Dean&Francis

ISSN 2959-6149

Aging Vulnerability in Natural Disasters:Lessons from Japan's 2011 Tohoku Earthquake

Kamiya Mika

United World College Thailand, Phuket 83110, Thailand

Abstract:

The 2011 Tohoku earthquake disproportionately impacted the elderly, as evidenced by their overrepresentation in casualties, evacuation obstacles, disrupted medical care, and long-term physical and psychological decline. Despite accounting for 33.8% of the population, those aged 65 and older made up over 60% of all deaths and 89% of post-disaster-related deaths. Japan's preparedness, known as "one of the best prepared for emergencies," has mitigated disaster impacts through "Bosai culture," strict building codes, and public education. However, the earthquake highlighted the vulnerability of aging societies, exacerbated by financial factors, location, and insufficient government response.

Keywords: Tohoku earthquake; Elderly casualties; Disaster vulnerability

1. Introduction

The 2011 Tohoku earthquake disproportionately impacted the elderly, as shown in their over-representation in casualties, obstacles during evacuation and recovery, disrupted medical care, and long-term decline in physical and psychological abilities. It highlights the vulnerability of aging societies during natural disasters.

It is undeniable that social vulnerability is exposed because of natural disasters. Factors including social class, age, gender, and location are considered when calculating the level of vulnerability (Cutter, Susan). Although countless studies have been made to address issues and impacts regarding the environment, infrastructure, or economics, only a few focus on the social impacts of aging populations. According to the World Health Organization, countries with over 21% of people older than 65 years old are known as a "super-aging society" (EHINZ). As a part of this title, Japan has suffered greatly in the aftermath of the Tohoku earthquake. On March 11th, 2011, Japan underwent the most devastating earthquake in its history. The earthquake struck below the North Pacific, reaching a magnitude scale of 9.0. In merely six minutes, the earthquake irreversibly affected the Tohoku region: Iwate, Miyagi, and Fukushima prefectures; causing more than 18,500 deaths, costing $360 billion from the destruction of 120,000 buildings, resulting in the displacement of 500,000 people, and initiating a catastrophic failure at the Fukushima Daiichi Nuclear Plant. Though the Tohoku earthquake undoubtedly affected the entire population of Japan, it disproportionately impacted the elderly, as shown in their overrepresentation in casualties, obstacles during evacuation and recovery, disrupted medical

care, and long-term decline in physical and psychological abilities. As a result, although only 33.8% of the area is made up of people who are 65+ years old, they account for over 60% of all deaths (Wang et al.). Moreover, 89% of post-disaster-related deaths were aged 65 years or older (Displacement). This highlights the vulnerability of aging societies during natural disasters.

The Tohoku earthquake has sparked a significant increase in research in this area, including public health issues, support networks, disaster recovery, etc. A study titled "Japanese Perceptions of Societal Vulnerability to Disasters during Population Aging: Constitution of a New Scale and Initial Findings" uses a 13-item PADVS to identify the results and impacts of Japan's aged society; this essay will focus on the factors that have led to this "scale of vulnerability" amongst the elderly during the quake (Annear et al.). The identifications could mitigate this ongoing issue from the root of their vulnerability, not just in the aftermath.

2. "Bosai Culture" and Japan's Comprehensive Approach to Disaster Preparedness

In general, Japan's preparedness can be praised as "one of the best prepared for emergencies". As an article titled "Japan's Culture of Prevention" mentions; "'Due to its geography, topography, and climate, Japan has been deemed a "disaster-prone country' For this reason, the experience of great disasters contributes to society's awareness of the importance of preventive measures incorporating, among others, structures to prepare for and respond to disasters and participate in DRR (Pastrana-Huguet, J). This level of frequency in disasters not only physically impacts the Japanese society, but also impacts them unconsciously spiritually. According to the same article, those who have experienced the hazardous events would pass down the stories to their descendants, forming an ancestral practice from generation to generation. On the other hand, the Bosai culture could also be under the influence of "Confucian values, Taoist philosophy, and Buddhist religious practices". The multifaceted culture of Japan makes social preparedness and its roots blurry and unspecified (Pastrana-Huguet, J). An example of this ancestral practice is a slogan that can often be heard: "*Tsunami Tendenko*". This slogan is used to express the act of escaping and prioritizing yourself rather than others' lives. This slogan has been passed off through generations (Disaster Education in Japan). This culture has indirectly mitigated the severity of the 2011 Tohoku earthquake as the awareness of the public has always been emphasized and enforced over the generations.

2.1 ARCHITECTURE

An article written by Alan Greenblatt compares Japan to developing countries regarding disaster preparedness. Firstly, Greenblatt recognizes a huge gap in wealth between Japan and Haiti; as a wealthy country, Japan can afford to spend on reinforcing building structures to ensure safety during natural disasters. Haiti, on the other hand, one of the poorest nations worldwide even before earthquakes, prioritizes other expenses. In simple words, "when you have an earthquake in developing countries, they die. In developed countries, they pay," Roger Bilham, a University of Colorado geologist, says (Greenblatt).

Other than that, Japan also utilizes a strict building code. This results in 82% of buildings in Japan being designed to withstand earthquakes. This code has evolved significantly over time to incorporate the lessons learned from past seismic activities and the latest advancements. They have renewed it after every major earthquake, once after the 1978 Miyagi earthquake, once after the 1995 Great Hanshin-Awaji Earthquake, and once during the 2011 Great East Japan Earthquake. These amendments include factors such as structural requirements, technological innovations, materials, and design specifications (Greenblatt). He emphasizes the importance of building safety throughout the article, using examples such as "an 8.0 earthquake in 2008 in Sichuan, China. That earthquake led to loud complaints about corruption and shoddy materials used in school construction" (Greenblatt). This comparison further proves the significance of strict building codes in Japan.

2.2 PUBLIC EDUCATION

In Japan, earthquake education is included in school curricula and lessons. This includes the science behind earthquakes, the risks they create, and evacuation actions during an earthquake. This is reinforced through drills and practices. Additionally, Japan also hosts workshops and seminars to cover a wide variety of topics, including how to create emergency kits, secure homes, and develop emergency plans, all of which are essential skills when an earthquake occurs. During September 1st, also known as "Disaster Prevention Day," a nationwide drill involving millions of people is held to simulate scenarios and ensure that all residents know how to respond effectively to emergencies (Anderson). By investing heavily in earthquake education, Japan ensures that its citizens have a thorough knowledge of how to handle seismic emergencies. This proactive approach is an important factor in Japan's overall earthquake resilience.

ISSN 2959-6149

2.3 MEDIA AND ANNOUNCEMENTS

Japan has put efforts into creating an advanced early warning system. This includes an efficient detection and analysis system. This system allows Japan to identify earthquakes as well as their magnitude in less than a minute. Moreover, there are also multi-channel alerts. These warnings are sent out via TV, radio, and cellphones, reaching most of Japan's residents almost immediately. This system also exists for tsunamis in coastal regions; however, some consider this warning "too short" as it only lasts around 15 minutes. This advanced system has greatly mitigated casualties and injuries during the 2011 Tohoku earthquake.

2.4 SOCIAL STRATIFICATION

The social stratification of a community is another determining factor of a community's vulnerability. Social stratification refers to a way a society categorizes or ranks its members through some set of criteria; this can include money, power, education, etc. There are two ways to view social stratification — Class systems or caste systems — depending on the belief systems of the community. Class systems are "achieved"; meaning, it heavily depends on your personal achievements. "The American Dream" is a classic belief system that leads to a class system, with fluid social mobility and the belief that one can achieve anything with handwork, this often applies to more developed countries (Japan included).

With modern Japan mainly being a part of the "Class system" category, it encourages interaction between people of different social classes due to the fluidity of social class. This benefits disaster response, as one's perception of disaster relies heavily on individual interactions. An effect of this mass interaction can be shown in Japan's culture of earthquakes. Stories, folklore, and historical accounts about earthquakes are often spread around communities and different classes, raising awareness for seismic activity.

3. JAPAN'S RESPONSE TO THE TOHOKU EARTHQUAKE COMPARED TO THE 2008 SICHUAN EARTHQUAKE

Table 1 Comparison of the Sichuan Earthquake and the East Japan Earthquake

	Sichuan Earthquake	East Japan Earthquake
Actual damage		
Area	Sichuan Province [1]	Tohoku Prefectures [6,7]
Date	May 12th, 2008, 2:28 p.m. [1]	March 11th, 2011, 2:46 p.m. [6,7]
Magnitude	8.0 [1]	9.0 [6,7]
Fatalities	70,000 [1]	15,660 [8]
Major fatality age group	Children under 5 years old [2]	Those over 60 years old [9]
Injuries	374,000 [1]	5689 [8]
Missing	20,000 [1]	5329 [8]
Buildings destroyed	7,967,000 [5]	109,741 [8]
Buildings damaged	24,543,000 [5]	583,340 [8]
Estimated expense	10.26 trillion yen [3]	1.69 trillion yen [8]
Preparedness for earthquakes	**No basic earthquake emergency plan[11]**	**Prepared with earthquake emergency plan**
Government level	Not enough supplies	Enough supplies [8,12]
Community level	No trained staff	Experienced staff [12,13]
Personal level	No fixed evacuation sites	Fixed evacuation sites
	No experience and awareness	Earthquake education
Government action		
Coordination	Successful [14]	Unsuccessful [17]
Forces	People's Liberation Army, local troops	DMAT, Self-Defense Force [16]
Legislation adjustment	Yes [3,14,15]	Partial
Financial aid	Yes [14]	Yes, but delayed [17,18]
Reconstruction	Yes [14]	Yes, but delayed [17,18]
Acceptance of medical rescue teams		
Forces	Army	Volunteers and medical staff [12,17,18]
National	Successful [14]	Successful [12,17,18]
International	Yes, but delayed [14]	Successful [19]
Earthquake induced-secondary effects	Heavy rain [2]	Tsunami + nuclear power plant meltdown

(Otani et al).

Otani et al vaguely compare some of the aspects of the Sichuan 2008 earthquake and the 2011 Tohoku earthquake. As shown in the first category of the table (Figure 1), the actual damage of the earthquake has a substantial gap in all subcategories (fatalities, injuries, missing, buildings destroyed, buildings damaged, and estimated expense). Another point that needs to be mentioned is the major fatality age group. While the Sichuan Earthquake caused major loss among children, the Tohoku earthquake primarily affected citizens over 60. This highlights the effort Japan has put into preparing for the occurrence of an earthquake as well as its education and emphasis on awareness for the younger generation. Similarly, there is an immense difference in the buildings destroyed by these earthquakes. While the Sichuan Earthquake resulted in almost 8 million buildings being destroyed, Japan had around 110,000. This reflects how much the strict rules and conducts on structures have mitigated the disaster impacts. However, the destruction of buildings was the main cause of the skyrocketing number of fatalities for children, as many were at school during the seismic activity. On the contrary, Japan's government action was more substandard. This is mainly because "Some disaster emergency resources were replicated across different agencies. The response of each agency became independent, leading to delays in adjusting legislation and reconstructing infrastructure" (Otani et al). It was an area that the Japanese government could focus on and improve upon – to have efficient communication and organization. Nonetheless, the Japanese government was still able to put a valid plan in place, which was implemented for the next 10 years for reconstruction and long-term recovery.

Another great influence on the difference in target groups was the timing of the earthquakes. While the 2008 Sichuan earthquake hit during school hours, the Tohoku earthquake occurred when most students were on spring break. This created a huge difference as the reason for the millions of deaths of children during the Sichuan earthquake was due to the insecurity of school campuses. If most students had been at home when the earthquake struck, it could have avoided much of this tragedy.

4. Factors Contributing to the Vulnerability of the Elderly During the Tohoku Earthquake

4.1 LOCATION

To begin with, the location of the Tohoku region itself puts its citizens at risk. Japan, in general, is located at the convergence of the Pacific, Philippine, and Eurasian plates, making it the country with the most frequent earthquakes. Approximately 30% of all seismic activity occurs in this area, with Japan experiencing 1,014 (both strong and weak) earthquakes annually (MEDC Earthquake). Furthermore, the Tohoku earthquake also caused startling tsunamis, peaking at 39 meters tall in Miyagi and flooding 560 square kilometers of land. The eastern side of the Tohoku region, which is located on the coast, is entirely exposed to the tsunami. Factors such as tectonic plate boundaries and exposure to tsunamis significantly increase a population's vulnerability during earthquakes.

4.2 FINANCIAL FACTORS

With 22% of all elderly people in Japan living in poverty, this inevitably increases their vulnerability. This is due to several reasons: the basic pension of $6,000 annually is not enough to cover daily expenses; the rising population of residents over 65 years old puts immense pressure on the pension system; healthcare and living costs; as well as changing family dynamics in which the elderly lack support from their adult children. People in poverty are more likely to live in hazard-exposed areas, lack health insurance, and lack social protection. These factors greatly expand their vulnerability and losses during disasters, adding even more burden to their financial standing during the recovery stages. They bear the greatest costs during disasters since they are more likely to live in unsafe buildings, making them more vulnerable to injuries and fatalities. Impoverished elderly people who undergo these situations will undoubtedly suffer from the impacts of the earthquake. Poverty also limits one's mobility. Compared to higher socioeconomic classes, the poor have limited choices in terms of evacuation plans. They often rely on public transport and shelters. Therefore, when these factors aren't accessible to the impoverished, their mobility is extremely limited. Furthermore, while the rich can simply move or travel to escape the destroyed area, the poor, who don't have enough savings for transportation or relocation, will only accumulate additional suffering because they are unable to relocate.

An article titled "Natural Disaster by Location: Rich Leave and Poor Get Poorer" explores this topic. It states: "If a county experienced two natural disasters, migration out of that county increased by one percentage point." In contrast, "Poverty rates also increased by one percentage point in areas hit by super-severe disasters." This indicates that once a disaster occurs, the rich simply leave, and the poor stay. Consequently, those who are impoverished will continuously get poorer when left with the mass destruction caused by disasters.

ISSN 2959-6149

Limited access to financial support can also affect their speed of recovery. Poorer people recover at a slower rate than non-poor people. As mentioned earlier, the lack of access to health insurance makes healthcare unreachable for the impoverished. The delay in treatment will only worsen their already declining health.

On the other hand, the short recovery time for their housing will also be greatly affected. However, this doesn't apply as much to Japan, as almost all housing is assured to be earthquake-resistant. But in poorer regions, where only the poor live in thin and weak housing, earthquakes will have a significant impact on these specific houses.

Poorer countries also face difficulties in gathering needed support: they receive less aid than non-poor countries and are less likely to qualify for loans. This factor should be considered when mitigating or recovering from a severe disaster, even though Japan currently ranks 4th worldwide in terms of the size of its economy.

4.3 JAPAN'S AGING SOCIETY

Japan's increasingly aging society and its isolation is becoming a classic example with its population decreasing since 2008. In fact, the proportion of citizens above the age of 65 has skyrocketed "From 6% in 1960 to 29% in 2020… and is projected to reach 40% by 2060"(Wikipedia contributors). This population shift has caused an immense healthcare burden for Japan; with a rising number of cardiometabolic diseases, diabetes, and heart failures, it puts Japan on the edge with the accumulation of injuries and casualties of the earthquake.

To look at the Tohoku earthquake on a closer scale, the people aged 65 or above took up approximately 33% and accounted for over 60% of the deaths and casualties in 2011(Miyazaki).

On the other hand, the isolation of the elderly, as the Seattle Times writes, "is so common… each year, some of them died without anyone knowing, only to be discovered after their neighbors caught the smell" (Seattle Times). This emphasizes and represents the 4.8 million seniors who lived alone in 2011, with nobody to check on them. This factor contributes to the vulnerability of the elderly; as well as the isolation at home when disasters occur, resulting in no direct support from family members or relatives to evacuate to safer ground.

The reason for their isolation is due to both physical and psychological reasons. On the surface level, it could be simply because of the death of a spouse, or having no children nearby. On another level, most "older people who live alone express a keen desire to maintain their independence. Many fear being overly dependent on others and wish to continue to live alone despite the challenges they face" (Kaplan). This phenomenon is commonly seen in Japanese culture, hence the phrase "ojama shimasu", which is commonly said when visiting other family members. It means "I am going to get in your way" or "I will disturb you". It showcases the Japanese people's fear of being a burden to anyone else.

In this aspect, it indicates that the elderly who live alone have no one to support them when in need/emergency. Making them more vulnerable during the earthquake, with many of them being alone when it occurs.

4.4 LIMITED MOBILITY AND BARRIERS

In the response phase of a disaster, the elderly group also experiences inequality. Many of the preparation plans require the involvement of technology; although this benefits adults and teenagers, the elderly lack the knowledge of the usage of technology, especially back in 2011. Even today, 56% of older adults are still struggling to access or use technology. This has limited their access to emergency alarms or announcements that are transmitted via electronics or tech. Not only so, but the disability of technology could make it harder to contact relatives or family members when undergoing a disaster.

On the other hand, older people also have limited mobility, mostly due to physical reasons. Undoubtedly, the elderly have more pre-existing health issues that limit their physical performance such as running or flexibility; For instance, more than 34% of people older than 65 years old have knee joint problems, compared to 15% of comparatively younger adults (Rehabilitation).They will experience more casualties if immediate evacuation is not performed. Transportation for the elderly can also be a contributing factor to their limited mobility. As people age, they are less likely to drive because of inevitable health factors such as blurred vision, as only 20% of people aged 65 or above drive ("Older Drivers | NHTSA"). The limitation of mobility reduces the chance they reaching evacuation sites in time.

As mentioned earlier, Japan's preparation is thorough due to its widespread education. Though this is undeniable across the majority, 20% of the elderly weren't aware of the nearest evacuation sites (Displacement), proving that this education system is applied to most residents, but not all. It could also be the lack of access to the newest information via electronic devices.

4.5 Physical health issues caused by insufficient evacuation centers

For 31% of the elderly that evacuated to public shelters, they suffered harsh conditions such as inaccessible basic needs. Food, fitting clothes, heavy water supplies, and

heating fuels in evacuation centers (Displacement). This caused conditions such as hypothermia and dehydration which accounted for 47% of the 2034 post-disaster-related deaths associated with conditions developed while living in evacuation centers. Not only so, but a study that interviewed older survivors claims that most elderly found evacuation centers lack privacy even during showers or baths. 40% of them reported difficulties using toilet facilities in shelters (Displacement). Although these factors are not life-threatening, these aspects are hoped to be improved to mitigate worsening mental health.

5. Discussion

Following the devastating Tohoku earthquake of 2011, the Japanese government undertook a comprehensive response and recovery effort. The Japanese government quickly established an emergency command center and mobilized about 100,000 members of the Japanese Self-Defense Force for relief efforts. International assistance was received from various countries and organizations. By late summer 2011, many affected businesses resumed at least limited production, contributing to economic growth. Transportation infrastructure, including train lines and major highways, was gradually restored to full operation. Hundreds of emergency shelters were established to house displaced people, though supplies were often limited initially. A cabinet-level Reconstruction Agency was established in February 2012 to coordinate rebuilding efforts over10 years. The Japanese government allocated 32 trillion yen ($295 billion) for the region's recovery. By early 2015, nearly all disaster debris had been removed from affected areas. Despite the significant strides in recovery taken by the Japanese government, the challenges facing elderly individuals continuously remain and require targeted interventions. The following recommendations are proposed:

Basic plans on a community level to map or identify people aged 65 or above who live alone. This can help with emergency support as the security will be able to track down these houses immediately, reducing the chances of older adults' casualties or deaths in their own houses. Develop an effective communication system to warn people in advance of the disaster. Preferably not using complex technology but using simple, direct, and physical systems that are accessible to the elderly. Develop transportation plans that are easily accessible to older adults. As they have limited mobility, it is important that transport for those who live far away from shelters or centers, allows them to have similar access to those who live close. Establish mandatory trainings/drills. As mentioned above, Japan does hold nationwide drills and practices; however, they are not mandatory to everyone. Making these mandatory will reduce their mobility as they will know where to go and what to do once disaster hits Japan.

Overall, the 2011 Tohoku earthquake disproportionately impacted the elderly, as shown in their overrepresentation in casualties, obstacles during evacuation and recovery, disrupted medical care, and long-term decline in physical and psychological abilities. The different aspects that contributed to this disproportionality such as Japan's society, pre-disaster preparations and culture, physical and mental health impacts, as well as financial statuses highlight the vulnerability of aging social groups during natural disasters.

References

[1] Pastrana-Huguet, J., Casado-Claro, M.-F., & Gavari-Starkie, E. (2022). Japan's culture of prevention: How Bosai culture combines cultural heritage with state-of-the-art disaster risk management systems. *Sustainability, 14*(13742). https://doi.org/10.3390/su142113742

[2] Web Japan. (n.d.). Disaster education in Japan: Preparing for natural disasters to protect kids' lives. *Web Japan*. Retrieved August 13, 2024, from https://web-japan.org/kidsweb/cool/20/202011_disaster-prevention-education_en.html

[3] Cutter, S. L., & Finch, C. (2008). Temporal and spatial changes in social vulnerability to natural hazards. *Proceedings of the National Academy of Sciences, 105*(7), 2301–2306. https://doi.org/10.1073/pnas.0710375105

[4] Environmental Health Indicators New Zealand (EHINZ). (n.d.). Social vulnerability to natural hazards. *EHINZ*. www.ehinz.ac.nz/indicators/population-vulnerability/social-vulnerability-to-natural-hazards

[5] Wang, S., Cao, W., Peacock, C., & Li, J. (2022). Urban–rural disparity of social vulnerability to natural hazards in Australia. *Scientific Reports, 12*(1). https://doi.org/10.1038/s41598-022-17878-6

[6] Annear, M. J., Okabe, T., Shiba, K., & Shimada, H. (2016). Japanese perceptions of societal vulnerability to disasters during population ageing: Constitution of a new scale and initial findings. *International Journal of Disaster Risk Reduction, 18*, 32–40. https://doi.org/10.1016/j.ijdrr.2016.06.001

[7] Greenblatt, A. (2011, March 13). Japanese preparedness likely saved thousands. *NPR*. www.npr.org/2011/03/11/134468071/japanese-preparedness-likely-saved-thousands

[8] Otani, Y., Nishikawa, T., & Sakai, Y. (2012). Comparison of two large earthquakes: The 2008 Sichuan earthquake and the 2011 East Japan earthquake. *The Keio Journal of Medicine, 61*(1), 35–39. https://doi.org/10.2302/kjm.61.35

[9] Cool Geography. (n.d.). MEDC earthquake case study. *Cool Geography*. www.coolgeography.co.uk/A-level/AQA/Year%2013/Plate%20Tectonics/Earthquakes/MEDC%20Case%20study.

ISSN 2959-6149

htm

[10] Wikipedia contributors. (2024, August 4). Aging of Japan. *Wikipedia*. en.wikipedia.org/wiki/Aging_of_Japan

[11] Miyazaki, T. (2022). Impact of socioeconomic status and demographic composition on disaster mortality: Community-level analysis for the 2011 Tohoku tsunami. *International Journal of Disaster Risk Science, 13*(6), 913–924. https://doi.org/10.1007/s13753-022-00454-x

[12] Anderson, A. (2011, March 14). Learning from Japan: Promoting education on climate change and disaster risk reduction. *Brookings*. www.brookings.edu/articles/learning-from-japan-promoting-education-on-climate-change-and-disaster-risk-reduction

[13] Kaplan, D. B. (2023, April 14). Older people living alone. *Merck Manual Consumer Version*. www.merckmanuals.com/home/older-people%E2%80%99s-health-issues/social-issues-affecting-older-people/older-people-living-alone

[14] Classic Rehabilitation. (2021, August 4). Knee pain statistics and causes. *Classic Rehabilitation*. Retrieved from https://classicrehabilitation.com/knee-pain-statistics-and-causes/#:~:text=Between%2015%20and%2020%25%20of,pain%20in%20women%20roughly%2020%25

[15] HelpAge International. (n.d.). Displacement and older people: The case of the Great East Japan earthquake and tsunami of 2011. *HelpAge International*. www.helpage.org/silo/files/displacement-and-older-people-the-case-of-the-great-east-japan-earthquake-and-tsunami-of-2011.pdf

[16] National Highway Traffic Safety Administration (NHTSA). (n.d.). Older drivers. *NHTSA*. www.nhtsa.gov/book/countermeasures-that-work/older-drivers