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A report that Fukushima residents are concerned about radiation from Land, Food and Radon

Yuki Tamari[1,†], Yujiro Kuroda[2], Ryu Miyagawa[3,†], Kanabu Nawa[1,†], Akira Sakumi[1,§], Naoko Sakata[4,§], Nozomi Mizushima[5,§], Osamu Sakura[5,§], Yumi Iwamitsu[6,§], Kazuhisa Takemura[7,§] and Keiichi Nakagawa*[1]

[1]Department of Radiology, The University of Tokyo Hospital, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8655, Japan
[2]Department of Public Health, Fukushima Medical University, Fukushima, Japan
[3]Department of Pathology, The University of Tokyo Hospital, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8655, Japan
[4]Department of Palliative Medicine, The University of Tokyo Hospital, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8655, Japan
[5]Interfaculty Initiative in Information Studies, The University of Tokyo, Tokyo, Japan
[6]Department of Medical Psychology, Graduate School of Medical Sciences, Kitasato University, Kanagawa, Japan
[7]Department of Psychology, Waseda University, Tokyo, Japan
*Corresponding author. Keiichi NAKAGAWA, Department of Radiology, The University of Tokyo Hospital, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8655, Japan. Tel: +81-3-5800-8667; Fax: +81-03-5800-8786; Email: nakagawa-rad@umin.ac.jp
[†]Contributed equally.
[§]Supervised.
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ABSTRACT

The Great East Japan Earthquake and subsequent TEPCO Fukushima Daiichi nuclear disaster occurred on 11 March 2011, which caused the leakage of radioactive materials into the environment. In this study, we report public concerns about radiation in Fukushima and Tokyo almost one year after the nuclear disaster. We examined the public concerns by analyzing the data from 1022 participants, 555 in Fukushima and 467 in Tokyo. They were asked whether they were concerned about radiation from some of six different types of sources, which could be answered in a binary way, 'yes' or 'no'. We found not only similarities, but also significant differences in the degrees of concerns between Fukushima residents and Tokyo ones. Fukushima residents more concerned about radiation from land, food and radon in larger rate than that of Tokyo ones, while Tokyo residents were concerned about radiation from medical care. Residents in neither location were concerned about radiation from space. Our results suggested that careful risk communication should be undertaken, adaptively organized depending on location and other factors, e.g. comprehension about radiation, presence of the experience of evacuation, and also age and gender of the people.

KEYWORDS: Daiichi nuclear disaster, radiation, risk communication, radiation source

INTRODUCTION

The Great East Japan Earthquake and subsequent TEPCO Fukushima Daiichi nuclear disaster occurred on 11 March 2011. As a result, a certain amount of radioactive materials leaked into the environment [1]. After the disaster, the Ministry of Economy, Trade and Industry introduced three zones in Fukushima; Zone 1, where evacuation orders were ready to be lifted, Zone 2, where the residents were not permitted to live, and Zone 3, where it was expected that residents would have difficulties to live in the long term [2]. In 2015, there were still ~106 000 people evacuated from these zones [3].

Of those present in Fukushima, the number of people concerned about radiation has drastically increased. Experts have tried to quantitatively estimate the effect, e.g. carcinogenesis of the exposure to low-dose radiation; however, it has not been achieved yet. Therefore, the importance of well-established communication about radiation hazards was noted [4, 5], and appropriate information for effective risk communication was provided [6, 7]. With this situation, it is important to be clear how much the public is concerned about radiation. In this study, we report on the public concerns in Fukushima and Tokyo almost one year after the nuclear disaster. This study is explorative for constructing expected risk communication. By comparing public concerns between Fukushima and Tokyo in detail, we consider the proper risk communication with regional dependence taken into account. The data was systematically collected within one year, commencing just after the disaster, when people not only in Fukushima and Tokyo, but also in the whole of Japan and in other countries were still largely affected by its emotional impact. In this sense, our data would possibly reveal non-trivial aspects of people's concern in the presence of this extraordinary event. Tokyo is one of the biggest cities near Fukushima, and is the capital of the country and the center of government. A large amount of aid has been provided from Tokyo to Fukushima, and the similarities and differences in public concerns about radiation between Fukushima and Tokyo could potentially affect the reconstruction process of Fukushima into the future. Moreover, in view of the continuing supporting activities taking place in Fukushima, it is very important to report on the situation in Fukushima as it was and as it is today.

MATERIALS AND METHODS

We performed a questionnaire survey involving stratified two-stage sampling in Fukushima and Tokyo in August 2012. In the first stage, using a population of 200 000 as a basis, 30 regions based on the national population census in Japan were extracted from each prefecture. The sums of the populations in these regions were ~9.7 million in Tokyo and ~1.5 million in Fukushima.

In the second stage, residents aged from 20 to 79 years were regarded as the target population; by using the Basic Resident Registers, 1000 people were randomly sampled from the extracted regions of each prefecture. The questionnaires were sent by postal service to each target. We commissioned the selection of regions, access to the Basic Resident Registers, and posting process to an external agency. Respondents received a book coupon (¥500) as an incentive. We obtained responses partially from 1022 participants including 555 in Fukushima (237 male, 316 female, and 2 unknown gender; mean age 52.79 years with standard deviation 16.33 excluding 4 unknown age) and 467 in Tokyo (194 male, 273 female; mean age 51.62 years with standard deviation 15.82). Response rates were 55.5%, i.e., 555 per 1000 in Fukushima, and 46.7%, i.e., 467 per 1000 in Tokyo. Response rate around 50% is relatively large value in usual questionnaire surveys via posting.

Q. Please choose all radiation sources which you are concerned from the below list.

1 Radiation from land	4 Radiation from radon in the air
2 Radiation from space	5 Radiation from medical care
3 Radiation from food	6 Radiation from nuclear facilities

Fig. 1. Questionnaire survey sheet, which was actually conducted in Japanese

Table 1. Frequencies of concern for each of six radiation sources in Fukushima and Tokyo

$n = 1022$	Radiation sources											
	Land		Space		Food		Radon		Medical care		Nuclear facilities	
Frequencies	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fukushima	156	399	92	463	325	230	107	448	125	430	464	91
Tokyo	83	384	87	380	224	243	60	407	169	298	369	98
Total	239 (23.39%)	783 (76.61%)	179 (17.51%)	843 (82.49%)	549 (53.72%)	473 (46.28%)	167 (16.34%)	855 (83.66%)	294 (28.77%)	728 (71.23%)	833 (81.51%)	189 (18.49%)
Row relative frequencies	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fukushima	28.11%	71.89%	16.58%	83.42%	58.56%	41.44%	19.28%	80.72%	22.52%	77.48%	83.60%	16.40%
Tokyo	17.77%	82.23%	18.63%	81.37%	47.97%	52.03%	12.85%	87.15%	36.19%	63.81%	79.01%	20.99%
χ^2 (df = 1)	14.55		0.64		11.02		7.21		22.17		3.24	
P	$P < 0.001$		0.437		0.001		0.007		$P < 0.001$		0.072	

We asked the participants whether or not they were concerned about radiation from each of six sources (Fig. 1): land, space, food, radon in the air, medical care, and nuclear facilities. Land, space, food, and radon were in the top four natural exposure radiation sources causing concern, and medical care was the main source of artificial exposure causing concern [8]. We added the nuclear facilities as the other choice to see the effect of the Fukushima Daiichi nuclear disaster on public concerns.

RESULTS AND DISCUSSION

Concerns about radiation sources

We calculated the (relative) frequencies (summarized in the cross table) of concern about each of the six radiation sources versus location (see Table 1). We conducted chi-square tests of independence. Table 1 shows that Fukushima residents were more concerned about radiation from land, food and radon than Tokyo residents; on the other hand, Tokyo residents were generally more concerned about radiation from medical care than Fukushima residents. Fukushima is located closer to the area contaminated by the released radioactive materials than Tokyo, so public concerns about land and food have become more significant there. After the disaster, Fukushima residents had opportunities to be educated about radiation, and they may know more about radon as a radioactive source than Tokyo residents [9]. On the other hand, in Tokyo, there are so many hospitals promoting advanced medical care and also clinical trials in some cases in radiation therapy. Therefore, people in Tokyo might have become more aware of the radiation from medical exposure and its risks.

Table 2. Regression coefficients for each of six radiation sources

	Land		Space		Food		Radon		Medical care		Nuclear facilities	
	β	*P*	β	*P*	β	*P*	β	*P*	β	*P*	β	*P*
Intercept	4.17	$P < 0.001$	3.89	$P < 0.001$	3.78	$P < 0.001$	4.13	$P < 0.001$	3.87	0.000	2.63	$P < 0.001$
C_Y	−2.45	$P < 0.001$	−1.29	$P < 0.001$	−0.49	0.005	−2.45	$P < 0.001$	−0.98	0.000	1.33	$P < 0.001$
L_F	0.03	0.694	0.30	0.007	0.02	0.882	0.09	0.205	0.36	0.054	−0.11	0.464
G_F	0.18	0.014	0.55	$P < 0.001$	0.05	0.612	0.26	$P < 0.001$	0.35	0.065	0.31	$P < 0.001$
A_M	−0.05	0.555	−0.12	0.378	−0.08	0.595	−0.02	0.837	0.00	1.000		
A_H	−0.28	0.002	0.05	0.696	−0.25	0.115	−0.13	0.139	−0.23	0.282		
C_Y:L_F	0.60	$P < 0.001$	−0.45	0.056	0.11	0.626	0.48	0.006	−1.64	0.002	0.33	0.041
C_Y:G_F	0.58	$P < 0.001$	−1.10	0.003	0.49	$P < 0.001$	0.31	0.076	0.13	0.717		
L_F:G_F			−0.19	0.190					−0.19	0.452		
C_Y:A_M	0.31	0.130	0.64	0.026	0.04	0.863	0.15	0.503	0.05	0.889		
C_Y:A_H	1.18	$P < 0.001$	−0.01	0.970	0.36	0.117	0.77	$P < 0.001$	0.48	0.211		
L_F:A_M					−0.01	0.963			−0.12	0.647		
L_F:A_H					−0.36	0.131			0.22	0.428		
G_F:A_M			0.05	0.769					−0.37	0.185		
G_F:A_H			−0.22	0.197					−0.09	0.743		
C_Y:L_F:G_F			0.62	0.064					1.10	0.084		
C_Y:L_F:A_M					0.26	0.404			1.23	0.064		
C_Y:L_F:A_H					0.77	0.016			0.82	0.213		
C_Y:G_F:A_M			−0.16	0.704					0.61	0.218		
C_Y:G_F:A_H			1.00	0.020					0.20	0.690		
L_F:G_F:A_M									0.52	0.156		
L_F:G_F:A_H									−0.13	0.734		
C_Y:L_F:G_F:A_M									−1.66	0.040		
C_Y:L_F:G_F:A_H									−0.59	0.459		

C_Y = Concern (Yes), L_F = Location (Fukushima), G_F = Gender (Female), A_M = Age (Middle), A_H = Age (High).

Next, we performed Poisson regression analysis to see the dependence of concerns for radiation sources on gender and age. The cross tables for concern ('Yes' or 'No'), location (Fukushima or Tokyo), gender (Male or Female), and age were analyzed by means of Poisson regression, and the fitting models were selected based on the forward–backward stepwise AIC method (see Table 2). Age was classified into three categories: 'Low' from age 20 to 43 with $n = 338$, 'Middle' from age 44 to 62 with $n = 340$, and 'High' from age 63 to 80 with $n = 340$. The interacting terms with existence of concern in Table 2 indicate that females were more concerned about radiation sources relative to males (see, e.g. $\beta_{Land}(C_Y{:}G_F) = 0.60$, $P < .001$; $\beta_{Food}(C_Y{:}G_F) = 0.49$, $P < .001$). This tendency naturally reflects the fact that females tend to be more worried about the health effects resulting from the radiation exposure of children. They might also be concerned about the possible effects of radiation on an unborn baby, because babies are well known to be much more sensitive to low-dose radiation. We also found that people in the Middle and High groups were concerned about radiation sources relative to those in the Low group (see, e.g. $\beta_{Space}(C_Y{:}A_M) = 0.64$, $P = .026$; $\beta_{Land}(C_Y{:}A_H) = 1.18$, $P < .001$; $\beta_{Radon}(C_Y{:}A_H) = 0.77$, $P < .001$). Here we considered that people in the Middle and High groups tend to carry less social network devices to connect to the internet, so that, at least within the year following the disaster, a lesser amount of systematic information was available to people in the Low group. Lack of information might increase the people's concern more than is necessary.

Limitations

This study is limited in that only concerns about radiation sources were examined, and concerns about other factors were not assessed. We should assess the concerns about various risk factors and examine whether the tendency of public concerns observed in this report was specific to radiation in the future study. In addition, it might be possible that the public who were particularly concerned about radiation tended to respond to the questionnaire of this survey, which could affect the statistics in an unexpected way. Further study with sufficient improvement on the points above is undertaken by our group in an ongoing way [10].

CONCLUSION

Since it has been difficult to quantitatively estimate the effect of radiation at present, it is very important to know how people in Fukushima and Tokyo recognize and understand radiation. In this study, we found significant differences in level of public concerns about radiation between Fukushima and Tokyo, and this was observed even just after the big earthquake. We also found a non-trivial tendency affected by other factors, e.g. gender and age. It is actually important to know and understand the existence of the differences with each other. For example, the aid supplied from a non-disaster area often encounters a severe mismatch with the actual need of the disaster area. Therefore, understanding the differences informs proper choice of aid and helps to promote careful risk communications where regional dependences are appropriately taken into account. Finally, we anticipate that our results and ongoing examination can contribute to Fukushima's reconstruction and to communication efforts in Fukushima. Therefore, despite the limitations, our findings may offer insights for reducing excessive concern about the radiological risk and improve risk communication.

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