05	0.08	1.05	0.17*	0.09	1.19	0.46***	0.09	1.58
7	Morning Condition (0 = No, 1 = Yes)	0.06	0.21	1.06	0.08	0.20	1.08	− 0.48*	0.20	0.62	0.18	0.20	1.20
8	Evening Condition (0 = No, 1 = Yes)	− 0.09	0.20	0.91	0.19	0.20	1.21	− 0.24	0.20	0.79	0.44*	0.20	1.55
	AIC	1,329			1,350			1,414			1,459		
	R^2_{McF}	0.01			0.01			0.03			0.04		
	Model χ^2 (8)	13.3			10.3			46.6***			53.8***		

$N = 518$

Each outcome variable is converted as follows: 1st response = 5, 2nd = 4, 3rd = 3, 4th = 2, 5th = 1, and unranked responses = 0

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

β Regression coefficient; *AIC* Akaike information criterion

family-oriented behavior in the predicted direction. Therefore, the first hypothesis was not fully supported. The second hypothesis was also not supported, as the participants were not more likely to engage in warning confirmation behavior and family-oriented behavior when an evacuation order was issued in the morning or the afternoon than the evening.

Gender and age were associated with the family-oriented behavior in the same manner as with evacuation in previous research (Thompson et al. 2017): Women tended to contact their family members compared to men, whereas older people were less likely to do so than younger people. However, these two variables were not found to have any significant association with warning confirmation behavior, as well as with evacuation preparation. Prior evacuation experience has been thought to be a robust predictor of future evacuation behavior (Thompson et al. 2017; Meyer et al. 2018). Nevertheless, in this study, this predictor variable was not found associated with any of the outcome variables. The present study defined evacuation experience as moving to a safer place in the event of a water-related disaster, which ranged from the government-designated evacuation center to the second floor of one's house. Thus, the type of a safer place (the degree of prior evacuation experience) might have confounded the effect of evacuation experience on the outcome variables.

Risk area residence was only associated with one of the two warning confirmation behaviors. Unexpectedly, the participants living in high-risk areas were not more likely to survey the environment in emergency situations than those living in low-risk areas, but they were less likely to do so. Moreover, previous research indicated that risk area residence is positively associated with evacuation behavior (Baker 1991; Huang et al. 2015; Lazo et al. 2015). However, this variable was not found to have any significant association with evacuation preparation in the present study. Of course, there may be a certain number of people who do not engage in warning confirmation behavior and evacuation preparation before evacuation. That being said, since the participants living in high-risk areas were aware that they lived in such areas (they answered so in the questionnaire), they might have simply been less sensitive about the circumstances surrounding them than those living in low-risk areas, possibly leading to their reluctance to surveying the environment as well as to preparing for evacuation.

Disaster preparedness was found positively associated with seeking information, contacting family, and preparing for evacuation, while risk perception was positively related to contacting family and preparing for evacuation. Disaster preparedness seems to have the most consistent effects on behaviors that precede evacuation among the eight predictor variables, as it was associated with three out of the four outcome variables. Although the present predictor variables explained very little of the variance in each of the outcome variables, disaster preparedness seems to be a key factor in encouraging behaviors that precede evacuation at the onset

of a disaster. Moreover, family-oriented behavior seems more strongly associated with the present predictor variables than warning confirmation behavior, as five out of the eight predictor variables were associated with it.

The effects of the timing of an evacuation order on warning confirmation behavior and family-oriented behavior were somehow puzzling. The participants were not found more likely to engage in warning confirmation behavior and family-oriented behavior in the morning and the afternoon than the evening. Rather, they were less likely to contact their families when an evacuation order was issued in the morning than when issued in the afternoon or the evening. Contrary to the previous findings (Fu et al. 2007; Huang et al. 2012), the participants were more likely to prepare for evacuation in the evening than in the morning or the afternoon. One possible explanation for these findings is that the timing of the evacuation order in the morning condition might have been a little too early for the participants to take contact with their families and to prepare for evacuation (the evacuation order was issued at 4:00 a.m.), while the timing of the evacuation order in the evening condition might have still been favorable for the participants to take refuge (the order was issued at 8:00 p.m.). These possibilities obviously need to be further examined in the future.

With regard to the limitations of the present study, there was one big limitation in the research method. Because this study only examined intentions of warning confirmation behavior and family-oriented behavior in a hypothetical disaster scenario, it is still uncertain whether these participants will actually act in emergency situations as they answered in this study. On the one hand, with regard to evacuation behavior, previous research found that responses in hypothetical scenarios were generally similar to responses in actual disasters although there were significant differences in effect sizes of several variables between actual and hypothetical disaster studies (Huang et al. 2015). On the other hand, however, it is still unclear whether self-reported expectations for evacuation in hypothetical disasters can lead to actual evacuation behavior in emergency situations (Thompson et al. 2017). As Huang et al. (2015) suggested, laboratory and Internet experiments employing hypothetical scenarios, rather than just asking participants to read a written hypothetical disaster script, could possibly provide disaster researchers with more fruitful insights into potential factors affecting behaviors that precede evacuation in emergency situations than the present study.

Second, this study was only performed in Japan, so the findings may not be valid in other countries, particularly in developing countries where the basic infrastructure (for example, housing, street lighting, and road network) and the infrastructure for disaster risk reduction (for example, disaster-resistant housing, the number of evacuation centers, and disaster information systems) are not as solid as in developed countries. Nonetheless, warning confirmation behavior and family-oriented behavior seem observable in developing countries (Saha and James 2017; Saha and Pittock 2021). Thus, future research that examines differences in factors affecting these two behaviors between developed and developing countries should deepen the understanding of why people are not quick to respond to evacuation warnings.

5 Conclusion

Non-significant and weak associations of the examined variables with warning confirmation behavior and family-oriented behavior imply the possibility that these behaviors are not strongly dependent on the evacuation-enhancing factors. As previous research indicated, people's tendencies to confirm warning messages and reunite family members in emergency situations are quite robust (Drabek and Boggs 1968; Perry 1979). Therefore, it may be that people engage in warning confirmation behavior and family-oriented behavior before evacuation regardless of individual characteristics and the circumstances surrounding them. Nevertheless, disaster preparedness had the most consistent effects on warning confirmation behavior (seeking information) and family-oriented behavior, as well as on evacuation preparation. It seems likely that increasing people's preparedness for potential disasters and evacuation planning can help people evacuate early at the onset of a disaster. Periodic emergency preparation workshops hosted by municipal and academic organizations may be effective in fostering awareness of how to prepare for future disasters in local communities.

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