



Characteristics of Disaster-Related Suicide in Fukushima Prefecture After the Nuclear Accident

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Abstract. *Background:* Suicide is a major concern after the 2011 earthquake and nuclear accident in Fukushima. *Aims:* This study delineates characteristics of the disaster-related suicides in Fukushima. *Method:* Data provided by the Fukushima Prefectural Police and data published by the Fukushima or Japanese Government were analyzed. Numbers of disaster-related suicides and evacuees were compared among the three prefectures affected. Age, sex, occupation, and means for disaster-related suicides in Fukushima were compared with overall suicides in Fukushima or Japan. History of medical treatment, changes in job and family structure after the disaster, and signs of contemplation were examined within the disaster-related suicides of Fukushima. *Results:* While other prefectures have experienced a drop in disaster-related suicides, Fukushima has not. Age-standardized disaster-related suicide rates were remarkably higher in men than in women. Moreover, disaster-related suicide rates in Fukushima were higher in women in their 50s and 80s as compared with overall suicide rates in Fukushima or Japan. *Limitations:* No detailed comparisons were made between disaster-related and non-disaster-related suicides. *Conclusion:* Disaster-related suicide rates were higher in men than in women. Also, it was found that the disaster-related suicide rates of elderly women were higher compared with overall suicide rates in Japan and Fukushima. In addition, many who died by suicide showed signs of contemplation before the attempt and had started psychiatric treatment. Improvement of suicide risk assessment skills for mental health professionals and gatekeeper training among residents will be essential to prevent disaster-related suicides.

Keywords: disaster-related suicide, nuclear accident, the Great East Japan Earthquake, Fukushima Daiichi Nuclear Power Station

The Fukushima Daiichi nuclear accident that occurred after the Great East Japan Earthquake (GEJE) in March 2011 seriously affected residents' lives. Radiation was scattered into neighboring areas, resulting in ordered evacuation. Since the health risks from radiation exposure were very limited in this accident, and since the additional lifetime effective dose was less than 30 mSv in this accident (Ishikawa et al., 2015), the government has cancelled evacuation orders in many areas where decontamination work has advanced. However, according to the Fukushima Local Government, more than 40,000 people still continued evacuation as of December 2018. Lifestyle changes accompanying long-term evacuation have led to an increase in multiple health risks for residents. For example, researchers found an increase in mortality for elderly people associated with evacuation during the first month after the disaster (Morita et al., 2017); an increase in lifestyle-related diseases (hyperlipidemia and diabetes) associated with long-term evacu-

ation (Nomura et al., 2016); and increased mental health issues such as posttraumatic stress disorder (PTSD), depression (Oe et al., 2016), and alcohol dependency (Ueda et al., 2019). It has been suggested that the seriousness of the mental health problems of residents is related to the impact of the nuclear accident on society and local communities (Maeda & Oe, 2017), similar to the Chernobyl accident (Bromet, 2014). The nuclear accident became a major social concern through the mass media, and inconsistent information and rumors were circulated during the period when the health effects were uncertain. As a result, disagreements among residents about radiation led to community fragmentation, and social networks that normally functioned as mental health buffers were weakened. It is generally known that severe psychological distress increases the risk of suicide. Changes in lifestyle, loss of work and social bonds caused by evacuation due to nuclear power plant accidents, and bereavement over losing close relatives after tsunamis and earthquakes

both directly and indirectly increase the risk of suicide (O'Connor & Nock, 2014).

With regard to the relationship between nuclear accidents and the prevalence of suicide, it has been reported that the number of suicides has increased in decontamination workers after the Chernobyl accident, but the occurrence of suicide among evacuated residents has not been reported (Bromet, 2014). Kölves, Kölves, and De Leo (2013) reviewed 42 articles that examined the link between natural disasters and suicide. They found that the direction of the relationship between natural disasters and suicide varies from study to study. Following that review, Matsubayashi, Sawada, and Ueda (2013) examined various types of natural disaster that occurred in Japan from 1982 to 2010 and showed that suicide rates differed depending on the number of victims, the postdisaster time, age, and gender. Specifically, for men under the age of 65 and women over the age of 65, the suicide rate was high as a function of the number of victims during the year following the earthquake. Also, after 1 year, the suicide rate decreased as a function of the number of victims. It was reported that 2–4 years later, the suicide rate increased again as a function of the victims, showing a U-shaped pattern. For men aged 65 years and older, the suicide rate increased as the number of victims increased in the year after the disaster, but the suicide rate decreased as the number of victims increased after 5 years. There was no clear pattern for women under 65 years of age.

In Fukushima, the overall suicide rate was higher than the national average in the first year immediately after the disaster; it then declined and showed a U-shaped curve ris-

ing again after 3 years (Maeda & Oe, 2017; Ohto, Maeda, Yabe, Yasumura, & Bromet, 2015). Orui, Suzuki, Maeda, and Yasumura (2018) have estimated suicide rates in residents of the evacuation-ordered area in Fukushima from vital statistics and have reported time-related change stratified by sex and age. Among men, suicide rates increased in the partial/terminated evacuation-ordered area for about half a year immediately after the accident. These rates decreased and reached the national average level with the passing of years. However, after 2.5 years, there was again an upward trend. Among women, an increase in suicide rates was observed 1.5 years after the earthquake and this increase continued thereafter. However, their estimate included suicides that were not related to the disaster. Thus, the trends in disaster-related suicides determined by the government are unclear.

The purpose of this study was to examine data on disaster-related suicides as defined by the Cabinet Office. In particular, we focused on (a) descriptive time series regarding number of disaster-related suicide deaths for Fukushima in comparison with Miyagi and Iwate, (b) disaster-related suicide rates by gender, age, occupation, and means (methods) considering numbers of evacuees in the evacuation-ordered areas as the denominator (geographical location of Fukushima and the evacuation order zone are shown in Figure 1), (c) and background factors implicated in disaster-related suicides based on micro death data provided by the Fukushima Prefectural Police. This study was approved by the Ethics Review Board of Fukushima Medical University (No. 2367).

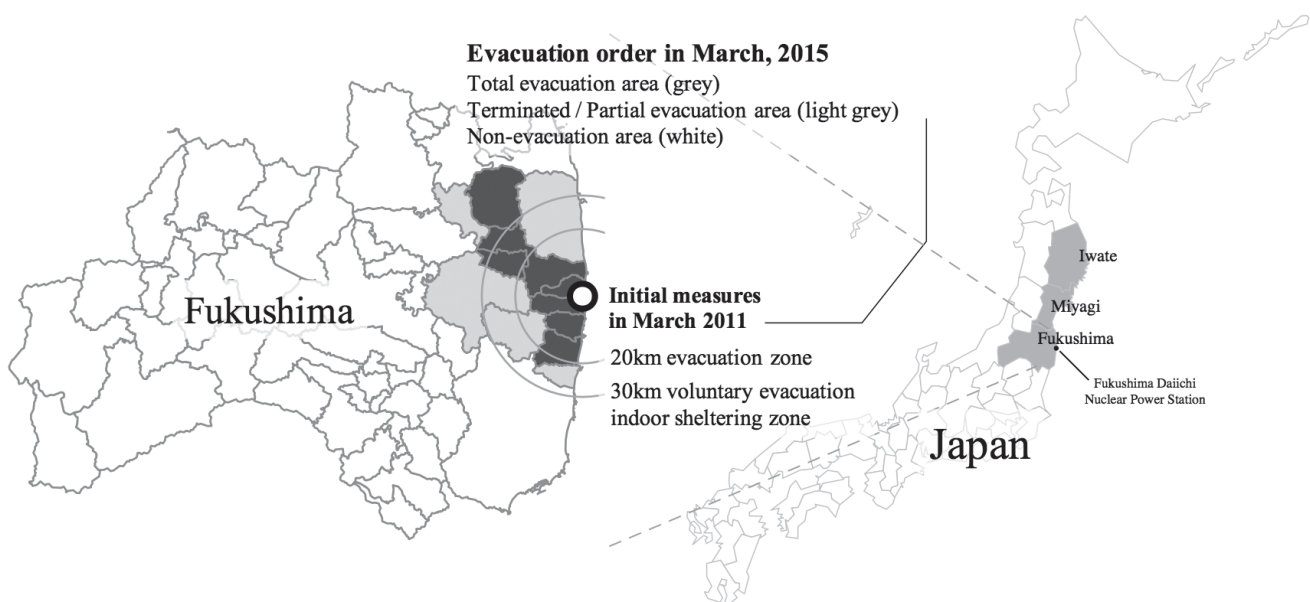


Figure 1. Geographical location of Fukushima Prefecture and evacuation order zone related to Fukushima Daiichi nuclear power station accident.

Method

Data Collection

In Japan, a psychological autopsy system has not yet been established. Instead, prefectural police departments gather information regarding suspected decedents of suicide from their family members, relatives, friends, acquaintances, colleagues, and neighbors who may have information concerning the deceased. Prefectural police departments exclusively have the power to gather relevant information in order to decide whether deceased persons died from suicide or not. This process applies in the case of disaster-related suicides as well.

Data on disaster-related suicides are managed by the police department of each prefecture. We requested the Fukushima Prefectural Police to provide and analyze data on disaster-related suicides in Fukushima Prefecture. We explained that we would not disclose the data or results of the analysis for purposes other than this study. They agreed to provide data up to 2017.

According to the Cabinet Office of Japan, “a suicide related to the GEJE” refers to a suicide that meets any one of the following conditions, by which definition the Fukushima Prefectural Police abides:

1. The site of discovery of the corpse is at a shelter, temporary housing, or morgue.
2. A person who died by suicide stayed in a shelter or temporary housing, confirmed by the statement of the bereaved or some other evidence.
3. A person who died by suicide was evacuated from an affected area, confirmed by the statement of the bereaved or some other evidence.
4. A dwelling (area of residency) or a workplace of the person who died by suicide was confirmed to be damaged by the earthquake or tsunami, confirmed by the statement of the bereaved or some other evidence.
5. The cause or motivation for the suicide was found to be directly influenced by the GEJE, in ways other than mentioned above, confirmed by the statement of the bereaved or some other evidence. For example, (a) if the person who died by suicide left a suicide note that he or she ended his or her life because of the GEJE, or (b) while the person who died by suicide was alive, he or she expressed the desire to end his or her life and provided reasons related to the GEJE to his or her bereaved family.

On the basis of this definition, 99 cases of individuals who died by suicide were determined to be disaster-related suicides by 2017 in Fukushima. Data provided by the Fukushima Prefectural Police included the following variables: (a) age, (b) sex, (c) change of dwelling after the disaster, (d)

occupation before the disaster, (e) change of occupation after the disaster, (f) family structure before the disaster, (g) change in family structure after the disaster, (h) means of suicide, (i) circumstances at the time of discovery, (j) development and treatment history of physical and psychiatric diseases before and after the disaster, (k) worries expressed to others before suicide, and (l) speech or behavior that indicates the person wanted to end his or her life.

Among the aforementioned variables, we used age, sex, occupation before the earthquake, means of suicide, and family structure to compare the data on disaster-related suicides with that of the whole prefecture and Japan. Change in the history of physical and psychiatric treatment, change in job and family structure after the disaster, worries expressed to others before suicide, and signs of suicide contemplation were used to examine the characteristics within disaster-related suicides.

The aforementioned definition of disaster-related suicide indicates that this category of suicide is closely related to evacuation due to the nuclear accident. Therefore, we used the population of the evacuation-ordered area as the denominator for calculating the disaster-related suicide rate. We obtained the population data of the evacuation-ordered area from a database on municipalities in Fukushima Prefecture published by the Mental Health and Welfare Section of the Fukushima Prefectural Government (Mental Health and Welfare Center, Fukushima Prefectural Government, 2018). This database is derived from the population census taken by Japan’s Ministry of Internal Affairs and Communications, and the suicide statistics were taken from the published data by the Japan National Police Agency. Data on the population of the evacuation-ordered areas from 2015 to 2017 were missing in the census data; thus, we replaced the population from 2015 to 2017 with that of 2014. The population of municipalities in the partial evacuation-directed areas was assessed through calculating the evacuation coefficient based on the United Nations Scientific Committee on the Effects of Atomic Radiation report (United Nations Scientific Committee on the Effects of Atomic Radiation, 2014) and multiplying the age class population as of 2011 by the evacuation coefficient to obtain assessed populations of each year. To compare disaster-related suicide rates with overall suicide rates in Fukushima Prefecture or Japan, data for Fukushima Prefecture or Japan were extracted from the same database published by the Japan National Police Agency.

Data Analysis

We calculated the 7-year suicide rates for disaster-related suicide in Fukushima Prefecture and the whole of Japan. The population and number of suicides were summed for

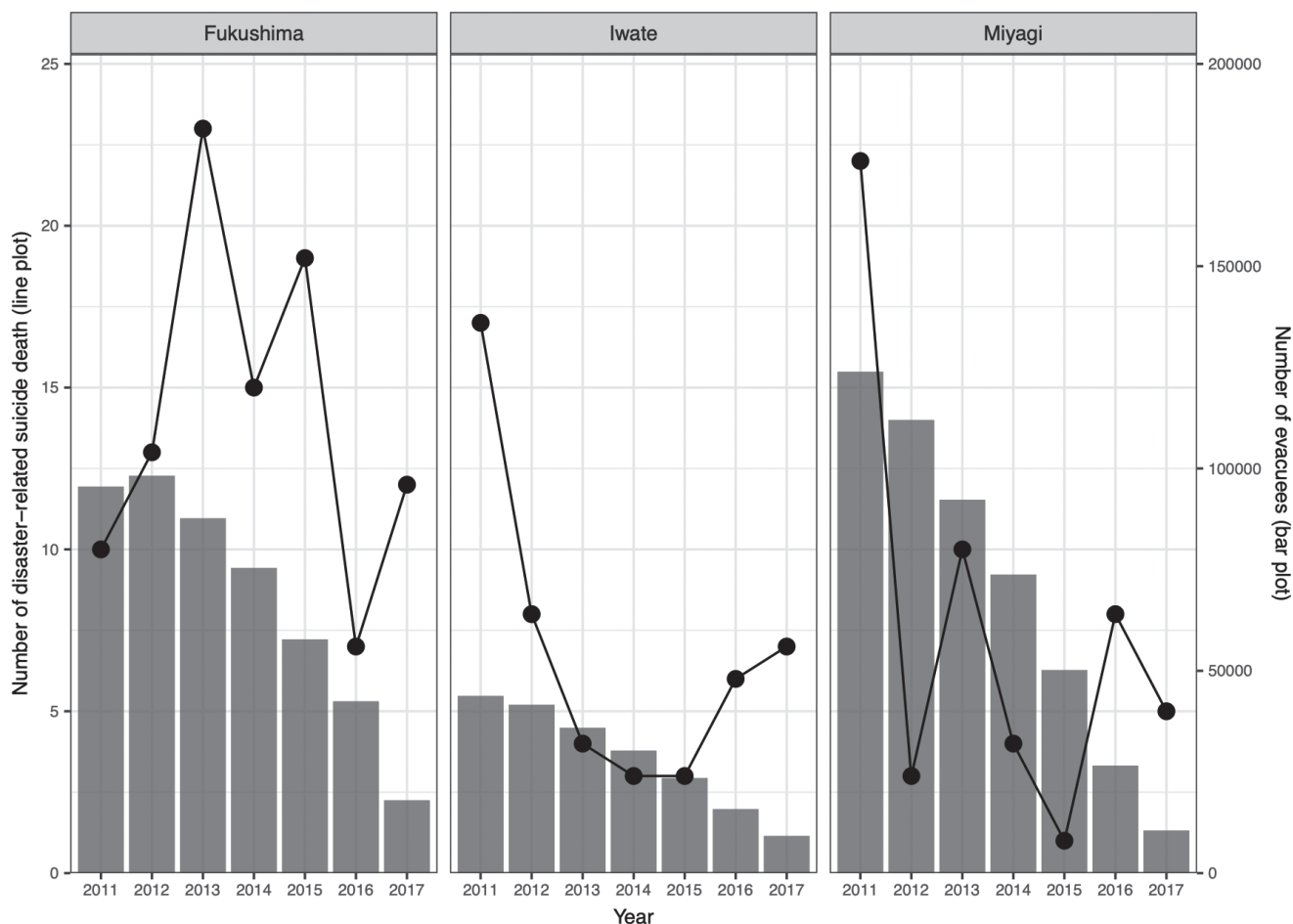


Figure 2: Numbers of evacuees (bars) and disaster-related suicides (line plot) by year in Fukushima, Iwate, and Miyagi prefectures.

each year for 7 years after the earthquake, and the 7-year suicide rate was calculated using the summed 7-year population as the denominator and the summed 7-year suicide number as the numerator.

The chi-square test was used to examine differences between data of categorical variables, including living with or without someone else, change in history of physical and psychiatric treatment after the disaster, job and family structure change after the disaster, and signs of suicide contemplation. In order to avoid Type I errors, the Benjamini-Hochberg procedure was employed.

Results

Number of Disaster-Related Suicides of Fukushima in Total or by Year

As shown in the Data Collection section, the total number of disaster-related suicides in Fukushima Prefecture from 2011 to 2017 was 99 (male, 59; female, 40). The numbers

of disaster-related suicides and evacuees for Fukushima, Iwate, and Miyagi prefectures are displayed in Figure 2. The bar plot indicates the total number of evacuees, which consistently decreased over time, for Fukushima, Iwate, and Miyagi prefectures as reported by Japan's Reconstruction Agency. The line plot in Figure 2 indicates the numbers of disaster-related suicides, which varied over time, and there was no consistently decreasing trend for three prefectures (Japan Ministry of Health, Labour and Welfare, 2018). Remarkably, even though at the end of 2017 almost 6 years had passed since the earthquake and nuclear accident, disaster-related suicide was still most likely to occur in Fukushima.

Comparing Disaster-Related Suicide Rates in Fukushima Prefecture With National and Prefectural-Level Data

Table 1 summarizes the numbers from 2011 to 2017 of overall suicides or disaster-related suicides by age, gender, means, and occupation, which are expressed as rates per

Table 1. Disaster-related suicide rate during 2011–2017 compared with overall suicide rate of Japan and of Fukushima, per 100,000 persons

Characteristics	Japan		Fukushima overall		Fukushima disaster-related	
	Men	Women	Men	Women	Men	Women
Age adjusted rate of suicide death	17.50		19.40		10.50	
	24.92	10.18	28.00	10.50	15.61	6.50
Stratified rate of suicide death by age						
≤ 19	3.43	1.64	5.53	1.39	3.36	0.00
20–29	29.66	12.20	41.35	8.31	23.10	6.40
30–39	30.38	12.25	38.70	6.97	16.77	2.34
40–49	33.96	12.98	40.77	8.09	17.75	0.00
50–59	39.74	14.78	48.93	8.43	27.26	22.75
60–69	33.91	14.38	38.03	10.06	23.42	4.87
70–79	32.38	17.06	42.20	14.40	13.41	24.22
≥ 80	38.66	17.04	61.48	16.16	10.35	50.05
Means						
Hanging	19.48	7.46	21.08	8.47	10.81	7.21
Poison	0.52	0.50	0.93	0.80	0.28	0.55
Charcoal-burning	2.54	0.50	4.07	1.05	1.94	0.55
Jumping	2.29	1.57	1.63	0.87	1.11	1.11
Drowning	0.60	0.33	0.20	0.09	0.55	0.28
Other	2.98	1.85	3.41	2.37	1.66	1.39
Job						
Self-employment/ Family worker	2.81	0.34	3.40	0.52	2.50	0.55
Employee	9.49	1.91	10.60	1.99	5.54	0.83
Student	1.05	0.38	0.94	0.35	0.55	0.28
Unemployed	8.34	6.23	7.80	6.10	2.77	3.05
Unemployed (> 65)	6.11	3.57	6.25	4.53	3.60	5.55
Job loss	1.65	0.18	3.31	0.52	1.66	0.55

100,000 persons. The total numbers for Japan (overall suicides), Fukushima (overall suicides), and Fukushima (limited to disaster-related suicides) are described in the left, middle, and right columns, respectively.

Gender and Age

As can be seen in Table 1, disaster-related suicides were found to be higher in women in their 50s and 80s compared with the overall suicides in Japan and Fukushima Prefecture. These suicides were characteristically low in men aged 70 years and older.

Means

As is shown in the right column of Table 1, the most frequent means of disaster-related suicide was hanging. There seemed to be no differences regarding means among Japan (overall suicides), Fukushima Prefecture (overall suicides), and disaster-related suicides of Fukushima.

Jobs

Among men, disaster-related suicide was frequent in employees. Among women, disaster-related suicide was frequent in unemployed people and elderly people (right column, Table 1). Except for the remarkably high suicide rates among elderly women, the overall trend was similar to that of overall suicides of Japan (left column, Table 1) or overall suicides of Fukushima Prefecture (middle column, Table 1).

Characteristics of Disaster-Related Suicides of Fukushima

As described in the Method section, we asked the Fukushima Prefectural Police to provide us with data on variables relevant to delineate the characteristics of disaster-related suicides in Fukushima. Among them, (a) development

and treatment history of physical and psychiatric diseases before and after the disaster, (b) change of occupation and family structure after the disaster, and (c) speech or behavior that indicates the person wanted to end his or her life seemed particularly worth mentioning. In the following, the exact number of persons with regard to items (a)–(c) as well as results of chi-square tests are shown.

Change in History of Physical and Psychiatric Treatment

Regarding the development and treatment history of physical and psychiatric diseases before and after the disaster among 99 individuals with disaster-related suicides of Fukushima, the numbers were as follows: no treatment (before, 19 persons; after, 8 persons), only physical illness treatment (before, 27; after, 22), only psychiatric illness treatment (before, 20; after, 34), and both physical and psychiatric treatments (before, 7; after, 26). They significantly differed before and after the disaster, $\chi^2(3) = 17.98$, $p = .04$. The Benjamini–Hochberg adjustment comparison method revealed that the total number of treatment history of psychiatric illnesses significantly increased after the disaster ($p < .05$). This result suggests that psychiatric illnesses developed newly after the disaster in many individuals of disaster-related suicides.

Job and Family Structure Change After the Disaster

Regarding change of occupation after the disaster among 99 individuals with disaster-related suicides, the number of persons with a change was 29 (men, 21; women, 8) and with no change it was 70 (men, 38; women, 32), with men showing more changes than women, but without a statistically significant difference, $\chi^2(1) = 2.10$, $p = .15$. As for change in family structure, the number of persons with change was 52 (men, 30; women, 22) and with no change it was 47 (men, 29; women, 18), with similar numbers for both men and women, $\chi^2(1) = 0.04$, $p = .84$.

Signs of Suicide Contemplation

The rate of signs of suicide contemplation in women (yes, 27; no, 13) was significantly higher than in men (yes, 34; no, 25), $\chi^2(1) = 5.07$, $p = .02$. The rate of presence of worries expressed to others before suicide in women (yes, 32; no, 8) was significantly higher than in men (yes, 33; no, 26), $\chi^2(1) = 5.10$, $p = .02$; however, more than half of men expressed worries.

Discussion

The total number of disaster-related suicides in Fukushima Prefecture was higher than those in Iwate and Miyagi

prefectures. In terms of time-related change, the number of disaster-related suicides for Iwate and Miyagi fell with time as the number of evacuees decreased, whereas Fukushima did not show any correspondence between the number of evacuees and disaster-related suicides. Differences in this trend by region may be due to differences in the cause of evacuation. Many of the evacuations in Fukushima Prefecture were due to the nuclear accident, whereas evacuations in other prefectures were due to damage caused by the earthquake and tsunami. Fukushima residents face many difficulties resulting from the nuclear disaster, including ongoing rumors and public stigma about radiation, distrust of government and medical authorities, and friction among community members stemming from different risk perceptions of radiation. These psychological factors, which weaken pre-disaster community bonds and resilience, contribute to PTSD and depression, which are critical risk factors for suicide (Maeda & Oe, 2017; Takebayashi, Lyamzina, Murakami, & Suzuki, 2017).

A study by Ohto et al. (2015) comparing standardized suicide mortality ratios (SMRs) before and after the GEJE (2010–2014) in three affected prefectures (Iwate, Miyagi, and Fukushima) revealed two significant trends: one was that SMRs in all of the prefectures showed a U-shaped pattern (an increase after a 2-year drop following the disaster), and the other was that only the SMR in Fukushima Prefecture 3 years after the disaster was considerably higher than that before the disaster, in contrast to those in the other two prefectures. With regard to gender differences, the suicide rate in the 7 years after the disaster was significantly higher in men than in women (disaster-related suicide: 2.4 times, Japan: 2.45 times, Fukushima: 2.67 times). The ratio of male-to-female suicide rates in the 2 years before the disaster was approximately 2.5 in Japan (2009: 2.61 times, 2010: 2.46 times) and approximately 2.9 in Fukushima, which were comparable to that after the disaster. Regarding gender differences, there were no specific patterns for disaster-related suicides before and after the earthquake.

Disaster-related suicide rates were higher in elderly women compared with the overall suicides of Japan or Fukushima Prefecture, whereas the rates for elderly men were lower than the overall suicides of Japan or Fukushima Prefecture. The means and occupation for disaster-related suicides did not show obvious differences from those of the overall suicides of Japan or Fukushima Prefecture. Matsubayashi and colleagues (2013) examined panel data after natural disasters of various sizes, such as typhoons, floods, and earthquakes that occurred in Japan between 1982 and 2010, and found increased suicide rates among elderly women 3–4 years after the disaster, whereas they found a decreasing trend after an initial rapid increase among elderly men. Orui et al. (2018) also revealed that

suicide rates among women tended to increase in the evacuation-ordered area after the Fukushima nuclear power plant accident. According to a recent meta-analysis, the risk of developing PTSD after a natural disaster is higher in elderly people than in young people (Parker et al., 2016), and a recent cohort survey targeting residents in evacuation-ordered areas following the Fukushima Daiichi Nuclear Power Plant accident found that radiation anxiety predicted the severity of mental distress (Oe et al., 2016). A study indicated that radiation anxiety was associated with the severity of PTSD symptoms (Suzuki et al., 2018). In addition, it has also been reported that anxiety over radiation is generally higher in elderly women than in men and young people (Takebayashi et al., 2017). Thus, vulnerability to PTSD may contribute to an increased suicide risk among elderly women. According to the finding that social connections are a buffer for the deterioration of life satisfaction, especially in elderly women (Cheng & Chan, 2006), community fragmentation due to individual differences in attitudes toward radiation strongly affect mental health among elderly women. Interestingly, an increase in suicide rates among elderly women was also observed in relation to severe acute respiratory syndrome (SARS) outbreaks in Hong Kong in 2003. Like the Fukushima disaster, the SARS outbreak caused mass fear, hopelessness, uncertainty, breakdown of social networks, and limited access to health-care services (Chan, Chiu, Lam, Leung, & Conwell, 2006). Since male disaster-related suicides were not concentrated in certain age groups, support is necessary regardless of age. Also, in general, unemployment is a risk factor for male suicide, but in the case of disaster-related suicide, considering that the suicide rate was higher in employees than in the unemployed, and that self-employed and unemployed people had similar suicide rates, it is suggested that support not only for the unemployed but also for employees and self-employed persons is necessary.

Analysis of micro data on disaster-related suicide indicated that more than half of the individuals who died by disaster-related suicide expressed worry to others. Furthermore, many people newly received psychiatric treatment after the disaster. These findings suggest that even if an individual who died by suicide had shown signs of contemplating suicide, other individuals were most likely unable to properly respond and the suicide risk of the patients who visited specialized agencies was most likely not properly evaluated and managed. Therefore, for evacuations due to a nuclear accident, it may be effective to promote gatekeeper training for neighboring residents and to improve suicide risk assessment skills among professionals of psychiatric services.

Limitations


The limitation of this study was that the micro data on disaster-related suicides provided by the prefectural police office, mainly due to confidentiality, were limited to disaster-related suicides that occurred in Fukushima Prefecture. Therefore, there were no comparisons of age, gender, jobs, and means with other prefectures such as Iwate and Miyagi. In addition, because the micro data on non-disaster-related suicides correctly matched to disaster-related suicides were not provided, only the micro data on disaster-related suicide were provided and only within-group comparisons were conducted in terms of signs of suicide contemplation, changes in family structure and occupation, and changes in treatment history.

Conclusion

Disaster-related suicide rates were higher in men than in women. Additionally, it was found that the disaster-related suicide rates of elderly women were higher compared with the overall suicide rates in Japan and in Fukushima. In addition, many who died by suicide showed signs of contemplation before their attempt and had started psychiatric treatment. Improvements in mental health professionals' suicide risk assessment skills and gatekeeper training for residents will be essential to prevent disaster-related suicides.

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