



Household preparedness for natural disasters: Impact of disaster experience and implications for future disaster risks in Japan



Hiroki Onuma^a, Kong Joo Shin^{b,*}, Shunsuke Managi^b

^a Graduate School of Engineering, Kyushu University, Fukuoka, Japan

^b Urban Institute & Department of Urban and Environmental Engineering, School of Engineering, Kyushu University, Fukuoka, Japan

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ABSTRACT

This paper analyzes the impact of disaster experience on household preparation of emergency supplies for natural disasters using originally collected Japanese data from 2013. The data cover more than 20,000 households from all parts Japan and include areas with recent disaster experiences as well as areas with low disaster risks. We generate indices for three categories of preparedness using data on household preparation of nine emergency items: Basic Preparedness (BP), Energy/Heat Preparedness (EHP), and Evacuation Preparedness (EP). We use regression analyses to measure the effect of disaster experiences on the preparation of categories of emergency supplies. The results show that experience with disaster damage increases preparedness, but the magnitude of the impact varies among the item categories. Additionally, evacuation experience has a positive impact on the preparation of items from the BP and EP categories. Moreover, the people who experienced damage from the Great East Japan Earthquake (GEJE) in 2011 are relatively more prepared, but evacuation experience in the GEJE does not have a significant impact on preparedness. Furthermore, we find that some regions with higher future risk of large-scale earthquakes are less prepared compared to other regions. This result suggests the importance of policy makers' efforts to raise awareness of disaster risks and to combat insufficient preparedness to reduce future disaster damages.

1. Introduction

Natural disasters can be extremely costly and are difficult to prevent. Hence, the risks involved with and the occurrences of natural disasters have consistently been major concerns for policy makers at national and local levels, especially in disaster-prone regions and countries. At the time of an emergency, insufficient preparation can increase disaster damage in terms of injuries, deaths, and physical damage to the housing and infrastructure. In order to reduce disaster damage, governments commit to the preparation of emergency supplies as part of an effective disaster management plan. However, despite the efforts of administrators, the victims of catastrophic disasters often do not receive adequate relief supplies when they are most needed [1].

Given that public stocks may not be immediately available, it is important to be prepared at the household level for emergencies. Donahue [2] concisely summarized the importance of household-level

preparedness as follows: "Citizens share responsibility for their own protection, by taking protective actions and avoiding the harms that may befall them. The more prepared people are, the less harm they will suffer when disaster strikes." While household-level preparation of emergency supplies is recognized as important by both researchers and policy makers to secure living conditions in a post-disaster period, previous studies have provided evidence of individuals' tendency to underinvest in disaster prevention and damage mitigation [3,4]. Hence, in this study, we analyze the factors that affect preparation of emergency items at the household level using Japanese survey data.

According to the Federal Emergency Management Agency [5], disaster (or emergency) management can be categorized into four stages: (1) Prevention/Mitigation, (2) Preparedness, (3) Response, and (4) Recovery. The Prevention/Mitigation and Preparedness phases are components of pre-disaster management, which are often called *hazard adjustments* in the context of the literature, mainly in the area of social psychology. To prepare for the post-impact phases, govern-

* Corresponding author.

E-mail address: kjshin@doc.kyushu-u.ac.jp (K.J. Shin).

ments and individuals can prepare for the occurrence of disasters and the subsequent damage in two main ways: by buying insurance¹ and by gathering and storing emergency supplies (e.g., supplies of food and water, a radio, energy sources and medicine) [9]. This paper focuses on the latter – the stockpiling of emergency supplies.

Over the past few decades, many studies have investigated the relationship between preparedness for natural disasters and the factors that promote the adoption of protective measures. In related studies, social scientists have tried to predict and explain the levels of adjustment using theoretical models from behavioral sciences and psychology.² Empirical studies have based their estimation models on theoretical studies and have provided empirical evidence on a wide range of factors that influence the adoption of disaster preparedness measures, including disaster experience, disaster awareness, and socio-demographic characteristics such as income, education, household composition, and location of residence (e.g., for a review of seismic risks, see Lindell and Perry [3]; Solberg et al. [16]).

Of the various factors that may influence disaster preparedness, the impact of disaster experience has been extensively studied. The results, however, are not necessarily consistent in their implications. Several studies have reported significant positive effects on hazard adjustments for earthquakes [17–20] and floods and/or storms [21–25]. On the other hand, other studies have found limited or insignificant effects of disaster experience on preparedness [6,19,26–28].

According to Lindell and Hwang [22], a possible explanation for the conflicting empirical results on the impact of disaster experience on preparedness is that the effect of hazard experience on hazard adjustment adoption may be mediated by perceived personal risk. Because mediation involves the product of two causal path coefficients, the results may be sensitive to sampling fluctuations between studies. Moreover, as suggested by Lindell and Prater [29], hazard experience has both an indirect effect (via perceived personal risk) and a direct effect on hazard adjustment adoption; thus, the mediation of the effect through personal perception of risk is partial rather than complete.

In this study, we focus on quantifying the direct effect of disaster experience on the preparation of emergency items at the household level. We use originally collected survey data that cover more than 20,000 households in Japan. The emergency preparedness indices that we use in the analysis are generated from information on the collection of nine emergency items.

Although most of the previous studies have focused on disaster-prone areas or areas with recent disaster experience, our study covers all areas of a country that varies in disaster risks and experiences.³ Selection bias is likely to occur in the restricted samples used in many of the previous studies because households located in specific areas are likely to share special characteristics that may cause bias in the estimation results [24]. Using data with national coverage allows us to avoid such bias and analyze the impact of disaster experience because the respondents are not selected based upon their experience. Moreover, although Japan is generally known as a natural disaster-prone country, especially in terms of earthquakes, future disaster risks are shown to vary by region. The analysis of these data allows us to determine the relative preparedness by region and to identify ‘high

alert’ regions with relatively high future disaster risks but relatively lower preparedness levels.

In addition, we capture different effects of two types of experiences: direct damage experience and evacuation experience. Thus, we attempt to clarify the possible different effects of experience depending on its characteristics. Furthermore, we present policy implications for discussion to improve the preparation of emergency supplies for future disaster risks.

The remainder of the paper is structured as follows: Section 2 describes our survey data and the variables used in the empirical analyses. Section 3 provides the estimation model and the results. Section 4 presents the discussion, including relevant policy implications. Section 5 concludes.

2. Data and variables

2.1. Survey

We collected 20,726 household samples across all areas of Japan from January 26 to March 15, 2013 through an Internet survey. Individual representatives of households were asked to answer the questionnaire to avoid duplicated samples of the same household. The data cover all 47 prefectures in Japan, and we divided the prefectures into 14 commonly used geographic sub-regions (see the list in Appendix A). The gender and age distribution of the data collected from each sub-region matched the national distribution of the Japanese population aged between 20 and 69.⁴ Some observations are missing information regarding household income, geographic location, and housing type because some respondents answered incorrectly or did not provide an answer. Thus, we were left with 19,318 observations that included all of the information we needed for the regression analysis.

To our knowledge, these survey data represent the largest household survey on household preparation of emergency supplies that covers all areas of Japan. Given that many empirical analyses on household preparedness efforts have used local data [9,23,30,31], this dataset allows us to tackle the issue of data availability and to improve the quality of disaster preparedness data. In addition, these data were collected after the Great East Japan Earthquake (GEJE) in 2011, which resulted in considerable damage to *Tohoku* and nearby regions, thus allowing us to analyze the impact of experiencing the GEJE separately from other disaster experiences.

2.2. Variables

2.2.1. Household preparation of emergency supplies

The main dependent variable in this analysis is the preparedness level of emergency supplies, where the unit of analysis is the household. In our survey, we collected data on the preparation of nine different categories of emergency supply items and utility substitutes. The list of items was based on previous studies related to the preparation of emergency kits and/or water/food supplies [9,23].

In the survey, respondents were asked whether they have each of the following nine emergency supplies: emergency food, drinking water, battery, radio, first-aid kit, fuel, heating equipment, helmet, and disaster prevention hood.⁵ We coded the preparation of each type

¹ Disaster insurance is an important preparation tool to facilitate a smooth recovery phase, and several studies have focused on this aspect [6,7]. While insurance is useful in the recovery process for those who acquired it pre-disaster, compensation payouts take time due to the required damage evaluation. Botzen et al. [8] provided evidence that people prefer to pay to live in low-risk, elevated locations rather than pay for damage insurance. This result implies that people weigh various options to address life and property damage and do not necessarily invest in disaster insurance, depending on their preference.

² Examples of these models are the theory of reasoned action [10], the theory of planned behavior [11], protection motivation theory [12], person relative to event theory [13], and the protective action decision model (PADM) [14,15].

³ Osberghaus [24] is a notable example of a study with a large representative sample for Germany. His data cover 4272 households.

⁴ With respect to the household and demographic characteristics, we observed that the average household income level in our sample was 6.314 million yen, which is higher than the 5.372 million yen reported based on the National Comprehensive Survey of Living. Moreover, the distribution deviated from the general demographic distribution in terms of age (the distribution in our sample was skewed to the right) and education (respondents had a higher number of years of education in the sample).

⁵ A disaster prevention hood is the traditional Japanese hood for emergency evacuation. In an elementary school, the hood is generally used as a cushion for a student's chair when there is no disaster.

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