Experimental Surveys on Information Provision to Promote Disaster Management Measures

Mayu KATO*, Shintaro TERABE**, Hideki YAGINUMA**, Kosuke TANAKA** and Nan KANG **

Abstract

Many large-scale natural disasters including earthquake, river floods, and landslides, have affected Japan. Promotion of household disaster prevention is a serious problem. Disaster preparedness at home has not been implemented despite its importance. This study aims to investigate the effectiveness of providing information to promote disaster prevention measures. Key research questions are; how promoting improvements contributes to household disaster prevention and how disaster prevention consciousness reflects behavior.

The study consists of three experiments. In the first, we tried to verify the change in disaster prevention awareness of university students and the usefulness of the disaster prevention diagnostic test. In the second experiment, we tried to verify the influence on disaster prevention measures behavior using “the information provision strategy” and “the behavioral planning strategy.” In the third experiment, we tried to verify the influence of providing information according to TPB (Theory of planned behavior) explaining the disaster prevention behavior.

Although the disaster prevention diagnostic test did not contribute to the disaster prevention behavior in the first experiment, it could be seen to act as a trigger to rethink the improvement in disaster awareness and disaster prevention measures. If people were in an environment with tools for disaster prevention, an awareness of disaster prevention, and a level of knowledge had an influence on disaster prevention behavior. In the second experiment, the information provision strategy and the behavioral planning strategy did not contribute to improvement in all aspects of disaster prevention awareness and disaster prevention behavior. However, we were able to promote “simple disaster prevention behaviors”, etc. related to the information provision. In the third experiment, the information provided in this survey did not contribute to the promotion of the “attitude toward the behavior”, “subjective norms”, and “perceived behavioral control”, which are the factors of TPB. Based on these results, we examined other factors contributing to disaster prevention behavioral intentions and found that “cost cognition”, etc. contribute to disaster prevention behavioral intentions.

The significance of this research is that these surveys can clarify effective methods for promoting disaster prevention measures in each home, and can be used as a method improving disaster preparedness in the future.

Keywords: disaster preparedness, disaster prevention diagnostic test, randomized controlled trial, theory of planned behavior, storage of food and drink, household food stockpiling

* Nippon Koei Co., Ltd.
** Tokyo University of Science
E-Mail: terabe@rs.tus.ac.jp

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1. Introduction

Many large-scale natural disasters have affected Japan. Natural disasters of various types and sizes, led by the Great East Japan Earthquake of 2011, occur every year. Earthquakes directly beneath the Tokyo metropolitan area and Nankai Trough earthquakes are expected to occur with high probability within several decades thus preparation for natural disasters is important.

In particular, disaster prevention measures at home are essential. According to a survey by the Japanese Cabinet Office in December 2013, only 46.6% of respondents answered that they were preparing food, drinking water, daily necessities, etc. because of the occurrence of the Great East Japan Earthquake. Moreover, this had dropped to 45.7% after four years, in November 2017. If many people were affected by the large-scale natural disaster, they would have to procure food and drink themselves. The low preparation will make them suffer from food and drink shortages. This suggests that promotion of household disaster prevention has a problem and that disaster preparedness at home has not been implemented despite its importance.

Unprecedented damage by an earthquake in the capital region is expected to occur 70% of the time within 30 years. Thus, disaster prevention measures in each home are indispensable and urgently needed. This study aims to investigate the effectiveness of providing information to promote disaster prevention measures. Our focus is on household disaster preparedness. Key research questions are; how promoting improvements contributes to household disaster prevention and how disaster prevention consciousness reflects behavior.

The previous research on disaster prevention awareness and behavior were divided into the field of disaster education and the field of home disaster prevention. Since we want to consider disaster prevention in the Japanese context, we have reviewed research that studied in Japan. First, we will focus on the field of disaster prevention education. Tatsukawa et al.2) examined changes in disaster prevention awareness using workshops. They clarified that the effectiveness of holding disaster prevention workshops and understanding local vulnerability was effective for decision-making about the evacuation. Ito et al.3) examined the effectiveness of a disaster prevention course, key persons, and course contents. The results showed that local residents had a higher awareness of disaster prevention than junior high school students. In addition, the content that it is easy to be aware of and take interest in—understanding earthquakes, and interest in regional disaster prevention—is significant. However, these experiments have not been able to analyze the views of people who are unaware and do not attend workshops. Kurosaki et al.4) implemented disaster prevention education for elementary, middle, and high school students through school education program. Their results showed that communication is effective for disaster prevention education, and that disaster prevention awareness decreased after more than one year. However, they did not test university students who have fewer binding commitments and a period before they take on social responsibilities or become parents. Aduma et al.5) developed an app called “Disaster Reduction Class” and examined its usage. The result showed that the “Disaster Reduction Class” leads to people’s own sense of self-efficacy and improvements in the relatively simple disaster prevention behaviors around them. Shiwaku, et al.6) conducted a survey in Kathmandu, Nepal to identify the factors which enhance students’ awareness and promote the actual action for disaster reduction. Results showed that current school disaster education—which is based on lectures—can raise risk perception, but it cannot enable students to know the importance of pre-disaster measures and to take actual
action for disaster reduction. In order to understand the impact of earthquake experiences and education on their awareness, Rajib Shaw et al. surveyed 1,065 first-grade students from five prefectures in Japan. Results showed that earthquake experience is not the prime factor to enhance awareness. Education, when it is confined to school education, can provide useful information as the knowledge base for earthquake. However, in the gradual path of knowing, realizing, deepening, decision and action, family, community, and self-education are found to be more prominent. Shiwaku et al. conducted a survey to point out the effectiveness of education at Maiko high school and show the direction of effective school disaster prevention education. The questionnaire results show a distinct higher risk perception and risk reduction actions of the students in the Maiko high school, as compared to other schools. The Maiko high school focuses on mitigation and preparedness, mainly teaches about the social environment, and makes students think of the importance of implementation. This learning process is found to be effective in reducing the gap between intention and action.

Second, we consider some research on the field of household disaster prevention. Motoyoshi et al. examined the factors contributing to disaster prevention behavioral intentions based on the theory of planned behavior (TPB). As a result of their research, it became clear that the intention to participate in local disaster prevention activities is higher when benefit cognition, subjective norms, and disaster likelihood are high. They also examined the factors affecting local and household disaster prevention behavioral intentions. When the cost cognition was low, and the benefit cognition was high, the behavioral intentions became high. On the other hand, it was found that benefit cognition, subjective norms, and heightened interest in disasters have an effect on home disaster-prevention behavioral intentions.

Maruta et al. studied drinking water storage behavior using protection motivation theory (PMT). Their results showed that the higher the householder’s risk cognition, the higher the probability of storing drinking water, and the lower the shortage of drinking water storages. Miyazaki et al. examined the benefits and costs of household stockpiling in a previous study on household disaster prevention. Their results showed that the need for food stockpiling was not sufficiently recognized and the ability to make stockpiling plans was insufficient as a reason for not implementing food stockpiling. Moreover, it became clear that the image each family has about the taste and the expiration date of the stockpiled food greatly influences the evaluation about the cost of the food stockpile. Mori considered the future prospects of disaster stockpiling. A stable community has been shown to acquire the ability to manage their own area through experience. Baker conducted telephone interviews with 1,200 Florida households to ask about current levels of preparedness in the spring of 2006 and about preparedness levels during the 2004 and 2005 hurricane seasons. Results indicated that most households reported being well prepared to subsist on their own for at least three days following a disaster. Preparedness was strongly related to income, home ownership, race, age, and type of housing. Becker et al. used a symbolic interactionism perspective to explore the earthquake preparedness process, through a series of qualitative interviews with householders in three New Zealand urban locations. During the study, the relative influence of cognitive, emotive and societal factors on the preparedness process was explored and the interactions between these identified. Tomio et al. examines the prevalence and the determinants of disaster preparedness among the residents of a provincial city in Japan at household- and community-level preparedness. As a result, we found insufficient disaster preparedness at both household and
community levels. Older, female, and better educated household heads were associated with better household preparedness, while length at residence, non-single status, presence of an elderly household member, and farming occupations were associated with better community preparedness. Households with one or more household-level preparedness measures were more likely to receive community assistance than those lacking them. The relationship between household and community preparedness was not complementary. Hence, a large proportion of the households were unprepared at both the community and household levels.

In this research, three experiments were conducted to investigate the effectiveness of information provision that increases an awareness of disaster prevention and promotes those measures. Multivariate analysis was performed to examine factors contributing to the improvement of disaster prevention awareness and the promotion of disaster prevention behavior. The significance of this research is that these surveys can clarify effective methods for promoting disaster prevention measures in each home, and can be used as a method improving disaster preparedness in the future.

2. First experiment

In the first experiment, we created a disaster prevention assessment called “disaster prevention diagnostic test,” and investigated its influence on improving disaster prevention awareness and behavior. This was to improve awareness and interest in disaster prevention for the younger generation, who is less aware of disaster prevention than other generations. The “disaster prevention diagnostic test” allows respondents not only to acquire knowledge easier but also allows them to review their own disaster preparedness. To identify the changes in students’ awareness and measures against disasters caused by taking the disaster assessment test, awareness and personal characteristics surveys were conducted. In addition, the web page link to detailed information was included on the last page of the disaster prevention diagnostic test. We thus devised an easy means for subjects to access disaster prevention information and verified the effect of browsing the page.

To randomize subjects’ personal attributes, participants were divided into two groups by odd or even numbers of student identification. The survey was conducted with 204 students at Tokyo University of Science, once a week for two weeks. The first survey, conducted on December 7, 2017, included the disaster prevention diagnostic test and awareness survey. We put the link to the web page for disaster prevention information at the end of the first survey. One week later, on December 14, 2017, we carried out a personal characteristics survey together with the second disaster prevention diagnostic test and awareness survey. The number of valid responses was 100.

2-1. Contents of survey

(1) Awareness survey

To measure the change of the disaster prevention awareness by taking the disaster prevention diagnostic test, the awareness survey about disaster prevention was conducted before and after the test. An overview of the awareness survey is shown in Table 1.

(2) Disaster prevention diagnostic test

The purpose of the test is not only to diagnose people’s disaster preparedness, but also to
enable them to assess the current situation of their own disaster prevention measures. The awareness and measures for disaster prevention were scored based on the subjects’ responses. Table 2 shows the test questions. The responses were evaluated on a four-point scale: three points were added when the answer with the highest motivation for disaster prevention was selected, and zero points when the lowest answer was selected. For example, regarding the question 1; “do you have any hazard map?”, three points for “I have it, and I remember where I keep it”, two points for “I have it, but I don't remember where it is”, one point for “I do not have it, but I want to get it in the future”, and zero point for “I don't have it, and I don't need it in the future” are added. Regarding the question 2; “Do you know the evacuation site and route?”, three points for “I know and remember them”, two points for “I checked, but I don't remember them”, one point for “I have not confirmed them, but I would like to do it in the future”, and zero point for “I haven't confirmed them, and I'm not going to do it in the future” are added.

| Concept          | Question                                                                 |
|------------------|--------------------------------------------------------------------------|
| Interest         | Are you interested in disaster prevention?                               |
| Consciousness    | Do you usually live with a disaster in mind?                             |
| Information      | Have you seen or heard information about disaster prevention recently?   |
|                  | Do you remember the contents of the disaster prevention information you saw or heard? |
| Measures         | Have you considered any disaster prevention measures yourself?           |
|                  | Do you thoroughly understand methods of disaster prevention?             |
| Fear             | Are you worried about disasters?                                         |

Table 2: Disaster prevention diagnostic test questions

(1) Possession of hazard map  
(2) Confirmation of evacuation route and evacuation site  
(3) Possession and confirmation situation of disaster prevention handbook  
(4) Preparation status of emergency goods  
(5) Understanding disaster message dials  
(6) Action confirmation at the time of disaster occurrence  
(7) Recognition of the government’s approach to disaster prevention  
(8) Awareness of evacuation training  
(9) Grasps the disaster resistance reinforcement situation  
(10) Action if lifeline was to stop  
(11) Possession of emergency contact card  
(12) Stock of food and drink at home  

Table 3: Personal characteristics survey questions

(1) Personal attributes (gender, age, etc.)  
(2) Address  
(3) Family structure  
(4) Disaster prevention information  
(5) Information acquisition method and time  
(6) Disaster experience  
(7) Awareness and participation in evacuation training
(3) Personal characteristics survey

In the personal characteristics survey, we examined the respondent’s individual attributes and disaster experience. Table 3 shows the list of question themes.

(4) Link to the web page about disaster prevention information

To provide information on contents of the disaster prevention diagnostic test, we prepared a link connecting to the web page of the information. The respondents were divided into two groups and responded to the same questionnaires. Members of a group with a link, (group 1), were presented with the link at the end of the test, whereas those in a group without a link, (group 2), were not. One of the hypotheses here is that score of the disaster prevention diagnostic test will increase by reading the web page.

2-2. Result

(1) Personal attributes

There was no difference in gender ratio or age group ratio among the respondents. However, about 20% more respondents in group 2 are living with their family compared to those in group 1.

(2) Change of disaster prevention diagnostic test score by comparison analysis between groups

To measure the effect of the disaster prevention diagnostic test, the difference between the average of the first and second scores was tested within group 2. The average score of the second survey decreased by 0.73 points (p = 0.449) from the first survey.

In addition, a test of the difference in the average scores of the second survey was conducted to measure the effect of browsing information on disaster prevention. The difference would be observed based on the presence or absence of a link to disaster prevention information. The mean score of group 2 was higher than group 1 at a level of 1% statistical significance. This significant difference was opposite to the hypothesis that the score of group 1 would be higher than group 2, which was not presented with the link to the web page about disaster prevention information.

(3) Change of consciousness for disaster prevention

Figures 1 and 2 show significant changes in the awareness survey conducted before and after taking the disaster prevention diagnostic test. As for disaster awareness, the proportion of the answer to “I am conscious of disasters” increased after the test at 10% statistical significance in both groups. The rate of “yes” responses increased in group 1 at a 10% significance level and in group 2 at the 5% level, when we asked, “Have you ever thought about disaster prevention measures?”
(4) Analysis of factors that affect disaster prevention behavior

From the results of the disaster prevention diagnosis test, it was shown that reading the disaster prevention information web page does not contribute to disaster prevention actions. It means that groups 1 and 2 are not different from each other. Thus, we combined the two groups into one and applied multiple regression analysis to identify other factors affecting disaster prevention behavior. The score of the second test was used as the objective variable, and the result of the awareness survey was used as the explanatory variable (Table 1). Table 4 shows the results of the multiple regression analysis. The coefficient of determination is 0.345, which indicates a poor fit. “Recognition of disaster prevention measures method” is the only variable contributing to disaster prevention behavior at 5% statistical significance.

Next, the score of the second test was used as the objective variable, and the result of the personal characteristics survey was used as the explanatory variable (Table 3). Table 5 shows the results of the multiple regression analysis. The coefficient of determination was 0.538, which means a minimally good fit. “Living with family dummy,” “hazard map viewing dummy,” and “reading the city bulletin” were significant at the 1% level, and “browsing the Internet” was significant at 5%.

We extracted some explanatory variables with statistical significance from Tables 4 and 5, and performed multiple regression analysis once again. The coefficient of determination was 0.626, which indicates a good fit. The p-values were 1% significant for “high or low awareness of disaster prevention”, “living with a family dummy,” “viewing a hazard map dummy,” and “reading the city bulletin.” “Browsing the Internet” was significant at the 5% level, while “recognition of disaster prevention measures method” was significant at 10%. Thus, “viewing a hazard map dummy” and “reading the city bulletin,” which have particularly low p-values, are the most effective factors among disaster prevention behaviors.

We confirmed that multicollinearity is not a significant affecting factor in these regression models in Table 4, 5, and 6.
Table 4: Result of awareness survey

| Explanatory variable                        | Coefficient | P-value |
|---------------------------------------------|-------------|---------|
| Intercept                                   | -3.57       | 0.254   |
| Interest in disaster prevention             | 1.84        | 0.166   |
| Awareness of disaster prevention            | 2.20        | 0.104   |
| Awareness of disaster prevention information| 1.35        | 0.258   |
| Memory of disaster prevention information   | 0.39        | 0.723   |
| Awareness of disaster prevention measures  | 1.81        | 0.174   |
| Recognition of disaster prevention measures method | 4.16        | 0.002** |
| Fear of disaster                            | 0.77        | 0.381   |
| Coefficient of determination                |             | 0.345   |

Notes: (**p < 0.05)

Table 5: Results of personal characteristics survey

| Explanatory variable                        | Coefficient | P-value |
|---------------------------------------------|-------------|---------|
| Intercept                                   | 12.5        | 0.000***|
| Male dummy                                  | -1.67       | 0.337   |
| 20s dummy                                   | 0.725       | 0.544   |
| Living with family dummy                    | 3.87        | 0.006***|
| Disaster experience dummy                   | -0.126      | 0.956   |
| Disaster time                               | 0.315       | 0.845   |
| Participation of evacuation training dummy  | 7.78        | 0.000***|
| Viewing hazard map dummy                    | 12.5        | 0.000***|
| Reading the city bulletin                   | 2.30        | 0.002***|
| Reading circulation board                   | 0.935       | 0.237   |
| Reading newspaper                           | -0.017      | 0.982   |
| Viewing TV program                          | -0.501      | 0.436   |
| Browsing Internet                           | -1.43       | 0.024** |
| Link dummy                                  | -1.12       | 0.377   |
| Coefficient of determination                |             | 0.538   |

Notes: (**p < 0.05, ***p < 0.01)

Table 6: Overall result

| Explanatory variable                        | Coefficient | P-value |
|---------------------------------------------|-------------|---------|
| Intercept                                   | 13.1        | 0.000***|
| Recognition of disaster prevention measures method | 1.05        | 0.083*  |
| Awareness of disaster prevention            | 1.99        | 0.001***|
| Living with family dummy                    | 3.16        | 0.008***|
| Viewing hazard map dummy                    | 6.34        | 0.000***|
| Reading city bulletin                       | 2.58        | 0.000***|
| Browsing Internet                           | -1.12       | 0.037** |
| Coefficient of determination                |             | 0.626   |

Notes: (*p < 0.1, **p < 0.05, ***p < 0.01)
2-3. Discussion

We now discuss the results obtained by the disaster prevention diagnostic test. Although the scores did not contribute to the disaster prevention behaviors, they were effective to improve disaster prevention awareness. The test reminded people of disaster prevention measures. However, knowledge, interest, fear, information acquisition, and measures were not improved. Thus, the effect of the disaster prevention diagnostic test on these research subjects is limited.

There are two possible reasons why the effectiveness of the disaster prevention diagnostic test did not make a significant difference in the score between groups. The first is fatigue in answering. It seems that ambitious answers decreased because the subjects were impatient in answering because there were too many questions, 38 questions, in the survey, answered the same questions twice. The subjects were students, who are sometimes lazy to answer. The second possible reason is that the group’s personal attributes were not randomized. The effectiveness of the disaster prevention diagnostic test could not be measured correctly because personal attributes, such as disaster experience and living with family, which were some of the factors contributing to the disaster prevention behavior, were not sufficiently randomized.

However, as a result of examining the factors contributing to disaster prevention behavior, familiarity with disaster prevention measures is likely to lead to disaster prevention behavior, when disaster prevention measures are in place. This is because students who live with their families are already in an environment where disaster prevention tools such as hazard maps, are fully developed. Moreover, it is easy to engage in disaster prevention behavior because local public relations, such as city bulletins, are easier to obtain than when living alone. In addition to the high awareness about disaster prevention, abundant knowledge of disaster prevention contributes to disaster prevention behavior.

3. Second experiment

As mentioned earlier, there were considerable reflections on the first experiment. Therefore, in the second experiment, we reduced the number of questions to prevent deterioration of the quality of the answers due to fatigue. Moreover, in the first experiment, the disaster prevention diagnosis test reminded people of disaster prevention measures. Thus, in the second experiment, we focused on the action of acquiring disaster prevention information that could not be measured in the first experiment.

In this experiment, the disaster prevention measures of university students were examined. Here we consider the “information provision strategy,” which provides objective information and “the behavioral planning strategy,” which efficiently promotes voluntary behavior change as a basic framework. Figure 3 shows the psychological process for human action to be implemented. In this research, it is expected that there will be an effect of transitioning to disaster prevention behavior by forming disaster prevention behavior intentions via the information provision strategy and forming disaster prevention behavioral intentions by the behavioral planning strategy.

In the survey, we conducted an individual attribute survey asking respondents about their attitudes and behaviors regarding disaster prevention and their individual attributes. We divided respondents into groups by individual surveys that included gender, whether they are living with their family, and disaster experience. We then showed a video to provide information to each group followed by a short essay. One week later, we conducted a second survey on respondents’
awareness and behavior.

The survey was undertaken by 94 students in the Department of Civil Engineering, Tokyo University of Science on December 10–20, 2018. In this survey, the subjects were divided into three groups: “information provision strategy group,” “behavioral planning strategy group,” and “control group.” The number of valid responses for each group was 30, 31, and 30, respectively. To examine the effect of information provision, we performed basic tabulation using the results of the awareness survey. Subsequently, multiple regression analysis was performed to verify the factors contributing to disaster prevention action.

3-1. Contents of survey

(1) Information provision

We showed the “information provision strategy group” and the “behavioral planning strategy group” a short video about the earthquake. The video on the Tokyo metropolitan area earthquake refers to the possible damage and it provokes the viewer’s anxiety. To equalize survey time with the other groups, the “control group” was required to watch a video that had nothing to do with disasters or disaster prevention.

(2) Essay

We assigned an essay task for each group after showing the video. The theme of the essay for the behavioral planning strategy group was Q1: Explain how you felt or what you thought after watching a video about the Tokyo Metropolitan Earthquake, and Q2: Explain what you should do to prepare for a large earthquake. The theme for the information provision strategy group and the control group had nothing to do with disasters or earthquakes.

(3) Awareness survey

After providing information on disasters, we conducted an attitude survey on disaster prevention. The major items in the attitude survey were 18 questions related to cost cognition, benefit cognition, disaster risk cognition, anxiety, interest in disasters, and disaster prevention behavioral intentions. The respondents were asked to evaluate each question on a four-point scale: “I really think so,” “I think so,” “I do not think so,” and “I do not think so at all.”
(3) Behavior survey

We conducted a behavior survey on disaster prevention after the awareness survey. The behavior survey included nine questions based on the “disaster prevention diagnostic test” of the first experiment. It was rated on a four-point scale: “very well,” “well,” “not much,” and “not at all.” Table 7 shows the question items of the behavior survey.

| Table 7: Themes of behavior survey |
|-----------------------------------|
| (1) Method of acquiring disaster prevention information |
| (2) Confirmation of the seismic reinforcing situation of home |
| (3) Dealing with difficulties when returning home |
| (4) Possession of mobile charger and radio |
| (5) Home Stock of food and drink at home. |
| (6) Action at the time of disaster |

3-2. Result

(1) Individual attributes

There was no difference between the groups in terms of the individual attribute survey and their disaster experience. About 40% of the respondents answered that they had experienced a disaster.

(2) Effects of providing information

To measure the effect of providing information, we performed basic tabulation and a chi-square test using the results of the awareness surveys. In the basic tabulation, we calculated the ratio of the answers for each question of the awareness survey for each group. We summarized the four-point scale responses into two answers: “I think so” and “I don't think so” for the chi-square test.

As a result, compared with the control group, a statistically significant difference was obtained in the question on “risk cognition” in the information provision group. However, no statistical difference was obtained on the “anxiety” question. The results are shown in Figure 4 and Figure 5.

**Figure 4:** Risk perception “Do you think that the place where you live now is an area prone to earthquake damage?”

**Figure 5:** Anxiety “Do you worry if you think about a large-scale earthquake that is expected to occur in the future?”
(3) Effect of writing an essay

To measure the effects of writing an essay, we performed basic tabulation and chi-square tests using the results of the behavior survey. The same procedure was applied to the behavior survey as for the awareness survey.

As a result, compared with the information provision strategy group, a statistically significant difference was obtained for the following items: “confirmation of the seismic reinforcing situation of home,” “possession of mobile charger and radio,” and “home stock of food and drink.” The results are shown in Figures 6 to 8.

Figure 6: “Have you checked the age of the house where you live and the situation of seismic reinforcement?”

Figure 7: “Do you carry a cell phone charger so it can be used even in the event of an earthquake?”

Figure 8: “Do you have at least three days of food and water stockpiled?”

(4) Analysis of factors affecting disaster prevention behavior

The results of awareness surveys and behavior surveys show that information provision and essays do not contribute to disaster prevention behavior. Thus, multiple regression analysis was performed on other factors that affect disaster prevention behavior. The answer to “disaster prevention action intention” was used as the objective variable, and the result of the awareness survey and the individual attribute were used as the explanatory variables.
Table 8 shows the results of the multiple regression model. The determination coefficient was 0.546, indicating a good fit. “Risk cognition” was found significant at the 5% level, “benefit cognition” and “interest in disaster” were significant at the 1% level. These results indicate that these variables contribute to disaster prevention behavior. We confirmed that multicollinearity is not a significant affecting factor in this regression model.

Table 8: Multiple regression analysis result

| Explanatory variable     | Coefficient | P-value |
|--------------------------|-------------|---------|
| Intercept                | -0.033      | 0.876   |
| Risk cognition           | 0.199       | 0.022** |
| Benefit cognition        | 0.537       | 0.000***|
| Interest in disasters    | 0.331       | 0.000***|
| Coefficient of determination |          | 0.546   |

Notes: (**p < 0.05, ***p < 0.01)

3-3. Discussion

We now discuss the results obtained above. First, information was provided by video and the results were analyzed using the chi-square test. The statistical test showed a significant difference in “risk cognition.” In this study, we provided information by short video. Since the content of the video evoked a particular risk in the Tokyo metropolitan area earthquake, the respondents watched the video could acknowledge a specific risk of the earthquake instead of feeling a vague risk. On the other hand, no statistically significant difference was obtained in the “anxiety” question. This is because the respondents felt uneasy about large-scale earthquakes regardless of the information provision.

Next, the effect of the essay was analyzed by a chi-square test. As a result, a statistically significant difference was obtained in the items: “confirmation of the seismic reinforcing situation of home,” “possession of mobile charger and radio,” and “home stock situation of food and drink.” The following reasons can be considered for these results. As the respondents of this study are university students, it is easy to have mobile chargers and radios, or to stock food and drink at home. In addition, regarding “confirmation of the seismic reinforcing situation of home,” the contents of the video referred to damages such as the collapse of the house, so there may be a large percentage of respondents who felt that risk and took some action.

Finally, we performed multiple regression analysis on factors contributing to disaster prevention measures. As a result, it was shown that “risk cognition,” “benefit cognition,” and “interest in disaster” contribute to disaster prevention action. From these estimates, it appears that people will take disaster prevention measures when they have an interest in disasters and understand the risks and benefits of countermeasures.

4. Third experiment

The second experiment generated several reflections. Therefore, in this experiment, the same question was not repeated after a certain period, so that the difference could be examined in a one-time survey. On this occasion, we used adults, not students, as subjects. This change was intended to avoid being limited to the personal attributes of students. We expected the general public could then participate in our survey.
In the second experiment, we could only examine the promotion of disaster prevention measures by conveying a sense of fear to the participants. Therefore, in this experiment, the survey was designed according to the theory of planned behavior (TPB) that sees disaster prevention measures as rational behavior.

In the first experiment, the disaster prevention diagnosis test reminded people of disaster prevention measures. In the third experiment, we focused on the behavior of acquiring disaster prevention information. In addition, the theme was changed to “home storage of food and drink,” an item that was particularly inadequate in the disaster prevention diagnostic test.

In this experiment, we examined the household stock of food and drink, which is one of the home disaster prevention measures. Household stockpiling of food and drink is necessarily a planned and continuous approach especially in family disaster prevention. In this research, we applied TPB especially to factors contributing to behavior as TPB is a powerful theory for actions that require planning and consideration. Through the information provided to them, subjects could learn the methods and effects of home stockpiling. It was expected that provision of information on the family stockpile, a rational action, has an effect on the family stockpiling.

In the survey, we conducted an individual attribute survey asking respondents about their awareness of disaster prevention and their individual attributes. On the final page of the awareness survey, we also showed a link to a web page explaining the rolling stockpile method, which is effective for continuous household stockpiling. We regarded browsing information on the page as disaster prevention information-acquisition behavior.

After providing information based on the rolling stockpile method and TPB, we then conducted an awareness survey. After the awareness survey, we showed the URL link to the web page explaining the rolling stockpile method and observe the number of page accesses.

The survey was completed by 256 graduates of the Tokyo University of Science, Planning Laboratory, from November 22 to December 3, 2018. In this survey, the subjects were divided into four groups: “attitude toward the behavior group,” “subjective norms group,” “perceived behavioral control group,” and “control group.” Numbers of valid responses for each group were 25, 25, 22, and 22 respectively. The number of female respondents was seven out of 94. The age distribution was as follows: 20–29 years (40), 30–39 years (43), and 40–49 years (11). To examine the effect of information provision, we performed basic tabulations using the results of the awareness survey. Subsequently, to verify the factors contributing to disaster prevention behavior, Hayashi’s quantification method was performed.

4-1. Contents of survey

(1) Information provision

We provided the participants with information on the rolling stockpile method and a message to promote family stockpiling based on TPB. The provided messages are shown in Figures 9–12. We insisted people need at least three days of stockpiling, although the ideal amount is for one week in Figure 11. The reason of this change is that easier task is more acceptable.

First, we provided the rolling stockpile method message shown in Figure 9 for all groups. After that, we showed messages on TPB shown in Figures10–12 to the three groups other than the control group. We did not present the second message to the control group.
(2) Awareness survey

After providing information, we conducted an awareness survey on disaster prevention. The major items in the survey were “cost cognition,” “benefit cognition,” “subjective norms,” and “perceived behavioral control” based on the TPB. In addition, there were 22 questions on “disaster risk cognition,” “anxiety,” “interest in disaster,” and “disaster prevention behavioral intentions” with the purpose of asking about disaster awareness. The survey responses were evaluated on a four-point scale: “I really think so,” “I think so,” “I do not think so,” and “I do not think so at all.”

(3) Individual attributes survey

In the individual survey, we surveyed all 12 questions on information about the disaster including gender and personal attributes on lifestyle, the disaster experience, and the time of the disaster experienced.

(4) Link to the web page explaining the rolling stockpile method

The link to the web page explaining the rolling stockpile method was presented soon after the awareness survey and the individual attribute survey. When the respondent accesses this link, he/she can browse information on the rolling stockpile method and learn more about the details.
In this survey, access to the link and browsing was considered a disaster prevention information acquisition behavior.

4-2. Result

(1) Number of samples and individual attributes

The total number of valid responses in this survey was 94. The effective response for each group was around 25 and the recovery rate was 36.7%.

There were no differences among the groups in terms of individual attributes, living with family or not, or the experiences of the disaster. Also, about 60% of the respondents experienced a disaster. The number of respondents who answered that they were affected by the Great East Japan Earthquake in March 2011 was 28. Four respondents were affected by the Hokkaido Iburi Eastern Earthquake in September 2018, three respondents were affected by the heavy rainfall in July 2018, and two respondents were affected by other disasters.

(2) Effects of providing information

To measure the effect of information provision based on TPB, we performed basic tabulation and the chi-square test using the result of awareness survey. In the basic tabulation, for each group and for each question on the awareness survey, we calculated the ratio of the answers of “I really think so,” “I think so,” “I do not think so,” and “I do not think so at all.” We summarized the four-point scale into two answers: “I think so” and “I do not think so” for the chi-square test.

A result was that no statistically significant difference was found in the difference of awareness of disaster prevention between the group that provided information and the control group. In addition, there was no improvement in the awareness of household stockpiles as a result of providing information.

(3) Result about shift to disaster prevention action

Apart from the provision of information based on TPB, information on whether the rolling stockpile method was browsed when provided was verified. The link was presented to the respondents after the awareness survey, and the number of accesses to the linked web page was counted.

For the number of accesses to the web page, we performed a chi-square test after performing basic tabulation by group. The results of the basic tabulation are shown in Figure 13. The results show that the percentage of browsing web pages in all groups was about 60–80%, and it was found that a majority of respondents also engaged in disaster prevention information acquisition behavior.

Based on these results, the chi-square test was conducted to confirm the influence of the difference in information provision on the transition to disaster prevention behavior. In the chi-square test, analysis was performed using a three-factor group and a control group. As a result, no statistically significant difference was found between the control group and each of the three-factor groups. Although the transition to disaster prevention information acquisition behavior could not be promoted, the majority did engage in this behavior.
(4) Hayashi’s quantification method

As it was shown that the difference in the provision of information based on TPB does not contribute to a difference in disaster prevention behavior, we examined other factors that affect this behavior. In this analysis, data obtained from awareness surveys and individual attribute surveys were regarded as qualitative data, and were examined using Hayashi’s quantification method.

The objective variable was defined as the level of “disaster prevention behavioral intentions” in the awareness survey. Explanatory variables are defined as “cost cognition,” “benefit cognition,” “subjective norms,” and “perceived behavioral control” based on TPB. In addition, “disaster risk cognition,” “anxiety,” and “interest in disaster” based on disaster prevention awareness were also used as explanatory variables. In addition, “male dummy,” “age,” “type of residence,” “dwelling period,” “living with family dummy,” “disaster experienced dummy,” “disaster period,” and “viewing detailed information about the rolling stockpile method” based on personal attributes are listed. Table 9 shows the results of Hayashi’s quantification method. The correlation ratio was 0.647, and the discriminant predictive value was 92.6%. From the obtained results, it was found that “cost cognition,” “subjective norms,” “disaster risk cognition,” “Type of residence,” “living with family dummy,” and “disaster period” have a great influence on disaster prevention behavioral intentions.
Table 9: Result of Hayashi’s quantification method

| Explanatory variable                                      | Range |
|-----------------------------------------------------------|-------|
| Cost cognition                                            | 1.03  |
| Benefit cognition                                         | 0.826 |
| Subjective norms                                          | 1.36  |
| Perceived behavioral control                               | 0.567 |
| Disaster risk cognition                                    | 1.29  |
| Anxiety                                                   | 0.283 |
| Interest in disaster                                      | 0.591 |
| Male dummy                                                | 0.543 |
| Age                                                       | 0.906 |
| Type of residence                                          | 1.28  |
| Dwelling period                                            | 1.00  |
| Living with family dummy                                   | 1.74  |
| Disaster experienced dummy                                 | 0.079 |
| Disaster period                                            | 1.51  |
| Viewing detailed information about the rolling stockpile method | 0.606 |

4-3. Discussion

First, the chi-square test was performed to measure the effect of the difference in the provision of information based on TPB. No statistically significant difference was found in any of the questions. The following reasons can be considered for this cause. It is possible that the content of the message when providing information was insufficient to affect the respondents. There is also an opinion that in previous studies, subjective norms, which are one of the factors of TPB, are less likely to be promoted compared to other factors. Given this, it may be that the influence of the provision of information on the subjective norms was small even in this survey.

Next, a chi-square test was performed to confirm the transition to disaster prevention behavior with regard to the number of times the link to web pages that explain the rolling stockpile method in detail was accessed. As a result, it was not possible to confirm the transition to disaster prevention behavior by providing information. There are two possible reasons for this. First, it seems that the way the link was displayed was insufficient. Because the link was described after answering the awareness survey, there is a possibility that the subject did not notice the link because the page closed immediately after the subject finished answering the awareness survey. Second, because the link provided a detailed explanation of the rolling stockpile method, some respondents who were not interested in the details of the method did not access the link. It is thought that those who with low awareness of disaster prevention did not show an interest in detailed disaster prevention measures and did not access the link.

As the transition to disaster prevention behavior by the provision of information based on TPB and the link was not confirmed, the factors contributing to the disaster prevention behavior intention were examined using Hayashi’s quantification method. From the results, it was apparent that “cost cognition” and “subjective norms” are the defining factors of TPB that contribute to promoting a disaster prevention behavior intention. In addition, it was shown that it is also effective to raise the cognition of disaster risks because this also makes a contribution. Personal attributes such as residence type, living together with family, and time of the disaster
were also shown to contribute to disaster prevention behavioral intentions. It is thought that the existence of other people who are close either emotionally contributes to disaster prevention behavior, because people who are closer to others, through subjective norms and living with family members, have higher intentions for disaster prevention. In addition, it was found that time of the disaster also contributes to disaster prevention behavior. It is thought that this is related to “disaster prevention awareness” because someone experiencing a recent disaster time will engage in disaster prevention behavior. The disaster experience is one of the major factors promoting awareness of disasters, and it is thought that the more recent the experience, the more the concern for disasters will be maintained. On the other hand, many respondents who experienced the Great East Japan Earthquake, which was about eight years ago, indicated that the disaster experience did not contribute to disaster prevention behavioral intentions. This suggests that awareness of disaster risks was not retained among our respondents.

5. Conclusions

This study consists of three experiments. In the first, we tried to verify the change in disaster prevention awareness of university students and the usefulness of the disaster prevention diagnostic test by using the disaster prevention diagnostic test. In the second experiment, we tried to verify the influence on disaster prevention measures behavior using “the information provision strategy” and “the behavioral planning strategy.” In the third experiment, we tried to verify the influence of providing information using TPB to explain the disaster prevention behavior.

Although the disaster prevention diagnostic test did not contribute to the disaster prevention behavior in the first experiment, it could be seen to act as a trigger to rethink the improvement in disaster awareness and disaster prevention measures. Moreover, it contributed to participants reading a hazard map and a city bulletin as disaster prevention behaviors. It was clarified that being in an environment with tools for disaster prevention, an awareness of disaster prevention, and a level of knowledge had an influence on disaster prevention behavior.

In the second experiment, the information provision strategy and the behavioral planning strategy did not contribute to improvement in all aspects of disaster prevention awareness and disaster prevention behavior. However, we were able to promote “risk cognition” and “simple disaster prevention behaviors” related to the information provision content. This suggests that if the contents of the information provided can be made more comprehensive and memorable, then information provision and the essay task are effective in promoting disaster prevention behavior measures.

In the third experiment, the information provided in this survey did not contribute to the promotion of the “attitude toward the behavior”, “subjective norms”, and “perceived behavioral control”, which are the defining factors of TPB. Moreover, the contribution to disaster prevention behavior using the web page link was not confirmed. Based on these results, we examined other factors contributing to disaster prevention behavioral intentions and found that “cost cognition,” “subjective norms,” “disaster risk cognition,” “Type of residence,” “living with family dummy,” and “disaster period” contribute to disaster prevention behavioral intentions.

Given the results of this study, some improvements can be made in its design. Although some of the improvements in the first experiment were applied in the second experiment, the
respondents were not randomized in the first experiment. The proportion of students living with their families, which is one of the factors contributing to disaster prevention behavior, differed among the groups. Therefore, improvements in disaster prevention awareness and the effectiveness of the disaster prevention diagnostic test could not be found. This suggests that when grouping subjects, it is necessary to do so with respect to individual attributes, in particular, the type of residence.

In the third experiment, there are two major improvements that could be made. First, the effect of the provided message on subjects was insufficient. In this survey, the message of the subjective norms was insufficient in emphasizing “how much other people important to the actor expect the actor to do.” This suggests that it is necessary to create a message that can emphasize “storage of food and drink = protecting the family.” The re-created message based on this consideration is shown in Figure 14 below. The second improvement involves devising the contents of the information provision on the web page link. It is necessary to consider the contents of information provision that will interest people in groups that are already highly aware of disaster prevention and those who are taking disaster prevention measures. In this research, one outcome was that we could clarify the factors contributing to the improvement of disaster prevention awareness and the intention of disaster prevention behavior, and demonstrate that it was possible to show that a majority can acquire the behavior of obtaining disaster prevention information. However, it was not possible to promote the transition to disaster prevention behavior by providing information. From this point of view, the issue is how to promote disaster prevention behavior. In addition, as disaster prevention awareness has an impact on disaster prevention measures, it is necessary to maintain improvement in disaster prevention awareness permanently.

![Image: Subjective normative message improvement plan](image)

Figure 14: Subjective normative message improvement plan

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