Clinical Features of Disaster-Related Deaths After the Kumamoto Earthquake 2016
— Comparison With the Great East Japan Earthquake 2011 —

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Background: Although “disaster-related death” as a category awarded disaster-related compensation includes death not caused by the tragedy itself, the actual definition remains unclear.

Methods and Results: In the Kumamoto earthquake 2016, compared with the Great East Japan Earthquake 2011, excessive mental and physical stress and suicide were observed significantly more as causes of disaster-related death.

Conclusions: It is essential to give maximum consideration to refugees to support them while in shelters.

Key Words: Disaster, Disaster-related death

“Disaster-related death” is a term that indicates deaths not caused by the tragedy itself but rather by disaster-induced fatigue, psychological trauma, or the aggravation of existing chronic diseases. These disaster-related deaths have been used for accreditation criteria, such as the provision of disaster-related compensation. Although disaster-related death is a very important concept in disaster-related medical practice, the actual condition remains to be defined.

In April 2016, the Kumamoto earthquake occurred. The number of aftershocks at night was very high. Therefore, many victims were afraid to return to their homes and chose to evacuate. Kumamoto Prefecture reported that the number of disaster-related deaths was 197. Kumamoto Prefecture examined all 197 cases of post-disaster deaths that were confirmed in 19 municipalities in the prefecture. The prefecture compiled data from each local government on the causes of death. We compared the results with those regarding disaster-related deaths after the Great East Japan Earthquake 2011 (GEJE) published by the Reconstruction Agency on 21 August 2012. Of all disaster-related deaths, the Reconstruction Agency examined 1,263 cases of post-disaster deaths that were confirmed in 18 municipalities in the three worst-hit prefectures of Fukushima, Miyagi, and Iwate. The agency compiled data from each local government on the causes of death. Kumamoto Prefecture reported the general status of disaster-related deaths in the Kumamoto earthquake as of August 2017 as follows. As shown in Figure A, there was no big deviation in the male:female ratio, but the proportion of male subjects was slightly higher. As shown in Table A, >91% of victims (n=180; 95% in GEJE) were aged ≥60 years or older; approximately 87% (n=172; 64% in GEJE) had chronic diseases (Figure B); and approximately 61% (n=120, 48% in GEJE) of deaths were confirmed <1 month, and 85% (n=167, 78% in GEJE) were confirmed <3 months after the earthquake (Table B).

The most common cause of death was “excessive mental and physical stress caused by the earthquake and fear of aftershocks” (n=100, 40%; 8.0% in GEJE), followed by “physical or mental fatigue from life at evacuation shelters” (n=74, 30%; 32.7% in GEJE) and “delay in initial treatment and aggravation of illnesses due to halted hospital operations” (n=43, 17%; 4.6% in GEJE; Table C). A total of 111 people died of respiratory or cardiovascular diseases, accounting for approximately 56% of the total (Table D). In total, 8.1% were accounted for by suicide (n=16, 1.0% in GEJE). The causes of death were categorized by the...
Figure. General status of disaster-related deaths after the Kumamoto earthquake at December 2017 according to (A) sex and (B) presence or absence of chronic disease.

Table. (A) Age at Disaster-Related Death After the Kumamoto Earthquake, (B) Time to Disaster-Related Death After the Kumamoto Earthquake, (C) Causes of Disaster-Related Deaths: Kumamoto 2016 vs. GEJE 2011, (D) Disaster-Related Death After the Kumamoto Earthquake According to ICD-10 Category

(A) Age (years) 0–9 10s 20s 30s 40s 50s 60s 70s 80s 90s ≥100 Total
n 2 1 0 4 1 9 27 41 70 39 3 197
% 1.0 0.5 0.0 2.0 0.5 4.6 13.7 20.8 35.5 19.8 1.5 100.0
(B) Period <1 week <1 month <3 months <6 months <1 year ≥1 year Total
n 51 69 47 23 7 0 197
% 25.9 35.0 23.9 11.7 3.6 0.0 100

(C) Cause
Kumamoto earthquake 2016 Kumamoto Prefecture GEJE 2011 Fukushima Prefecture
No. deaths 197 761
Causes
Excessive mental and physical stress caused by the earthquake and fear of aftershocks 100 (40.2) 71 (5.5)
Mental and physical fatigue from life at evacuation shelters 74 (29.7) 813 (63.2)
Delay in initial treatment and aggravation of illnesses due to halted hospital operations 43 (17.3) 237 (18.4)
Mental and physical stress due to disruption of electricity, gas and water 13 (5.2) –
Deterioration of nursing functions such as social welfare 7 (2.8) –
Delay in treatment due to traffic conditions 1 (0.4) 4 (0.3)
Large amount of pneumoconiosis suction 1 (0.4) 0 (0.0)
Exhausting work in rescue and relief activity 0 (0.0) 0 (0.0)
Other (injuries caused by collapsed houses) 10 (4.0) 105 (8.2)
Unknown 0 (0.0) 56 (4.4)
Total 249 1,286

(D) Cause
Respiratory diseases (pneumonia, bronchitis etc.) 56 28.4
Cardiovascular diseases (heart failure, subarachnoid hemorrhage etc.) 55 27.9
Endogenous sudden deaths, sudden deaths etc. 28 14.2
Suicides 16 8.1
Infections (sepsis etc.) 14 7.1
Renal and urogenital diseases (renal failure etc.) 6 3.0
Digestive system diseases (liver failure etc.) 3 1.5
Other (anaphylactic shock, hemorrhagic shock etc.) 19 9.6
Total 197 100.0

Data given as n (%). GEJE, Great East Japan Earthquake; ICD, International Statistical Classification of Diseases and Related Health Problems.
Features of Disaster-Related Deaths

Reconstruction Agency, organizing information and selecting multiple possible causes based on the death certificate or the document used in the provision of disaster-related compensation.

On chi-squared analysis, in the 2016 Kumamoto earthquake, excessive mental and physical stress (P<0.01) and suicide (P<0.01) were observed significantly more commonly as the causes of disaster-related death, compared with the GEJE. Given that this is may be because the elderly people and other people were forced to evacuate and remain for a long time in an environment other than the one they were used to, such as shelters, it is necessary to work on the maintenance of the environment in which the victims are sheltering to support their physical and mental wellbeing.

Regarding the characteristics of the earthquake, in the Kumamoto earthquake, the number of aftershocks at night was very high. Therefore, many victims were afraid to return to their homes and chose to evacuate. At that time, although some people evacuated to a public evacuation shelter provided by the administration, many victims were forced to stay in their vehicles.3 In contrast, in the GEJE, the earthquake-triggered nuclear crisis at the Fukushima power plant caused extreme hardship for local residents.1 Moreover, the disaster victims’ residences (residential area), workplaces and so on were severely damaged by the earthquake or the tsunami. These differences are thought to have contributed to the differences in mental and physical stress, including suicide, between the two earthquakes.

The only concerns in this study were that it was not clear whether the criteria for outcomes were the same for the GEJE and Kumamoto earthquake, and also that the multifactorial analysis approach to excluding a major role for population property differences was not clear. Moreover, we could not compare the cardiovascular deaths between Kumamoto earthquake and GEJE5 because no data were available.

All procedures were conducted in accordance with the Declaration of Helsinki and its amendments. The study protocol was approved by the Institutional Review Board of Kumamoto University (Approval No. Rinri 1177).

Differences between 2 groups were tested using chi-squared test for categorical variables, as appropriate. Opt-out material was available at the following website: http://www.kumadai-junnai.com/home/wp-content/uploads/shinsai.pdf

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Devotion Statement
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Disclosures
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References
1. Ichiseki H. Features of disaster-related deaths after the Great East Japan Earthquake. Lancet 2013; 381: 204.
2. Sueta D, Akahoshi R, Okamura Y, Kojima S, Ikemoto T, Yamamoto E, et al. Venous thromboembolism due to oral contraceptive intake and spending nights in a vehicle: A case from the 2016 Kumamoto earthquakes. Intern Med 2017; 56: 409 – 412.
3. Sueta D, Hokimoto S, Hashimoto Y, Sakamoto K, Hosokawa H, Nishigami K, et al. Venous thromboembolism caused by spending a night in a vehicle after an earthquake (night in a vehicle after the 2016 Kumamoto earthquake). Can J Cardiol 2018; 34: 813.e9 – 813.e10.
4. Sato K, Sakamoto K, Hashimoto Y, Hanzawa K, Sueta D, Kojima S, et al. Risk factors and prevalence of deep vein thrombosis after the 2016 Kumamoto earthquakes. Circ J 2019; 83: 1342 – 1348.
5. Aoki T, Fukumoto Y, Yasuda S, Sakata Y, Ito K, Takahashi J, et al. The Great East Japan Earthquake Disaster and cardiovascular diseases. Eur Heart J 2012; 33: 2796 – 2803.