TITLE: A cross-sectional study on risk of flooding and landslides and their associated perceptions among home health care patients living in Fukui prefecture, Japan

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ABSTRACT:

This study aimed to evaluate a risk of flooding and landslides among home care patients, to reveal an extent to which patients require support for evacuation, and to determine whether risk was accurately perceived among the patients. This is a cross-sectional study targeting the patients who were actively treated at the home care clinic in Fukui Prefecture, Japan. We collected data on the patients' sociodemographic and clinical characteristics. Additionally, we collected data on their risk of flooding and landslides through hazard maps and distributed a questionnaire to these patients regarding their risk awareness of flooding and landslides. Out of the 199 eligible home care patients, 84.9% (169 out of 199) were at risk of flooding and/or landslides, and 58.6% (99 of 169) of them needs support during evacuation. Furthermore, of those who were at risk of flooding and/or landslides, 46.0% (45 out of 99) had accurate risk assessments. Factors that resulted in inadequate risk awareness of flooding and landslides included: not placing importance on evacuation; not using medical equipment; and living on the first floor. The information of the risk factors regarding inadequate risk awareness of flooding and landslides should be used to sophisticate flooding and landslides evacuation strategy.

INTRODUCTION

Home care is a service in which doctors and other healthcare providers visit patients' houses, elderly housing, and nursing facilities to support their discharge from the hospital, support their daily medical care, deal with unexpected medical changes, and provide terminal care. The number of people choosing home care is increasing. Moreover, the home care sector is expected to grow significantly with the aging of the global population and the increasing preference of patients for high quality care and is estimated to reach a market size of $49.7 billion by the end of 2030, up from $27.9 billion in 2022.[1]

Persons with home care services are considered a vulnerable population during flooding and landslides due to the need for continuous access to healthcare and declines in physical functions caused by aging, chronic diseases. Natural disasters are increasing all over the world,[2] and have become a major health and socioeconomic problem worldwide, but home care patients may not be fully prepared for disasters.[3-6] In

particular, flooding damage was concentrated among those with low activity of daily living.[5,6]

In Japan, the number of home care patients is increasing,[7] and they face various difficulties in evacuation during flooding and landslides. In the case of Typhoon No. 21 on 1 September, 2019, power outages caused a number of problems, including safety concerns for home care patients using medical equipment such as ventilators, oxygen concentrators, and infusion pumps, as well as for older people who had difficulty in moving were exposed to the risk of heat stroke as a result of the lack of air conditioning.[8] A wide range of flooding and landslides preparedness is necessary when considering flooding and landslides countermeasures for home care patients.[9]

Our study purposes were as follows: (i) to determine the prevalence of home care patients at risk of flooding and/or landslides; (ii) to reveal the extent to which patients require support for evacuation, and (ii) to clarify whether risk of flooding and landslides was accurately perceived among the participants.

MATERIALS AND METHODS

STUDY SITE AND PARTICIPANTS

This study was conducted in Fukui Prefecture, located in the north-central part of Japan. The prefecture has a population of 766,863 and its population density is 183.0 people/km^2. The elderly population over 65 years old accounts for 30.6%, and about 17.8% of this elderly population is in need of nursing care. Fukui Prefecture experienced a flooding caused by the torrential rains in July 2004, which resulted in 4 deaths, 1 missing person, and 14,157 destroyed houses.[10]

The study site was Orange Home-Care Clinic in Fukui City, Fukui Prefecture, a detail of which was provided elsewhere.[11-13] In short, it provides home care services to patients living at home or in elderly facilities such as group homes. There are about 20 people running the clinic, including several doctors, nurses, and office staff. In this clinic, one doctor and one staff member (nurse or office staff) visit the patients as a team. Each team visits 8-10 patients/day on weekdays, and the visiting area covers a radius of 16 km from the clinic. Some of the patients are living in nearby cities that are

more than 16km away and are treated in cooperation with visiting nurses. About 350 patients, from children to the elderly, are treated at this clinic every year. The clinic also provides medical care for patients in the terminal stages of cancer, chronic diseases such as neural intractable diseases and dementia, and severely handicapped children, including not only terminal care but also life support.

This is a cross-sectional study targeting the home care patients using the services of the Orange Home-Care Clinic on 1st December 2020. We excluded facility users and hospitalized patients because we aimed to evaluate those who received home care

SURVEY SHEET

The questionnaires were developed based on the experience of Typhoon Hagibis and other previous evidence as well as the local context of Fukui Prefecture. For example, in the course of treating patients affected by Typhoon Hagibis and in compiling data, it became clear that evacuation was difficult for those with low activity of daily living, [5,6] and we assumed that this was also the case for home care patients. There have been studies on specific needs among the those with special needs care who stay at disaster reception centers,[14] but to the best of our knowledge, there are no studies in Japan on risk of flooding and landslides of home care patients. Therefore, we created a questionnaire on the topics we considered important.

The self-administered questionnaire consists of four sections.
Section 1 asks about perceptions of evacuation in the event of flooding. It asked about the importance of evacuation, perception of disaster risk of flooding and landslides in their houses, attitudes toward evacuation, the range of needs for care and support, and the use of medical devices.
Section 2 focuses on the patient's home situation, such as the structure of the house and the bedroom floor.
Section 3 asks patients and their families about their actual feelings about evacuation, and their concerns and inadequacies in flooding measures through open-ended questions.
Section 4 asks the date the questionnaire was completed and who completed it.
The survey questions are described in greater detail in the Supplementary Methods.

DATA COLLECTION

We collected information on sex, age, the range of care required, name of the primary disease, and address of the study subjects from the electronic medical records belonging to the Orange Home-Care Clinic. Age was calculated as of the time the questionnaire was distributed (1st December 2020). The range of needs for care or support was classified as Not certified, Support level 1, Support level 2, Care level 1, Care level 2, Care level 3, Care level 4 and Care level5 as described in the electronic medical record. As for the primary disease names, the diseases were classified based on the International Classification of Diseases, 11th Edition (ICD11). For those with more than one disease name listed, the first disease name was given priority.

For the risk of flooding and landslides, we checked whether the home addresses of patients collected from their medical records were included in hazard areas on hazard maps issued by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. We investigated the risk information of flooding and landslides of patients' houses based on the addresses listed on the electronic medical records. Risk Information of landslides was collected considering that landslides can be caused by flooding as well as earthquakes. For this survey, we used "Overlapping Hazard Map," which is a free website provided by the Ministry of Land, Infrastructure, Transport and Tourism of Japan that enables disaster risk information to be displayed on a map.[15] The risk of flooding was categorized into nine types based on the depth of flooding, and the risk of landslides was categorized into seven types based on the area. We checked whether the patients' houses were in the warning areas or special warning areas. When we could not identify an address with "Overlapping Hazard Map", we searched for it on "Yahoo! Maps" and made the assessment as above.[16] All checks were completed by at least two of us, and if there were differences in the classification of risk of flooding and landslides, we asked another person to check and make a decision.

Then, we conducted a questionnaire survey from 1st December 2020 to 30 April 2021 to determine whether their risk of flooding and landslides was accurately assessed. Self-administered questionnaires were sent to the participants from 1st December 2020, and the staff of the Orange Home-Care Clinic asked the patients and their families to

complete the questionnaire. Its details will be described in the following section. To reduce response bias, participants were informed their participation was voluntary and their participation and response results would not affect their future services. The deadline for responses was set for 30 April 2021.

The completed self-administered questionnaires were collected by the Orange Home-Care Clinic, and the written contents of the questionnaires were tabulated and integrated with information on the presence or absence of responses, basic patient information obtained from electronic medical records, and information about risk of flooding and landslides

DATA ANALYSIS

We calculated the absolute number of home care patients whose houses were at risk of flooding and/or landslides and the percentage of these patients in the total number of home care patients using the Orange Home-Care Clinic as of 1st December 2020.

Basic information on home care patients such as sex, age, range of care needs, name of main disease, address (by city), depth of flooding, landslides information, and special warning areas were tabulated separately for participants and non-participants in the survey. Data from non-respondents are also included to provide a denominator for risk assessment and to calculate the number of persons requiring assistance who may need help during evacuation. In the respondent’s group, information about the structure of their houses and the use of medical equipment were additionally tabulated.

Respondents were divided into two groups: those at risk of flooding and/or landslides and those not at risk. We tabulated their responses to question 2) in section 1 and to question 3) in section 1 of the questionnaire. Then, we investigated how many people are aware of risk of flooding and landslides of their houses accurately by comparing their risk assessment of flooding and landslides with that based on hazard maps. First, for those who have both flooding and landslide risks, only those who answered "located" for both in question 2) and 3) in section 1 were considered to have the accurate perception. Second, for those with only flooding risk, only those who answered "located" in question 2) in section 1 were considered to have the accurate perception.

Finally, for those with only landslide risk, only those who answered "located" in question 3) in section 1 were considered to have the accurate perception.

Among the questionnaire respondents who were at risk of flooding and/or landslides, we did univariate and multivariate logistic regression analysis to investigate the factors associated with those who are not fully aware of risk of flooding and landslides . In the univariate logistic regression, sex, age, primary disease, presence of flood risk, flooding depth, presence of landslide risk, presence of special alert, building count, home structure, presence of medical device use, evacuation is important, presence of difficulties in evacuating alone, bedroom floor, presence of evacuation concern, respondents and number of disaster risk was used as the explanatory variable and inadequate comprehension of disaster risks as the independent variable. In the multivariate logistic regression, we used explanatory variables that were significantly different in the univariate analysis. We considered p values of 0.05 or less to be significant.

For all analyses, the results of the answered questionnaires were recorded in Microsoft excel for Mac (ver. 16.53) for data extraction and tabulation. For logistic regression analysis, we used Stata/IC 15. Missing data of the questionnaire was excluded from the analysis.

ETHICAL REVIEW

The Institutional Review Board of Medical Governance Research Institute granted ethics approval of this study (MG2020-06), adhering to the Ministry of Health Labor and Welfare and The Ministry of Education guidelines, Culture, Sports, Science, and Technology in Japan. In addition, the conduct of this study was announced in writing, and participants were given an opt-out that guaranteed them the opportunity to refuse.

RESULTS

INFORMATION FOR ALL PATIENTS RECEIVING HOME CARE

There were 390 patients listed in the Orange Home-Care Clinic's electronic medical records as of 1st December 2020, including 7 (1.8%) patients who were hospitalized, 36 (9.2%) patients who had ended their services, 44 (11.3%) patients who had died, and

104 (26.7%) patients who had been institutionalized. These patients were excluded from the study because of the difficulty in having those patients respond. There were 199 home care patients using the services of the Orange Home-Care Clinic, of which 86 (43.2%) were male, the median age was 78 (range 2-105), and 112 (56.3%) were certified as requiring nursing care. 165 (82.9%) of the patients lived in Fukui City. The prevalent conditions were ‘diseases were of the nervous system’ in 60 patients (30.2%) and ‘mental, behavioral, or neurodevelopmental disorders’ in 57 patients (28.6%). Of the 199 home care patients, 169 (84.9%) were at risk of flooding and/or landslides, and 99 (58.6%) of them were certified as requiring nursing care. (Table 1)

INFORMATION OF QUESTIONNAIRE RESPONDENTS AND NON-RESPONDENTS

Questionnaires were sent to 199 participants and 98 people filled out the questionnaire (response rate: 49.3%). Table 1 presents the sociodemographic and clinical characteristics of respondents and non-respondents. Of the 98 respondents, 25 (25.5%) responded by themselves, 58 (59.2%) by family members living with them, 14 (14.3%) by family members living separately, and 4 (4.1%) by others. Of the respondents, 86 (87.8%) lived in Fukui City, and 35 (35.7%) used medical equipment. (Table 1)

Comparing the characteristics of Respondents and Non-respondents, 38 (38.8%) and 48 (47.5%) were male, and the median age was 79.5 (range 2-105) and 78 (range 1-102) years old, and 87 (88.8%) and 82 (81.2%) were at risk of flooding and/or landslides.

PERCEPTION OF FLOODING AND LANDSLIDES RISK

Among the respondents, there were 87 (88.8%) respondents whose houses were at risk of flooding and/or landslides, and of those respondents, 47 (54.0%) were not fully aware of the flooding and landslides risks based on hazard maps. (Table 2) The percentage of those who thought evacuation was important was 86.2% (75 respondents) in the group with risk of flooding and/or landslides and 63.6% (7 respondents) in the group without flooding and landslides risks. (Figure 1) Of the 87 respondents at risk of flooding and/or landslides, 32.2% (28 respondents) were unaware of the risk yet considered evacuation necessary.

FACTORS ASSOCIATED WITH LACK OF FLOODING AND LANDSLIDES RISK PERCEPTION

Those who were at risk of flooding and/or landslides but failed to accurately assess their risk had the following in common: not placing importance on evacuation (OR: 11.9, 95% CI: 1.4–9.6), not using medical equipment (OR: 3.1, 95% CI: 1.1–9.0), and living on the first floor (OR: 4.71, 95% CI: 1.2–18.0). (Table 3) For not using medical equipment, 11 did not answer, and their data were excluded from the analysis.

DISCUSSION

This survey revealed that 169 (84.9%) of home care patients were at risk of flooding and/or landslides. Of the respondents who lived there, 47 (54.0%) did not have an accurate risk awareness of flooding and landslides. Factors for this included not placing importance on evacuation, not using medical equipment, and living on the first floor.

Out of 199 home care patients, 169 (84.9%) were at risk of flooding and/or landslides, and among them, 141 (70.9%) were at risk of flooding. The Japanese Ministry of Land, Infrastructure, Transport and Tourism of Japan reports that the number of people at risk of flooding as of 2015 was 37.03 million across Japan, which was 29.1% of the total population.[17]

However, this study revealed that the percentage of home care patients in Fukui under risk of flooding and landslides was higher than the Japanese average. Therefore, this suggests that the home care patients included in this study may be living in geographically disadvantaged areas in terms of flooding and landslides risk. Fukui Prefecture has a population at risk of flooding reaching 410,000 (52.7%) and a risk of flooding area of 490,000 (62.5%),[17] which is higher than the Japanese average, because of the ground being lower than the major rivers and sloping gradually.[16] Previous studies reported geographical vulnerability among home care patients both in economically developing countries and developed countries.[18-21] The average income of Fukui residents was 4,450,000 yen, which puts them in the top 17% of the world's population,[22,23] indicating that even though they were economically well off, they lived in an area vulnerable to flooding and landslides. Vulnerability to flooding

and landslides of home care patients may also need to be considered, in addition to the vulnerability to access to health care.

Of the169 patients (84.9% of the total) who were at risk of flooding and/or landslides, 99 (58.6%) had been certified as needing nursing care. A previous study on Typhoon Hagibis indicates the vulnerability of those in need of supports for flooding, as 33.3% of all deaths were those who could have evacuated but failed to do so because of their own health problems.[5] Furthermore, the mean age of those at risk of flooding and landslides were 62.8 and 81.9 years old, respectively. Previous study has pointed out vulnerabilities such as the fact that flooding victims are often concentrated in older people, and that even when they survive, older people are more likely to develop PTSD and general psychiatric symptoms than younger people.[24] In addition, patients with suppressed immune systems such as cancer may be at increased risk of infections caused by flooding.[6] Considering the fact that the frequency of flooding is expected to increase in the future, it is desirable to provide more support to home care patients in times of flooding and landslides so that they can minimize the damage.[25]

There were not many people who had an accurate assessment of the risks of flooding and landslides at their houses. Among 98 Respondents, there were 87 (88.8%) whose houses were at risk of flooding and/or landslides, and among whom 47 (54.0%) had inadequate risk awareness of flooding and landslides. Previous study has highlighted the importance of being aware of the risks of disaster, such as the fact that simple preparations by family members and community members can increase the probability of surviving the first 72 hours of a disaster before the arrival of government supports,[27] and that residents who were aware of hazard maps were able to start evacuating one hour earlier than those who were not and had a 10% higher evacuation rate.[28,29] It is true that the risk awareness of flooding and landslides among home care patients in Fukui is higher than the Japanese national average of 38.6% for awareness of hazard maps,[26] probably because flooding and landslides occur more frequently in Fukui than in the rest of Japan, and most people are at risk of flooding.[17] However, considering that their survival rates may increase with a little more flood preparedness (e.g., 72 hours of durable supplies such as an attic axe, freshwater, to allow survival until rescue arrives; improvement of the first floor structure to resist water damage such as converting the

first floor from wood to cement or wooden floors to cement or tile; ability to run equipment with a generator with safety devices to prevent carbon monoxide poisoning), the awareness rate of risk of flooding and landslides may not be sufficient to minimize the damage to home care patients during flooding and landslides.

Of the 87 respondents at risk of flooding and/or landslides, 32.2% (28 respondents) were unaware of the risk yet considered evacuation necessary, suggesting a lack of awareness regarding a hazard map. These finding warrants caution, given that an evacuation in flooding could be dangerous. Indeed, from the perspective of our previous study, in which we evaluated the fatalities associated with Typhoon Hagibis in 2019, some of the residents involved might have died outdoors in the process of evacuating from their homes 6. Of note, evacuation risk is higher among residents with impaired daily living activities, such as home care patients. Therefore, home care patients and their families need to be aware of the risks of floods and landslides in advance, and they should determine whether to evacuate while weighing the risk of staying at home.

We found that the factors resulted in lack of risk awareness of flooding and landslides include not placing importance on evacuation, not using medical equipment, and living on the first floor. In a previous study, it was mentioned that men over 55 years old (33%) and married people with children (27%) were the most well prepared for evacuation, and that the awareness rate of hazard maps improved as their age increased.[30] Furthermore, there was a difference of 25% in the awareness rate of hazard maps depending on whether they knew their neighbors or not.[26] Judging from the results of this study and previous studies, it is necessary to extend support to such people to make them more aware of risk of flooding and landslides.

We found that there are many people who need support during evacuation. However, it is necessary to survey what risks they face and what needs they have when they evacuate to consider flooding and landslides countermeasures for home care patients. Specifically, it is desirable to research what problems exist during preparation, during evacuation, and after evacuation, respectively. It also needs to be examined whether risk awareness of flooding and landslides increases survival rates. It is desirable to

investigate how risk awareness of flooding and landslides affects evacuation behavior among patients receiving home care.

Although we found some factors associated with inadequate risk awareness of flooding and landslides, there may be factors that were not detected due to the small sample size. Therefore, it is still unclear what interventions are effective in improving their risk assessment.

LIMITATIONS

There are several limitations in this study. First, the response rate for the questionnaire was 49.3%. Because of the small sample size, generalizability was low. Moreover, we do not know if these patients are representative of the population, and there may be undetected factors. In fact, information on the reasons for not responding to the questionnaire could not be obtained. These factors made it difficult to make accurate risk assessment to those who were at risk but did not respond to the survey.

Second, when comparing Fukui with other regions, it is necessary to consider the factors that are unique to Fukui Prefecture. Most of the respondents were residents of Fukui, so many of them lived in flooding areas where the ground being lower than the major rivers and sloping gradually.[31] These environmental factors may have an influence on the awareness of evacuation. Therefore, its applicability to other communities, especially outside of Japan, is limited.

Third, we failed to consider the seasonal influence on the awareness of flooding and landslides. In Japan, flooding generally occurs during the rainy season in June and July and the typhoon season in August and September, so the awareness of flooding may be higher during these periods. The response period for this questionnaire was from 1st December 2020 to 30 April 2021, a period when flooding is relatively rare, while potentially allowing for more persons not to be evacuated during seasonal flooding, so seasonal factors could not be fully considered.

Fourth, this study was conducted at a single clinic only. Comparisons between clinics were not possible, thus making it difficult to generalize the results.

Fifth, bias may not be sufficiently reduced in the collection of survey responses. When handing out the survey, it was made clear that the responses would not affect future services. In addition, an opt-out format was used to disclose information about the study and to guarantee the opportunity to refuse. However, it might not be sufficient to reduce bias.

Sixth, there exist situations where family members and Orange Home-Care Clinic staff completed the survey. This made the assessment of the perception of flooding and landslides risk among the home care patients challenging.

CONCLUSION

This study reported the importance of discussing the vulnerability to flooding and landslides of home care patients. We identified the risks flooding and landslides and awareness of it among home care patients living in Fukui. We found that in addition to 84.9% (169 out of 199) of participants at risk of flooding and/or landslides , 58.6% (99 out of 169) needed assistance during evacuation. Moreover, more than half of those exposed to risk of flooding and/or landslides did not accurately identify their risk. This result is important in discussing evacuation strategies for home care patients. Further research in this area is needed in the future.

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AUTHOR'S CONTRIBUTION

MY analyzed the data. MY, MK, YK and AO wrote the manuscript. All authors conceptualized and designed the study and revised the manuscript.

CONFLICTS OF INTEREST

AO received a personal fee from MNES Inc, outside the submitted work. YN received a personal fee from MRT Inc, outside the submitted work.

DATA DISCLOSURE STATEMENT

This information has not been published elsewhere.

DATA AVAILABILITY STATEMENTS

Data available on request.

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