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Autonomous Refuge for Apartment Residents after an Earthquake

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Abstract

In recent years, the rapid increase in the population of urban areas in Japan has created the possibility of insufficient capacity in disaster evacuation centers. As a result, some municipalities have begun to encourage residents of apartments to consider autonomous refuge, i.e., to shelter in place, rather than to use public disaster evacuation centers.

In this study, we conducted a questionnaire survey among residents of high-rise apartment complexes with active disaster preparedness programs to clarify the challenges associated with sheltering in place.

From the questionnaire survey, while approximately 90% of the respondents felt anxious about water or power being cut off in the event of an earthquake, the status of implementation of specific disaster preparedness measures was insufficient. Specifically, there was a disparity between the expected number of days required to restore the water supply and the number of days' worth of stockpiled drinking water, with the latter being less than the former.

In order to increase the effectiveness of sheltering in place, it is expected that these issues will not be regarded as individual issues, and that they will be the main focus of disaster preparedness strategies implemented by the entire apartment. Further, an appreciation of these issues will facilitate the establishment of disaster preparedness workshops and manuals for residents. In this way, it is hoped that residents' awareness of disaster preparedness will improve comprehensively.

Keywords: Disaster preparedness, Apartment residents

1. Introduction

1.1. Research Background

In recent years, the population of Osaka has increased due to many high-rise apartment buildings constructed. As a result of the population growth, the capacity of disaster evacuation centers may be insufficient, and in some areas, autonomous refuge (i.e., sheltering in place) is being encouraged for residents of robustly built apartments. Compared to evacuation centers in gymnasiums, sheltering in place provides better privacy and a better living environment, but there are some problems such as the lack of supplies and information. In the 2019 Typhoon No. 19 in Japan, power outages and flooding occurred in high-rise apartments, forcing some residents to continue living in apartments with no utilities. In addition, due to the impact of the COVID-19, the number of residents who would prefer to shelter in place is expected to increase. However, several issues need to be resolved when sheltering in place, including the extent to which individual residents have been stockpiling food and water, the implementation status of disaster preparedness measures, and the attributes of the residents. Further, it is important to understand the issues that are specific to each region and to high-rise apartments.

1.2. Previous Studies

Some studies on disaster preparedness measures for residents of high-rise apartment buildings have been conducted [1] [2]. Egawa et al. [1] conducted an interview survey in an area of high-rise apartments in the center of Sendai City. Their study showed the need to understand and disseminate information on the characteristics of residents, including those who require assistance. Yoshimori et al. [2] conducted a questionnaire survey on the current status of disaster preparedness behavior and awareness of disaster preparedness among residents of high-rise apartment complexes, and found that those who were considering evacuation at the time of an earthquake were more affected by the decline in disaster preparedness behavior at home.

Hisaki et al. [3] and Hirata et al. [4] also conducted research on the continuation of life in high-rise apartments at the time of a disaster. Hisaki et al. [3] conducted a web-based questionnaire survey of high-rise apartment residents in central Tokyo, and found that while many of them expected to shelter in place, they did not stockpile emergency supplies as they considered that the restoration of services to apartments would be shorter than that to detached houses. Hirata et al. [4] conducted a web-based questionnaire survey of high-rise apartment residents in the 23 wards of Tokyo and found that stockpiling was insufficient to ensure self-sufficiency at the time of a disaster, especially among those who did not participate in drills and study groups. Furthermore, studies on the ability to continue living after a disaster have been conducted by Kim et al. [5] and Iiyama et al. [6]. Kim et al. [5] conducted a questionnaire survey among residents of apartment complexes in Sendai City at the time of the Great East Japan Earthquake. Specifically, they analyzed post-earthquake responses relative to housing attributes, the management systems of the complex, and the time series after the disaster. Iiyama et al. [6] conducted a survey on the conditions of basic utilities in high-rise apartments during a disaster, and evaluated the lifeline continuity performance (LCP) based on the status of lifeline outages, supply potential, and the ownership ratio of disaster preparedness stockpiles.

To date, there are no examples of initiatives or studies that have been undertaken to improve the disaster preparedness of apartments based on questionnaire surveys of high-rise housing residents. The number of people in evacuation shelters and the stockpiling status of residents differ in each apartment, and it is necessary to consider whether or not it is possible to shelter in place during a disaster.

In this study, we conducted a questionnaire survey of the residents of high-rise apartments where disaster preparedness initiatives had been implemented. Specifically, we sought to clarify residents' stockpiling and disaster preparedness habits, and examine the disaster prevention measures that should be focused on for sheltering in place in the apartments surveyed. The results of the survey will be used to improve the disaster preparedness of the surveyed high-rise apartments through disaster preparedness workshops and the development of disaster preparedness manuals.

2. Method

The research methodology was as follows. First, the current status of stockpiling and disaster preparedness measures and residents' intention to shelter in place were assessed through a questionnaire survey of residents in high-rise apartment buildings. In this study, we analyzed the relationship between the current status of stockpiling and disaster preparedness measures and other attributes that significantly affect the decision to shelter in place. In addition, we identify issues for realizing a shelter in place lifestyle.

2.1 Questionnaire Survey

The survey items are shown in Table 1. The survey asked about the status of stockpiling and the implementation of disaster preparedness measures, both of which are considered to have an impact on being able to shelter in place or evacuating to a shelter. The survey was conducted in late November 2019. The questionnaires and their responses were distributed and collected by the management association of the apartment and questionnaires were answered by the head of each household.

Table 1 Questionnaire survey items

Item	Content
Personal attributes	Sex, age, occupation, number of household members, roommates, location during the week
Housing situation	Period of residence, type of ownership, floor number, and floor plan
Disaster awareness	Anxiety about disasters, types of disaster that make respondents feel uneasy, means of obtaining disaster information, expectations regarding damage, expectations regarding disruption to utilities, reasons for evacuating to shelters
Disaster preparedness	Fixing of furniture, disaster prevention measures, reasons for not implementing measures, status of stockpiled supplies, mitigation measures for power outages, places to live when infrastructure is damaged, places to live when elevators are not functional
Interaction with neighbors	Whether or not respondent is a member of a group organization, willingness to participate in disaster drills and study sessions, whether or not respondents are trustworthy, whether or not respondents have relationships that can benefit others, number of people respondents have relationships with (inside and outside the apartment building).

2.2 Characteristics of the Surveyed Apartments and Their Disaster Preparedness Efforts

The management system of the surveyed apartments is characterized by the management association and the residents association being jointly responsible for organizing disaster preparedness initiatives on a voluntary basis. In many cases, the management association oversees the voluntary disaster preparedness organization, but while official information is transmitted to the residents association, the management association, the president of the management association, and the president of the residents association are responsible for implementing disaster preparedness measures in the apartment. The management association is responsible for infrastructure related issues such as building maintenance and management, while the residents association is responsible for the developing strategies such as a district disaster preparedness plan.

There are many issues related to the stockpiling of food, drinking water, electricity, and toilets in apartments. In September 2019, the homeowners associations approved a plan to a install water tap in front of a hand pump so that it can be used for drinking water.

3. RESULTS

3.1. Study attributes

The survey was distributed to 455 households, and 195 (42.9%) responses were returned. Valid responses for sex were obtained for 194 respondents; 104 (53.6%) were male and 90 (46.4%) were female. Similarly, valid responses for the age of respondents were obtained for 187 respondents; 47 (25.1%) were in their 50s and 41 (21.9%) were in their 60s, indicating that a wide range of age groups responded to the survey.

As for the type of ownership, 169 (88.0%) of 192 valid respondents responded that they “owned” the house and 23 (12.0%) responded that they “rented” the house. As for the length of residence, valid responses were obtained for 190 respondents, 93 (48.9%) of which responded “20 years or more”, followed by 27 (14.2%) who responded, “1 to 5 years”.

3.2. Sense of Anxiety about Disasters

Of the 193 valid responses obtained for the section on anxiety, 85 (44.0%) were “very anxious,” 85 (44.0%) were “a little anxious,” 12 (6.2%) were “undecided,” 10 (5.2%) were “not very anxious,” and 1 (0.5%) was “not anxious at all. Of the 186 valid respondents obtained for type of disaster, 175 (94.1%) were worried about "earthquakes”, followed by 112 (60.2%) about “fire”. In addition, the most common type of damage expected in the event of a disaster was "water being cut off" by 169 (90.9%) of the 186 valid respondents, followed by “power failure” for 168 (90.3%) of responses.

3.3. Lifeline Outage Forecast

Figure 1 shows the results of the questionnaire on whether respondents considered that the four lifelines of electricity, water, gas, and elevators would be interrupted in the event of a disaster. The number of valid responses was 176 for electricity, 177 for water, 177 for gas, and 173 for elevators. Most respondents answered that the lifelines would be shut down: 170 (96.6%) for electricity, 171 (96.6%) for water, 172 (97.2%) for gas, and 148 (85.5%) for elevators. In addition, Table 2 shows the results for the question about the expected duration of the outage. The number of valid respondents was 169 for electricity, 170 for water, 171 for gas, and 150 for elevators. The average expected duration of each outage was 6.1 days for electricity, 6.9 days for water, 8.3 days for gas, and 7.4 days for elevators.

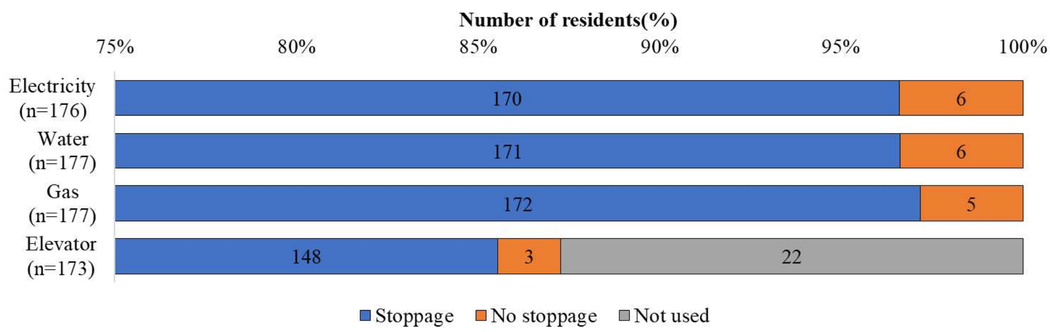

Figure 1 Lifeline outage forecast.

Table 2 Expected number of days of lifeline outages

	Electricity	Water Supply	Gas	Elevator
Number of valid Respondents	169	170	171	160
Mean	6.050	6.890	8.300	7.410
Standard deviation	7.691	8.721	10.212	8.573
Minimum value	1	1	1	1
Maximum value	60	60	60	45

3.4. Disaster Preparedness Measures

As for the disaster preparedness measures implemented by respondents, 626 responses were obtained from 186 valid responses. The largest number of respondents 127 (68.3%) responded that they had implemented "countermeasures against power outages", followed by "preparation of stockpiles" 122 (65.6%).

Figure 2 shows the results for stockpiling drinking water, food, and simple toilets for disasters. The number of valid responses was 182 for drinking water, 111 for food, and 178 for simple disaster toilets. While 113 (62.1%) of the respondents responded that they stockpiled drinking water and 111 (60.7%) responded that they stockpiled food, only 42 (23.6%) responded that they stockpiled simple toilets for disasters.

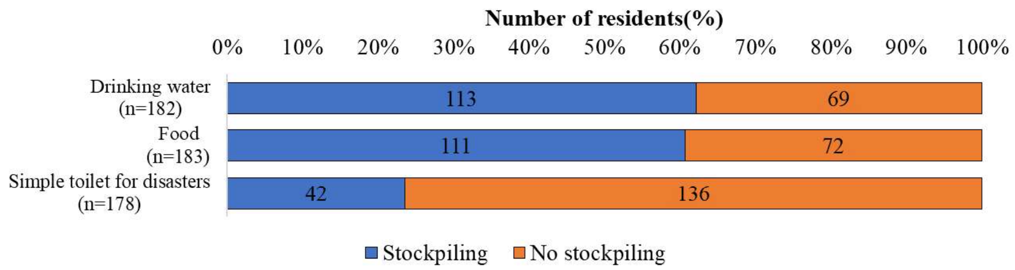

Figure 2 Status of stockpiling

Figure 3 shows the survey results for respondents who were asked how much of each item (i.e., water, food and toilets) they had stockpiled in terms of the number of days per family member. A total of 113, 111, and 41 people answered that they stockpiled water, food simple toilets for disasters, respectively. The average number of days' worth of each item was 3.2 for drinking water, 3.36 for food, and 3.83 for simple toilets.

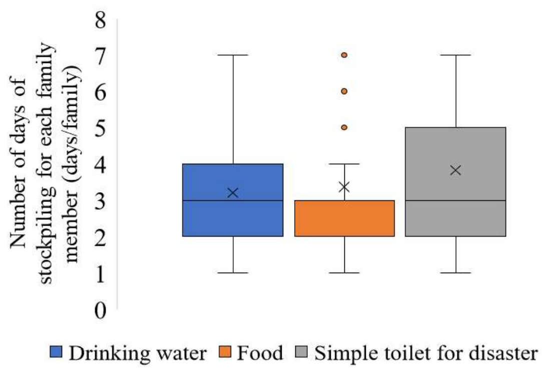

Figure 3 Number of days' worth of stockpiled supplies.

3.5. Relationship between the Expected Number of Days Required for Restoring the Water Supply and the Number of Days of Stockpiled Drinking Water

The relationship of between the expected number of days required for restoring the water supply and the number of days of stockpiled drinking water is shown in Figure 4. The figure clearly shows that the number of days of stockpiled water is low compared to the expected number of days of water supply.

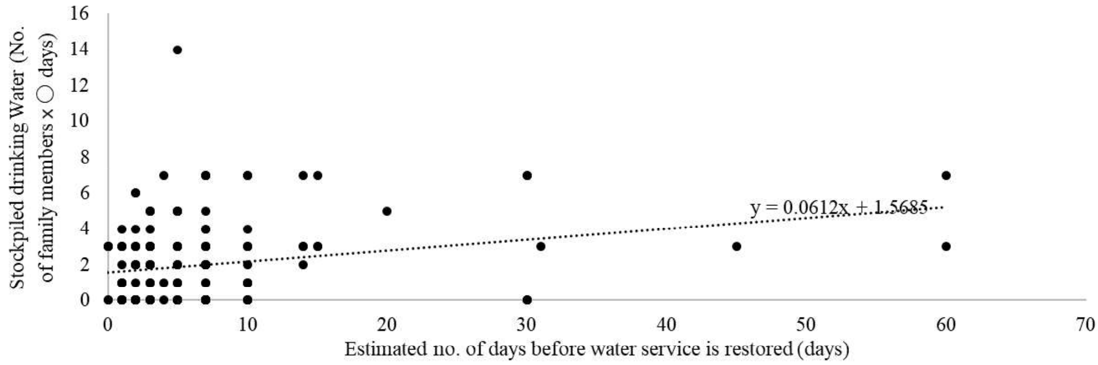

Figure 4 Status of stockpiling.

Figure 5 shows the results of a multiple-answer survey of respondents who implemented power outage countermeasures as disaster preparedness measures. The most common item was "flashlights" 131 (71.2%), and respondents who stockpiled them had 2.5 on average. Candles were stockpiled by 63 (34.2%) of the respondents.

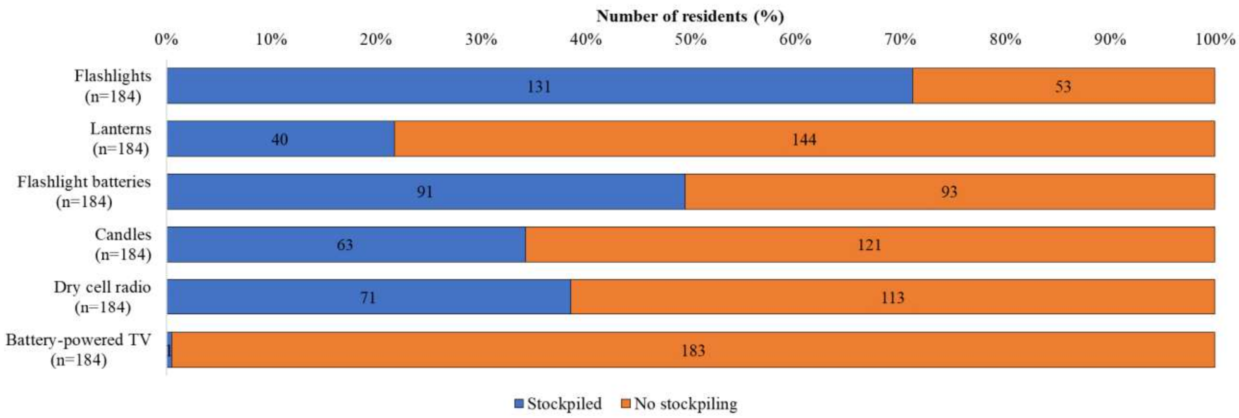

Figure 5 Implementation status of power-outage countermeasures.

3.6. Preferred Place to Live after an Earthquake

Figure 6 shows the results for the item on where respondents would live after a disaster based on different infrastructure and elevator outage scenarios. The scenarios were as follows: "I. All infrastructure and elevators have stopped after the disaster," "II. Infrastructure, including elevators, are generally functioning after the disaster," and "III. Infrastructure is generally functioning after the disaster, but elevators are stopped." The number of valid responses was 181 for I, 184 for II, and 182 for III.

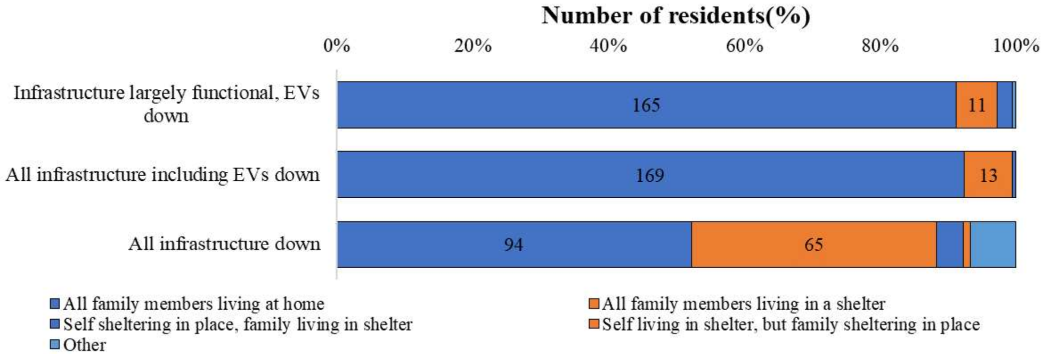

Figure 6 Where to live after an earthquake.

In the case where infrastructure including elevators is generally functioning after a disaster, 170 respondents (92.4%) responded that “all family members will live at home”, while in the case where the infrastructure is generally functioning, but elevators are stopped, 166 respondents (91.2%) answered that "all family members will live at home". In the case where all infrastructure, such as water, electricity, and elevators have stopped after a disaster, only 95 respondents (52.5%) responded that they would stay at home.

Figure 7 shows the results of the multiple-answer survey on the reasons for evacuating to a shelter. The most common reason was “because relief supplies are available” 110 (61.5%), followed by “because I think I can use the toilet in a shelter” 88 (49.2%).

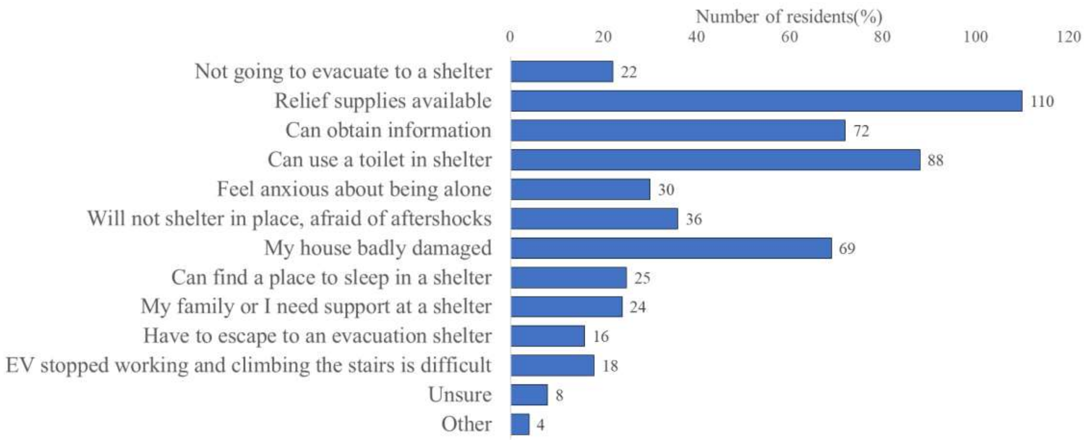

Figure 7 Reasons for evacuating to a shelter.

4. DISCUSSION

While the surveyed apartments have implemented well-developed disaster mitigation measures and are making efforts to be able to shelter in place, the questionnaire survey revealed some issues in terms of residents' stockpiling and implementation of disaster preparedness measures.

While many residents feel anxious about disasters and are concerned about the stoppage of utilities, such as power outages and no water in the event of a disaster, the implementation of specific disaster preparedness measures is not sufficient. Approximately 70% of the residents had implemented measures against power outages and about 60% had stockpiled drinking water, and the average amount of drinking water that had been stockpiled was not sufficient for 3.2 days. The relationship between the expected number of days required for the restoration of water supply and the number of days for stockpiling drinking water revealed that the latter was relatively low. In high-rise apartments, rapid recovery after a disaster is important, but it is also necessary to strengthen self-help measures to secure one's personal safety.

As for the preferred place to live after a disaster, about half of the residents thought that they would live in an evacuation shelter if the surrounding infrastructure was totally shut down, while most of the residents preferred to stay at home if the infrastructure was still functioning.

5. CONCLUSION

In this study, we found that while many residents of high-rise apartments wish to shelter in place, their stockpiling and implementation of disaster mitigation measures, which are the basis of self-help, were insufficient. Because it has been pointed out that residents of apartments expect a shorter time to restore service than residents of single-family homes [3], residents' awareness of disaster mitigation will be improved comprehensively by adopting disaster mitigation activities in the entire apartment in order to shelter in place effectively, and by linking them to practices such as convening disaster response workshops and drafting disaster preparedness manuals.

6. Acknowledgements

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7. References

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