

# Health Impact Caused by a Nuclear Disaster –Preventable Deaths and Illnesses–

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The damage caused by a nuclear disaster is quite complex, and it extends far beyond health damage from radiation. In the specific case of the Fukushima nuclear disaster, no comprehensive assessment has been conducted to examine the health damage caused by the misguided evacuation plan. In the ongoing debate over the pros and cons of the possible resumption of nuclear power, we may be distracted by the issue of radiation and lose sight of something important. The author, who lives in Soma, Fukushima Prefecture, describes the health damage that resulted from the evacuation conducted in response to the nuclear accident based on findings gained from her fellow local professionals.

**KEYWORDS:** *nuclear disaster, mass evacuation, health, disaster risk reduction, public health*

## I. Introduction

We often hear of the increasing likelihood of the resumption of nuclear power. Personally, I am not in a position to know what is really going on and who would make such a decision.

A discussion of the pros and cons of this resumption is certainly important. However, anyone with a background in disaster public health can see that the possible resumption of nuclear power and the potential occurrence of nuclear accidents can be considered quite similar to a natural disaster in the eyes of the public. The reason for this is that nuclear accidents happen when they do whether people like it or not.

Even if Japanese nuclear power plants do not resume operation, many other such plants are in operation throughout the world. Probably the only option that we have now is to be as well prepared for the future as possible based on the lessons learned and wisdom gained from our experience of the Fukushima Nuclear Accident.

Preparations for the resumption of nuclear power essentially involve the development of adequate measures against nuclear accidents. In the aftermath of the Fukushima Daiichi Nuclear Accident, many people lost their lives in the secondary disaster caused by a misguided evacuation plan. Their number far exceeds the reported number of victims of radiation

exposure to date. The health damage that they suffered mostly passes unnoticed by stakeholders of the nuclear sector, who are distracted by debates over radiation.

What should be learned from the experience of the Fukushima Nuclear Accident and what measures should be reinforced to prevent the secondary disasters that would inevitably follow another nuclear accident? Let us examine some examples of the health damage caused by the emergency evacuation and prolonged evacuation of local residents to address these questions.

## **II. Damage Caused by the Assignment of Evacuation Zones**

Soon after the nuclear accident, the government of Japan assigned evacuation zones that were defined mostly by concentric circles that indicated three different levels of measures. Forced evacuation was imposed in the restricted area up to 20 km from the accident site. Sheltering was ordered in the “evacuation-prepared area in case of emergency” (an evacuation zone designated in anticipation of a further emergency) within a range of 20 to 30 km from the site. The “deliberate evacuation area” (a zone assigned for planned evacuation) was designated within a range of 30 to 50 km from the site.

The designation of evacuation zones based on concentric circles and the adequacy of the distance of 20 km are often debated. However, this commentary does not discuss the illogical zoning, as it did not directly cause any significant health damage among the residents.

In my opinion, the failure to prevent the recent secondary disaster was mainly due to two incorrect assumptions about the evacuation zones.

Firstly, the restricted area was designated based on the unwarranted assumption that residents would be able to evacuate in unison under the same conditions. Secondly, the evacuation-prepared area was mistakenly assumed to have a clear-cut borderline.

### **1. Vulnerable People Left Behind in the Restricted Area**

The municipalities of Minamisoma, Fukushima Prefecture, were divided into different evacuation zones. Fortunately, all the rescue crews stayed put in the communities affected by the earthquake-induced disaster, and ambulance transportation was still intact even after the nuclear accident. The author would like to deeply appreciate the incredible efforts made by the rescue crews, who were also victims themselves.

According to their records, six ambulance calls were made from people inside the restricted area within a week of the evacuation zones having been designated. Clearly, the evacuation order issued by the government was not thoroughly carried out on the ground. Special note must be taken of the fact that most of the people that remained there did not necessarily do so out of choice.

The “information poor” are the most vulnerable to disasters. For example, elderly people with hearing impairments may often fail to notice evacuation advisories and end up being left behind during a mass evacuation. Some even need assistance just stepping outside the door to their house, such as the bedridden elderly and those who rely on home-care ventilators. One family explained that they were completely confused during the evacuation. They actually left behind a bedridden family member with some food at his bedside, only to find out later that they could no longer return to their home.

Evacuation advisories were not announced door to door to make sure that everyone was informed. Even if they had found people who needed special assistance, it would have been

impossible to rescue them all.

It is not clear how many people within the 20-km range had to die at home alone without being able to call an ambulance. However, such solitary deaths were not limited to the restricted area. Some vulnerable people were “forgotten” even in other more accessible areas.

## **2. Confusion Caused by the Sheltering Order**

The chaos that accompanied the forced evacuation was eclipsed by the social upheaval caused by the sheltering order issued in the evacuation-prepared area within a range of 20 to 30 km from the accident site.

The order for sheltering-in-place may well have been scientifically justified as a means of securing a dramatic reduction in external radiation exposure. In reality, however, it threw society into a great panic.

For instance, most business operators have forbidden their personnel from entering a 50-km range from the nuclear power plant since the designation of the evacuation zones. Some personnel probably refused to enter there out of their own fear of radiation. In other cases, companies might have imposed this ban out of a sense of duty to ensure the safety of their personnel. Amidst the mistrust of information provided by the government and the media, private companies naturally designated much more extensive evacuation zones than the official ones.

As a result, people in the evacuation-prepared area within a range of 20 to 30 km were cut off from the distribution network even though they were allowed to reside there. The denial of access to food for their survival was aggravated when gasoline deliveries were cut off. Despite having access to electricity and water in the area and being legally allowed to reside there, they were effectively denied the chance to live there.

“If we don’t evacuate now, we will be left behind.” This fear gave rise to further panic and resulted in almost all of the residents who were mobile evacuating the area.

Vulnerable people were left behind due to the disaster, including solitary elderly people with poor access to information, people without cars, hospitalized patients, and hospital personnel. A doctor who was assigned to Minamisoma at that time recalled the following: “I performed almost all of the autopsies in Minamisoma within a 30 km radius for a month after the earthquake-induced disaster. Without access to food, many elderly people I saw had starved to death at or near their homes.”

## **III. Harm Caused by the Evacuation**

Aside from the vulnerable people who had been left behind, many evacuees were also affected by a secondary disaster. A particularly serious problem was health damage to the elderly.

Main problems clarified to date involved the evacuation of patients from healthcare facilities such as elderly people, nursing home and hospitals, the loss of access to medical care needed by patients with chronic diseases, and the prolonged evacuation of healthy elderly people.

## 1. Harm Caused by the Evacuation of Hospitalized Patients

The social panic at that time compelled many healthcare facilities for the elderly to evacuate patients in ordinary passenger cars that were unequipped with mattresses and the like. Many patients lost their lives lying across the seats of a minibus during a long-distance evacuation.

Moreover, the 60% of hospitals in Japan that are privately managed probably cannot count on swift emergency support from public institutions. Every hospital interviewed by the author had to mobilize their personnel and their personal connections to coordinate car transportation and find new host facilities for the patients. Hospitals without a strong network took a very long time to decide on the destinations for their patients. Hampered by the conducting of radiation exposure surveys and the congested roads, the transportation of patients took more than 10 hours, all without adequate provisions for blankets, water, and the necessary equipment. According to a report by the Diet Accident Investigation Committee, over 40 patients lost their lives while they were being evacuated from their original hospitals before reaching their destination hospitals<sup>1)</sup>.

Moreover, a rise in the mortality rate was reported among patients after their evacuation, because of inadequacies in the handover between hospitals and sudden changes in their environments. After long periods of hospitalization, some elderly patients fail to eat their meals if there is even a slight difference in the meal preparation or assistance. Furthermore, transporting elderly patients without periodically changing their positions can heighten the risk of bedsores and aspiration pneumonia.

For instance, a study conducted by Nomura et al. to investigate the evacuation of patients from seven long-term care facilities in Minamisoma<sup>2)</sup> found that the mortality rate over the course of one year after their evacuation more than doubled compared to the level before their evacuation.

## 2. Harm Caused by the Evacuation of Chronic Disease Patients

Inadequate access to proper medical care in the midst of such a panic caused health damage to many patients with underlying diseases who could otherwise have led normal lives. The most notable examples of this are dialysis patients.

At my workplace, Soma Central Hospital, they say that the water supply was disrupted for a few days after the earthquake and that they experienced a serious shortage of water that was needed to operate the dialyzers. “Fortunately, water was still supplied to the opposite side of the national road, so when a water tank truck reached our hospital, we used the entire supply of water from that truck to operate the dialyzers,” said one member of the hospital staff recalling this challenge. “We also asked patients who had a stable condition to bear with a prolonged dialysis cycle. Our dialyzers were overextended due to the new arrival of dialysis patients from Minamisoma. There was also a patient from Iwate (which also suffered tsunami damage despite being located 200 km to the north of Fukushima) who had travelled south while searching for an alternative dialysis facility in one place after another before reaching us...”

Special care needed to be taken not only for dialysis patients, but also for elderly people who were reliant on home oxygen therapy and tubal feeding. Health damage can also be caused by an interruption to the administration of agents for treating basic diseases such as diabetes and high blood pressure. No report has been obtained to determine whether all of the patients who required home oxygen therapy in the evacuation zones were able to remain safe without access to care services provided by outside contractors.

In fact, patients with chronic diseases often encounter such problems during a major disaster that involves mass evacuation. A review<sup>3)</sup> of papers from Japan and other countries that was conducted by the author and her colleagues revealed that chronic diseases required a substantial proportion of the medical care provided in the aftermath of the 2011 Great East Japan earthquake. Numerous cases of health damage reported from recent major disasters, including the latest earthquake-induced disaster in East Japan, involved the loss of medical devices (e.g., regular medication, allergy medication, and other emergency medication, including assistive devices, such as glasses, dentures, and canes)<sup>4)</sup>. Many people from the Miyagi coast and other coastal areas where the 2011 Great East Japan earthquake and tsunami struck faced problems as they left their therapeutic agents at home<sup>5)</sup>. A similar situation is expected to arise for evacuees from Fukushima who had to engage in a mass evacuation without adequate preparation.

### **3. Harm Caused by the Prolonged Evacuation at Temporary Shelters**

In addition to patients with underlying diseases, elderly people who were initially healthy were also affected by the prolonged evacuation at temporary shelters.

Life in a temporary shelter poses various types of health risks. One of the most crucial factors is that indoor activity inside one-storied temporary shelters with an area of just 30 m<sup>2</sup> is extremely limited. The geographical locations of the temporary shelters can also be a cause of reduced activity. It has been reported that good access to restaurants, grocery stores, and convenience stores play an important role in keeping the elderly active<sup>6,7)</sup>. At remote temporary shelters located at some distance from the local communities, evacuees become dependent on car transportation to compensate for the poor access to shops. As a result, their levels of activity may be diminished considerably. Some evacuees from coastal areas explained that they felt unable to leave their temporary shelters in the mountains because they were afraid of wild boars and pit vipers.

This lack of physical activity became glaringly apparent in the checkup of locomotor systems that was conducted in Soma in 2012, a year after the earthquake-induced disaster. Among people aged 65 and older, evacuees living in temporary shelters proved to have a five times greater risk of experiencing a reduced ability to stand on one leg with their eyes open than was the case for their peers who had remained living at home (data sourced from a paper being submitted by the author and her colleagues). In contrast, evacuees living in temporary shelters exhibited a significantly greater grip strength than other residents. Given that most evacuees living in temporary shelters used to engage in agriculture and fisheries, these findings seem to suggest that formerly strong people who had been engaged in the primary sector of the economy are quickly losing their leg strength while living in temporary shelters.

Life as an evacuee also leads to changes in diet. Before their evacuation, these people used to consume locally produced food, with many of them refusing to buy fish and vegetables from supermarkets as they are “expensive and taste lousy.” Furthermore, the long distance to the supermarkets meant that evacuees also began to consume less vegetables and perishable food in an effort to stock up on food in the shelters. As a result, they have an unbalanced meat-heavy diet today. Worse still, concerns over radiation discourage people from consuming healthy ingredients, such as fish, vegetables, mushrooms, and fruits, even when they are on the market. Health checkups in Soma demonstrated that high blood pressure, diabetes, and obesity could be observed among a greater share of evacuees living in temporary shelters than among local residents<sup>8)</sup>. Given this, there are concerns that this prolonged evacuation may increase the prevalence of chronic diseases.

Lastly, the evacuees have also suffered mental harm. The losses caused by a disaster are known to trigger depression. People did not only lose their property due to the forced evacuation, farmers and fishers lost their jobs when the nuclear disaster put an end to the primary sector. Furthermore, their prolonged evacuation is adding to their psychological stress. When the author participated in a health checkup at a temporary shelter, one person told her: “I seldom go out for a walk because I cannot bear the sight of my house on the way back to the shelter.” This is just one example of the damage to mental health that this prolonged evacuation has caused.

## **IV. Difficulties Involved in Planning The Evacuation in Fukushima**

The preceding section provided an overview of the health damage caused by the evacuation conducted in response to the Fukushima Daiichi Nuclear Accident. Has the evacuation plan been improved based on these experiences? Unfortunately, the answer to that question is “no” at the moment.

Take Soma, where I live, for instance. Parks, schools, and other public spaces are equipped with NaI scintillation detectors for measuring the air dose rates. Such a measure is certainly important in enabling people to find out the levels of local contamination on the spot. Unfortunately, however, no guidelines have been presented to explain how these measurements should be applied in practice. In other words, no guiding benchmarks have been set in the units of  $\mu\text{Sv/h}$  to allow residents to decide whether they (and children in particular) should evacuate if the dose rate exceeds a certain level.

People living in Hamadori, an area of Fukushima located along the Pacific coast, best understand the difficulty involved in setting such a benchmark. “Suppose a benchmark is set on a scientific basis to initiate an evacuation at a certain dose level. In practice, no residents would wait until the dose rose to that level.” Mr. Hidekiyo Tachiya, the mayor of Soma, points out the problems associated with numeric targets while acknowledging their importance. “A voluntary evacuation would be prompted by a dose level much lower than any benchmark. It is easy to imagine that vulnerable people would be left behind yet again. The earlier chaos experienced with the sheltering order discourages us from setting any guiding benchmarks.”

This paradox stands in the way of performing radiation surveillance using scintillation detectors and other means in Fukushima.

## **V. Lessons to be Learned from Fukushima**

What can be learned from these experiences in Fukushima? The disaster can arguably be said to have shed light on the issues described below.

### **1. Designation of Evacuation Zones**

Along with the assignment of relevant ranges (e.g., distance and dose level), evacuation zones must be designated with due consideration given to the problems induced by these demarcations. Any discussion of the appropriate distance probably does not carry much practical

significance.

### **(1) Removing obstacles to distribution**

The matter that requires the most consideration is the way in which distribution and the necessary personnel are maintained in the outer rims of the evacuation zones. As mentioned earlier, private companies are likely to set a wider evacuation zone than those designated by the government. Furthermore, no one has the authority to order distributors and healthcare professionals (especially female nurses) to go to the peripheries of the evacuation zones given the risks of radiological contamination. In this respect, it is safe to say that the distribution systems in the evacuation zones today depend solely on the goodwill of residents. This must be reformed as soon as possible.

### **(2) Preventing vulnerable people from being left behind**

During a disaster, caregivers and other care workers are also affected on the ground. It is completely unreasonable to expect them to escort all of their patients in the midst of all the chaos. The care workers could be mentally overwhelmed. Given its rapidly ageing society, Japan must take note of an increase in the number of vulnerable people during an emergency.

## **2. Planning of Evacuation Activities**

Adequate evacuation planning is impossible without a prior assessment of the potential health damage caused by evacuation activities.

At present, however, almost no study or analysis has been conducted from a bird's-eye perspective regarding the health damage caused by the nuclear disaster.

### **(1) Planning evacuations from care facilities**

As explained earlier, an evacuation can increase the mortality risks for the elderly. Does that mean that long-term care facilities should delay an evacuation? If so, care workers and distributors of food and other items would also have to remain there. Without the appropriate authority, nobody can guarantee that vulnerable people would receive the adequate assistance they need. A more sensible alternative may be to minimize the burden on evacuees by, for example, securing the necessary items and vehicles, arranging the destinations efficiently, and preparing handover templates.

### **(2) Planning evacuations to temporary shelters**

Any prolonged evacuation after a disaster also leads to an increase in the number of deaths caused by musculoskeletal disorders, lifestyle diseases, heatstroke, cold weather, and other environmental factors. In fact, in Fukushima Prefecture, the number of people who lost their lives from indirect causes in the aftermath of the earthquake-induced disaster exceeded the number who died from direct causes during the disaster<sup>9)</sup>. This is considered to be due to prolonged evacuation, which poses greater disease risks.

As matters stand today, the health damage caused by the disaster has not even been quantified. Aside from the identification of risk factors, efforts must be made by the relevant organizations to swiftly resettle evacuees in permanent housing, improve their access to shops and medical services, and help rebuild their communities.

## **VI. Turning the Disaster into a Positive Legacy**

“Who should take the lead in solving these problems?” People often ask me this question

when I talk about the health damage caused by the nuclear accident. However, Japanese society will fail to learn any lessons from the last disaster as long as people remain on the sidelines and expect somebody else to take care of these problems. Indeed, health is everyone's business.

Some may think that health should be left to the healthcare professionals. However, the basic duty of a doctor is to diagnose diseases at a hospital, and diseases are just one aspect of health damage. In my capacity as a doctor, I have focused my attention on diseases and deaths in this commentary. However, health is not maintained simply by preventing diseases. Rather, the bedrock of health is formed through access to adequate food, clothing, shelter, and mental fulfillment as well as education. Naturally, the nuclear sector, which is also represented by readers of this journal, must assume important responsibilities and roles in the safeguarding of people's health by maintaining a robust social infrastructure.

For instance, distribution in the outer rims of evacuation zones and the means of transport for evacuees could be secured with the assistance of a power utility company. In the event of a nuclear accident, food and supplies for workers must also be brought into the relevant nuclear plant. Perhaps distribution channels could be integrated with the logistics network for local residents.

To ensure the health of local residents living in the environs of a nuclear power plant, it is vital for various professionals from the public and private sectors to cooperate on a regular basis to improve community healthcare. After all, healthy local residents will suffer less health damage. Multiple-disciplinary cooperation is necessary to keep communities healthy and prevent diseases. This is common knowledge in the public health field. Everyone is expected to reflect on the professional contributions that they can make to protect people's health.

Lastly, on a more personal note, I wonder if our healthcare system could be maintained in collaboration with a variety of professionals. Healthcare services in Fukushima had already been pushed to the brink of collapse before they were further overwhelmed by the nuclear disaster. The resultant breakdown stands in the way of the reconstruction of local communities. Residents of difficult-to-return zones are reluctant to return home even if evacuation orders are lifted partly because of poor access to healthcare and welfare services. In Fukushima, nurses and caregivers, who are predominantly women, have little incentive to continue providing healthcare assistance. Healthcare professionals could perhaps be more motivated by the provision of better management, guidance by sales professionals, and material assistance.

Much more wisdom is needed today to prevent health damage from nuclear disasters. Without excluding anyone as an outsider, all kinds of professionals should be invited to combine their specialist knowledge. By adopting this approach, I believe that we will be able to find the right approach to post-disaster reconstruction efforts and the necessary disaster management measures.

## VII. Conclusions

This commentary examines how mass evacuation causes health damage based on the experience gained in the aftermath of the Fukushima Nuclear Accident based on survey results, facts obtained from interviews, and some personal observations.

Radiation is not the only challenge posed by a nuclear accident. In fact, social, economic, psychological, cultural, and other factors are intricately intertwined. There is no silver bullet



(specific medicine/unique answer) for dealing with such a complex disaster. To build a more prosperous society by heeding the lessons learned from previous disasters, professionals from every field should combine their knowledge and skills to achieve the common goal of protecting people's health. In any future nuclear accident, what can we do to prevent health damage like that experienced in the last disaster? I hope that a number of professionals will draw on their collective expertise to answer this question.

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