Post-nuclear disaster evacuation and survival amongst elderly people in Fukushima: a comparative analysis between evacuees and non-evacuees

Shuhei Nomura¹, Marta Blangiardo¹,², Masaharu Tsubokura³, Yoshitaka Nishikawa⁴, Stuart Gilmour⁵, Masahiro Kami³, Susan Hodgson¹,²

¹. Dept. of Epidemiology and Biostatistics, School of Public Health, Imperial College London, UK
². MRC-PHE Centre for Environment and Health, Dept. of Epidemiology and Biostatistics, School of Public Health, Imperial College London, UK
³. Division of Social Communication System for Advanced Clinical Research, the Institute of Medical Science, University of Tokyo, Japan
⁴. Soma Central Hospital, Japan
⁵. Dept. of Global Health Policy, Graduate School of Medicine, University of Tokyo, Japan

Introduction

Considering the health impacts of evacuation is fundamental to disaster planning, especially for vulnerable elderly populations; however, evacuation-related mortality risks have not been well-investigated. This analysis compared survival of evacuated and non-evacuated residents of elderly care facilities, following the Great East Japan Earthquake and subsequent Fukushima Daiichi nuclear accident on 11th March 2011.

Objective

To assess associations between evacuation and mortality after the Fukushima nuclear accident.

Methods

Design, Setting, and Participants

The study population comprised 1,216 residents admitted to seven elderly care facilities in Soma city (non-evacuees) and Minamisoma city (evacuees) located 20-40 km from the nuclear plant in the five years before the accident (Figure 1). Demographic and clinical characteristics were obtained from medical records. Evacuation histories were tracked until mid 2013. The impact of the disaster and of evacuation on mortality risk was assessed.

Figure 1: Geographical location of Soma city and Minamisoma city

Main Outcome Measures

Hazard ratios in evacuees versus non-evacuees using random-effects Cox hazards models, and pre- and post-disaster survival probabilities.

Results

Hazard Ratios

Experiencing the disasters did not have a significant influence on mortality (hazard ratio 1.10, 95% CI: 0.84 – 1.43) after adjusting for confounders, including city. Evacuation was associated with 1.82 times higher mortality (hazard ratio 1.82, 95% CI: 1.22 – 2.70), with the initial evacuation from the original facility being associated with 3.37 times higher mortality risk (95% CI: 1.66 – 6.81) than non evacuation (Table).

Table: Random-effects regression model of survival

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1: Model for evacuation impact (pre versus post disaster data)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation</td>
<td>No</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.82</td>
<td>1.22 – 2.70</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Experience of disaster</td>
<td>No</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.10</td>
<td>0.84 – 1.43</td>
<td>0.49</td>
</tr>
<tr>
<td>Part 2: Model by evacuation stage (post disaster data)††</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation type</td>
<td>None</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>3.37</td>
<td>1.66 – 6.81</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Subsequent</td>
<td>1.93</td>
<td>0.90 – 4.14</td>
<td>0.09</td>
</tr>
</tbody>
</table>

† Adjusted for City, Sex, and Age
†† Adjusted for Sex, Age, and Care-level

Pre- and Post-Disaster Survival Probability

No significant difference in pre- and post-disaster survival time was observed in Soma (non-evacuees) (Wilcoxon test: p=0.2), while in Minamisoma (evacuees) the post-disaster survival was significantly reduced compared to pre-disaster survival (p<0.001) (Figure 2)

Figure 2: Estimated pre- and post-disaster survival in Soma and Minamisoma

Conclusions

The competing risks to health of radiation exposure and evacuation must be balanced. Following the Fukushima accident evacuations of some facilities were inevitable due to lack of staff and other resources, but at other sites sheltering in situ might have minimized mortality risk. The government should consider updating its requirements for emergency planning for elderly facilities and ensure that, in a disaster setting these facilities have the capacity and support to shelter in place for, at least, sufficient time to adequately prepare initial evacuation.

Acknowledgments

We thank Dr. Hidekio Tachiya, Dr. Reiko Moriyasu and Dr. Yuko Yamaguchi for data collection and management, and for so readily complying with our interview requests.