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The findings from the survey on the Great East Japan Earthquake originate from an unpublished study by Yoko Hagiwara, Katsuhito Miyake, Tadashi Nakasu, Yuichi Ono, and Mari Sawai.² All data on mortality and risky behavior during the Great East Japan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*

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 Unpublished study in Japanese.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 tsunami 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. <u>http://www.mofa.go.jp/mofaj/saigai/index.html</u> (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 disproportionally 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, <u>http://www.ce.gunma-u.ac.jp/kamaishi_tool/index.html</u> (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







https://www.yunbaogao.cn/report/index/report?reportId=5_7788