

‘Life communication’ after the 2011 Fukushima nuclear disaster: what experts need to learn from residential non-scientific rationality

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ABSTRACT

After chemical, biological, radiological, nuclear or explosive (CBRNE) disasters, trepidation and infodemics about invisible hazards may cause indirect casualties in the affected society. Effective communication regarding technical issues between disaster experts and the residents is key to averting such secondary impacts. However, misconceptions about scientific issues and mistrust in experts frequently occur even with intensive and sincere communications. This miscommunication is usually attributed to residents’ conflicts with illiteracy, emotion, value depositions and ideologies. However, considering that communication is an interactive process, there are likely to be additional factors attributable to experts. This article aims to summarize the gaps in rationality between experts and residents observed after the 2011 Fukushima nuclear disaster to describe how residents perceived experts. There were discrepancies in the perception of ‘facts’, the perception of probability, the interpretation of risk comparison, what were included as risk trade-offs, the view of the disaster, whose behavior would be changed by the communication and whether risk should be considered a science. These findings suggest that there was a non-scientific rationality among residents, which often exercised a potent influence on everyday decision-making. It might not be residents but experts who need to change their behavior. The discrepancies described in this article are likely to apply to communications following any CBRNE disasters that affect people’s lives, such as the current COVID-19 pandemic. Therefore, our experiences in Fukushima may provide clues to averting mutual mistrust between experts and achieving better public health outcomes during and after a crisis.

Keywords: Fukushima nuclear power plant accident; science communication; dialogue with residents

INTRODUCTION

In the aftermath of chemical, biological, radiological, nuclear or explosive (CBRNE) disasters, trepidation and worry about the invisible hazard can provoke fear and anxiety, which often leads to social disruption and even increased mortality. For example, after the Ebola outbreak in West Africa in 2013, fear of contagion and mistrust in public hospitals caused a severe decrease in utilization of healthcare services, and the non-Ebola morbidity and mortality rates increased for longer than a year [1]. After the Chernobyl nuclear accident, the odds of chronic diseases such as respiratory disorders and ischemic heart diseases increased among immigrants, suggesting that the indirect health impact may increase long-term mortality [2]. In such situations, effective communication regarding technical issues between experts and the affected population is key to averting negative public health impacts.

The 2011 Fukushima Daiichi Nuclear Power Plant (NPP) accident was one of the largest CBRNE disasters in world history. It occurred in a society in which information was highly networked, and misunderstandings of health risks were potentially exacerbated by media outlets [3]. Such ‘media hype’ engendered public stigma against Fukushima immediately after the disaster [4] and interrupted channels of supply over a wide area around the NPP [5]. As a result, even essential services, such as healthcare, became dysfunctional [6], which led to a collapse of the local community.

To respond to and recover from the dysfunction caused by the media’s misleading communication, other forms of communication were urgently needed. Many radiation and health experts came to Fukushima to facilitate more scrupulous communication, such as small-group lectures and dialogues. These efforts were successful in

Table 1. Common measures in science communication with lay people.

Assumption	Solution
People may not understand technical jargon	Use plain language, illustration and manga (i.e. books and graphic novels)
Affected people may be too emotional to accept objective facts	Speak with politeness, sympathy and condolence
Local people have their own culture	Take an ethnological approach by learning local culture and social values
People often make decisions on the basis of ideology, partisanship and religious identity rather than science	Cease science communication with such people

many cases and contributed to reduced anxiety in local residents [4]. Nevertheless, these experts repeatedly faced misconceptions about scientific facts and mistrust of experts from residents.

There were several discussions about potential causes of and solutions to these misconceptions. First, residents may have limited scientific literacy, so technical issues should be communicated in a comprehensive manner with plain language and illustrations. Second, victims of a disaster may be too emotional to accept scientific facts, and experts must show sympathy and compassion to establish trust before discussing potentially difficult topics. Third, residents' social values, identities and other cultural factors may affect their risk perception, requiring experts to take ethnological approaches. Fourth, residents' opinions were more influenced by value depositions, such as ideology, partisanship and religious identity, rather than logic, and could not be changed by improved science literacy [7]. In these cases, experts may prefer to cease communication (Table 1).

These discussions were to the point to some extent. Even so, it should be noted that all the discussions described above only discuss the residents through the eyes of experts and not the perceptions of experts by residents. There seems a premise that experts are more literate, logical and rational than lay people; thus misconceptions are attributable to the residents. However, some research shows that people with higher science literacy are also biased by their own theses and policies [8]. Furthermore, in many instances of science communication, those who challenge experts are often themselves experts in other scientific fields and have reliable scientific intelligence [9]. Therefore, it is important to consider whether these misconceptions are also attributable to people with higher science literacy.

The aim of this article is to describe the non-scientific rationality observed among the residents in Fukushima after the 2011 NPP accident and to show how experts might be seen from the view of the residents. This may provide new aspects of misconception in science and may contribute to improved communication during CBRNE disasters, including the current COVID-19 pandemic.

DISCREPANCY IN PERCEPTION OF 'FACTS'

After the Fukushima NPP accident, both internal and external radiation exposure levels among the residents in Fukushima were considered minimal [10, 11] and it is not expected that this incremental radiation exposure will increase the incidence rate of cancer among the residents [11]. Indeed, data from the local government in a local city near the NPP showed no increase in cancer mortality after the accident [12].

However, even with such data, some residents remained skeptical. A resident said:

'But some of my neighbors have already been diagnosed with cancer after the accident. And you, as a medical doctor, must have seen cancer patients at your hospital. So, I do not understand why you say cancer is not increasing.'

This is not a scientific way of thinking. Cancer is a common disease, especially in an aging society, and it is impossible to show a causal relationship between radiation exposure and the occurrence of cancer in her neighbors. However, it remains a 'fact-based judgment'.

Such disagreement between experts and residents revealed that there was a discrepancy in the perception of facts between experts and residents. When experts talk about 'a sound fact', they assume the fact is representative of a population. This means that experts usually exclude outliers and cut-off tails of a normal distribution curve. On the contrary, lay people rely greatly on personal experiences when they make judgments. A frequent question asked by the residents was:

'Why are academic papers more reliable than our own experience?'

Considering that academic papers often aim for generalization, they do not always reflect regional and cultural differences. Therefore, it might be reasonable for the residents to rely on the experiences of their colleagues or local news rather than on academic papers. Additionally, journalists often emphasize outliers rather than representative examples: as the old saying goes, 'Dog Bites Man' is not news, but 'Man Bites Dog' is news, though both are 'sound information'. Due to this discrepancy, residents exposed to media tended to become mistrustful of experts.

Therefore, from the viewpoint of the residents, the perceived 'facts' of experts are limited and more biased by statistics than the real-life 'facts' of the general population.

DISCREPANCY IN PERCEPTIONS OF 'PROBABILITY'

A similar discrepancy exists in the perception of probability, which was exemplified by disputes around the results of thyroid cancer screenings conducted after the NPP accident. In response to an increasing concern about thyroid cancer among residents, the local government started thyroid cancer screening of all children who lived in Fukushima prefecture at the time of the accident since September 2011 [13]. As it takes several years from the time of radiation exposure to cancer development, the first screening conducted from 2011 to 2012 was considered the 'baseline survey', which was a surrogate marker

of the prevalence of thyroid cancer before the accident. However, this baseline surveillance detected 116 subjects with malignant disease or suspicion of malignancy [14]. This number can be explained by the ‘screening effect’ wherein small cancers are detected years or decades before they become symptomatic [15], a conclusion supported by observations that there was no correlation between the incidence rate of cancer and the distance from the NPP or an increase of the rate over time.

Even so, this explanation about a screening effect did not always satisfy the residents.

‘What you are explaining is just estimation,’ residents often said, and, ‘These statistics do not explain why as many as 100 children have been diagnosed with cancer.’

Such arguments imply that the residents do not understand statistics. However, in some cases, they were not ignorant of statistics; they just did not need statistics to understand the current status, because statistics are just estimations.

Another resident commented:

‘I cannot trust experts who talk about scientific forecasts in a convincing manner.’

It is true that most of the health information that experts provided after the nuclear accident—cancer risks, health risks caused by evacuation, effects of mental stress, and so on—are not facts, but estimations. Even if the estimations are true with a probability of 99.99%, they are not 100% accurate. For people experiencing anxiety about the current situation, this 0.01% is an insurmountable barrier between the ‘knowable’ present and the ‘unknowable’ future. In this case, experts are viewed by the residents as a group of people who place too much emphasis on stochastic calculation.

DISCREPANCY IN INTERPRETATIONS OF RISK COMPARISON

Gaps between experts and lay people were also observed in risk comparison, which is a typical method used to let people understand the size of radiation risk. Experts often compare the risk of radiation exposure with more popular risks such as smoking, drinking alcohol, obesity and a sedentary lifestyle [16].

Although adequate risk comparison was very useful to enhance both subjective and objective understanding of cancer risks [17], this did not always lead to risk acceptance or reduced anxiety among residents. First, for those who want to minimize the risk, risk comparison has little meaning. This is represented by the following comment by a resident:

‘I understand the radiation levels are negligible compared with other risks like smoking, but it still exists. Why do you pretend as if there is no risk?’

Second, some kinds of risk comparison may increase skepticism. A mother in Fukushima was upset by the comparison of radiation risk with that of cigarette smoking:

‘My child is not a smoker. It sounds deceiving that you compare radiation risk with such an unrealistic risk.’

Third, anxious people may not be relieved by risk comparison but may become afraid of the risks used for the comparison. One expert compared radiation levels of radioactive cesium in wild products in Fukushima and those of radioactive potassium from natural resources. She used bananas, which contain much potassium, as an example of natural radiation. A month after the lecture, a resident said to her:

‘I became afraid of eating bananas because they contain radioactive substances.’

Fourth, some people prefer overestimating a risk from a viewpoint of risk management. A public health expert wrote on a social networking site:

‘Taking actions under the assumption that cancer is increasing in Fukushima is more reasonable from the viewpoint of health protection.’

In these cases, people were not too emotional or too irrational. They understood the size of the radiation risk but made different choices from what experts expected. Experts thought that the residents would accept radiation risk when they understood it to be as negligible as other risks they are exposed to every day. On the contrary, people who are anxious about a specific risk often try to minimize it, regardless of its size. For these people, risk comparison may look like a trick of ‘hiding a leaf in a forest’.

DISCREPANCY IN RISK TRADE-OFFS

To describe the relationship between radiation exposure level and the health impact it causes, a non-threshold hypothesis is usually adopted [18]. This means that the lower the radiation exposure level is, the better it will be for health. Therefore, if all conditions are the same, it might be preferable to lower radiation exposure as much as possible. The problem is that actions to reduce radiation exposure inevitably invite other major health risks (risk trade-offs). For example, staying indoors may reduce external radiation exposure levels but may increase risks of immobility, obesity and mental disorders. Not eating fish and mushrooms from fear of internal radiation exposure may increase nutritional problems such as vitamin D deficiency.

There are many reports about the risk trade-offs of evacuation, including mental disorders [19] and declines in physical performance [20]. What we have learned from cases in Fukushima is that people may need to weigh the risks related to radiation exposure and the risk trade-offs before taking risk avoidance actions such as evacuation. Talking about these risk trade-offs is important to help residents refrain from endlessly pursuing unrealistic null risks.

However, there was a significant discrepancy between the residents and experts in what to put on the balance of risk and its trade-off. Experts put radiation on one side of the balance, and measurable health risks related to radiation avoidance on the other side (Fig. 1a). On the other hand, residents considered more factors when balancing risk and its trade-offs than experts did (Fig. 1b). For example, some residents preferred eating local products even after the NPP accident, saying:

‘I choose to eat local products in Fukushima not because it is safe, but because it is tasty.’

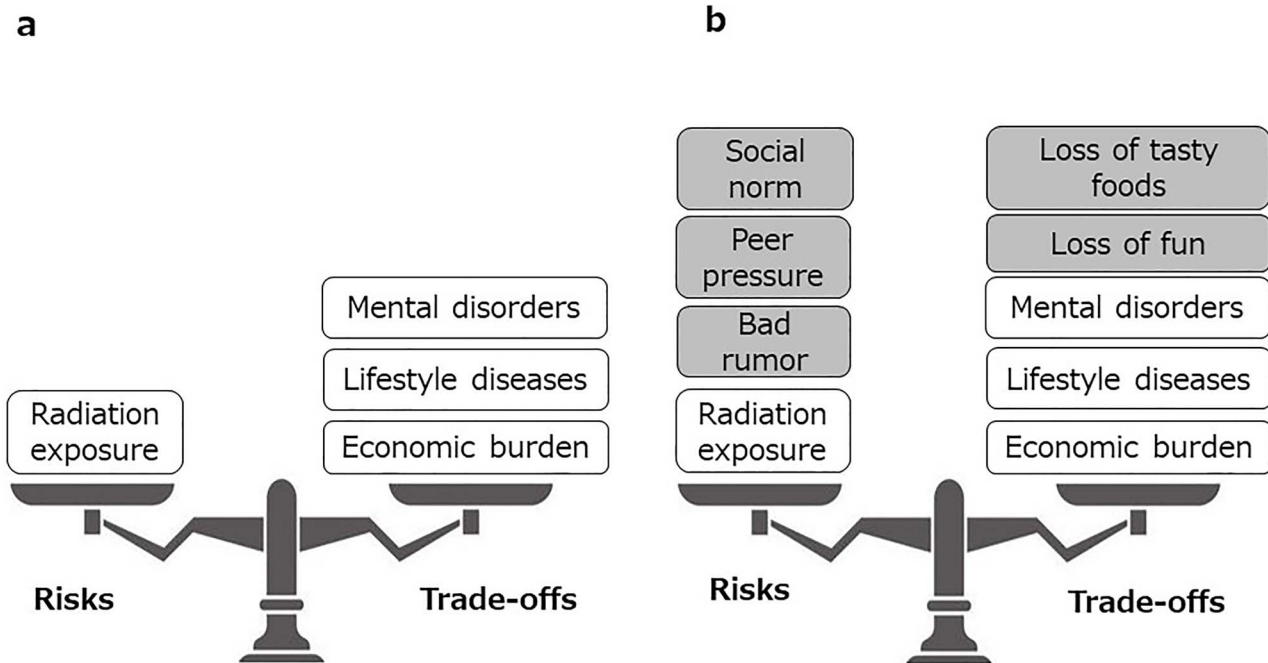


Fig. 1. Discrepancy in risk trade-offs. (a) Balance of risks and risk trade-offs for experts; (b) balance of risk and risk trade-offs for residents, including loss of benefits.

Other residents did not eat local products even when it was well inspected. They explained:

'I understand the radiation risk is minimal, but I cannot stop wishing for a null risk for my child, because it is my parental responsibility' and 'I know eating Fukushima products is safe, but I cannot speak up because I am afraid of being ostracized'.

Such discrepancies in risk trade-offs might also be observed in other situations such as discussions about climate change. Kahn explained that when positions on a specific topic such as climate change become an identifiable indicator of one's cultural commitments, people may adopt a stance that prevails among his/her closest associates. He noted that the choice is perfectly rational [8].

Considering additional risk trade-offs may be key to understanding communication gaps between experts and lay people. Here are examples of risk trade-offs that were observed during dialogues in Fukushima.

- Benefit side of risk taking: people continued eating potentially contaminated wild mushrooms and wild boars because they had a strong food culture.
- Economic reasons: some people did not evacuate not because they thought Fukushima was safe but because they could not afford it.
- Peer pressure in the community: those who rejected thyroid cancer screening might be seen as being antisocial.
- Social norms: parents pursue null risks for their children while knowing the risk is negligible.

When risk trade-offs presented by experts did not cover these factors, they were often seen as narrow-minded or arrogant people who were ignoring the residents' culture and values.

DISCREPANCY IN VIEWS OF A DISASTER

Similar to risk trade-offs, a nuclear disaster that experts think of is not the same as that which the residents experienced. While experts were talking about safety impacts caused by radiation exposure, the residents were talking about all the impacts to their livelihoods caused by the nuclear disaster.

'Whenever experts insist on the safety of living in Fukushima, I felt that all the difficulty we faced after the disaster was being ignored'.

Similar comments were frequent among the most affected residents, such as evacuees living in temporary housing. The NPP accident was not a simple event of radiation and contamination: it was a combination of a series of events including mass evacuation, job losses, dangerous rumors and an aging population, among others, all of which may lead to health deterioration (Fig. 2) [3]. Overall, experts tended to focus too much on radiation and cancer instead of appreciating a holistic view of health. This is exemplified by a case of a policymaker who stated on TV:

'The Fukushima NPP accident caused no casualty'.

By saying so, she did not intend to tell a lie but she did not have an appreciation of the indirect mortality caused by the accident.

Due to this gap, residents and experts often talked at cross-purposes. For example, an expert in radiation came to a shelter in Fukushima and provided a lecture about cancer risk related to radiation. After the lecture, an older woman raised her hand and asked:

'Then, when can we go to pick wild vegetables and eat them?'

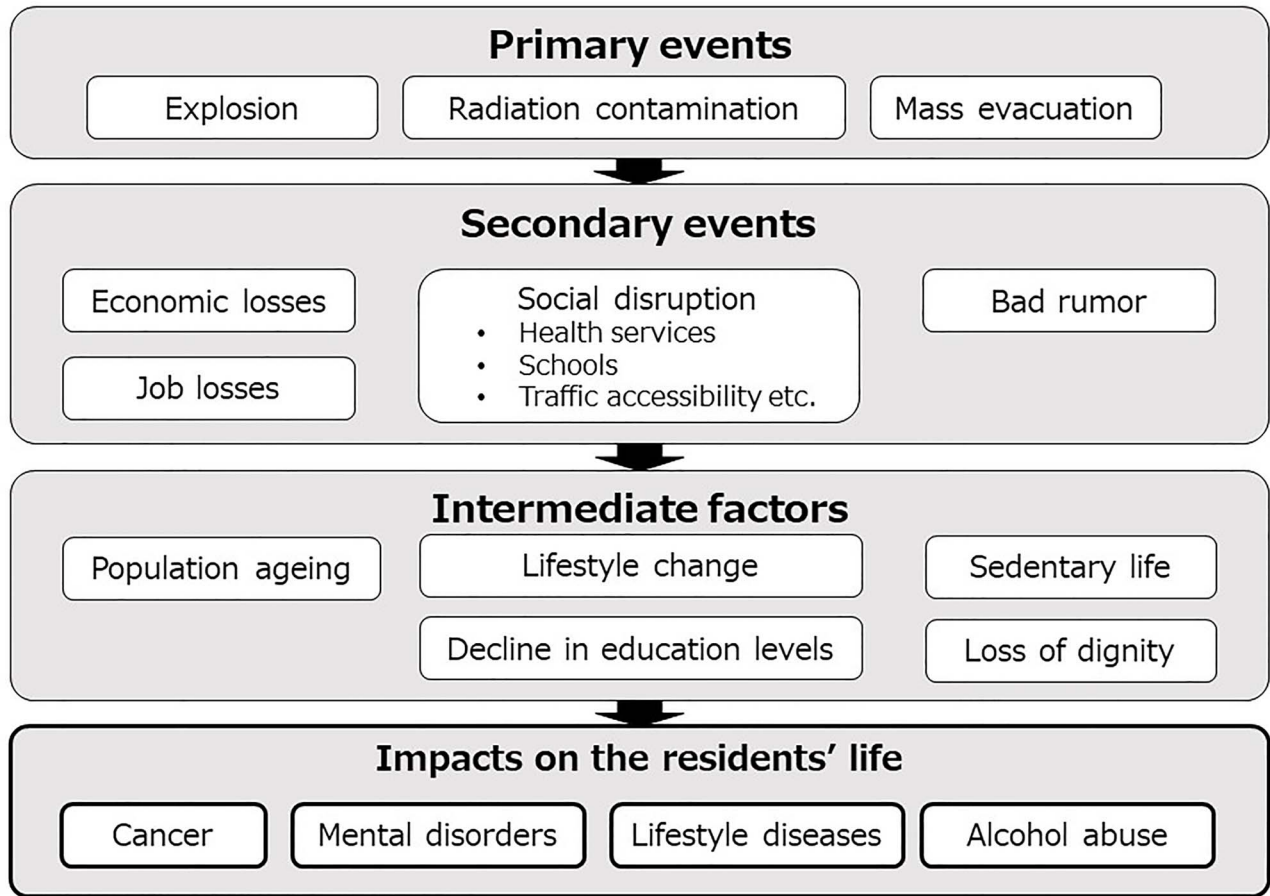


Fig. 2. How a nuclear accident impacts residents' life. A nuclear accident is not a single event of an explosion, but a mixture of a series of events such as mass evacuation. These events, through secondary events and intermediate factors, impact residents' life and health.

The lecturer mumbled, unable to answer the question. It is not fair to expect scientific experts to answer such a specific question that is outside their field of expertise. However, this question exemplified the gap in the purpose of communication between residents and experts.

Even though anxiety about radiation is widespread, radiation is not at the center of the lives of the residents. The residents' purpose is to reconstruct their lives. If experts simply talk about radiation and cannot show how it is related to daily life, residents may feel that experts do not give them cogent information.

DISCREPANCY IN VIEWS OF WHO SHOULD CHANGE

As views of the disaster were different, so were the goals of communication. In particular, a major gap existed in which side should change in response to the communication.

In general, the common purposes of risk communication among experts are: (i) to increase knowledge; (ii) to increase satisfaction with communication; (iii) to change risk perception and alleviate concerns; (iv) to reduce psychological distress; (v) to build trust; (vi) to change

decision-making and behaviors; and (vii) to improve self-efficacy [21]. When experts consider these purposes, they naturally assume that the subjects are lay people or residents: for example, experts often aim to 'increase the knowledge' of 'behavioral changes' by residents but rarely their own. In the same way, risk communication often aims to build residents' trust in experts but not to build experts' trust in lay people.

This means that although risk communication is defined as 'an interactive process of exchanging information and opinions' [22] and that some risk communication activity aims to 'facilitate mutual understanding' [21], the flow of knowledge is still restricted to that of experts to residents.

However, in a rare and extreme crisis such as the NPP accident, residents often expect experts to learn from the lived experiences of those in the disaster area. It was pointed out by a resident in Fukushima:

'You, experts always try to change our behaviors, but it is experts who never changed behaviors.'

For him, experts were people who refused to learn from their communication efforts.

NOT SCIENCE BUT LIFE

As experts, we thought we were conducting science communication, which is typically defined as ‘the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science: awareness, enjoyment, interest, opinion-forming, and understanding’ [23]. However, the residents may not think of radiation as science in the first place. A schoolteacher who did not eat any fish after the NPP accident said:

‘For you experts, radiation and residents are just objective matters. But for us, radiation is what we have to live with.’

Put simply, residents were talking about life instead of science. In science communication, the health impact resulting from evacuation can be compared in an objective manner with scales such as the loss of life expectancy [24]. On the other hand, in ‘life communication’, this comparison does not work because the weight of each risk varies with the individual. In this sense, talking about radiation risk is equivalent to talking about consumption of sweets, drinking alcohol, smoking and engaging in risky behaviors such as bungee jumping: people have the right to make their own choices according to their own set of values, even when a choice might be an unhealthy one. Therefore, when someone chooses to stay indoors after knowing the risk of a sedentary life, no one should blame him/her for making a worse or wrong choice.

From this viewpoint, if experts try to provide ‘correct’ information, it may look as if experts are invading the residents’ freedom to live unhealthy lives. What experts need to do is not to expect people to choose the right answer, but to humbly show people what is on both sides of a balance of risks and risk trade-offs.

VIOLENCE IN THE NAME OF SCIENCE

Additionally, experts need to understand that the vindication of science sometimes hurts the victims of a disaster even if they do not intend to be paternalistic. For example, experts who emphasize science cynically refer to non-scientific opinions of residents as ‘conspiracy myths’. A mother in Fukushima once said that:

‘When we showed our concern about the impact of radiation on our children, experts often treated us as representatives of stupid and emotional mothers who are at the mercy of disinformation.’

Of course, scientific evidence should not be skewed by sympathy and condolence to the victims. Even so, if experts talk too much about the scientific evidence that the radiation risk in Fukushima is safe, those who evacuated after the accident may feel that they are blamed for taking the wrong action, though there was no ‘correct’ action. In crisis situations, science should not be used to advocate for a single, correct course of action. Instead, scientific evidence should be used to describe all the available options and their consequences to enable people to make informed choices as appropriate for their level of anxiety.

CONCLUSION

These cases, observed in Fukushima, demonstrate that it is not always emotion and illiteracy that cause misconceptions of scientific issues by

residents in disaster areas. There seems to be a context-specific rationality among residents, which often exercises a more potent influence on decision-making than epidemiology and statistics. Especially in a situation where a risk affects a person’s life as a whole, the failure of experts to learn meaningful aspects of the residents’ lived experiences may be a major cause of miscommunication, as was seen in the HIV pandemic [25].

Currently, the social disturbances caused by the COVID-19 pandemic cause mistrust and distrust of scientists and authorities [25], resulting in an infodemic that is killing many people [26]. The world is now keen on effective communication to manage such social disturbances. As communications after any CBRNE disaster have problems in common, the experiences with communication and miscommunication in Fukushima may be a clue to averting mutual mistrust, thus contributing to achieving better public health outcomes after a crisis.

CONFLICT OF INTEREST

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