Natural Hazards
https://doi.org/10.1007/s11069-024-06600-6

ORIGINAL PAPER

The relationship between disaster resilience and household food security in a disaster-prone area in Kumamoto prefecture, Japan

Shuyu Han[1] · Minakshi Keeni[1] · Katsuhito Fuyuki[1]

Received: 2 June 2023 / Accepted: 31 March 2024
© The Author(s) 2024

Abstract
This study explores the relationship between residents' disaster resilience and potential household food security in the context of natural disasters. Disaster resilience capacity consists of absorptive capacity, adaptive capacity, and transformative capacity, while household food security is composed of food availability, accessibility, and utilization. Based on data from 539 questionnaires administered to residents in Kumamoto Prefecture, Japan, this study examines households' disaster resilience capacity and food security conditions. The entropy method is adopted as a quantitative assessment approach to integrate the data, and a Tobit model is constructed to detect the correlation between households' disaster resilience capacity and food security. We draw five main findings from the results. (1) Over half of the respondents do not have good food security; moreover, food accessibility is the poorest dimension, as reflected by low scores for water purification capacity and facility preparedness. (2) Most of the respondents do not have high disaster resilience capacity; their transformative capacity is the lowest, followed by absorptive and adaptive capacity. (3) There is a significant positive correlation between disaster resilience and household food security. (4) Disaster damage experience restrains residents' food utilization. (5) The elderly and senior population may be exposed to food-borne diseases because of their low food utilization. This study provides insights into the influence of disaster resilience activities on household food security before a disaster hits. The study informs the debate on the association between disaster resilience and household food security so as to aid future disaster risk reduction management.

Keywords Household food security · Disaster resilience · Disaster risk reduction measures · Natural disaster · Japan

✉ Shuyu Han
shuyu.han.s8@dc.tohoku.ac.jp

Minakshi Keeni
keeni.minakshi.d1@tohoku.ac.jp

Katsuhito Fuyuki
katsuhito.fuyuki.d2@tohoku.ac.jp

[1] Graduate School of Agricultural Science, Tohoku University, Sendai, Japan

Published online: 08 April 2024

Abbreviations

FSIs	Food Security Indicators
HFIAS	Household Food Insecurity Access Scale
FCS	Food Consumption Score
DDS	Dietary Diversity Score
FAO	Food and Agriculture Organization of the United Nations
CDC	Centers for Disease Control and Prevention
FEMA	Federal Emergency Management Agency

1 Introduction

Immediate-onset natural disasters frequently result in food security challenges. The Great East Japan Earthquake of 2011 left 470,000 people homeless, and 8.4 million servings of food were consumed in the week following the earthquake (Nakazawa and Beppu 2012). Disasters' impact on the demand side severely disrupts residents' access to food, procurement routes, and food handling due to infrastructure failures. Meanwhile, the slow implementation of humanitarian aid and government relief, alongside paralyzed supply routes, highlights the importance of fostering food security preparedness at the individual and household levels. This is because individuals and households are basic units on the frontline, and are able to help reduce risks. Unsafe food (due to unprepared or available prepared food being destroyed by the disaster) and the failure to cook food properly can lead to secondary or unintended health challenges (food-borne diseases) after a disaster, which may cause more harm. Although these risks can be mitigated through the implementation of policies by local departments or disaster governance by communities, food preparedness and disaster risk reduction knowledge at the household level still play an important role in disaster mitigation (Hiatt et al. 2022; Oktari et al. 2020).

Numerous factors influence household food security in disaster-threatened areas. Firstly, the characteristics of a household, such as population composition, economic status, and living environment, may influence that household's food utilization methods and storage quantities. The demographic composition of a household influences both the quantity and variety of food that its residents require (Chakalian et al. 2019). Moreover, the economic status of a household determines the types and quantities of food its inhabitants can purchase. Regions less prone to disasters may not implement additional disaster preparedness measures (Daimon et al. 2023). Secondly, household food security is influenced by disaster risk reduction management (Shukri et al. 2023). A household's increased proactive response to disasters and its possession of diverse disaster coping strategies imply greater adaptability, prompting consideration of food security and preparation during such events. Thirdly, understanding disaster prevention is crucial for households, as it directly relates to the sustainability of their preparedness efforts, involving threat comprehension and collaborative work. The education level of the household head may impact disaster preparedness decisions, while the involvement of household members in disaster activities can enhance decision-making quality (Zheng et al. 2024). Examples of such activities include regular learning sessions and discussions on disaster preparedness, as well as checking the availability of disaster relief supplies. Establishing more social connections also facilitates smooth information exchange, as it enables individuals to share information about local disaster preparedness arrangements through community activities, thereby promoting understanding of disaster household food security. In Japan, these social connections have played a crucial role in reducing the risk of disasters (Cabinet Office, Government of Japan 2023). The said connections are fostered through neighborhood associations, known as Chonaikai or Jichikai, organizing events, conducting disaster prevention drills, and engaging in activities to enhance local communities. Summarily, the multidimensional factors impact household food security in various ways, making it challenging to systematically establish connections with multiple factors.

Within disaster risk reduction, resilience serves the main function of integration, helping connect and integrate these multiple factors (Béné et al. 2016). At the household level, resilience is often considered as a household's responsive capacity, because the dynamic factors of a household in disaster risk reduction, such as learning and decision-making, are essential when it comes to enhancing the sustainability of the household's disaster resilience. In disaster-prone Japan, a comprehensive disaster prevention system has been established at national, local, and household levels. Residents enhance disaster awareness and preparedness through community events and assistance from local authorities, enhancing overall resilience (Cabinet Office of Disaster Management in Japan 2014). These disaster risk reduction activities can effectively increase human resilience capacities to reduce disaster effects (Ahmad and Afzal 2019; Shah et al. 2018). Household food security is often included as a disaster resilience component, and it is assumed that high resilience indicates that household food security is guaranteed. However, the resilience level is not indicative of the corresponding food security capacity (Ansah et al. 2019). This is because the household food system involves multiple components and reflects a household's livelihood outcomes. Moreover, some household disaster risk reduction interventions may not effectively enhance household food security in the short term. For instance, short-term economic assistance to families may not lead to sustainable resilience improvement in the long term. Therefore, it is necessary to differentiate between resilience concepts and dimensions of household food security, exploring their relationship to enable policymakers to develop more detailed intervention measures to enhance household food security.

Since Alinovi et al. (2008, 2010) developed a conceptual framework, researchers have investigated the relationship between resilience and household food security in the context of disasters. According to our review of the literature, firstly, studies have focused on how household resilience impacts household food security in the context of disasters (Smith and Frankenberger 2018; Murendo et al. 2020), although most have not explored how resilience mitigates household food insecurity before disasters, nor have they addressed how resilience affects the food security conditions of households during the preparedness phase. The Sendai Framework highlights the importance of preparedness and prevention in the pre-disaster period. Therefore, this contributes to a growing body of literature on relevant topics and provides empirical evidence for the connection between disaster resilience and household food security in the pre-disaster preparedness phase. Secondly, most studies have developed their food security measurements by adopting existing food indicators, such as the Household Food Insecurity Access Scale (HFIAS)[1], Food Consumption Score (FCS)[2],

[1] The HFIAS approach measures development food aid programs' effects on households' access to food, as a food insecurity component.

[2] The FCS is determined by assessing the frequency at which a household consumes various food groups in the seven days leading up to the survey.

and Dietary Diversity Score (DDS)[3] (Bahta and Myeki 2022; D'Errico et al. 2018; Vaitla et al. 2020). However, these indicators are designed to measure hunger- or undernutrition-related issues that do not fit certain disaster scenarios. For instance, people in Japan enjoy relatively good welfare conditions and most people do not have to worry about food. However, food supply shortages or food destruction due to frequent natural disasters may drastically impact a household's food security conditions. Thus, an indicator based on disaster characteristics, consistent with the context of the study site, could describe household food security. This helps provide profiles of disaster resilience and potential household food security in the pre-disaster period. Lastly, Béné et al. (2012) argued that common food security indicators (FSIs) cannot capture the potential disruptions that could affect multiple food security dimensions. According to the Food and Agriculture Organization of the United Nations (FAO), food security includes availability, accessibility, utilization, and stability, all of which can be impacted by disasters. Therefore, exploring the relationship between household disaster resilience and food security also helps capture how the different disaster resilience dimensions mitigate disasters to affect these different household food security dimensions.

In sum, the present study explores the relationship between disaster resilience and potential household food security. This paper can contribute to the current knowledge about (1) understanding the potential household food security of disaster-prone households by considering three of the four food security dimensions, (2) comprehending the disaster-prone households' resilience by considering three types of resilience capacities, and (3) assessing the relationship between the three disaster resilience capacities and three food security dimensions among disaster-prone households. A survey was conducted with the residents of Kumamoto Prefecture in Japan, where natural disasters have occurred in the past decade. Following this, the relationship between residents' disaster resilience and potential household food security was analyzed using a Tobit model.

2 Conceptual model and research hypotheses

2.1 Conceptual model

Studies have discussed the conceptual framework and links between disaster resilience capacities and household food security. These frameworks consider the household unit as a proxy of the food system and the FSI as the result of the system's internal activities (Ansah et al. 2019). Resilience is conceptualized as an internal characteristic, the result of adaptation activities and the joint action of various types of capital, establishing a link between food security and these attributes through pathways. Our study follows the same logic, although none of these frameworks focus on the linkage between the various resilience capacities and multiple household food security dimensions, thus overlooking their different impacts. Therefore, our framework explores the relationships between disaster resilience capabilities and household food security dimensions; the scenario discussed in this study is the potential situation before disasters (Fig. 1). This framework comprises three parts. The first introduces the constituent elements and categories of household disaster resilience capacity. The second part presents three potential household food security dimensions in

[3] The DDS is an indicator for assessing nutritional adequacy.

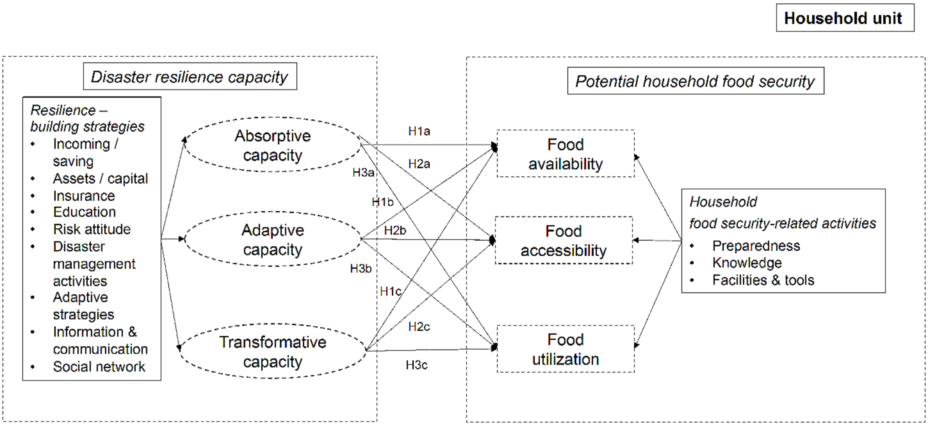

Fig. 1 Conceptual model

the pre-disaster period and their constituent elements. The third part is represented by the middle lines in Fig. 1, which present hypotheses for the relationship between disaster resilience capacities and household food security.

2.2 Hypothesis development

2.2.1 Absorptive capacity and potential household food security

Absorptive capacity describes a system's stability or rehabilitating capacity when exposed to change (Béné et al. 2012). The concept has emerged from numerous coping strategies or household attributes. Households adopt these strategies or attributes to mitigate the impact on their livelihoods (Béné et al. 2016). Earlier studies have identified the important role of assets, savings, and income in cushioning disaster shocks and helping households recover rapidly. Households with financial security have additional money to invest in non-essential products such as emergency food supplies and disaster kits (Onuma et al. 2017). Moreover, disaster-related insurance also helps a household to rehabilitate effectively and reduce post-disaster stress (Eriksen and Vet 2021). These factors mitigate the impact of disasters on households. However, household characteristics such as size and the proportion of vulnerable people affect the buffering and rapid recovery of households. Large households are more likely to need food and medical support during an emergency (Chakalian et al. 2019). Additionally, elderly and senior adults, children, and people with disabilities may require more assistance during crises, thereby exposing a household to danger for a longer period (Lee et al. 2022). These vulnerable populations reflect the weak coping capacity in households. Based on this, it can be assumed that household stability has a positive correlation with food preparation, tool acquisition, and food usage. Therefore, the *a* group of hypotheses is as follows.

H(a) There is a positive correlation between absorptive capacity and the three household food security dimensions (**H1a**-availability, **H2a**-accessibility, **H3a**-utilization).

2.2.2 Adaptive capacity and potential household food security

Adaptive capacity refers to a household's flexibility in using coping strategies without making qualitative changes to the way it operates (Béné et al. 2012). It is generated by considering the various coping measures households use when faced with disasters. Firstly, diversifying a household's access to information enables the acquisition of more information regarding the disaster's magnitude and the preparation of an effective response, while it also expands the household's options for accessing information about food supply locations (Shah et al. 2018). Secondly, family communication can raise awareness of the risks and encourage protective behavior in terms of preparing for hazardous events or provide warnings and trigger particular behavioral responses during such events (Hansson et al. 2020). Additionally, families use several other disaster risk reduction measures, such as acquiring information about the route to evacuation sites, preparing first-aid kits for disasters, and replacing damaged houses. All of these strategies reflect residents' flexibility to adjust and respond to disasters. Summarily, we argue that the diversity and flexibility of households' strategies based on changing contexts help them adapt in times of disaster, and that these disaster prevention strategies indicate households' potential disaster preparedness, which can indirectly or directly influence the preparation and utilization of household food security strategies. Based on this, we formulate the *b* group of hypotheses as follows.

H(b) There is a positive correlation between adaptive capacity and the three household food security dimensions (**H1b**-availability, **H2b**-accessibility, **H3b**-utilization).

2.2.3 Transformative capacity and potential household food security

Transformative capacity represents the ability to learn and reflect to adjust the system so that it is no longer vulnerable to similar disruptions (Ansah et al. 2021). At the household level, this capacity includes families' activities aimed at making permanent and fundamental changes to the household system's performance or structure (Béné et al. 2016). This ensures that households are more likely to survive a future disaster. Regarding the learning dimension, in Thailand, households whose members live in risk-prone areas and participate in disaster training or drills are more willing to adopt countermeasures (Muttarak and Pothisiri 2013). In Pakistan, individuals with lower education levels may lack an understanding of potential coping strategies and face high risk during disasters (Shah et al. 2018). These findings suggest that learning ability or experiences can change people's perceptions of disasters and their attitudes toward them. Regarding social engagement and decision pluralism, the community plays a crucial role in all disaster timelines, such as providing preparation guidance during the pre-disaster period, coordinating evacuation, rescue, and relief during disasters, and assisting recovery in the post-disaster stage (Patterson et al. 2010). In summary, transformative capacity enables households to fundamentally alter their response to future disasters, implying a higher disaster awareness level and more effective choices when preparing for disasters. As such, this study formulates the *c* group of hypotheses as follows.

H(c) There is a positive correlation between transformative capacity and the three household food security dimensions (**H1c**-availability, **H2c**-accessibility, **H3c**-utilization).

3 Research methods and data

3.1 Study area

Kumamoto Prefecture in Japan is located on the island of Kyushu (Fig. 2). Given the occurrence of multiple catastrophic disasters, Kumamoto Prefecture is recognized as a disaster-prone area. On April 14, 2016, 228 people were killed and 2,753 injured in house collapses and landslides caused by the Kumamoto Earthquake, which had a maximum magnitude of 7.3. Electricity, gas, water, and other essential facilities were affected, and 480,000 households were without electricity during the most severe stage of the earthquake damage (Cabinet Office of Disaster Management in Japan 2017). According to the Japanese Cabinet Office, the economic damage caused by the earthquake could amount to as much as 3.8 trillion yen (Cabinet Office, Government of Japan 2017). Moreover, during heavy rains in Kumamoto from July 3 to 8, 2020, 65 people were killed, two people went missing, and 51 people were injured, as the rains caused river flooding and sedimentation when the seasonal rain front expanded from central Chugoku, stagnating in Kyushu (Kumamoto Prefecture Government 2021a). Additionally, the heavy rains damaged 7,300 houses, railroads, highways, other infrastructure, and all industries. Total economic losses in Kumamoto Prefecture are expected to reach 522.2 billion yen (Kumamoto Prefecture Government 2021a). The frequent occurrence of mega disasters is the reason we selected Kumamoto Prefecture as our study site.

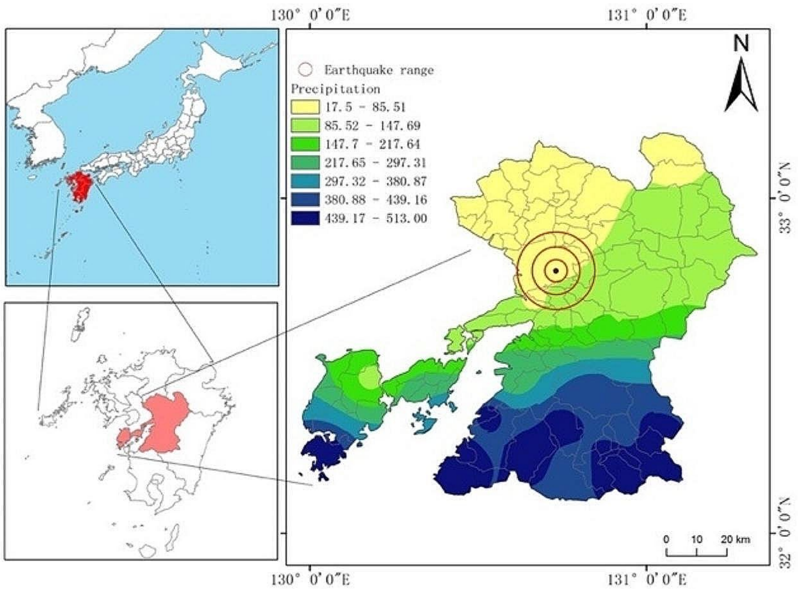

Fig. 2 Map of the study area. (Note: The map provides only a general description of the impact of the two different disasters. The red circle indicates the range of the 2016 Kumamoto Earthquake, and the precipitation distribution map shows the approximate rainfall distribution from July 3 to 4, 2020.)

3.2 Sampling and household survey

In total, 544 household samples were randomly drawn from Kumamoto Prefecture through an Internet survey (GMO RESEARCH) from March 16 to March 29, 2022. The Internet survey company allowed us to select participants from their registered respondents to avoid duplicate samples in the same household. We requested that the demographic characteristics of the sample be selected according to the local population characteristics. The sample size was calculated based on Rao's Sample Size Calculator, accepting a calculation error of 5% and a confidence interval of 95% (Raosoft, Inc 2004). With Kumamoto Prefecture's total population of 7.2 million (Kumamoto Prefecture Government 2021b) and a response distribution of 50%, the calculated sample size should be 384. As such, a sample size of 544 is sufficient to represent the overall population. Individual registered respondents were interviewed online using Google Forms. The questions pertained to the basic characteristics of residents, livelihood and savings, disaster-related preparation, and potential household food security contributions. Five samples were rejected owing to incomplete or missing information. Finally, 539 household samples were selected.

3.3 Variables

3.3.1 Potential household food security

The main dependent variable is potential household food security, and the unit of analysis is the household. As per the suggestions of the FAO, Centers for Disease Control and Prevention (CDC) and Federal Emergency Management Agency (FEMA), we created an integrated FSI. Since food security stability is largely disrupted by disaster damage, this study only focuses on three food security dimensions: *food availability*, *food accessibility*, and *food utilization*. Ten questions were adopted to measure three household food security dimensions (Table 1). Two questions on food availability indicated a household's food and water supply. During a mega disaster, power supply disruptions could result in poor electricity connectivity, contamination of groundwater, and eventual issues in accessing food supplies. Thus, it is crucial to make provisions for household food security until humanitarian aid arrives. Four other questions on food accessibility asked about households' access to food sources. This concept highlights households' ability to access food resources through various sources (e.g., purchasing vs. obtaining food and water from nature). Moreover, four questions on food utilization examined aspects related to knowledge and awareness actions. This dimension covers the sanitation and sufficiency of food and water. Houses may experience water damage from floods or tsunamis, while mold or sewage might contaminate the house, ruining prepared food and drinking water. Furthermore, power and gas outages may cut off power to the refrigerator and prevent individuals from cooking food or boiling water.

3.3.2 Disaster resilience capacity and other control variables

Household characteristics, various types of capital, adaptation strategies, and disaster prevention and preparedness are important components when it comes to building household resilience. Hence, we categorize disaster resilience capacity into *absorptive capacity* (eight disaster resilience attributes), *adaptive capacity* (seven disaster resilience attributes), and

Table 1 Indicators employed in the construction of the potential FSIs

Food security dimension	Indicator	Explanation	Source	Sign	Weight
Food availability	Food supply	Dummy variable = 1 if the household has prepared food for intake before the disasters; otherwise, 0	Adopted from Onuma et al. (2017) and established for the purposes of this study	(+)	0.150
	Water supply	Dummy variable = 1 if the household has made provisions for drinking water before the disasters; otherwise, 0	Adopted from Onuma et al. (2017) and established for the purposes of this study	(+)	0.850
Food accessibility	Tools for acquiring food and water	Dummy variable = 1 if the household has tinned food opening tools; otherwise, 0	Adopted from CDC and FEMA and established for the purposes of this study	(+)	0.177
	Distance to a food source	The distance from the house to a food source (km)	Adopted from Smith et al. (2016) and established for the purposes of this study	(+)	0.019
	Water purification capacity	Dummy variable = 1 if the household knows how to purify water; otherwise, 0	Adopted from CDC and FEMA and established for the purposes of this study	(+)	0.332
	Water purification facility	Dummy variable = 1 if the household has facilities (such as a filter, portable gas stove, and disinfectants) for purification; otherwise, 0	Adopted from Nakazawa and Beppu (2012), CDC, and FEMA and established for the purposes of this study	(+)	0.473
Food utilization	Safe food identification	Dummy variable = 1 if the household can identify safe food; otherwise, 0	Adopted from CDC and FEMA and established for the purposes of this study	(+)	0.441
	Safe water identification	Dummy variable = 1 if the household can identify safe water; otherwise, 0	Adopted from CDC and FEMA, and established for the purposes of this study	(+)	0.115
	Food storage capacity	Dummy variable = 1 if the household has a specific place to store food supply; otherwise, 0	Adopted from CDC and FEMA and established for the purposes of this study	(+)	0.249
	Water storage capacity	Dummy variable = 1 if the household has clean, sanitized containers with tight covers to store water; otherwise, 0	Adopted from CDC and FEMA and established for the purposes of this study	(+)	0.195

transformative capacities (seven disaster resilience attributes) (Table 2); these three abilities have a linear logical relationship. Firstly, stability is an essential household ability derived from household attributes. Secondly, when a disaster is beyond stability control, flexible adjustments are needed to accommodate the change. Thirdly, transformation is a fundamental change that helps a household cope with future exposure to loss or disasters for an extended time.

In addition to the necessary variables for the composition of resilience capacity, we included several disaster-related variables and households' basic demographic characteristics. We controlled for the *disaster damage experience*, which was coded 1 if respondents thought that they suffered losses during the last disaster. However, if they had not experienced a natural disaster in the study area, they stated that they did not suffer losses during the last disaster. We then controlled for the *length of residence* in the study area. Since the survey sites were disaster-prone, these variables were used to describe the impact of respondents' experiences with disasters on household food security. Regarding the demographic characteristic variables, we controlled for the *age* and *gender* of the respondents. Age is a categorical variable.

3.4 Data processing and entropy method

In this study, potential household food security and resilience capacity are integrated indicators formed by various dimensions of household activities or characteristics. To combine these variables into a comprehensive index and structure the data, we adopted the entropy method. This approach is a relatively objective way to evaluate each index's weight and each aspect's comprehensive index; the said strategy is used to describe residents' resilience capacity and potential household food security in this study. The entropy method is harnessed to determine the index dispersion level. The higher the dispersion of the entropy value, the higher the influence of this indicator in the comprehensive evaluation. Xu et al. (2019) described the entropy method's specific principle and calculation procedures. Each sub-variable's sign indicates whether it has a positive or negative effect on the composite index.

Once the entropy method had been implemented, by summing the composite scores of the variables in each dimension, disaster resilience capacity and household food security could be calculated. Among them, ABC, ADC, and TFC indicate households' absorptive, adaptive, and transformative capacities, which were discrete variables ranging from 0 to 1. Further, FAV, FAC, and FU indicate households' food availability, accessibility, and utilization, which were discrete variables ranging from 0 to 1. These indicators were used to build the FSI and resilience capacity.

3.5 Method of analysis

This study primarily assesses the correlation between disaster resilience capacity and potential household food security in the pre-disaster stage. The study's dependent variables are three dimensions of the potential household FSIs, and the independent variables are three dimensions of residents' disaster resilience capacity. Both groups of variables are transformed using the entropy method. Considering the dependent variables' discrete characteristics, this study attempted to use the Tobit model. The estimation of the research model was performed via Stata 17.

Table 2 Indexes of households' disaster resilience capacity

Major factor	Subfactor	Variable type	Explanation	Source	Sign	Weight
Absorptive capacity	Household size	Continuous	Number of people in the household	Adapted from D'Errico et al. (2018)	(-)	0.013
	Dependency ratio	Dummy	1 if the household has elder and senior people and children; otherwise, 0	Adapted from Ifejika Speranza et al. (2014)	(-)	0.294
	People with disabilities	Dummy	1 if the household has people with disabilities; otherwise, 0	Adapted from Zhou et al. (2021)	(-)	0.036
	Income	Continuous	The average annual income of the household (yen)	Adapted from Zhou et al. (2021)	(+)	0.123
	Savings	Continuous	The amount of savings of the household (yen)	Adapted from Zhou et al. (2021)	(+)	0.188
	Surrounding environment	Dummy	1 if the house is located in a relatively safe place (e.g., in the event of a flood or tsunami, the house will not be submerged in water); otherwise, 0	Established for the purposes of this study	(+)	0.094
	Insurance	Dummy	1 if the household has disaster-relevant insurance; otherwise, 0	Adapted from Kousky (2019)	(+)	0.211
	Labor number	Continuous	Number of laborers	Adapted from Zhou et al. (2021) and Sina et al. (2019)	(+)	0.042

Table 2 (continued)

Major factor	Subfactor	Variable type	Explanation	Source	Sign	Weight
Adaptive capacity	Emergency supply	Dummy	1 if the household ordinarily has disaster emergency kits; otherwise, 0	Adapted from Zhou et al. (2021)	(+)	0.210
	Escape site	Dummy	1 if household members know more than two escape sites for evacuation when the next huge disaster occurs; otherwise, 0	Established for the purposes of this study	(+)	0.129
	Information source	Continuous	Number of information sources used	Established for the purposes of this study	(+)	0.029
	House changing capacity	Dummy	1 if the household's residence could be replaced when affected by a disaster; otherwise, 0	Adapted from Ifejika Speranza et al. (2014)	(+)	0.084
	Neighbor consensus	Dummy	1 if the household gets along with its neighbors such that they share information and help each other when a disaster occurs; otherwise, 0"	Established for the purposes of this study	(+)	0.122
	Disaster preparation willingness	Dummy	1 if the household prepares for disasters when it receives a warning that a disaster may occur in the next few days; otherwise, 0	Adapted from Teo et al. (2018) and established for the purposes of this study	(+)	0.159
	Family activities	Dummy	1 if the household prepares for disasters together or holds a family meeting related to disaster risk reduction; otherwise, 0	Established for the purposes of this study	(+)	0.267

Table 2 (continued)

Major factor	Subfactor	Variable type	Explanation	Source	Sign	Weight
Transformative capacity	Household head education	Categorical	0 = other; 1 = elementary school; 2 = middle school; 3 = high school; 4 = junior college/technical college/vocational school; 5 = 4 years or 6 years of college; 6 = master's degree; 7 = doctoral degree	Adapted from Zhou et al. (2021) and Sina et al. (2019)	(+)	0.008
	Knowledge acquisition from previous disaster	Dummy	1 if the household thinks it has learned from previous disasters and can cope with the next disaster; otherwise, 0	Adapted from Kato and Endo (2020)	(+)	0.103
	Training and drills	Dummy	1 if the household has participated in disaster-related knowledge training or drills; otherwise, 0	Established for the purposes of this study	(+)	0.225
	Understanding of mutual aid and self-aid	Dummy	1 if the household has knowledge of self-aid and mutual aid; otherwise, 0	Established for the purposes of this study	(+)	0.187
	Women's decision-making	Dummy	1 if women are significantly involved in the decision-making in the household; otherwise, 0	Adapted from Smith and Frankenberger (2018) and established for the purposes of this study	(+)	0.026
	Governance	Dummy	1 if a household member participated in a disaster risk management meeting in the community; otherwise, 0	Adapted from Smith and Frankenberger (2018) and established for the purposes of this study	(+)	0.310
	Disaster awareness	Dummy	1 if the household is aware that the situation is very urgent when it receives a warning that a huge disaster may occur in the next few days; otherwise, 0	Adapted from Teo et al. (2018) and established for the purposes of this study	(+)	0.140

4 Results

4.1 Potential household food security

Regarding the two food availability aspects, the sample population had good food availability (90%); however, only 54% of the respondents made provisions for drinking water at home. As for the four food accessibility aspects, 96% of the respondents lived near (within 5 km) their food sources. However, the water purification capacity, water purification facility, and tools for acquiring food and water were insufficient, measuring 11%, 29%, and 49%, respectively. Food utilization was composed of four categories. Over half of the sample households had good water and food storage capacity (60% and 52%, respectively). Furthermore, they had a significant safe water identification capacity (74%). Conversely, few populations could identify whether food was safe or not (32%).

The household food security dimensions' weights were calculated using the entropy method (Table 1). The food availability, accessibility, and utilization scores were then calculated using the entropy method results to show the household food security level for each dimension. Household food security in disaster-prone areas was mainly based on food availability, with the highest comprehensive index (0.592), followed by food utilization (0.471) and food accessibility (0.210; Fig. 3). Each household's potential FSI was also calculated using the weight from the entropy method results. The FSI ranged from 0 (least food secure) to 3 (most food secure); based on this, the households were divided into six groups. The first group ($0 \leq FSI \leq 0.5$) accounted for 18.7% and the second group ($0.5 < FSI \leq 1$) accounted for 18.9% of the households. The third group ($1 < FSI \leq 1.5$) accounted for 18.4% of the households, while the fourth group ($1.5 < FSI \leq 2$) included the most households (27.5%). The fifth group ($2 < FSI \leq 2.5$) consisted of 14.1% of the households. Only 2.4% of the households belonged to the sixth group ($2.5 < FSI \leq 3$).

4.2 Disaster resilience capacity

The disaster resilience capacity attributes' weights were calculated using the entropy method (Table 2). Residents' disaster resilience in disaster-prone areas was mainly determined by adaptive capacity, which had the highest comprehensive index of 0.520, followed by absorptive capacity (0.403) and transformative capacity (0.315; Fig. 3). Based on the weight calculated using the entropy method, each household's resilience capacity was measured, which is the sum of absorptive, adaptive, and transformative capacities. Resilience

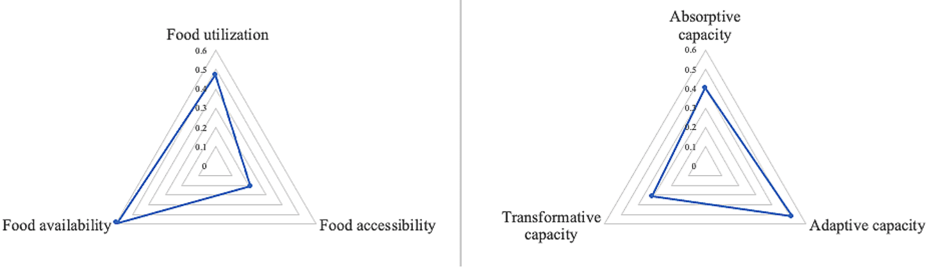

Fig. 3 Food security and resilience capacity radar map

capacity ranges from 0 (least resilient) to 3 (most resilient); based on this, the households were divided into six groups. The first group (0 ≤ resilience capacity ≤ 0.5) accounted for 10% of the households, and the second group (0.5 < resilience capacity ≤ 1) consisted of 28.4% of the households. The third group (1 < resilience capacity ≤ 1.5) accounted for 27.8% of the households. The fourth group (1.5 < resilience capacity ≤ 2) consisted of 21.5% of the households, while the fifth group (2 < resilience capacity ≤ 2.5) consisted of 10.9% of the households. Only 1.3% of the households belonged to the sixth group (2.5 < resilience capacity ≤ 3).

4.3 The relationship between disaster resilience capacity and potential household food security

Table 3 shows the regression results of the three types of disaster resilience capacities and household food security. Model 1, Model 3, and Model 5 represent the correlation between disaster resilience capacity and potential household food security. Meanwhile, Model 2, Model 4, and Model 6 incorporate control variables based on the above models. Overall, the results indicate that the disaster resilience capacity variables have a positive and statistically significant correlation with household food security, but their impacts on the three food security dimensions vary. Firstly, absorptive capacity has a positive and statistically significant correlation with food accessibility. Secondly, adaptive capacity has a positive and statistically significant correlation with all three household food security dimensions. Lastly, transformative capacity has a positive and statistically significant correlation with all three household food security dimensions.

4.4 The relationship between other factors and potential household food security

As shown in Table 3, the Model 6 results indicate that the disaster damage experience and age have a negative and statistically significant correlation with food utilization.

5 Discussion

This study focused on the relationship between three disaster resilience capacities and three household food security dimensions against the threats of natural disasters. The results partially support seven of the nine hypotheses proposed and point to two other factors related to household food security.

5.1 Absorptive capacity and potential household food security

Consistent with hypothesis H2a, the results showed that residents with stronger absorptive capacity have better food accessibility. Absorptive capacity represents the stability of the household system and can be adjusted through short-term humanitarian interventions aimed at reducing disaster vulnerability in the short term (Béné et al. 2016). According to our research design, households with high absorptive capacity have greater disaster evacuation mobility and better economic conditions. These attributes, which maintain absorptive capacity, result in a relatively well-maintained living environment (stronger buildings,

Table 3 Tobit regression results

Variable	FAV		FAC		FU	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ABC	0.1556	0.1402	0.1775***	0.1736***	-0.0029	0.0174
	(0.2074)	(0.2116)	(0.0492)	(0.0502)	(0.0598)	(0.0739)
ADC	1.4869***	1.5456***	0.1748***	0.1806***	0.2171***	0.2633***
	(0.1718)	(0.175)	(0.0371)	(0.0377)	(0.0452)	(0.0552)
TFC	0.2857	0.3029*	0.1467***	0.1371***	0.1449***	0.1797***
	(0.1794)	(0.1813)	(0.0408)	(0.0415)	(0.0496)	(0.061)
Disaster damage experience		-0.1117		0.0064		-0.0681**
		(0.0848)		(0.02)		(0.0294)
Length of residence		-0.0703		-0.0061		0.0003
		(0.0542)		(0.013)		(0.0191)
Age		-0.0256		-0.003		-0.0118*
		(0.0182)		(0.0043)		(0.0063)
Gender		-0.0105		-0.026		-0.0055
		(0.0899)		(0.0215)		(0.0315)
_cons	0.0094	0.5400*	-0.0023	0.0569	0.3138***	0.4012***
	(0.1043)	(0.2992)	(0.0251)	(0.0717)	(0.0304)	(0.105)
N	539	539	539	539	539	539
LR chi2 (χ2)	138.55	143.38	90.87	92.83	59.05	61.56
Prob > chi2 (χ2)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Pseudo *R2*	0.1268	0.1312	3.1197	3.1871	0.3176	0.1107

Standard errors in parentheses

$^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

relatively safe surroundings, proximity to business districts) and well-established household tools. Therefore, the absorptive capacity has a positive correlation with household food accessibility.

Inconsistent with hypothesis H1a and H3a, the results did not show a relationship between absorptive capacity and the other two food security dimensions. The results indicate that a household's absorptive capacity is limited to influencing its inhabitants' ability to access food, rather than affecting how much food they can obtain (availability) or how effectively they can utilize these food resources (utilization). The disaster food preparedness of households requires planning for the quantity, variety, and regular replenishment of supplies. This means that households must have flexible disaster management strategies and planning. Achieving efficient food utilization at the household level also requires long-term investment in learning and skill development. As a result, the correlations between absorptive capacity and food availability and utilization are not significant. The result also suggests that establishing a correlation between resilience and a traditional food security index is insufficient to understand how resilience impacts various aspects of household food security. This indicates the need to consider the specific dimensions of the relationship between resilience and household food security when establishing their relationship. Governments can design more efficient measures based on the differential impacts of resilience characteristics to enhance household food security. Lastly, the result also indicates that the impact of short-term resilience attribute on household food security is limited. It is suggested that the government should prioritize training in household disaster management and the development of household disaster preparedness awareness. To complement the limited influence of absorptive capacity, Béné et al. (2016) suggested that households can enhance their adaptive capacity through resilience-building exercises to supplement household absorptive capacity.

5.2 Adaptive capacity and potential household food security

Consistent with H1b, H2b, and H3b, the results showed a positive relationship between adaptive capacity and all three household food security dimensions. Adaptive capacity measures "the ability to make informed choices about alternative livelihood strategies based on changing conditions" (Béné et al. 2012). Adaptive capacity consists of a set of disaster prevention strategies adopted by a household, indicating a household's strong adaptability and flexible adjustment. Existing research has proved that the implementation of these strategies and behaviors is driven by strong disaster perceptions (Kurata et al. 2022; Ong et al. 2023). The development of disaster perception is influenced by various stressors, such as norms, culture, the availability of and access to information, the value placed on that information, and the immediate social circle (Béné et al. 2019; Jones and Boyd 2011). In this study, similarly, the diversity and flexibility of adaptive strategies stem from households' high-risk perception. Such perceptions lead households to take further steps in terms of protective behaviors to ensure household well-being, which is closely related to food security. Under this protective behavior, the focus is on learning about food security in times of disaster and how to handle and purify food or how to store it and protect it from being damaged. Thus, the combined evidence explains how higher adaptive capacity improves all three household food security dimensions. The study illustrates the effectiveness of incremental adjustments in disaster preparedness management by households to improve food security in all aspects and emphasizes that the Japanese government should continue current disaster management policies to promote bosai ishiki (disaster prevention awareness) among residents. This is due to the fact that, in Japan, bosai ishiki (disaster prevention awareness) is recognized as the main way to promote self-help and mutual assistance among residents (Cabinet Office, Government of Japan 2023). It also proves that this initiative can promote disaster food security in Japanese households.

5.3 Transformative capacity and potential household food security

Consistent with H1c, H2c and H3c, the results showed that households with stronger transformative capacity have better food availability, food accessibility, and utilization. Transformative capacity represents a fundamental change in the household system, which helps the family system cope with severe shocks in the future. However, there are numerous barriers to this fundamental change, all of which are rooted in cultures and cognitions. Hence, it is necessary to acquire and accumulate new knowledge and then utilize this in a different area. Previous studies have identified that education, learning from previous disasters, and drills could improve long-term disaster management capacity (Ardalan et al. 2020; Yin et al. 2021). In Japan, the Disaster Risk Reduction Drill Plan and Japan disaster management pamphlet have been used to inform people of the necessary disaster preparedness materials and how to utilize them well. Moreover, social engagement and decision pluralism could help households learn more about disaster management mechanisms within the community and strengthen the ties between them and the community. Residents participate in activities organized by Chonaikai and Jichikai, such as disaster prevention drills. These activities are based on local conditions, significantly enhancing residents' sense of participation and community responsibility, thereby fostering a spontaneous and transformative shift in their perception of household disaster management. Moreover, women's participation and voice are important for effective disaster management in Japanese households, as women are responsible for most of the household activities and disaster preparedness tasks. They are more experienced in using household storage facilities and handling food, while they also have more disaster management knowledge (Petraroli and Baars 2022). Therefore, establishing tight information connections between households and communities, as well as ensuring equal participation of household members in disaster management affairs, can cultivate a positive and long-term sustainable disaster management environment within the household, and such an environment motivates families to learn more about their food availability, food accessibility, and utilization.

5.4 Other factors and potential household food security

The results indicated that age negatively impacts household food utilization. Japan has a rapidly aging population and the well-being of and support for elderly and senior people after a disaster are critical to disaster recovery. Elderly and senior people are ill-prepared for and have a low-risk perception of disasters, which can increase the risk of food-borne illness in times of disaster (Kosa et al. 2012). Particularly, many elderly and senior adults lack knowledge of safe food and do not follow safe food recommendations (i.e., they might not be able to identify unsafe foods or have specific food storage areas) (Cates et al. 2009). In this study, 26.5% of the respondents were over 60 years of age, and the results indicated that their food utilization is lower than that of the younger respondents. This might significantly expose them to secondary damage after a disaster. Therefore, the government should promote activities to enhance the efficient use of food by elderly and senior people.

Previous studies have reported that disaster-related experiences promote households' food stockpiling preparedness and enhance their knowledge of disaster risk management. However, our study showed that disaster damage experiences negatively influence food utilization. This might be explained by the psychological effects of disasters. Natural disasters often have a strong relationship with mental health, as unpredictability and huge losses can severely undermine victims' mental health. Psychological trauma can lead to victims denying losses and trying to escape from reality (Makwana 2019). In the study area, residents have been exposed to two mega natural disasters in the last decade, namely the 2016 Kumamoto Earthquake and the July 2020 heavy rains. These multiple exposures may have produced more stress and trauma, affecting people's mental health (Shultz et al. 2013). Such stress might prevent residents from accumulating disaster management-related knowledge, such as how to process drinking water and store food.

Despite its contributions, this study has some limitations. The characteristics of those households with lower food security and resilience levels were not clearly defined. Since these vulnerable groups tend to be most affected by disasters, future research should further analyze the household characteristics of these groups via the use of cluster analysis.

6 Conclusions

This study explored the relationship between disaster resilience and potential household food security. As climate change continues to worsen and natural disasters increase in frequency, this study could be instrumental in informing disaster risk reduction policies related to household food security. Based on data from a disaster-prone area in Japan, the following conclusions were drawn.

1. Over half of the residents had low potential FSIs. This means that, in Japan, household food security is not guaranteed if humanitarian aid does not arrive in time after a disaster. Particularly, food accessibility is relatively weak, as water reserves, purification, and processing capacity are lacking. Thus, when encountering a water cut or contamination, households will face water shortages. We suggest that public administrators should make more efforts to systematically educate the population regarding potential food security threats to households during disasters and pre-disaster food security preparations. This would allow residents to understand the importance of food security in times of disaster and raise the potential household food security level.
2. Residents' average disaster resilience score is low, and when a disaster strikes, they might suffer a huge shock and find it difficult to recover. Specifically, they have a relatively low transformative capacity, which reflects their limited understanding and awareness of future disasters. This requires public administrators to target the appropriate basic resilience constituent elements and provide residents with enhanced measures to strengthen household food security. Such measures include focusing more on vulnerable populations' well-being, training in disaster response strategies, and increasing awareness to transform disaster preparedness knowledge from a short-term action into a long-term habit.
3. Three types of disaster resilience capacities partially and positively impact the different household food security dimensions. This suggests that enhancing disaster resilience at the household level could positively impact potential household food security and reduce the harm caused by the food security crisis after a disaster. Governments can design more efficient measures based on the differential impacts of resilience characteristics to enhance household food security.
4. We also note that the disaster damage experiences negatively influence food utilization. This implies that disasters cause psychological trauma for individuals. Governments should prioritize organizing psychological counseling in disaster-prone areas to promote mental well-being.
5. Lastly, we found that households' ability to utilize food decreases with age, indicating a lower disaster resilience among elder generations. Japan has an abundant aging population, and food-borne illnesses might seriously impair the post-disaster recovery of elderly and senior people owing to physical reasons and a lack of understanding when it comes to the hazards of disasters. Hence, it would be better to promote education and the adoption of suitable food safety practices among elderly and senior populations. For example, disaster preparedness materials should be tailored to elderly and senior people and more details regarding food security risk during disasters ought to be provided.

Acknowledgements This work was supported by Support for Pioneering Research Initiated by the Next Generation program by the Japan Science and Technology Agency (JST SPRING) under Grant number JPMJSP2114.

Author contributions Shuyu Han planned the project; Minakshi Keeni and Katsuhito Fuyuki co-supervised the project. Shuyu Han provided access to the research company for sample collection in 2022. Shuyu Han developed the data analysis, results interpretation, and data generation. Shuyu Han wrote the first draft of the manuscripts and participated in writing all drafts. Minakshi Keeni and Katsuhito Fuyuki were responsible for content review. All authors read and approved the final manuscript.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Ahmad D, Afzal M (2019) Household vulnerability and resilience in flood hazards from disaster-prone areas of Punjab. Pakistan Nat Hazards 99(1):337–354. https://doi.org/10.1007/s11069-019-03743-9

Alinovi L, Mane E, Romano D (2008) Towards the measurement of household resilience to food insecurity: Applying a model to Palestinian household data. Deriving food security information from national household budget surveys. Food and Agriculture Organization of the United Nations, Rome,Italy:137–152.http://www.stats.gov.cn/english/ICAS/papers/P020071017475481721768.pdf. Accessed 20 August 2022

Alinovi L, D'Errico M, Mane E, Romano D (2010) Livelihoods strategies and household resilience to food insecurity: an empirical analysis to Kenya. Eur Rep Development:1–52

Ansah IGK, Gardebroek C, Ihle R (2019) Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. Food Secur 11(6):1187–1203. https://doi.org/10.1007/s12571-019-00968-1

Ansah IGK, Gardebroek C, Ihle R (2021) Shock interactions, coping strategy choices and household food security. Clim Dev 13(5):414–426. https://doi.org/10.1080/17565529.2020.1785832

Ardalan A, Yusefi H, Rouhi N, Banar A, Sohrabizadeh S (2020) Household disaster preparedness in the Islamic Republic of Iran: 2015 estimation. East Mediterr Health J 26(4):382–387. https://doi.org/10.26719/emhj.19.048

Bahta YT, Myeki VA (2022) The impact of agricultural drought on smallholder livestock farmers: Empirical evidence insights from Northern Cape, South Africa. Agriculture 12(4). https://doi.org/10.3390/agriculture12040442

Béné C, Wood RG, Newsham A, Davies M (2012) Resilience: New utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. IDS Working Papers (405):1–61. https://doi.org/10.1111/j.2040-0209.2012.00405.x

Béné C, Headey D, Haddad L, von Grebmer K (2016) Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. Food Secur 8(1):123–138. https://doi.org/10.1007/s12571-015-0526-x

Béné C, Frankenberger T, Griffin T, Langworthy M, Mueller M, Martin S (2019) Perception matters': new insights into the subjective dimension of resilience in the context of humanitarian and food security crises. Prog Dev Stud 19(3):186–210. https://doi.org/10.1177/1464993419850304

Cabinet Office, Government of Japan (2017) Estimated impact of the 2016 Kumamoto Earthquake. https://www5.cao.go.jp/keizai3/kumamotoshisan/index.html. Accessed 13 April 2023

Cabinet Office of Disaster Management in Japan (2014) Disaster management in Japan. https://www.bousai.go.jp/1info/pdf/saigaipanf_e.pdf. Accessed 18 April 2023
Cabinet Office, Government of Japan (2023) White Paper on Disaster Management 2022 (Vols. 75–103). [PDF].https://www.bousai.go.jp/en/documentation/white_paper/pdf/2022/R4_hakusho_english.pdf. Accessed 14 April 2023
Cabinet Office of Disaster Management in Japan (2017) White paper on disaster management 2017. https://www.bousai.go.jp/en/documentation/white_paper/index.html. Accessed 13 April 2023
Cates SC et al (2009) Food safety knowledge and practices among older adults: identifying causes and solutions for risky behaviors. J Nutr Elder 28(2):112–126. https://doi.org/10.1080/01639360902949986
Chakalian PM, Kurtz LC, Hondula DM (2019) After the lights go out: Household resilience to electrical grid failure following Hurricane Irma. Nat Hazards Rev 20(4):05019001. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000335
D'Errico M, Romano D, Pietrelli R (2018) Household resilience to food insecurity: evidence from Tanzania and Uganda. Food Secur 10(4):1033–1054. https://doi.org/10.1007/s12571-018-0820-5
Daimon H et al (2023) A critical review of cognitive and environmental factors of disaster preparedness: research issues and implications from the usage of awareness (ishiki) in Japan. Nat Hazards 117(2):1213–1243. https://doi.org/10.1007/s11069-023-05909-y
Eriksen C, Vet E (2021) Untangling insurance, rebuilding, and wellbeing in bushfire recovery. Geogr Res 59(2):228–241. https://doi.org/10.1111/1745-5871.12451
Hansson S et al (2020) Communication-related vulnerability to disasters: a heuristic framework. Int J Disaster Risk Reduct 51:101931. https://doi.org/10.1016/j.ijdrr.2020.101931
Hiatt E et al (2022) Household food and water emergency preparedness practices across the United States. Disaster Med Public Health Prep 16(3):1029–1037. https://doi.org/10.1017/dmp.2020.480
Ifejika Speranza C, Wiesmann U, Rist S (2014) An indicator framework for assessing livelihood resilience in the context of social—ecological dynamics. Glob Environ Chang 28:109–119. https://doi.org/10.1016/j.gloenvcha.2014.06.005
Jones L, Boyd E (2011) Exploring social barriers to adaptation: insights from Western Nepal. Glob Environ Chang 21(4):1262–1274. https://doi.org/10.1016/j.gloenvcha.2011.06.002
Kato T, Endo A (2020) Involving citizens in sharing disaster experiences across areas: an investigation into disaster-stricken communities and observing communities. Int J Disaster Risk Reduct 42:101378. https://doi.org/10.1016/j.ijdrr.2019.101378
Kosa KM, Cates SC, Karns S, Godwin SL, Coppings RJ (2012) Are older adults prepared to ensure food safety during extended power outages and other emergencies? Findings from a national survey. Educ Gerontol 38(11):763–775. https://doi.org/10.1080/03601277.2011.645436
Kousky C (2019) The role of natural disaster insurance in recovery and risk reduction. Ann Rev Resour Econ 11:399–418. https://doi.org/10.1146/annurev-resource-100518-094028
Kumamoto Prefecture Government (2021) Digital achieves of Kumamoto Disaster. https://www.kumamoto-archive.jp/en. Accessed 13 April 2023
Kumamoto Prefecture Government (2021), December 22 The population and number of households in Kumamoto Prefecture in 2021. https://www.pref.kumamoto.jp/soshiki/20/82771.html. Accessed 5 January 2022
Kurata Y et al (2022) Factors affecting perceived effectiveness of Typhoon Vamco (Ulysses) flood disaster response among filipinos in Luzon, Philippines: an integration of protection motivation theory and extended theory of planned behavior. Int J Disaster Risk Reduct 67:102670. https://doi.org/10.1016/j.ijdrr.2021.102670
Lee J, Aldrich DP, Kiyota E, Yasuhiro T, Sawada Y (2022) Social capital building interventions and self-reported post-disaster recovery in Ofunato, Japan. Sci Rep 12(1):10274. https://doi.org/10.1038/s41598-022-14537-8
Makwana N (2019) Disaster and its impact on mental health: a narrative review. J Fam Med Prim Care 8(10):3090–3095. https://doi.org/10.4103/jfmpc.jfmpc_893_19
Murendo C, Kairezi G, Mazvimavi K (2020) Resilience capacities and household nutrition in the presence of shocks. Evidence from Malawi. World Dev Persp 20:100241. https://doi.org/10.1016/j.wdp.2020.100241
Muttarak R, Pothisiri W (2013) The role of education on disaster preparedness: case study of 2012 Indian Ocean earthquakes on Thailand's Andaman Coast. Ecol Soc 18(4). https://doi.org/10.5751/ES-06101-180451
Nakazawa T, Beppu S (2012) Shifting from emergency food to disaster preparation food to help disaster survivors. Sci Technol Trends Q Rev 44:36–52
Oktari RS, Munadi K, Idroes R, Sofyan H (2020) Knowledge management practices in disaster management: systematic review. Int J Disaster Risk Reduct 51. https://doi.org/10.1016/j.ijdrr.2020.101881

Ong AKS et al (2023) Factors affecting the intention to prepare for tsunami in Thailand. Ocean Coast Manag 233:106464. https://doi.org/10.1016/j.ocecoaman.2022.106464

Onuma H, Shin KJ, Managi S (2017) Household preparedness for natural disasters: impact of disaster experience and implications for future disaster risks in Japan. Int J Disaster Risk Reduct 21:148–158. https://doi.org/10.1016/j.ijdrr.2016.11.004

Patterson O, Weil F, Patel K (2010) The role of community in disaster response: conceptual models. Popul Res Policy Rev 29(2):127–141. https://doi.org/10.1007/s11113-009-9133-x

Petraroli I, Baars R (2022) To be a woman in Japan: disaster vulnerabilities and gendered discourses in disaster preparedness in Japan. Int J Disaster Risk Reduct 70:102767. https://doi.org/10.1016/j.ijdrr.2021.102767

Raosoft I (2004) Rao's sample size calculator. http://www.raosoft.com/samplesize.html. Accessed 6 January 2022

Shah AA, Ye J, Abid M, Khan J, Amir SM (2018) Flood hazards: household vulnerability and resilience in disaster-prone districts of Khyber Pakhtunkhwa Province, Pakistan. Nat Hazards 93(1):147–165. https://doi.org/10.1007/s11069-018-3293-0

Shukri MIM et al (2023) Application of Sendai framework for disaster risk reduction in food security during flood disaster in Malaysia: a narrative review. MJMHS 19(4):332–341. https://doi.org/10.47836/MJMHS.19.4.46

Shultz JM, Forbes D, Wald D, Kelly F, Solo-Gabriele HM, Rosen A, Espinel Z, McLean A, Bernal O, Neria Y (2013) Trauma signature analysis of the Great East Japan Disaster: Guidance for psychological consequences. Disaster Med Public Health Prep 7(2):201–214. https://doi.org/10.1017/dmp.2013.21

Sina D, Chang-Richards AY, Wilkinson S, Potangaroa R (2019) A conceptual framework for measuring livelihood resilience: Relocation experience from Aceh, Indonesia. World Dev 117:253–265. https://doi.org/10.1016/j.worlddev.2019.01.003

Smith LC, Frankenberger TR (2018) Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. World Dev 102:358–376. https://doi.org/10.1016/j.worlddev.2017.07.003

Smith K, Lawrence G, Macmahon A, Muller J, Brady M (2016) The resilience of long and short food chains: a case study of flooding in Queensland, Australia. Agric Hum Values 33(1):45–60. https://doi.org/10.1007/s10460-015-9603-1

Teo M, Goonetilleke A, Ahankoob A, Deilami K, Lawie M (2018) Disaster awareness and information seeking behaviour among residents from low socio-economic backgrounds. Int J Disaster Risk Reduct 31:1121–1131. https://doi.org/10.1016/j.ijdrr.2018.09.008

Vaitla B, Cissé JD, Upton J, Tesfay G, Abadi N, Maxwell D (2020) How the choice of food security indicators affects the assessment of resilience—An example from northern Ethiopia. Food Secur 12(1):137–150. https://doi.org/10.1007/s12571-019-00989-w

Xu D, Deng X, Guo S, Liu S (2019) Sensitivity of livelihood strategy to livelihood capital: an empirical investigation using nationally representative survey data from rural China. Soc Indic Res 144(1):113–131. https://doi.org/10.1007/s11205-018-2037-6

Yin Q, Ntim-Amo G, Ran RP, Xu DD, Ansah S, Hu JF, Tang H (2021) Flood disaster risk perception and urban households' flood disaster preparedness: the case of Accra Metropolis in Ghana. Water 13(17):2328. https://doi.org/10.3390/w13172328

Zheng Y et al (2024) Socioeconomic impacts on damage risk from typhoons in mega-urban regions in China: a case study using typhoons mangkhut and Lekima. Int J Disaster Risk Reduct 101. https://doi.org/10.1016/j.ijdrr.2023.104210

Zhou W, Guo S, Deng X, Xu D (2021) Livelihood resilience and strategies of rural residents of earthquake-threatened areas in Sichuan Province, China. Nat Hazards 106(1):255–275. https://doi.org/10.1007/s11069-020-04460-4

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.