Chapter 13
The Great East Japan Earthquake, the Fukushima Daiichi Nuclear Power Plant Accident, and Elderly Health

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Abstract On March 11, 2011, Japan experienced an earthquake of magnitude 9-9.1, called the Great East Japan Earthquake, with a subsequent giant tsunami, which caused massive damage to the Tohoku region Pacific coast (Iwate, Miyagi, and Fukushima prefectures), and a nuclear accident that occurred at the Fukushima Daiichi nuclear power plant. Disaster-related deaths occurred mainly in the elderly, and more than half of the disaster-related deaths occurred in Fukushima prefecture, where the nuclear accident occurred. During the first 2 years after the Great East Japan Earthquake, the suicide standard mortality ratio (SMR) in the three affected prefectures decreased. Three years after the disaster, however, the suicide SMR rose to the pre-disaster level in Iwate and Miyagi prefectures and exceeded the suicide SMR before the disaster in Fukushima prefecture. Mental health service providers for disasters should keep in mind that suicide rates can eventually increase after a disaster, even if they initially decrease.

Keywords Great East Japan Earthquake · A nuclear accident at a nuclear power plant · Suicide · Elderly

13.1 Introduction

13.1.1 Demographic Characteristics of Japan: Aging Society

Since World War II, the population of Japan has been aging at a very rapid rate compared with rates in European countries. The period from the time that the aging proportion [1] of the population was more than 7% (an "aging society") to the period when there was an aging proportion of 14% or more (an "aged society") was

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40 years in Germany, which has the most rapidly aging population in Europe, but this period was only 24 years in Japan [2]. It is clear that the rate of Japan's population aging is extremely fast. Now the proportion of elderly people aged 65 years or older in Japan has reached 27.7% (2017) [3]

The cabinet of Japan has noted two main reasons for the rapid aging of Japan's population [4]. The first reason is that the mortality rate for elderly people (those aged 65 or older) has rapidly declined since World War II. The reasons for this rapid decline include improvements in public health, better nutrient conditions, and the development of medical technology. Especially, the dramatic decline in neonatal and infant mortality has also contributed to the decreasing mortality rate in Japan. And mortality in elderly people of both sexes has decreased gradually in every age group, which means that the older proportion of the population is becoming relatively larger. Another reason for the rapid aging of the population is that the fertility rate has decreased over time. The crude birth rate has decreased from 13.6 (per 1000, in 1980) to 7.8 (per 1000, in 2016) [5]. This means there is a decrease in the extent of the young generation itself, as well as a decrease in the pool of potential mothers who have the possibility of having babies in the future.

Now Japan has become a "super-aged society", where the proportion of the elderly (i.e., those aged 65 years or older) is higher than 21% [1]. The Japanese National Institute of Population [2] has estimated that the proportion of the elderly in the population will be 35.7% in 2050 (Fig. 13.1).

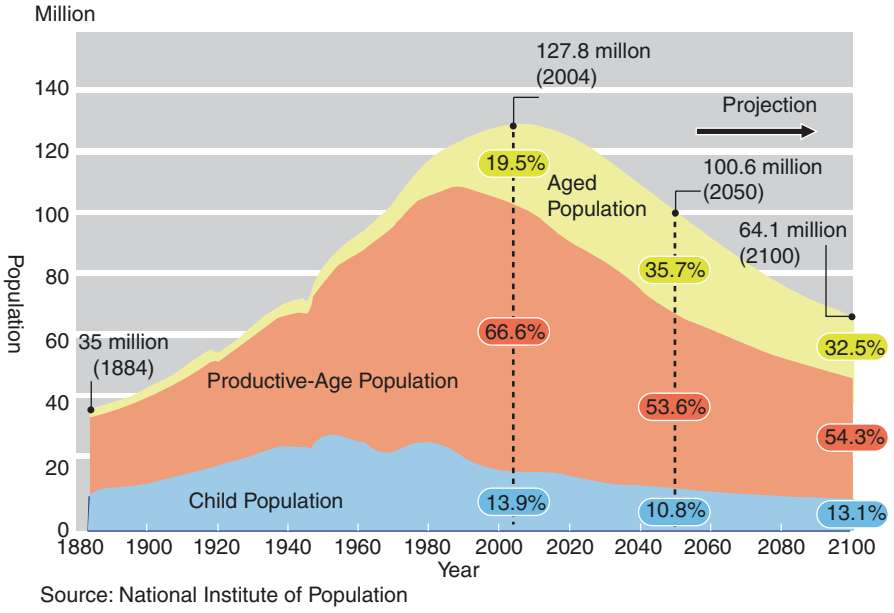

Fig. 13.1 Population trends in Japan [2]

13.1.2 Life Expectancy at Birth and Healthy Life Expectancy at Birth in Japan

Between 1947 and 2016 in Japan, life expectancy at birth increased by 30.92 years for males and by 33.18 years for females, reaching 80.98 years and 87.14 years, respectively, in 2016 [6]. Because life expectancy at birth is calculated by summing the age-adjusted mortality, the lengthening of life expectancy at birth means a decrease in total mortality. The reason for the decrease in the mortality rate is as described above.

Some points should be noted. Life expectancy at birth in males did not increase compared with that in females. Gender differences of life expectancy at birth have, rather, expanded. The true reason is not known, but inappropriate lifestyle factors in males, such as a high smoking rate and a high drinking rate, may have contributed to the gender difference.

In developed countries, life expectancy at birth has increased and this increase has not been so remarkable in recent years. Of note, not all elderly people are healthy and fit; some need nursing care and are bedridden and/or have severe cognitive dysfunction. Healthy life expectancy at birth, which is a new idea, indicates the period during which people can sustain their activities of daily living without receiving nursing care or becoming bedridden.

In Japan, healthy life expectancy at birth in males rose from 69.40 years in 2001 to 70.42 years in 2010; in females, healthy life expectancy at birth rose from 72.65 years in 2001 to 73.62 years in 2010 [7] (Fig. 13.2). The difference between life expectancy at birth and healthy life expectancy at birth in males was 8.67 years in 2001 and this figure had increased to 9.13 years in 2010; on the other hand, the difference between life expectancy at birth and healthy life expectancy at birth in females was 12.28 years in 2001 and this had increased to 12.68 years in 2010. The important point is that the gap between life expectancy at birth and healthy life expectancy at birth did not decrease, but rather expanded in both sexes. Reducing the gap is a big issue to be solved.

13.1.3 Increasing survivorship in the elderly population in Japan

The number of survivors of a certain age in a certain year is calculated as the accumulation of age-specific mortality up to that age. A high mortality rate means poor health, while a low mortality rate means good health. Therefore, the fact that the number of survivors is small implies that the mortality rate is high; that is, the health condition is poor, whereas a high number of survivors implies that the mortality rate is low; that is, the health condition is good. The Japan life tables for 1947, 1955, 1975, 2010, and 2015, showing female survivors who reach a specific age, are displayed in Fig. 13.3 [8].

Survivorship curves can be drawn using only the mortality rate data at each age in a certain year by sex. It can be seen, in Fig. 13.3, that the survivorship

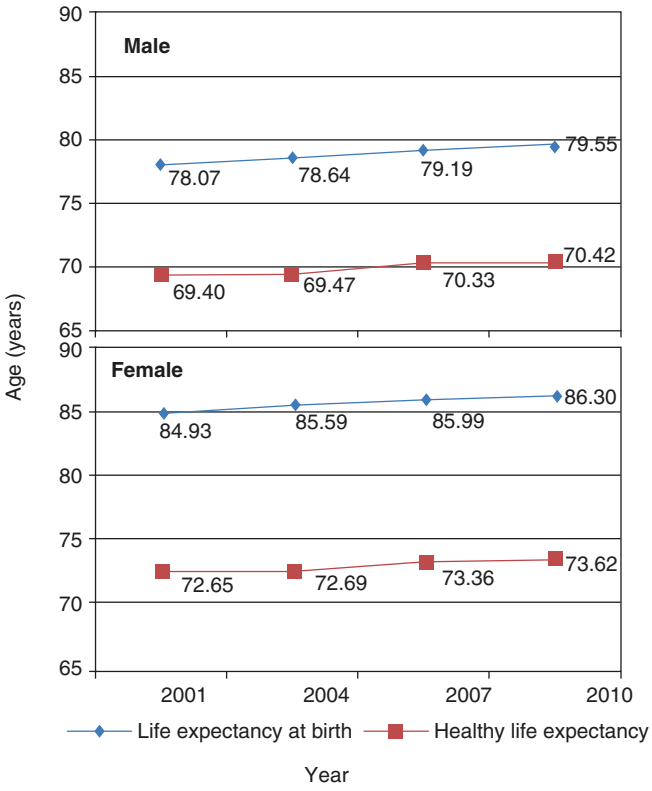

Fig. 13.2 Life expectancy at birth and healthy life expectancy by sex [7]

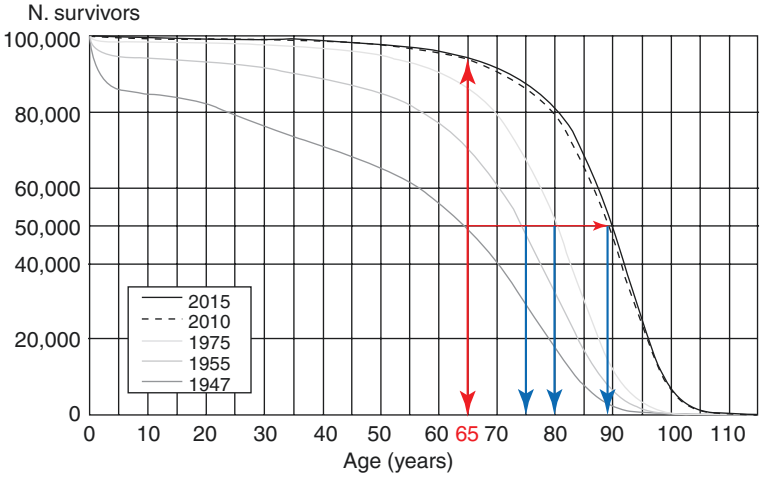

Fig. 13.3 Changes in numbers of survivors (female) [8]

curve has shifted to the right with time, which means that the number of survivors at each age increased in all age groups. The number of the young to middle-aged group increased from 1947 to 1955; on the other hand, that of the elderly group showed a relative increase from 1975 to 2015. Immediately after World War II, improvements in health levels in young to middle-aged people were remarkable, and from 1975 onward, improvements in health conditions have been remarkable in elderly people.

We can see that about half of the female babies born in 1947 (50,000/100,000) lived to be 65 years old. For example, ages at the time that about half of these babies lived to be 65 years old were about 75 years, 80 years, and 88 years in 1955, 1975, and 2010, respectively. This finding means that elderly Japanese females have tended to survive for longer over this period (1955 to 2010), which indicates that elderly Japanese females have become fitter over time. The same tendency was observed in Japanese males (data not shown). These data show that elderly people in Japan have continued to become healthier in both sexes.

13.1.4 Physical, Psychological, and Social Aspects of the Elderly Population in Japan

Various data on the physical and psychological health of the elderly population in recent years in Japan has shown that, in the current group of elderly people, the changes in physical function accompanying aging are delayed by 5–10 years as compared with data from 10–20 years ago [9]. There is a so-called "rejuvenation" phenomenon. Even in those aged 65 years or older, who have been regarded as elderly, especially those at the ages of 65–74, physical and mental health is being maintained, and the majority of those who are capable of active social activities are so occupied.

In regard to social aspects, according to the labor force survey conducted by Japanese Government, in 2016 the labor force participation rate for the elderly population (aged over 65 years) was 31.7% for males and 15.9% for females, both of which rates have been increasing in recent years [10]. On the other hand, the percentage of the labor force aged between 15 and 24 years is about 44% for both males and females; i.e., this group represents less than half the labor force. Thus, it is not appropriate to regard people aged 15–64 years as the "productive-age population." This term was used when the majority of Japanese did not go to high school and got a job at age 15 years. It is thought that this term is now inappropriate and there is a concern that it could promote ageism. We need to know that elderly people are not a social burden or a group who always require medical/nursing care services and pensions, but that some elderly people also contribute to society through their labor.

Under these circumstances, the working group focusing on the definition and classification of "elderly" in the Japan Gerontological Society and the Japan Geriatrics Society have made the following proposal [9]. They have proposed that the definition of "elderly" needs to be changed, with those aged 65–74 years defined as "pre-old people," those aged 75–89 years as "old people," and those aged over 90 as "oldest old people" or "superold elderly."

There are some concerns regarding the change in definition of the elderly. Some people think that the national government wants the elderly to keep working to compensate for the nation's labor shortage, so these people worry about whether this proposal will be implemented. They are also worried that the age at which a pension payment starts may be increased as the definition of elderly changes.

In the Japan Cabinet Office's "survey on the consciousness of elderly people," the percentage of people who regard the elderly as those "from the age of 70", which was the most frequent answer, was 29.1%. The second most common answer was "from the age of 75," at 27.9%. The consciousness of what constitutes an "elderly" population has also changed year by year [11]. We need to consider various possibilities of defining what is regarded as elderly.

13.2 The Great East Japan Earthquake, the Fukushima Daiichi Nuclear Power Plant Accident, and the Health of the Elderly

13.2.1 The Elderly in a Disaster Situation

We need to consider how elderly people are regarded in the context of a disaster situation. As mentioned above, the elderly population varies greatly in its physical, psychological, and social aspects.

In general, elderly people can be regarded as belonging to one of the following three categories: (1) independent and frail elderly living in their homes without a care service, (2) elderly people who use a care service in their homes, and (3) elderly people who live in institutions for the elderly or who are hospitalized because of chronic diseases. The number of people who belong to the latter two categories represents a relatively small proportion of the total elderly population but a relatively large proportion of the total population.

"People requiring assistance during a disaster," as defined by the Cabinet office, Government of Japan et al., refers to those who need help to take necessary actions in the case of a disaster [12]. This includes acquiring accurate and necessary information in a prompt manner and getting evacuated to safer places to protect from the disaster. Generally, this group includes the elderly, disabled people, foreigners, expectant mothers, and young children. The data described in reference [12] shows

that elderly people are more susceptible to becoming victims of disaster than young people. Elderly people constitute one of the most vulnerable populations in the case of a disaster [13].

13.2.2 Evacuation Support Plan

The Basic Act on Disaster Control Measures in Japan defines a disaster. The Act requires each municipality to create an evacuation support plan. The plan prescribes the management and duty to, first, collect information, such as that on housing, information transmission systems, and the type of needed care, related to "people requiring assistance during a disaster"; secondly, there is a duty to manage and share the information, using electronic or paper data; and thirdly, there is a duty to select a sufficient number of evacuation supporters for all "people requiring assistance during a disaster." The appropriate securing of an evacuation route is a very big and difficult problem.

In order to create an evacuation support system, the collecting and sharing of information during normal times, not only on "people requiring assistance during a disaster" but also on the total elderly population, is crucial. There are three methods for municipalities to collect and share information. Firstly, using the rule of utilization other than for intended purposes and the provision of data in the municipal Personal Information Protection Regulation, related institutions and members can share information without permission from the elderly individuals. Secondly, after informing people of the creation of an evacuation support system, information only on those who want to register themselves is collected. Thirdly, related institutions and members directly meet the "people requiring assistance during a disaster" and get information from them.

13.2.3 Life and Health Control Guidelines for Evacuation [14]

Once a severe disaster has occurred, people are requested to evacuate to the appropriate shelter or regional evacuation center. According to the guideline for controlling the health condition of people living in the shelter, the shelters are controlled and managed by the municipalities (Table 13.1).

Municipalities also create special shelters, named "welfare shelters", for "people requiring assistance during a disaster". Welfare shelters [15] are secondary evacuation centers that are established for elderly people and people with disabilities who find it difficult to stay at evacuation centers and need special assistance. In accordance with the Disaster Relief Act, municipalities form agreements with various bodies, such as preregistered welfare facilities.

Table 13.1 Guideline for control of the health condition of people living in shelters [14]

	Category	Contents
Daily living; general checkpoint	Living conditions, air and ventilation	1. Temperature control
		2. Maintaining cleanliness of bedclothes, supporting exchange of bedclothes
		3. Control of mosquito, fly, mice, and cockroach
	Water	1. Water replacement to the elderly who don't recognize such condition
		2. Sanitation of water supply
	Nutrition control	Supply good balanced meal based on the required quantity
	Prevention of food poisoning	Sanitation of food regardless of season
	In case of no bathing space	Supply warm towel to evacuees to wipe their own bodies to keep their body clean
	Environment of the surrounding the shelter	1. Make sink and toilet and keep them clean
		2. Collection of garbage, separate and sort them into several types, and storage them in closed space outside the shelter
		3. Decide the rule of drinking alcohol and smoking. Make sure that everyone is informed on the rule to avoid passive smoking and fire. No smoking inside the shelter
Disease prevention and maintenance of good mental health; general checkpoint	1. Prevention of outbreak of infection	2. Prevention of inhalation of dust
	3. Prevention of worsening of chronic diseases	4. Prevention of economy class syndrome
	5. Prevention of disuse syndrome	6. Prevention of heatstroke
	7. Prevention of hypothermia	8. Oral sanitation
	9. Prevention of carbon monoxide poisoning	10. Prevention of worsening of allergic diseases
	11. Health checkup	12. Building emergency consultation system

13.2.4 Great East Japan Earthquake

On March 11, 2011, an earthquake of 9.0-9.1 magnitude, the Great East Japan Earthquake, occurred off the Pacific coast of Tohoku prefecture, and a subsequent giant tsunami hit the coastal area of Japan, especially the northeast area. Many people died and many are still lost. Also, a nuclear accident occurred at the Tokyo Electric Power Company's Fukushima Daiichi nuclear power plant (NPP) and an evacuation zone was designated by the national government, according to the radiation dose in Fukushima, immediately after the accident.

Table 13.2 Number of disaster-related deaths after the Great East Japan Earthquake, by prefecture and age [16]

Prefecture	Total	Age group		
		≤20	>21 <66	≥66
Iwate	446	1	55	390
Miyagi	900	2	113	785
Fukushima	1793	0	169	1624
Others	55	3	10	42
Total	3194	6	347	2841

13.2.4.1 Disaster-Related Deaths

Over 164,000 people in Fukushima were forced to evacuate to areas outside the evacuation zone or they evacuated voluntarily from their living place to other places. In Fukushima, due to earthquakes and/or the tsunami, 1613 people died, and 204 people are still lost, as of September 30, 2017. In addition, 2202 deaths occurred as a result of the Fukushima Daiichi NPP accident (Table 13.2) [16]. These deaths are called "disaster-related deaths." Disaster-related death is defined as death not caused by the direct effect of an earthquake/tsunami but death caused by the worsening of a person's present disease or caused by a new disease that occurred after the disaster. The question we asked is "What type of person has a disaster-related death? Disaster-related deaths occurred mainly among the elderly (aged 66 years or over), while very few people aged 20 years or less died of a disaster-related cause. More than half of the disaster-related deaths after the Great East Japan Earthquake occurred in Fukushima prefecture.

13.2.4.2 Evacuation Stress in Disasters

Another point I would like to emphasize is the severe stress that occurs during evacuation. All inpatients in hospitals and residents in social institutions inside the evacuation zone were forced to evacuate by the government. Figure 13.4 shows changes in mortality rates in the institutionalized elderly before and after the Fukushima NPP accident. The quarterly mortality ratio for the first 3 months after the disaster was 3.1, followed by 1.8 for the next 3 months and 1.4 for another 6 months [17]. This finding, which shows that the negative effects of the evacuation continued for more than 1 year after the disaster, indicates that long-term evacuation was a serious stressor in the elderly residents. We need to take into account the relocation stress in the elderly, regardless of whether the relocation is compulsory or voluntary.

13.2.4.3 Suicide after the Great East Japan Earthquake

It is easy to understand that people who experience a severe disaster may become depressed and/or have post-traumatic stress disorder (PTSD). After the Great East Japan Earthquake, the suicide standardized mortality ratio (SMR) decreased during

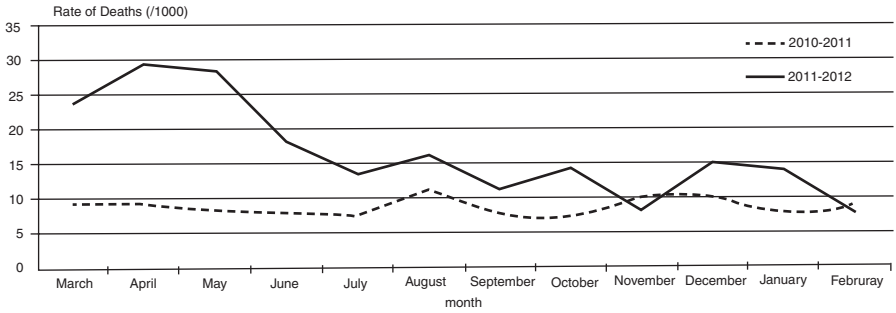

Fig. 13.4 Changes in mortality rates in the institutionalized elderly before and after the Fukushima nuclear power plant accident [17]

the first 2 years in the three affected prefectures (Iwate, Miyagi, and Fukushima) compared with the rates in 2010. The suicide SMR then rose in 2014 to the pre-disaster level in Iwate and Miyagi prefectures, while it exceeded the pre-disaster level in Fukushima prefecture [18]. Five years after the nuclear accident, using monthly data from vital statistics in the evacuation areas in Fukushima between March 2009 and December 2015, analysis by age revealed that post-disaster male suicide rates in the evacuation areas had decreased for those aged 50–69 years and had increased for those aged 29 years or less and those 70 years or older [19]. These findings suggest that providers of disaster mental health services need to keep in mind that suicide rates can eventually increase after a disaster, even if they initially decrease.

13.3 Conclusion

In 2011, Japan experienced the Great East Japan Earthquake, a subsequent giant tsunami hit the coastal area, and there was a nuclear accident at Fukushima Daiichi NPP. We need to consider how elderly people are regarded in the context of a disaster situation, as, generally, elderly people are more likely to become victims of a disaster than are young people. For "people requiring assistance during a disaster" accurate and necessary information needs to be acquired in a prompt manner so that these people can be evacuated to safer places to protect them from the disaster.

Disaster-related death is defined as death not caused by a direct effect of an earthquake/tsunami but death caused by worsening of a person's present disease or death caused by a new disease that occurred after the disaster. After the Great East Japan Earthquake, disaster-related deaths occurred mainly in the elderly, and more than half of these deaths occurred in Fukushima prefecture, where the nuclear accident occurred. The quarterly mortality ratio for the first 3 months after the disaster was 3.1, followed by 1.8 for the next 3 months and 1.4 for another 6 months. We also need to take into account the relocation stress of this group, regardless of whether their relocation is compulsory or voluntary.

After the Great East Japan Earthquake, suicide SMRs decreased during the first 2 years in the three affected prefectures (Iwate, Miyagi, and Fukushima) and in 2014 these rates rose to the pre-disaster level in Iwate and Miyagi prefectures and exceeded the pre-disaster level in Fukushima prefecture. Providers of disaster mental health services should keep in mind that suicide rates can eventually increase after a disaster, even if they initially decrease.

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