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Letter to the Editor

Factors influencing the occurrence of cardiopulmonary arrest in the Great East Japan Earthquake disaster

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On March 11, 2011, the Great East Japan Earthquake hit the northeast region of Japan with a magnitude of 9.0 on the Richter scale, which was one of the largest ocean-trench earthquakes recorded in Japan [1]. The epicenter of the Earthquake was located at 38° latitude, 06.2′ North, 142° longitude, 51.6′ East, where it was closest to our Miyagi Prefecture (Fig. 1A). In the Miyagi prefecture, there was the largest amount of damage and victims including 9538 dead, 1269 missing persons, and 238,114 destroyed houses as of August 8, 2014, especially in the seacoast areas by the tsunami [2].

It had been previously reported that cardiopulmonary arrest (CPA) could be triggered by earthquake disaster [3–5]. Recently, we also reported that the CPA was significantly increased after the Great East Japan Earthquake [6], however, the details remain to be elucidated. In this study, we examined the factors influencing the occurrence of CPA after the Earthquake.

In the present study, we extracted 5857 patients with CPA from all ambulance transport records in the Miyagi Prefecture from February 11 to June 30 (4 weeks before to 16 weeks after March 11) in each year of 2008–11 (n = 124,152). Among those CPA patients, as we excluded 3323 patients caused by trauma or diseases with non-cardiac origin, 2534 patients with CPA of presumed cardiac origin were finally subjected to analysis. The Ethics Committees of Tohoku University Hospital approved this study protocol.

To assess the differences in the occurrences of CPA between 2011 and the previous 3 years, we used the Poisson regression model, as previously reported [6]. Sub-group analyses were performed for age (<75 or ≥75 years), sex, and residence (seacoast or inland area). We defined the municipalities facing the Pacific Ocean as the seacoast area where the Tsunami directly attacked and the remaining inner area as the inland area (Fig. 1A). Furthermore, to compare the effects of the 3 factors used for dividing sub-groups on the change in the incidence of CPA after the Earthquake, we performed multivariate logistic regression analysis and calculated odds ratios (ORs) of CPA patients in 2011 to those of previous 3 years during the following 3 periods; March 11–24 (0–2 weeks after the Earthquake), March 25–April 7 (2–4 weeks after the Earthquake), and April 8–23 (0–2 weeks after the largest aftershocks). All statistical analyses were performed using R 2.15.0 (www.r-project.org/). $P < 0.05$ was considered to be statistically significant.

In the whole patients, the weekly occurrence of CPA was significantly increased with the bimodal peaks noted in the first 2 weeks after the Earthquake (March 11, 2011) and after the largest aftershock (April 7, 2011) compared with the previous 3 years (Fig. 1B). Sub-group analyses showed that the occurrence of CPA was significantly increased soon after the Earthquake in all groups, whereas the second peak after the aftershock was noted only in female, elderly and inland patients (Fig. 2A). In addition, elderly and seacoast patients had a sustained increase in the occurrence of CPA over the period of 4 weeks after the Earthquake. Multivariate analysis demonstrated that significant influence of age ≥75 years was noted on the increase in CPA [1.82 (1.04–3.20), P = 0.04] in 0–2 weeks after the aftershock and that female gender [OR (95% CI); 1.57 (0.97–2.54), P = 0.07] and seacoast residence [1.54 (0.91–2.59), P = 0.11] tended to correlate with the increase in CPA during 0–2 weeks and 2–4 weeks after the Earthquake, respectively (Fig. 2B).

It has been previously reported that CPA could be triggered by abrupt stress such as earthquake disaster [4,6,7] and there were individual differences in the response to stress [4], while the details remain to be elucidated. The present study showed that the occurrence of CPA was increased with the bimodal peaks after the Earthquake and the largest aftershock. On the other hand, the recent report which aimed at Iwate, Miyagi, and Fukushima Prefectures did not demonstrate the second peak after the aftershock [7]. As a report which investigated population-based incidence of CPA in part of Iwate Prefecture after the Earthquake indicated that the occurrence rates of CPA were significantly correlated with seismic activity [8], the largest seismic intensity of the aftershock in Miyagi Prefecture could create the second peak of the

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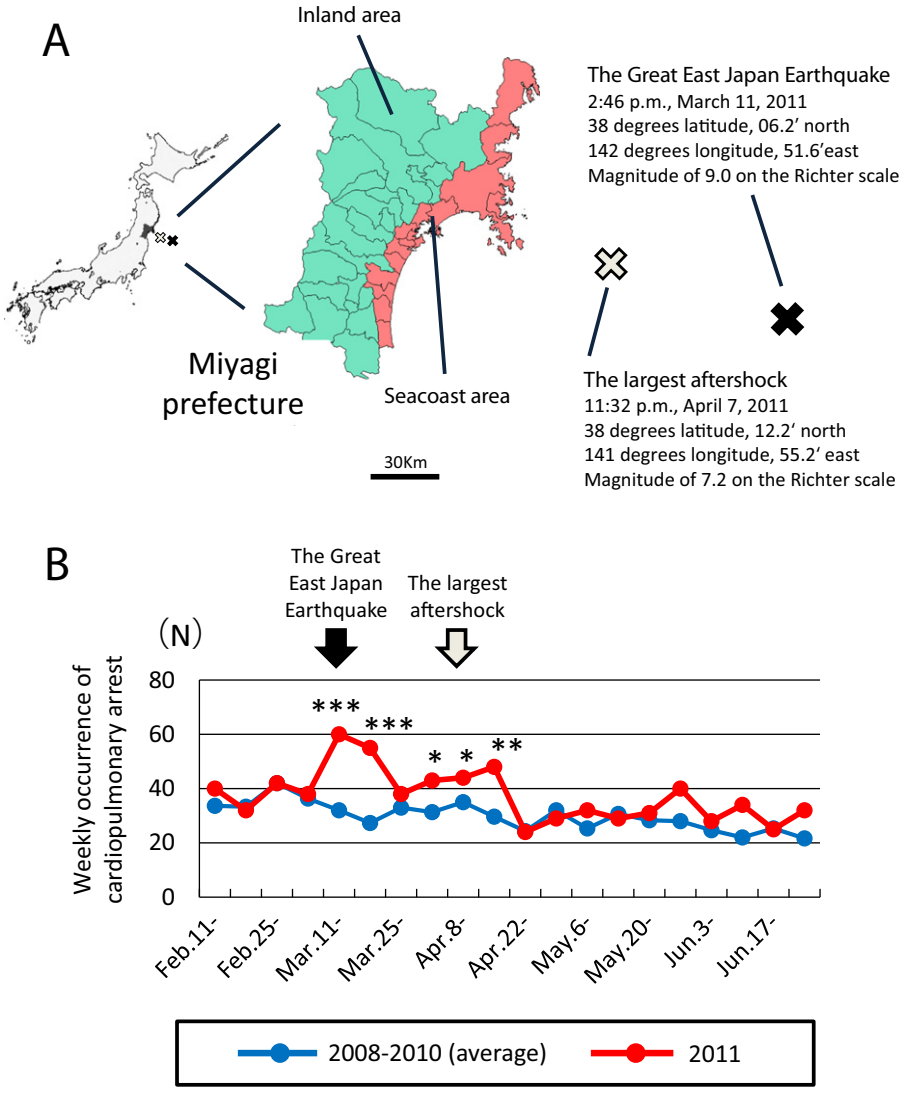

Fig. 1. (A) Location of the Miyagi prefecture and the epicenter of the Great East Japan Earthquake (black cross) and the largest aftershock (gray cross). The municipalities in the Miyagi Prefecture facing the Pacific Ocean were defined as the seacoast area (shown in red) and the other area as the inland area (shown in blue). (B) The weekly occurrence of cardiopulmonary arrest of presumed cardiac origin. *P < 0.05, **P < 0.01, ***P < 0.001 vs. 2008–2010.

occurrence of CPA. Additionally, since our Miyagi Prefecture was damaged most seriously among those prefectures [1,2], the discrepancy might be attributable to the severity of physical and emotional stress.

Moreover, the present study demonstrated that time-dependent changes of the incidence of CPA after the Earthquake were influenced by several factors including age, sex, and residence, and their influences could dramatically vary depending on the phases after the Earthquake and the occurrence of aftershocks. As previously reported, the elderly is a high risk group for cardiovascular events caused by increases in sympathetic nervous activity, coagulation activity and comorbidity such as hypertension after earthquakes [4]. The present results indicate that the elderly should be treated more carefully over the long term after a disaster, especially with aftershock occurrences, to prevent sudden death. Since the general population in developed countries including Japan has been rapidly growing older [9], it will take on added significance on how to treat the elderly people over the long term after the earthquake disaster.

Two limitations should be mentioned for this study. First, it is possible that the number of CPA patients was underestimated, especially in the seacoast areas with severe damages. Second, since this study was observationally-designed, the precise mechanisms of the increase in CPA after the Earthquake remain to be elucidated.

In conclusion, the present study indicated that the increase in the occurrence of CPA after the Earthquake was influenced by sex, age, and residence, and that their influences could change depending on the phases after the Earthquake and the occurrence of aftershock. We consider that the present study may provide a clue to reduce the occurrence of CPA in future disasters.

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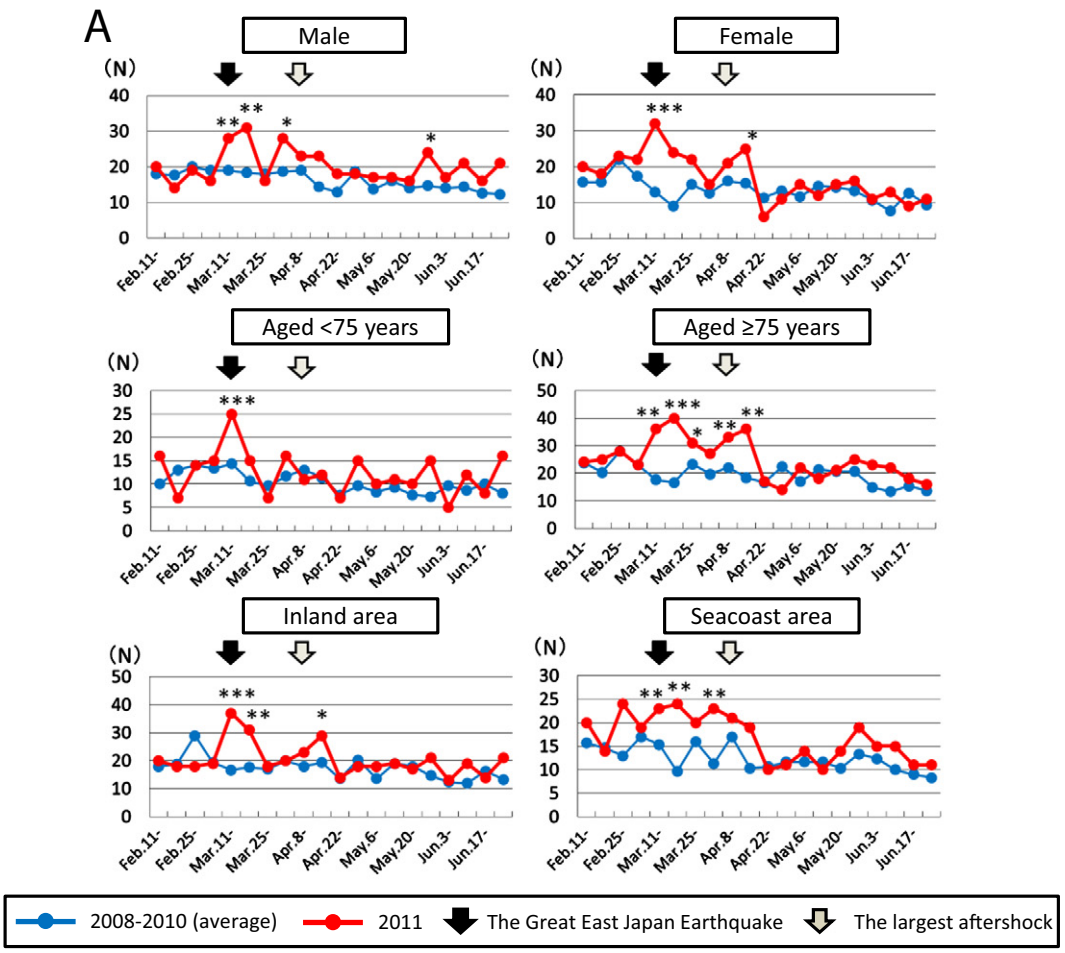
Disclosure statement

The authors have nothing to disclose.

Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.



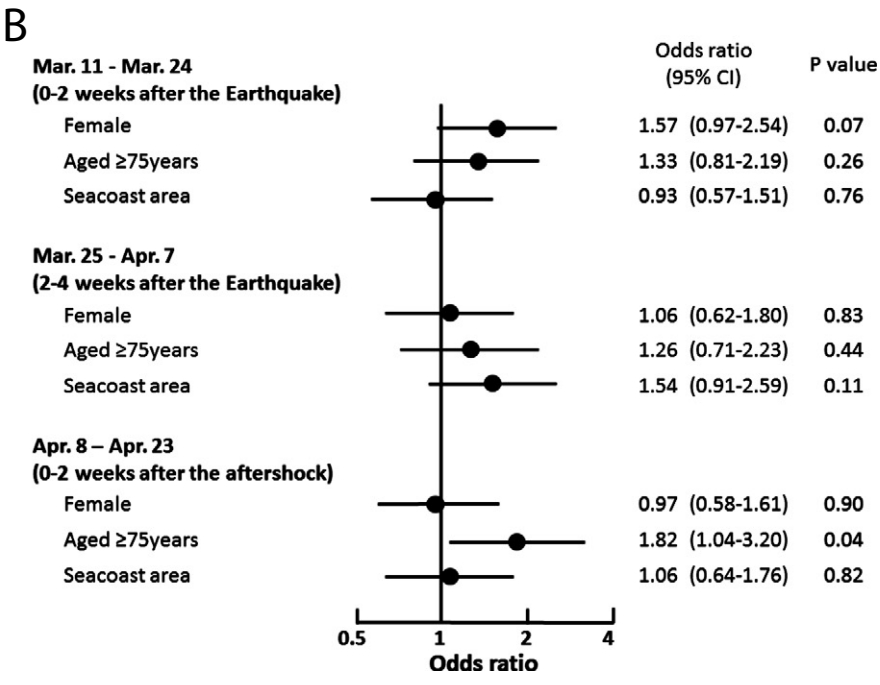


Fig. 2. (A) Sub-group analysis regarding gender, sex (<75 or ≥75 years), and residence (seacoast or inland area). *P < 0.05, **P < 0.01, ***P < 0.001 vs. 2008–2010. (B) Multivariate logistic regression to identify the factors that contributed to the increase in CPA during the following 3 periods after the Earthquake; March 11–24 (0–2 weeks after the Earthquake), March 25–April 7 (2–4 weeks after the Earthquake), and April 8–23 (0–2 weeks after the largest aftershock).

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