

Who is vulnerable during tsunamis? Experiences from the Great East Japan Earthquake 2011 and the Indian Ocean Tsunami 2004

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Abstract

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This paper aims to increase the understanding on mortality and people's behavior in the case of tsunami. This study combines the lessons learnt during the Great East Japan Earthquake and Tsunami of 11 March 2011 with the Indian Ocean Tsunami 2004 using data from Sri Lanka and Indonesia. Individual short case studies are used to highlight risky behaviour during the disaster. From the comparative quantitative analysis it emerges that a lack of a global standardized methodology to collect data in pre- and post-disaster context limits the ability of researchers to make general inference, therefore a common standard should be developed.

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Acknowledgment

The findings from the survey on the Great East Japan Earthquake originate from an unpublished study by Yoko Hagiwara, Katsuhito Miyake, Tadashi Nakasu, Yuichi Ono, and Mari Sawai.² All data on mortality and risky behavior during the Great East Japan Earthquake, including the excerpts on evacuee behavior, originates from the survey, with full credits given to its authors. Much appreciation is given to the survey team for allowing results to be published in the present paper and used as part of analysis.

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² Yoko Hagiwara, Katsuhito Miyake, Tadashi Nakasu, Yuichi Ono, and Mari Sawai, *People's Behaviour during the Great East Japan Earthquake*, August 2011. Unpublished study in Japanese.

1. Introduction

On 11 March 2011, the Great East Japan Earthquake measuring magnitude 9.0 occurred off the Sanriku coast of northern Japan, triggering one of the most deadly and devastating tsunamis in recorded world history. Although tsunamis occur in the region every few decades, resulting in high tsunami awareness, Sanriku coastline was unable to escape serious damage. There have been more than 15,000 deaths, 3,700 missing and more than 65,000 people displaced as a result of the tsunami.³

This study is aimed at identifying who is most vulnerable during the tsunami disaster, by measuring tsunami mortality and injury as well as the needs and current status of the displaced population. Identifying risk factors and people's behavior associated with tsunami mortality is critical for effective disaster risk reduction and management, as it can contribute to effective policy interventions and appropriate allocation of resources.⁴

This paper first discusses methodology of survey in Rikuzentakata, Iwate prefecture, Japan. Findings are then discussed with a comparative perspective with the tsunami experiences in Sri Lanka and Indonesia in 2004. Suggestions and recommendations are made to strengthen the research in tsunami mortality.

2. Methodology

Study design

The datasets used in this paper originate from an unpublished study by Hagiwara, Miyake, Nakasu, Ono and Sawai, entitled *People's Behaviour during the Great East Japan Earthquake*.⁵ The survey interviewed internally displaced persons (IDP) in Takatacho and Kesencho in Rikuzentakata City, Iwate prefecture, between 19 and 28 July 2011.⁶ Rikuzentakata City was chosen due to its high tsunami mortality, in spite of frequent tsunami occurrence in the past (Meiji tsunami 1896, Showa tsunami 1933, Chile tsunami 1960). The mortality was analysed as a retrospective cohort study. The survey had been approved as part of the Great East Japan Earthquake Research Group, headed by Professor Fumihiko Imamura of Tohoku University and Dr Yozo Goto of Tokyo University.⁷

Although all pre-tsunami family members had been identified through interviews, the survey mainly examined the households that had been severely affected by the tsunami, majority of whose houses had been destroyed or swept away. Thus, the mortality presented in this paper is likely to be higher than the population-based statistics which includes people who had already relocated to relatives' houses or new homes, or in towns that suffered less destruction. Another limitation of the study is the potential selection bias due to sampling from temporary housing, excluding those who had moved to other cities. It is also possible that the sample population is more vulnerable than the average IDP affected by the tsunami. This is because those who lost their houses tended to live on low ground closer to the coast, where the value of the land is likely to be lower compared to higher ground. It is also possible that more affluent families have moved

³ Ministry of Foreign Affairs, Government of Japan, as of 26 October 2011. <http://www.mofa.go.jp/mofaj/saigai/index.html> (Accessed 27 October 2011)

⁴ Nishikiori, Nobuyuki; Abe, Tomoko; Costa, Dehiwala GM; Dharmaratne, Samath D; Kunii, Osamu, and Moji, Kazuhiko, "Who died as a result of the tsunami? – Risk factors of mortality among internally displaced persons in Sri Lanka: a retrospective cohort analysis. *BMC Public Health* 2006, 6:73.

⁵ Hagiwara et al, 2011.

⁶ Hagiwara et al, 2011.

⁷ Hagiwara et al, 2011.

out from temporary housing to other locations such as relatives' houses. However, it is not possible to conclude this as question on household income was not asked during the interview.

Survey

The Japanese Cabinet Office, Ministry of Transport and other entities have carried out large-scale quantitative analysis of the Great East Japan Earthquake. The survey in Rikuzentakata in contrast limited the sample size, asking detailed open-ended questions to the interviewees that is not possible in a large-scale quantitative analysis.⁸

The interviews were conducted in evacuation centres, temporary housing, houses affected by the tsunami, as well as people's new homes. They were carried out between 9.30am and 4.00pm except lunchtime. Only houses with open doors and with people inside were asked to participate, giving consideration to those who were resting at home. After giving written informed consent, the survivors were interviewed by volunteer surveyors with a pre-written structured questionnaire. In order to address the ethical issues involved in asking people to recall recent pain, the survivors were not obliged to complete the interview should they feel uncomfortable at any point during the interview. There were a total of five interviewers working in a team of two to three people at a time.⁹

Data on all family members before the tsunami was collected along with information about the behaviour and fate of other family members, friends, and acquaintances in order to identify the critical factors related to survival. If any deaths occurred amongst people they knew, they were asked to recall the circumstances and behaviours before their deaths. Other household data such as the original address of residence, occupation, location at the time of tsunami, behaviour during evacuation, movement since the 11 March, and current needs of the survivors were recorded.

Attention was paid to place survivors at the centre of questionnaires, not strictly bound by the questions written down, but focusing on active listening and encouraging a dialogue in order to understand the emotional status of the survivors at the time of the disaster. At the beginning, interviewers hesitated to ask questions about the tsunami experiences which caused tremendous suffering for the survivors. However, being heard by volunteer third parties can be cathartic for survivors as it is a way to ease their psychological suffering. It also allowed an honest exchange of views and opinions between the survivors and surveyors. Some interviews led to conversations that lasted for several hours.

Sample size

A total of 37 in-depth interviews were conducted, which allowed us to gather information on 55 dead and 152 survivors, totaling 207 people's behaviours during evacuation. The size of the sample was a consequence of the nature of interview which is more time consuming compared to standardized quantitative survey. The small sample size particularly of those directly interviewed is a limitation, together with the rest of the sample collected on recall memory of the survivors.

⁸ Hagiwara et al, 2011.

⁹ Hagiwara et al, 2011.

Box 1: The importance of standardising survey methodology

The survey in Japan was designed in order to capture the behavior as well as psychology of survivors during the Great East Japan Earthquake and tsunami in Rikuzentakata on the Sanriku coastline in Japan. Other surveys seem to have been designed in a similar way taking into account cultural and social factors relevant for the areas. Different set of questions and sampling procedure have been developed depending on the countries of the disaster. The difficulties in making a comparative analysis between this study and the surveys in Sri Lanka and Indonesia underline a strong need to standardise survey methodology on tsunami mortality. The differently designed surveys limit the possibility of a full comparison between the three cases. While this partially reflects different characteristics of the affected areas, it is also a major constraint in the analysis of human behaviors during and after a disaster.

3. Results and Comparative Analysis

Tsunami damages to buildings and human loss since the Meiji Tsunami (1896) till present is shown in Figure 1 (as of 29 July 2011). It shows that in comparison to the Meiji Tsunami (1896), the Great East Tsunami had a sudden increase in the damage to victims ratio.

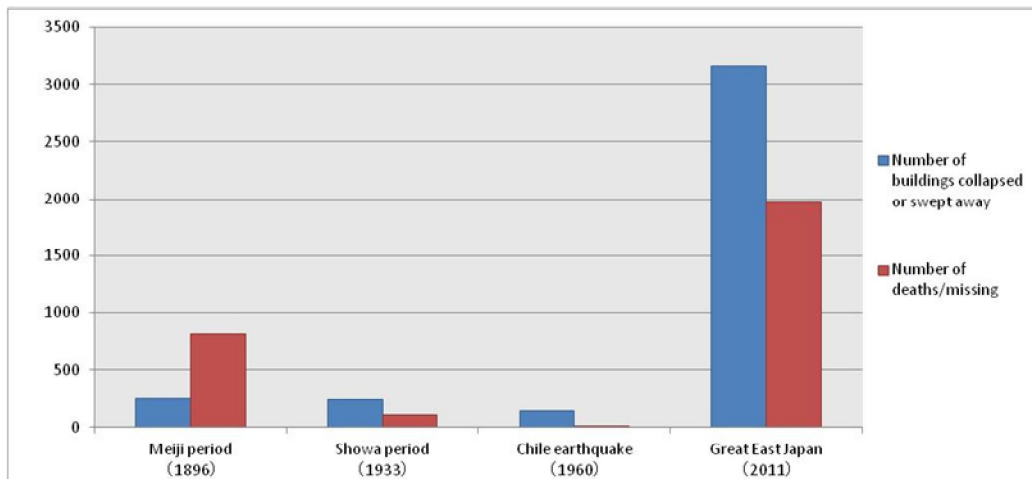


Fig. 1 Building damage and number of deaths/missing in Rikuzentakata, Iwate prefecture
Source: International Centre for Water Hazard and Risk Management (ICHARM)¹⁰

The results of the survey conducted are presented in the sections below. To better interpret the results, we use as benchmarks for a comparative analysis the data from the overall damage of the Great East Japan Tsunami and the Indian Ocean Tsunami 2004 in Indonesia and Sri Lanka.

Age of victims

Age of the victims in Rikuzentakata is analysed using the published data (as of 31 July 2011). The elderly population (60 years and above) were disproportionately affected by the tsunami. Pre-tsunami population of persons aged 60 and above were 34.9% in Rikuzentakata, higher than prefectural average (27.2%) and Iwate, Fukushima and Miyagi prefectures combined (31%).¹¹ In

¹⁰ International Centre for Water Hazard and Risk Management (ICHARM), material submitted to the Third Forensic Investigation on Disaster: Scientific survey on disaster (FORIN) working group, compiled by CTI Engineering Co. Ltd, 22 June 2011.

¹¹ Figures from Iwate prefecture and the National Police Agency.

the three prefectures, 65% of victims were aged 60 or above.¹² This seems to indicate that difficulty in mobility associated with increasing age delayed evacuation of many elderly persons. On a Friday afternoon when the tsunami occurred, most adults were at work, unable to evacuate with the elderly members of the family from home promptly. The survey in Rikuzentakata found that many returned home to check on the safety of their families, further delaying evacuation.

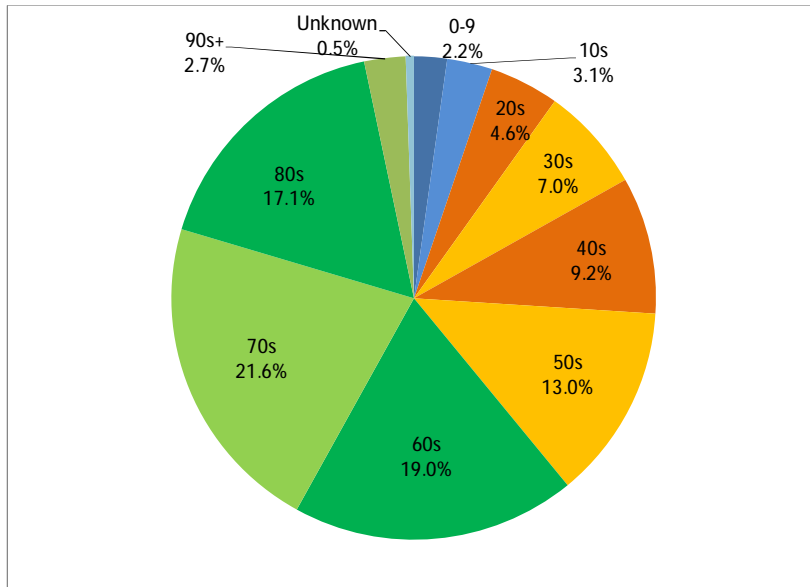


Fig. 2 Age distribution of deaths in Rikuzentakata

Source: Based on figures from Iwate prefecture and the National Police Agency, Japan

Mortality rate shows deaths as a percentage of pre-tsunami population. Children were disproportionately affected during past three tsunamis in Japan, while in the Great East Japan Earthquake, they were evacuated promptly from school on a school day afternoon. Some cities such as Kamaishi City in Iwate prefecture had a zero mortality of schoolchildren during the tsunami thanks to systemic and most effective tsunami education, which is mainstreamed into all school curricula.¹³ In contrast, as Figure 7 shows, in Aceh in Indonesia higher mortality rate was observed amongst young children (0-9 years) as well as the elderly (70 and above). This holds true also for Sri Lanka (see Figure 9) with high mortality amongst children (31.8% for 0-5 years, 23.7% for 5-9 years) and the elderly (15.3% for 50+ years), compared to young adults (20 to 29 years) who had a mortality rate of 7.4%.¹⁴

Sex of Victims

By the simple means of a victims composition analysis (number of victims by age group and gender / total number of victims), it is possible to see that in Rikuzentakata, more women died in absolute numbers compared to men. The likelihood of a woman dying increases with age in Rikuzentakata, while at the national level, the composition of death by gender and age group is more balanced, except that women above 80 are more likely to die than their male counterpart.

¹² Cabinet Office, Bosai Hakusho, 2011.

¹³ Kamaishi City, http://www.ce.gunma-u.ac.jp/kamaishi_tool/index.html (Accessed 25 December 2011).

¹⁴ Nishikitori et al, 2006.

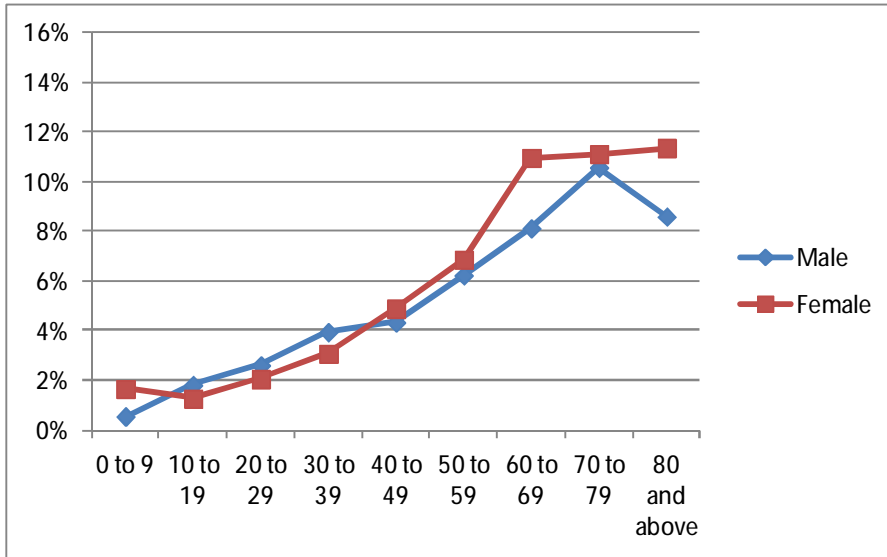


Fig. 3 Victims composition in Rikuzentakata, Iwate prefecture

Source: Compiled by author based on published figures from Iwate prefecture and the National Police Agency, Japan

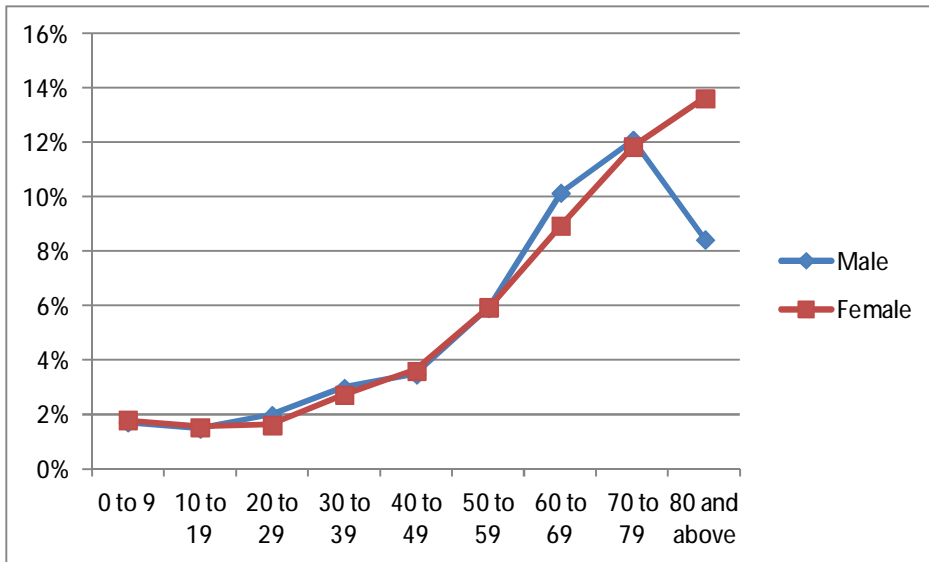


Fig. 4 Victims composition in three prefectures of Iwate, Miyagi and Fukushima

Source: Compiled by author based on published figures from the National Police Agency, Japan

At the national level, the mortality of male and female is largely the same across all the age groups (Figure 5).¹⁵ In contrast, in Rikuzentakata, the elderly (above 70 years) - particularly male - show a higher mortality from tsunami. In particular, the likelihood is higher by more than 4% for 80 years and above, while at the national level, there is less variation across age categories. Reasons for the higher male mortality may be related to preferential treatment given by men to women to evacuate first, as well as men taking risky behavior during the disaster. During the

¹⁵ Based on figures by the National Police Agency.

survey in Rikuzentakata, there were reports of men trying to save others from drowning during the tsunami disaster.¹⁶

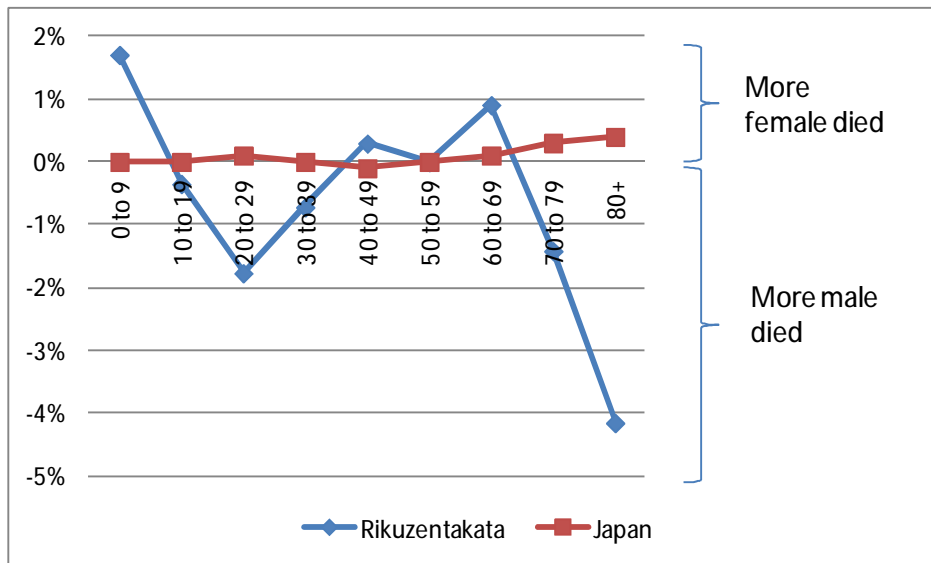


Fig. 5 Difference in mortality rate between male and female at national and Rikuzentakata

Source: Compiled by author based on figures published by Iwate prefecture and the National Police Agency, Japan

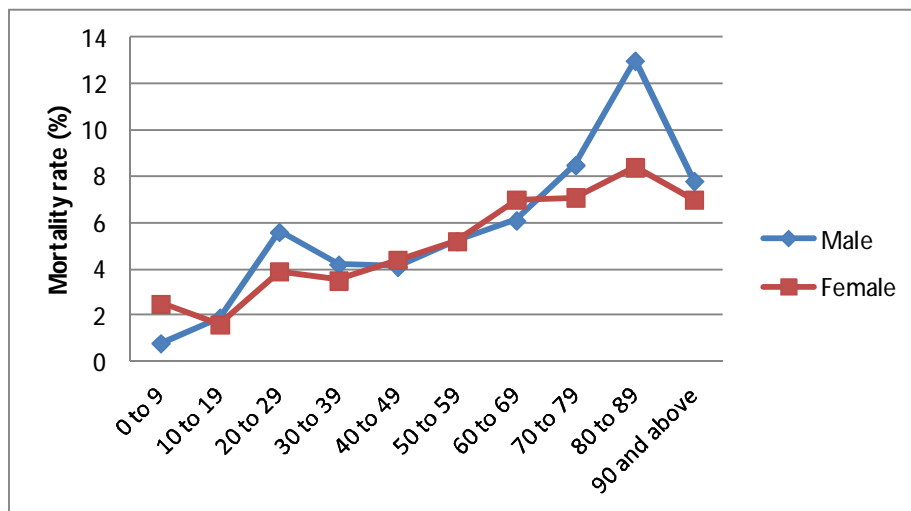


Fig. 6 Mortality rate (deaths as a percentage of pre-tsunami population) in Rikuzentakata, Iwate prefecture

Source: Compiled by author based on published figures from Iwate prefecture and the National Police Agency, Japan

In contrast, in Aceh in Indonesia, the tsunami mortality survey of 1,653 households found higher mortality among youngest children (aged 0-9 years) and the elderly (70+). Women were found to have consistently higher mortality than male population in any age group, with nearly two-thirds of dead or missing. With all ages combined, women were 1.44 times more likely to die in the

¹⁶ Hagiwara et al, 2011.

tsunami. Therefore both mortality and composition index seem to show higher female vulnerability.

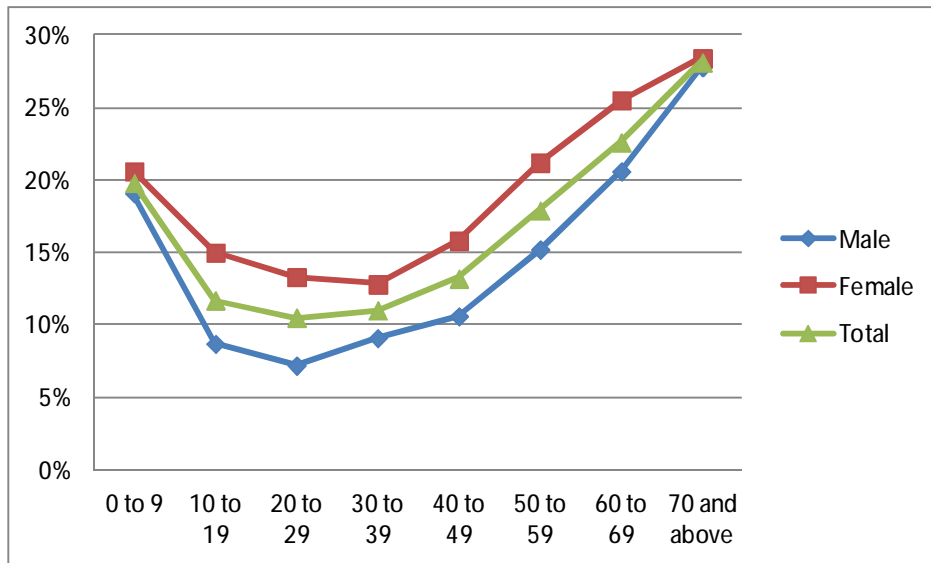


Fig. 7 Age and sex specific mortality rates among tsunami-displaced households in Aceh Province, Indonesia

Source: Adapted by author based on Doocy et al, 2007

Similarly, in Sri Lanka, higher female mortality was observed (17.5% vs. 8.2% for males) across all age groups. The census conducted in Sri Lanka in tsunami-affected areas showed that women represented the majority of casualty: out of more than 13,000 dead and missing persons, 65% were women. Females revealed highest share of mortality in the age group 19-29 years, at 79 per cent, which suggests a higher vulnerability amongst women who were at home with children at the time of the tsunami and the more fortunate fate of the young men who were at sea or out in the agricultural fields.¹⁷ Therefore, both mortality and composition analysis leads toward higher female vulnerability during the tsunami in Sri Lanka.

¹⁷ UN Statistics Division, The World's Women 2010, p.151.

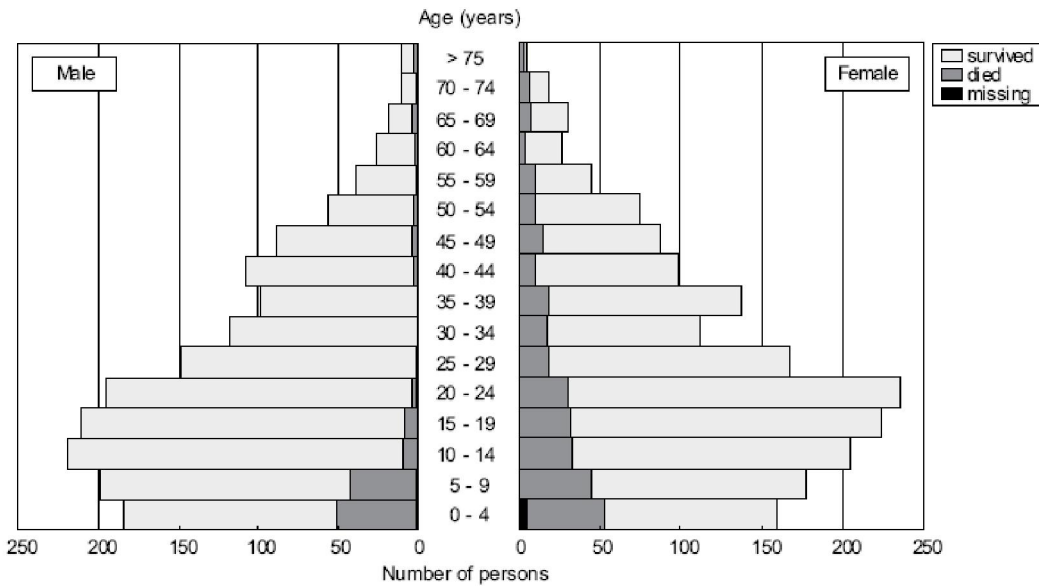


Fig. 8 Age/sex pyramid of 3,533 internally displaced persons due to the 2004 Indian Ocean tsunami in Ampara district, Sri Lanka. The number of persons surviving, dead and missing by age group is shown for males and female separately.
 Source: Nishikitori et al, 2006

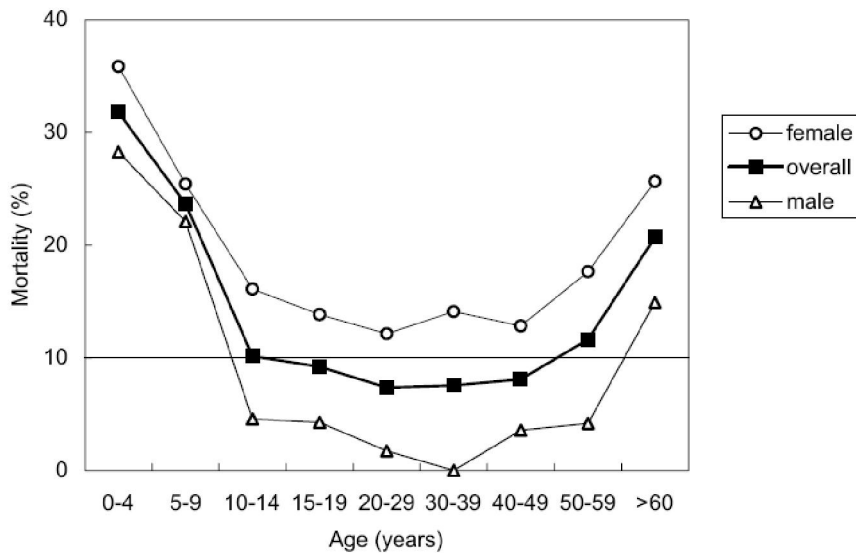


Fig. 9 Age-band specific mortality among 3,533 internally displaced persons due to the 2004 Indian Ocean tsunami in Ampara district, Sri Lanka.
 Source: Nishikitori et al, 2006

Although the survey in Sri Lanka did not go into an in-depth analysis of why females were more likely to die, Oxfam highlighted excerpts from the interviews with survivors.¹⁸

¹⁸ Oxfam International, *The tsunami's impact on women*. Oxfam Briefing Note, March 2005.

“In rural coastal areas many men were out fishing at sea, and many survived, as the waves passed under their small boats. The waves hit the shore, flattening the coastal communities and killing many of the women and children, most of whom would traditionally be at home on a Sunday morning. In agricultural areas, men were often out on the fields, working, or doing errands away from the house, or were taking produce to the markets. Again, women were at home with children, and when the wave struck, lost vital seconds in trying to gather children to them. The sheer strength needed to stay alive in the torrent was often also decisive in who survived. Many women and young children, unable to struggle to stay on their feet, or afloat, in the wave, simply tired and drowned.”¹⁹

The same report highlighted other factors contributing to higher mortality amongst females such as women’s traditional role as caretakers of the young and the elderly, and the inability of women to swim.

The Post-Nargis Joint Assessments in Myanmar similarly concluded that more women died or went missing during the May 2008 cyclone. Out of the over 85,000 people dead and 53,000 people missing in June 2008, 61 per cent were women.²⁰ In some of the villages, the figure was as high as 68 per cent for the age category 18 to 60 years.

The case of the 2004 tsunami in Indonesia and Sri Lanka and 2008 cyclone in Myanmar highlight the vulnerability of women in disasters. However, the higher tsunami mortality amongst men in local places such as Rikuzentakata suggest that gender differences may vary across regions, as well as by type of hazards. A study on male-female flood death ratios in Australia showed that out of the 1,513 deaths between 1930 and 1996, 81 per cent were male.²¹ Over the period studied, despite the male-female death ratio fluctuating between 10:1 and 1:1, it continued to disfavor men, suggesting that men were more prone to take risks or more likely to be involved in risk taking activities.²² The same may be said of the case in Rikuzentakata where men were more likely to be involved in risky activities than women.

Location

The interviews in Rikuzentakata found that people who found themselves at home were more reluctant to evacuate, compared to those who were already outside. One of the most common reasons for not leaving the house was to tidy up after the earthquake knocked many things over. Several people were also waiting for their family members to come home.

In Sri Lanka, survey found that being indoors was associated with higher mortality at 13.8%, compared to being outside, at 5.9%.²³ The result could be interpreted as a result of lower mobility and readiness to evacuate, as many people showed reluctance to leave their homes and belongings after the Great East Japan Earthquake. In the future tsunami surveys, it would be useful to include a question on location at the time of the disaster to identify whether higher mortality is associated with being at home, other indoor place or outdoor.

Profession

In terms of profession, the data does not highlight any significant correlation, which may be a result of a small sample size. As expected, retired people have higher mortality, as this is likely to be combined with increased age, as well as the factor of being at home.

¹⁹ Oxfam International, *The tsunami’s impact on women*. Oxfam Briefing Note, March 2005, pp.3-5.

²⁰ Myanmar Government, Association of Southeast Asian Nations and the United Nations, 2008.

²¹ Coates, Lucinda, “Flood fatalities in Australia, 1788-1996”, *Australian Geographer*, vol. 30:3, pp. 391-408, 1999.

²² Coates, 1999.

²³ Nishikitori et al, 2006, p.1.

In Sri Lanka, fishing as the household occupation was significantly associated with increased mortality (15.4% vs. 11.2% for other occupations) when statistical analysis was made using Stata, with data from 859 households.²⁴ It would be important to include questions regarding profession in a tsunami mortality survey to identify to what extent being a fisherman adds to risk of mortality.

Evacuation

In Rikuzentakata, following the earthquake which occurred at 2.46pm, the first wave of tsunami arrived around 3.30pm. During this period, the Japan Meteorological Agency issued large tsunami warning at 3 minutes after the earthquake at 2.49pm, and at the same time the cities began to give evacuation warnings to residents through community wireless broadcasting systems.

Out of 190 residents that we had information of, more than 80% (147) did not evacuate immediately (within five minutes). Amongst those who evacuated immediately, only one person died, with the remaining 32 people surviving. Out of 147 people who did not evacuate immediately, 28% died. There were 44 minutes between the earthquake and arrival of the first tsunami, making it clear that those who escaped before the tsunami hit had a much higher survival rate.

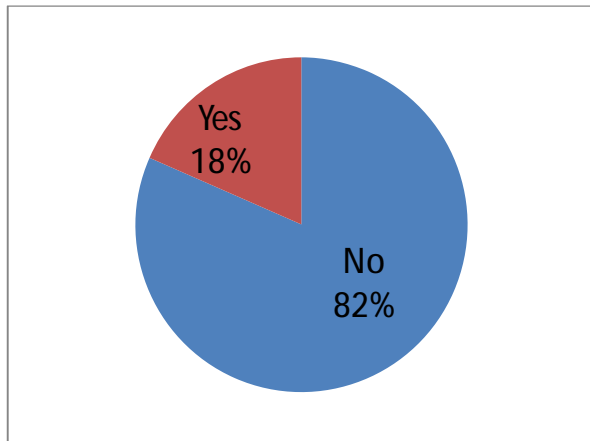


Fig. 10 Did you evacuate immediately?

Source: Hagiwara et al, 2011

In Rikuzentakata, the survey results showed that as long as people evacuated, there was a very high chance of survival. The longest timeframe for evacuation given by a respondent was 45 minutes, who evacuated when he saw the tsunami coming, which was visible through the cloud of dust fast approaching from the distance.²⁵

²⁴ Nishikitori et al, 2006, p.1.

²⁵ Hagiwara et al, 2011.

Box. 2: Shop owners during the disaster

The owner of a watch shop in Rikuzentakata was away from his shop during the earthquake. Worried about his shop, he headed back immediately to check the status of the premises. Another shop owner of a bicycle store ignored several calls of his neighbours to evacuate as he was rearranging the bicycles that had fallen during the quake. While it seems obvious that the best survival strategy would be to promptly evacuate, many shop owners, who felt the need to protect their businesses and assets, did not make it to safe ground before the tsunami came. Their cases remind us strongly of the importance to drop all our attachments when an earthquake comes, and to evacuate as soon as physically possible.

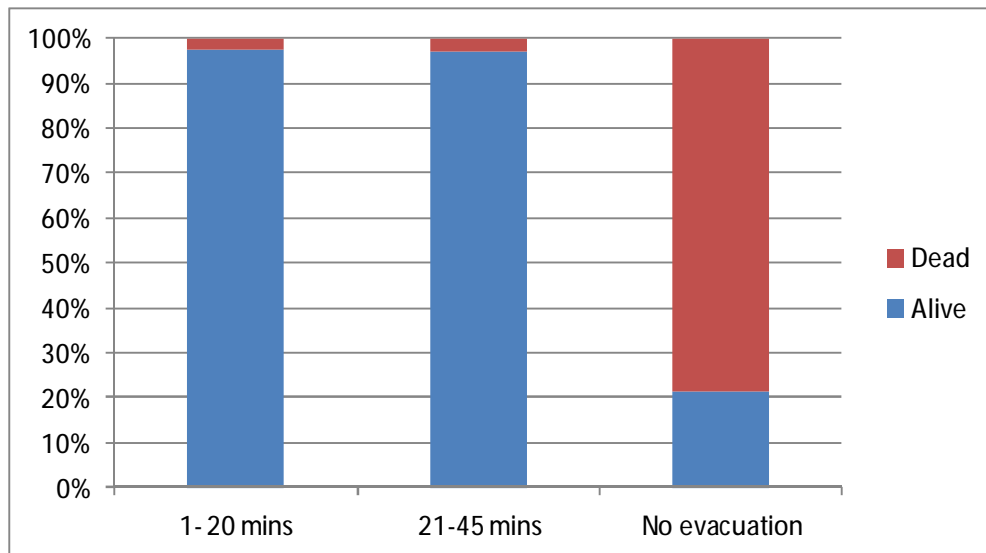


Fig. 11 When did you evacuate after the earthquake?

Source: Compiled by author based on survey results from Hagiwara et al, 2011

The 44 minutes timeframe is not such a short amount of time, allowing those who evacuated late enough time to move to a safe place. However, there is no way to know exactly, in advance, when a tsunami will hit, therefore a prompt evacuation is the best strategy to increase the chances of survival. In fact, in 1993, the tsunami that hit Okujiri Island arrived as early as 3-5 minutes after the earthquake.²⁶ In the Tokai Earthquake that is expected to occur, in Yaizu-city of Shizuoka prefecture, the possibility of tsunami arriving as soon as one minute after the earthquake has been pointed out. In the future, the tsunamis that will hit Sanriku Coastline are not guaranteed to give a 44 minute timeframe to allow for evacuation. If the earthquake occurs directly underneath, triggering a tsunami, it is possible that a tsunami would follow immediately as it happened in Okujiri Island.²⁷

Why did people fail to evacuate immediately? Many said they did not think that the tsunami would reach their house; others were waiting for a family member to pick them up, or they returned home to check up on their family. Some waited until they received the warning to evacuate, which suggests that for some reason they did not hear the tsunami evacuation warning.

²⁶ Hagiwara et al, 2011.

²⁷ Hagiwara et al, 2011.

There were a few who worked as volunteer firefighters, and one person cited that their boss did not allow them to evacuate immediately.²⁸

In comparison, in Aceh, Indonesia, the proximity of the fault line where the tsunami originated meant there was only 15 minutes between the earthquake and the tsunami hitting the coastline.²⁹ Evacuation to higher ground may have been possible in some villages if warning had been given immediately, which was not the case.³⁰ The timing of the 2004 earthquake, which occurred at 7.58am local time on a Sunday morning, also meant that many families were at home when the tsunami struck.

Nearly 40% of those directly interviewed by the Rikuzentakata survey told their neighbour to evacuate, showing strong community ties.³¹ By alerting other people who are nearby, more people can be made aware of the imminent risk and be able to take actions to evacuate. This is especially beneficial for the elderly who live alone or those who cannot evacuate by themselves by alerting them to the disaster risk. However, it must be noted that it is against the “Tsunami Tendenko”, the traditional knowledge in the Sanriku region passed on from ancestors to evacuate alone in the case of tsunami. It could also endanger people’s lives by delaying evacuation.

The origin of “Tendenko” is not clear, but in the past, it was not uncommon for tsunamis to completely wipe out several generations of families. During a time when family traditions and values were the fundamental basis of society, Tendenko may have been one survival mechanism of preserving families. In reality, however, only one interviewee evacuated without his/her family.³² There were also reports of those who saved their neighbours from drowning. On the other hand, a number of people reportedly returned home after evacuating once in order to check on their family members and did not come back as they became engulfed in the following tsunami waves. Furthermore, many policemen, firemen and local government officials who gave tsunami warnings to residents became victims of the tsunami themselves. Considerations for their safety must be a priority even if they were exercising their professions. The decision to stick to Tendenko will be up to the individual and the family to decide, but the saying needs to reflect the needs of modern society, such as making disaster preparedness plans to consider many elderly persons who live alone.³³

Evacuation drills

Asked whether they participated in tsunami evacuation drills, 70 per cent (31 out of 44) were reported to have taken part in previous drills, showing a high level of participation.³⁴ In contrast, asked whether the drills were useful in the recent tsunami experience, only 35 per cent (11 out of 31) gave positive responses, whilst more than half (65 per cent) said they were not useful.³⁵ This was because a number of designated evacuation centres were affected by the tsunami after people had evacuated there. Some of the centres were also either lower ground or closer to sea than the mountains, showing that it only took into consideration earthquake evacuation plan. It appears that Rikuzentakata City needs to revise its disaster preparedness plan to reflect future tsunami risks.

²⁸ Hagiwara et al, 2011.

²⁹ Jo da Silva, *Lessons from Aceh: Key considerations in post-disaster reconstruction*, p.42. Disaster Emergency Committee, 2010.

³⁰ Jo da Silva, 2010.

³¹ Hagiwara et al, 2011.

³² Hagiwara et al, 2011.

³³ Hagiwara et al, 2011.

³⁴ Hagiwara et al, 2011.

³⁵ Hagiwara et al, 2011.

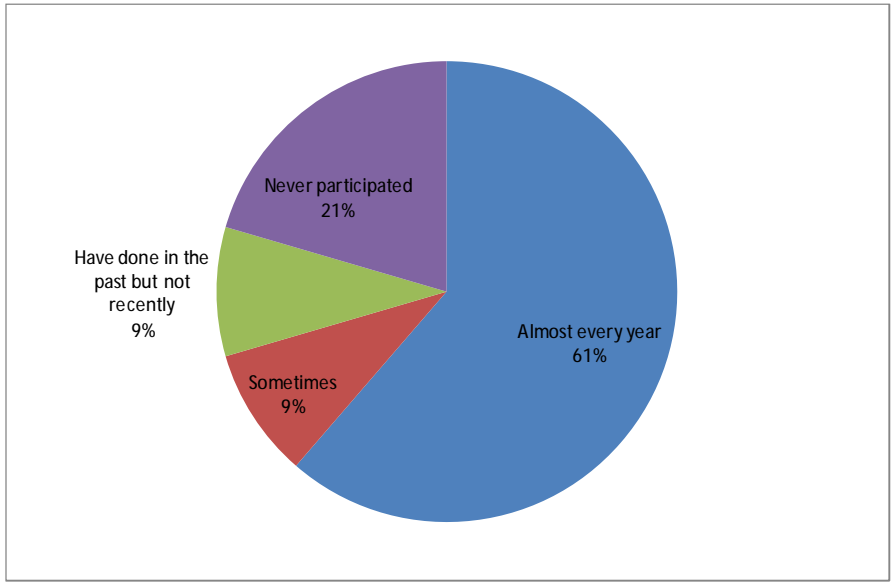


Fig. 12 Do you participate in community evacuation drills?
 Source: Hagiwara et al, 2011

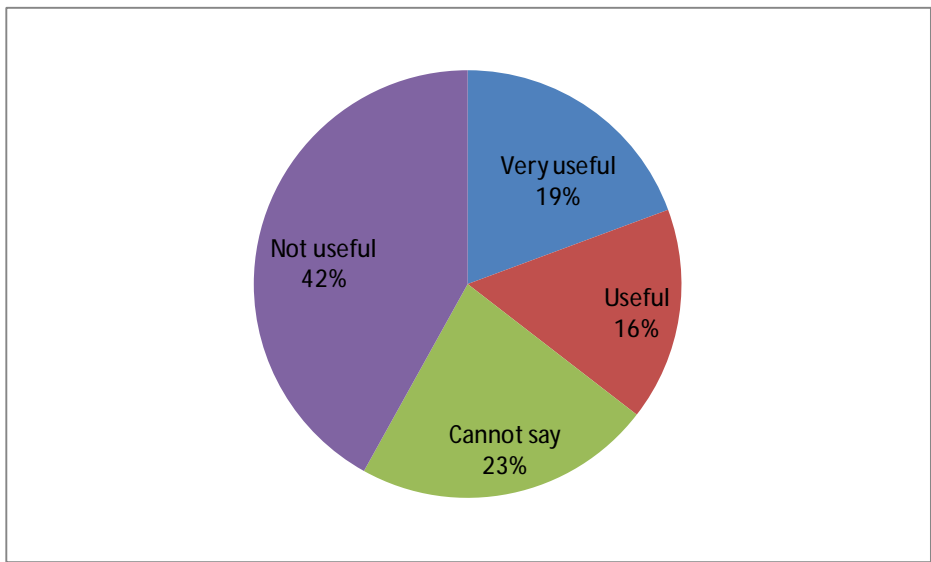


Fig. 13 Did the community evacuation drills prove useful during 11 March disaster?
 Source: Hagiwara et al, 2011

Box. 3: Do not wait to evacuate

One couple in Rikuzentakata, Iwate prefecture had an extremely unfortunate fate following the earthquake. As soon as the strong tremors came, the couple in their 50s knew of tsunami risks, but may not have realized how long they had before the first waves hit their house. The husband immediately took his car to evacuate their dog to a friend's house, while the wife stayed at home to pack the valuables. Upon his return, the couple was planning to evacuate after packing a few more items into the car, when the wave came and it was too late. Although the dog was saved, waiting too long to pack valuables meant that the dog was left without the owner.

Box. 4: Employers' awareness about disaster risk can save lives

One resident in her 50s was at her part-time work when the earthquake struck Rikuzentakata. Alarmed by the large magnitude of the quake, and based on her previous tsunami experience during the Chile tsunami of 1960, she immediately thought of tsunami risk. However, she reports she could not gain approval from her boss to evacuate herself as well as the rest of the employees in this medium-sized company: her boss instructed the employees to evacuate only when tidying up from the earthquake was finished. Eventually, after 20 minutes following the earthquake, she managed to convince her boss and others to evacuate by car individually and shortly afterwards the company was swept away by the tsunami. In another factory, the employer feared tsunami risk and immediately evacuated all the factory workers, many of whom immigrants from China. They had reached safe ground by the time tsunami came. In one care centre in the same city, not believing that the tsunami would come but with a sense of responsibility for the safety of the elderly persons, the CEO evacuated all his employees and the residents of the centre, all but himself. He was the only one not to have survived the tsunami. These experiences teach us that whilst the primary concern of employers lies in the continuity of the business, they play a crucial role in determining the safety of citizens. Priority for everyone, including employers themselves is to evacuate as soon as possible when a disaster occurs.

4. Conclusions

The purpose of this paper was to identify vulnerable groups and risk factors during the Great East Japan Earthquake and compare experiences from the 2004 Indian Ocean Tsunami. There are several limitations to this study. Firstly, the main constraint is the small sample size of the survey in Rikuzentakata. Secondly, since much of the analysis arising out of the survey focuses on displaced households only, its conclusions may not apply to the broader tsunami-affected population. Reports were given during the interviews about many families who were entirely perished, or only leaving the children behind, thereby being excluded from the survey. Similarly, since the present study focuses on IDPs, the mortality rates among households that were not displaced are not captured. Thirdly, since the survey was conducted based on memories of the interviewees, recall error may be expected on the rest of the sample.

The main finding from the survey in Rikuzentakata and analysis of victims population in Iwate, Miyagi and Fukushima prefectures is that men tend to have a slightly higher mortality than women, particularly amongst the elderly (above 60 years old).³⁶ Their vulnerability may be attributed to risky behavior such as rescuing others, their role as volunteer firefighters, as well as being civil servants who had the duty to give out evacuation warnings to residents till the last minute before tsunami struck. This finding is in contrast to that of Sri Lanka and Indonesia where

³⁶ Hagiwara et al, 2011.

women were consistently more likely to die. The Great East Japan Earthquake and the tsunami also highlighted an extreme vulnerability of the elderly in general during the disaster, representing 64.4% of the total deaths,³⁷ explained by their reduced mobility and weak physical strength, delaying evacuation. The elderly are also more dependent on evacuation by car which often experienced traffic jams. Communities need to give due considerations for evacuation of the elderly, through the help of families and neighbours. Further research is needed to understand why men experienced higher mortality in the Great East Japan Earthquake.

The difficulties in making a comparative analysis between this study and the surveys in Sri Lanka and Indonesia underline a strong need to standardize survey methodology. The three surveys asked different questions, severely limiting the possibility of a full comparison between the three cases. While this partially reflects different characteristics of the affected areas, it is also a major constraint in the analysis of human behaviors during a disaster. A major advancement in the field of behavioral analysis could be to identify the most relevant features that emerged in past studies, including the present survey, and propose a set of common questions to be used in all future comparative studies. More specific questions could be added to this common set of basic one in order to properly capture the different social, cultural, economic and geographic circumstance of the specific disasters.

Based on the difficulties met in the present study, it seems that the questions which need to be included during a standard mortality survey are, among others: gender, age, location at the time of the disaster (inside/outside and other specific locations), level of education, whether the respondent received tsunami education, family composition, household income, household profession (standardized groups for occupation need to be developed), whether they attended evacuation drills, early warning received (and time), time until evacuation, and ability to swim. The demographic data at normal times is crucial in understanding who is most at risk from disasters, which needs to include gender, age and by area.

³⁷ The National Police Agency, Japan.

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