ORIGINAL RESEARCH

Relationship Between Use of Media and Radiation Anxiety Among the Residents of Fukushima 5.5 Years After the Nuclear Power Plant Accident

Maiko Fukasawa, PhD; Norito Kawakami, MD, PhD; Chihiro Nakayama, PhD; Seiji Yasumura, MD, PhD

ABSTRACT

Objective: We aimed to investigate the relationships between use of media to obtain information on radiation and radiation anxiety among community residents in Fukushima, 5.5 years after the nuclear power plant accident.

Methods: A questionnaire survey was administered between August and October 2016 to 2000 randomly sampled residents in Fukushima prefecture. Radiation anxiety toward health and regarding discrimination and prejudice were assessed with 4- and 3-item scales, respectively. Participants nominated their most-used media for acquiring information on radiation by choosing up to 3 sources from 12 information sources listed (eg, local newspaper, TV news, websites, social networking sites [SNS], local government newsletter, word of mouth). We investigated associations of most-used media types and radiation anxiety, controlling for sociodemographic characteristics and anxiety regarding radiation's health effects immediately after the accident, using multivariate linear regression analyses.

Results: Valid responses were obtained from 790 (39.5%) residents. Acquiring information about radiation by word of mouth was related to higher radiation anxiety toward health. Regarding radiation anxiety concerning discrimination and prejudice, SNS use was related to higher anxiety, whereas acquiring information through Nippon Hoso Kyokai (NHK) TV news was related to lower anxiety.

Conclusions: Interpersonal interactions rather than gaining information from media – characterized by unidirectional information exchange – may increase radiation anxiety.

Key Words: Fukushima, media, nuclear power plant accident, radiation anxiety

Nuclear power plant accidents affect the long-term mental health of residents in neighboring communities.[1,2] One of the factors relating to their long-term mental health is radiation anxiety, that is, anxiety about radiation's adverse health effects. Correlations of radiation anxiety and poor mental health have been repeatedly reported after nuclear power plant accidents previously occurred in Three Mile Island[3,4] and Chernobyl,[5,6,7] as well as after the Fukushima nuclear power plant accident.[8-14]

Because of the invisibility of radiation and its adverse health effects, which might emerge several years later, people's anxiety seems to have been greatly impacted by the information on radiation to which they have been exposed since the nuclear power plant accident.[15-19] Among the various media types used to acquire information, identifying which media was related to radiation anxiety is the first step in examining the effects of information on radiation anxiety. Furthermore, identifying specific media related to radiation anxiety might provide suggestions as to how to respond to radiation anxiety through the media.

A previous study, which was based on the same sample as this one, found that the use of websites was related to higher anxiety about one's health, whereas the use of local TV news was related to lower anxiety.[16] However, this previous study focused on the use of individual media, without controlling for the parallel use of other types of media. Sugimoto et al.[18] examined the relationships between media frequently used to obtain information about the Fukushima nuclear disaster and radiation anxiety; the study revealed that different types of media were related to different aspects of radiation anxiety. They reported that the use of national newspapers was related to lower fears for the future (eg, concerns for effects on employment, income, and infertility), whereas the use of regional newspapers was related to higher fears for the future. In addition, the use of radio was related to fears about social disruption (eg, concerns for media information and future evacuation orders), and the use of rumors

was related to fears about radiation and health (eg, concerns for food and water safety and danger of daily radiation exposure). Their study subjects, however, were limited to radiation-health seminar participants, who were probably highly interested in and eager to learn about these problems. Therefore, the generalizability of their findings is limited.

In addition to radiation anxiety regarding health, residents in Fukushima have reported anxiety about interpersonal conflicts, perceived stigma, prejudice, discrimination, and bullying among children after the nuclear power plant accident, which seem to stem from radiation anxiety regarding health.[20,21,22] These kinds of anxiety and experiences have been reported anecdotally and seem to be strongly affected by media reporting; however, their relationships regarding the use of media have not been examined.

In this study, we aimed to reveal frequently used media for obtaining information on radiation among community residents in Fukushima prefecture, 5.5 years after the nuclear power plant accident and, among them, to examine the relationships between the type of media used and radiation anxiety regarding health and regarding discrimination and prejudice. This study extends our earlier study on radiation anxiety for one's health[16] by adjusting for the parallel use of several types of media and providing additional focus on radiation anxiety regarding discrimination and prejudice due to radiation exposure.

METHODS

Study Design and Population

We conducted a cross-sectional questionnaire survey from August to October 2016, about 5.5 years after the accident, among randomly sampled community residents in Fukushima prefecture. Its details have been reported elsewhere.[23] Briefly, in the present study, we divided Fukushima prefecture into 4 areas: (1) the evacuation zone, the area near the nuclear power plant designated as such by the Japanese government; (2) the eastern coastal area (Hama-dori), excluding the evacuation zone; (3) the central area in the prefecture (Naka-dori), excluding the evacuation zone; and (4) the western mountainous area (Aizu). From each area, we randomly sampled 500 residents ages 20 to 79 years old and sent the questionnaire to 2000 residents in total.

Study Variables

Radiation Anxiety

We defined *radiation anxiety* as negative cognitions and perceptions, such as worry and anxiety about the possible adverse health effects of radiation exposure, and related psychosocial problems such as perceived stigma and discrimination due to radiation exposure.[8] Current radiation anxiety was assessed using the 7-item Radiation Anxiety Scale developed and validated by Umeda et al.[24,25] The details of this scale have been reported previously.[8] The scale was suggested to consist of 2 factors by a factor analysis; the first factor included 4 items measuring anxiety for adverse health effects, and the second factor included 3 items measuring anxiety regarding discrimination, prejudice, and interpersonal conflicts due to radiation exposure.[24,25] This 2-factor structure was also confirmed in our study sample.[20] Therefore, in this study, we addressed these 2 dimensions of current radiation anxiety, using subscale scores corresponding to the 2 factors; we named these 2 dimensions, *radiation anxiety regarding health* and *radiation anxiety regarding discrimination and prejudice*. The subscale for radiation anxiety regarding health consisted of items such as "I am concerned about getting a serious illness in the future due to the effects of radiation" and "I am concerned that radiation effects can be inherited by the next generation, such as our children and grandchildren." The subscale for radiation anxiety regarding discrimination and prejudice consisted of items such as "I have had the experience of being discriminated against (or unfairly treated) because I lived in the area that is reported to have high levels of radiation." The items were rated on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree), and the item scores were summed to obtain a total score. The score for the subscale of radiation anxiety regarding health ranged from 4 to 16 and that for radiation anxiety regarding discrimination and prejudice ranged from 3 to 12; higher scores indicated higher levels of radiation anxiety.

Use of Media

We asked questions about the respondents' current use of media for acquiring information about radiation. We listed 12 sources of information (local newspaper, national newspaper, non-commercial TV news by the Japan broadcasting corporation [Nippon Hoso Kyokai: NHK], local commercial TV news, national commercial TV news, radio, Internet news, websites, social networking sites [SNS], magazines or books, local government newsletters, and word of mouth via friends or relatives) and asked respondents to choose no more than 3 that they used most frequently to acquire information on radiation.

Sociodemographic Characteristics

The sociodemographic characteristics included in this study were age, sex, educational attainment, and residential area. We also asked whether respondents had a family member under 18 years old or who was pregnant at the time of the nuclear power plant accident.

Anxiety Immediately After the Accident

The degree of anxiety for the health effects of radiation felt immediately after the nuclear power plant accident was assessed using a single-item scale, with response options ranging from 1 (none) to 5 (extreme).

Statistical Analysis

First, we calculated descriptive statistics of our study subjects, including sociodemographic characteristics, use of media, degree of anxiety immediately after the nuclear power plant accident, and current radiation anxiety. Regarding the use of media, we added a calculation stratified by age.

Second, we examined bivariate correlations of sociodemographic characteristics, use of media, and degree of anxiety immediately after the accident with 2 dimensions of current radiation anxiety, using single regression analyses. Next, we examined correlations of the use of media with current radiation anxiety, controlling for sociodemographic characteristics and anxiety immediately after the accident, using multivariate linear regression analyses. We included all of the media (12 variables) simultaneously in the model to adjust for overlapping usage of several types of media.

All statistical analyses were performed using Stata 15 for Windows (StataCorp LP, College Station, TX). The statistical significance was set at 0.05, and all tests were 2-tailed.

Ethical Considerations

All procedures followed were in accordance with the Declaration of Helsinki and its later amendments. The study protocol was reviewed and approved by the Ethics Committee of Fukushima Medical University (approval number: 2699).

RESULTS

Among the initial 2000 subjects, 916 individuals responded; we used the 790 responses (39.5%) without missing information on the study variables.

Table 1 reports the descriptive statistics of sociodemographic characteristics, use of media, the degree of anxiety immediately after the nuclear power plant accident, and the current radiation anxiety of our study subjects. Regarding the most-used media to acquire information on radiation, our study subjects frequently chose local newspapers, NHK TV news, local TV news, and local government newsletters. Figure 1 shows usage of these media stratified by age. It reveals that local newspapers, NHK TV news, and local government newsletters were chosen frequently by the older population, ages 65 and over, with more than 60% of them choosing local newspapers and NHK TV news. The middle-aged population tended to choose local newspapers and NHK or local TV news, with more than 60% choosing local newspapers. Conversely, the choices of the young population, less than 40 years old, were dispersed, with more than 40% choosing Internet news and local TV news. Local newspapers and NHK TV news were chosen by less than 40%.

Table 2 reports the relationships of sociodemographic characteristics, use of media, and anxiety immediately after the accident with current radiation anxiety regarding health. Residents in Hama-dori and the evacuation zone had higher radiation anxiety regarding health, compared with the residents in Aizu. The respondents who had a child under 18 years old had higher radiation anxiety. Those who felt higher anxiety for health in the immediate aftermath of the accident also had higher current radiation anxiety. Concerning the use of

TABLE 1

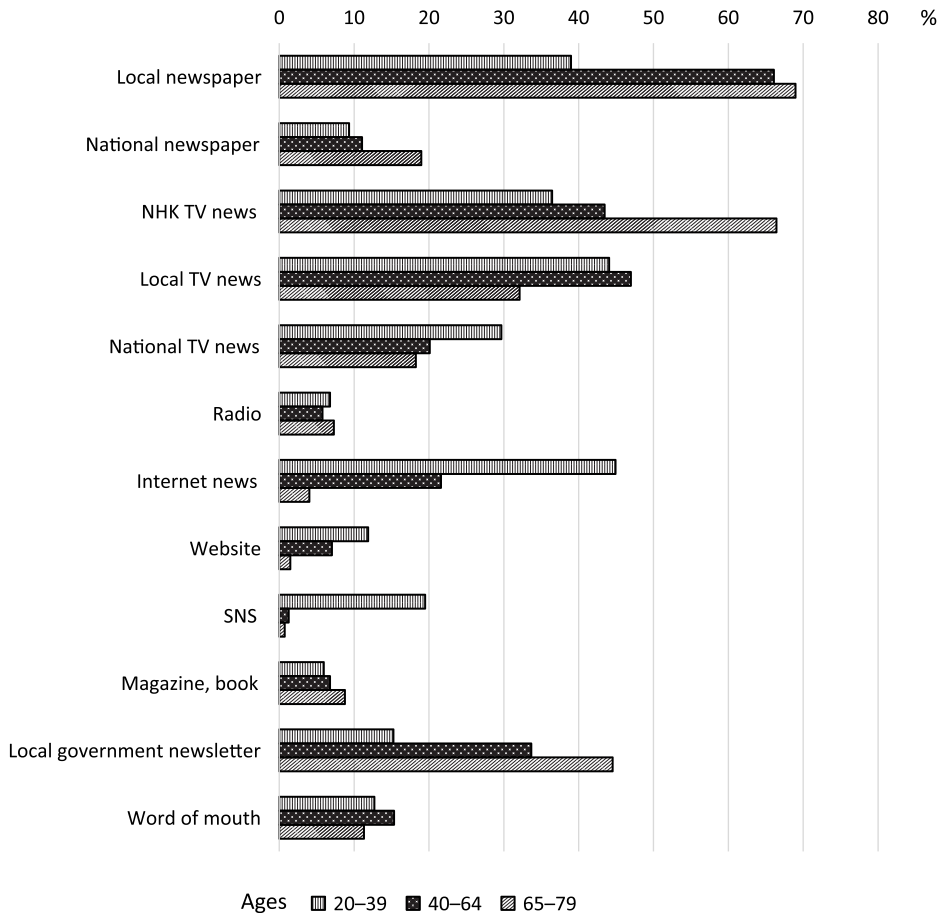
Demographic Characteristics, Use of Media, and Radiation Anxiety of the Study Participants (n = 790)

	n	%
Area		
Eastern coastal area (Hama-dori)	187	23.7
Central area (Naka-dori)	193	24.4
Western mountainous area (Aizu)	237	30.0
Evacuation zone	173	21.9
Age, years		
20-39	118	14.9
40-64	398	50.4
65-79	274	34.7
Sex		
Men	358	45.3
Women	432	54.7
Education attainment		
Junior high school	108	13.7
High school	407	51.5
Junior or technical college	174	22.0
University or graduate school	101	12.8
Have children		
No	462	58.5
Children under 18 or family member pregnant	328	41.5
Use of media for acquiring information on radiation (most-used media, select up to 3)		
Local newspaper	498	63.0
National newspaper	107	13.5
NHK TV news	398	50.4
Local TV news	327	41.4
National TV news	165	20.9
Radio	51	6.5
Internet news	150	19.0
Website	46	5.8
SNS	30	3.8
Magazine, book	58	7.3
Local government newsletter	274	34.7
Word of mouth (friends or relatives)	107	13.5
(Number of the respondents who did not choose any of the above)	22	2.8
	Mean	**SD**
Anxiety for health immediately after the NPP accident (score range: 1-5)	3.2	1.3
Current radiation anxiety for health (score range: 4-16)	9.6	2.9
Current radiation anxiety regarding discrimination and prejudice (score range: 3-12)	6.2	2.1

NPP = nuclear power plant; SD = standard deviation; SNS = social networking sites.

FIGURE 1

Use of Media for Acquiring Information on Radiation by Age



media, those who acquired information on radiation through websites had higher radiation anxiety regarding health than those who did not choose it as their most-used media. Those who acquired information on radiation through word of mouth (friends or relatives) also had higher radiation anxiety regarding health than those who did not choose it. Those who chose NHK TV news and local TV news had lower radiation anxiety. After controlling for sociodemographic characteristics, anxiety immediately after the accident, and parallel use of other types of media, acquiring information on radiation mainly by word of mouth (friends or relatives) was related to higher radiation anxiety regarding health.

Table 3 reports the relationships of the corresponding variables with current radiation anxiety regarding discrimination and prejudice. Residents in the evacuation zone had higher radiation anxiety regarding discrimination and prejudice compared with the residents in Aizu. Young respondents and those who had a child under 18 years old had higher radiation anxiety. Those who felt higher anxiety for health immediately after the accident had higher current radiation anxiety regarding discrimination and prejudice. Concerning the use of media, those who acquired information on radiation through websites had higher radiation anxiety regarding discrimination and prejudice than those who did not choose it as their most-used media. Those who acquired information on radiation through SNS also had higher radiation anxiety regarding discrimination and prejudice than those who did not choose it as their most-used media. Those who chose NHK TV news had lower radiation anxiety than those who did not choose it. After controlling for sociodemographic characteristics, anxiety immediately after the accident, and the parallel use of other types of media, acquiring information on radiation mainly by SNS was related to higher radiation anxiety regarding discrimination and prejudice, and NHK TV news was related to lower radiation anxiety.

DISCUSSION

The elderly population frequently chose local newspapers, NHK TV news, and local government newsletters as the most-used media to acquire information on radiation. The

. https://doi.org/10.1017/dmp.2019.132

TABLE 2

Relationships of the Use of Media With Radiation Anxiety for Health (n = 790)

	Unadjusted			Adjusted		
	Coef.	SE	*P*	Coef.	SE	*P*
Area (ref. Aizu)						
Hama-dori	0.50	0.24	0.039	0.07	0.25	0.790
Naka-dori	0.03	0.24	0.910	-0.03	0.24	0.884
Evacuation zone	0.63	0.25	0.011	0.24	0.25	0.346
Age, years (ref. 65-79)						
20-39	0.45	0.29	0.115	-0.03	0.32	0.923
40-64	-0.31	0.20	0.126	-0.24	0.21	0.242
Sex (ref. male)						
Female	0.28	0.21	0.180	0.02	0.18	0.912
Education attainment (ref. higher)						
Up to high school	0.08	0.22	0.693	0.38	0.19	0.045
Have children (ref. none)						
Children under 18 or family member pregnant	0.46	0.21	0.028	-0.01	0.19	0.977
Use of media for acquiring information on radiation (most-used media, select up to 3)						
Local newspaper	0.04	0.21	0.843	0.37	0.21	0.087
National newspaper	0.07	0.30	0.810	0.39	0.29	0.171
NHK TV news	-0.48	0.20	0.019	-0.09	0.21	0.675
Local TV news	-0.43	0.21	0.037	-0.07	0.21	0.752
National TV news	0.31	0.25	0.212	0.42	0.24	0.084
Radio	-0.02	0.42	0.958	0.22	0.37	0.548
Internet news	0.25	0.26	0.348	0.05	0.26	0.834
Website	1.02	0.44	0.020	0.36	0.40	0.365
SNS	0.68	0.54	0.206	0.30	0.49	0.537
Magazine, book	0.62	0.39	0.114	0.46	0.36	0.201
Local government newsletter	-0.23	0.22	0.292	-0.16	0.22	0.467
Word of mouth (friends or relatives)	0.87	0.30	0.004	0.66	0.28	0.019
Anxiety for health immediately after the NPP accident (score range: 1-5)	1.26	0.07	<0.001	1.25	0.07	<0.001

Coef. = coefficient; NPP = nuclear power plant; ref. = reference; SE = standard error; SNS = social networking sites.

middle-aged population chose local newspapers and NHK and local TV news, and the young population chose Internet news and local TV news. Concerning the relationships between the use of media and radiation anxiety, acquiring information on radiation by word of mouth (eg, from friends or relatives) was related to higher radiation anxiety regarding health. As for radiation anxiety regarding discrimination and prejudice, using SNS was related to higher anxiety, whereas acquiring information through NHK TV news was related to lower anxiety.

Our study revealed that higher radiation anxiety regarding health was related to acquiring information on radiation by word of mouth (friends or relatives), but not related to other types of media. This is consistent with the results of a previous study, which reported that obtaining information about a nuclear disaster through rumors was related to higher fears about radiation and health, whereas other types of media were not.[18] It is also consistent with the result of another study conducted after the 2011 Fukushima nuclear power plant accident by Murakami et al.,[15] which suggested that those who trusted direct information from friends perceived a higher radiation risk for health. Among studies exploring the social amplification of risk perceptions conducted in other contexts, a study on residents' wildfire risk perceptions indicates that receiving information from non-experts – neighbors, friends, or family members – and talking about the risks with neighbors were related to higher risk perceptions, whereas receiving information from the media was not.[26] Another study on risk perception related to a biological research facility reports that people who engaged in more frequent discussions of it perceived higher risk.[27] Exchange of information concerning radiation risks with those around them might increase people's perceived risk and amplify their radiation anxiety regarding health. However, these findings were inconsistent with those of our previous study reported by Nakayama et al.[16] In that study, whereas acquiring the information by word of mouth was not significantly associated with radiation anxiety regarding health, the use of websites was associated with higher anxiety regarding health, and the use of local TV news was associated with lower anxiety. In the present study, our results were partly consistent with these in an unadjusted model; that is, the use of websites was positively correlated, and the use of local TV news was negatively correlated, with the level of radiation anxiety regarding health. Therefore, one of the reasons for this inconsistency might stem from the confounding effects

TABLE 3

Relationships of the Use of Media With Radiation Anxiety Regarding Discrimination and Prejudice (n = 790)

	Unadjusted			Adjusted		
	Coef.	SE	*P*	Coef.	SE	*P*
Area (ref. Aizu)						
Hama-dori	0.07	0.18	0.704	0.21	0.19	0.256
Naka-dori	-0.17	0.18	0.326	0.18	0.18	0.333
Evacuation zone	1.44	0.18	<0.001	1.37	0.19	<0.001
Age, years (ref. 65-79)						
20-39	0.44	0.21	0.041	0.21	0.24	0.391
40-64	0.16	0.15	0.304	0.19	0.16	0.228
Sex (ref. male)						
Female	-0.14	0.15	0.360	-0.34	0.13	0.012
Education attainment (ref. higher)						
Up to high school	-0.25	0.16	0.116	-0.01	0.15	0.949
Have children (ref. none)						
Children under 18 or family member pregnant	0.60	0.15	<0.001	0.24	0.14	0.086
Use of media for acquiring information on radiation (most-used media, select up to 3)						
Local newspaper	-0.21	0.16	0.181	-0.01	0.16	0.949
National newspaper	0.07	0.22	0.741	0.12	0.22	0.573
NHK TV news	-0.60	0.15	<0.001	-0.32	0.16	0.043
Local TV news	-0.24	0.15	0.116	-0.07	0.16	0.663
National TV news	-0.08	0.19	0.680	-0.02	0.18	0.929
Radio	-0.54	0.31	0.083	-0.22	0.29	0.441
Internet news	0.26	0.19	0.180	-0.06	0.20	0.762
Website	1.02	0.32	0.002	0.24	0.31	0.425
SNS	1.19	0.40	0.003	0.83	0.38	0.029
Magazine, book	0.56	0.29	0.056	0.46	0.27	0.094
Local government newsletter	0.05	0.16	0.772	-0.05	0.17	0.787
Word of mouth (friends or relatives)	0.34	0.22	0.123	-0.07	0.22	0.740
Anxiety for health immediately after the NPP accident (score range: 1-5)	0.76	0.05	<0.001	0.66	0.06	<0.001

Coef. = coefficient; NPP = nuclear power plant; ref. = reference; SE = standard error; SNS = social networking sites.

of the other types of media simultaneously used, which were not controlled for in our previous study.[16]

Using SNS to acquire information on radiation was related to higher radiation anxiety regarding discrimination and prejudice. Using SNS could be an opportunity to see the individual responses of people outside of the Fukushima prefecture to radiation or the nuclear power plant accident, which might contain more discriminatory or prejudicial messages toward them. One study conducted after a natural disaster suggests that people who used social media to learn about the disaster had more posttraumatic stress symptoms, compared with those who used only traditional media such as newspapers, radio, and television.[28] Use of SNS to acquire information about a disaster may have adverse effects on post-disaster mental health.

Acquiring information through NHK TV news was related to lower anxiety regarding discrimination and prejudice. NHK runs non-commercial public broadcasting, and its broadcast contents are considered to be neutral and carefully checked so as to not imply any kind of discrimination or prejudices. Therefore, watching NHK TV news might not increase radiation anxiety regarding discrimination or prejudice, compared with the other types of media.

Local newspapers, NHK TV news, and local TV news were used frequently to acquire information about radiation by all age groups. Local newspapers and local TV news were chosen more frequently than national newspapers and national TV news, which seems to represent the trust of residents in local media. A gap was reported between a topic reported in the national television networks and the general feeling among the people of Fukushima.[29] In contrast to national media, individuals working for local media were, in most situations, the residents of Fukushima, whose lives had also been affected heavily by the nuclear power plant accident, and who seemed to be sharing the needs and concerns of the local community. In addition, the elderly population tended to use local government newsletters, which seems to represent their trust in the local government. The younger population tended to use Internet news, which seems to reflect the accessibility of their devices. These frequently used media, which mainly provide one-way information, were not related to radiation anxiety. Therefore, we could neither find suggestions for identifying

possible information that had affected radiation anxiety nor for responding to radiation anxiety through the media by providing tailored contents for those using specific media.

This study has several limitations, requiring a careful interpretation of the results. First, it was a cross-sectional study and discussions on causal relationships were limited. We discovered a possibility that acquiring information on radiation by word of mouth and using SNS increased radiation anxiety; however, it was possible that people with higher radiation anxiety tended to use these information sources because of dissatisfaction with the other types of media providing authoritative or official information. Second, while we revealed the relationships between most-used media and radiation anxiety, we could not identify any contents relating to radiation anxiety. Especially regarding websites and SNS, these contain a wide variety of information provided by authoritative experts to lay people without any specialized knowledge. This mixture of information might affect our results. Third, we did not have information on the respondents' length of exposure to each media. Longer exposure to media coverage on a disaster is suggested to relate with poorer psychological outcomes after a disaster,[30] which might confound our results. Fourth, although we adjusted for the possible confounding effects of anxiety for health immediately after the nuclear power plant accident, the single-item scale used might not be able to fully capture it, and its confounding effects might still affect the associations between the use of media and current radiation anxiety even after being adjusted for them.

CONCLUSIONS

We conducted a cross-sectional questionnaire survey 5.5 years after the Fukushima nuclear power plant accident for a representative sample of community residents in the Fukushima prefecture. Acquiring information on radiation by word of mouth was related to higher radiation anxiety regarding health, whereas using SNS was related to higher radiation anxiety regarding discrimination and prejudice. Acquiring information mainly through NHK TV news was related to lower anxiety regarding discrimination and prejudice. Although the types of media primarily providing one-way information, such as newspapers, TV or Internet news, and governmental newsletters, were frequently used, they were not related to radiation anxiety. Interpersonal interactions within relatively restricted groups, such as friends or relatives or connections through SNS, might increase or maintain anxiety regarding radiation among residents of neighboring communities affected by the nuclear power plant accident.

About the Authors

Department of Mental Health, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan (Drs Fukasawa, Kawakami) and Department of Public Health, Fukushima Medical University School of Medicine, Fukushima, Japan (Drs Nakayama, Yasumura).

Correspondence and reprint requests to Maiko Fukasawa, Department of Mental Health, Graduate School of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan (e-mail: fukasawa@m.u-tokyo.ac.jp).

Financial Support

This work was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI (Grant Number 15K08810), Research Center for Radiation Disaster Medical Science – Projects Responding to Fukushima Nuclear Power Plant Accident 4 (Research on Risk Communication Regarding Radiation Disasters), and Research on the Health Effects of Radiation, organized by the Ministry of the Environment, Japan.

Authors' Contributions

MF analyzed and interpreted the data and drafted the manuscript. CN and SY planned and managed the survey. NK, CN, and SY revised the draft for important intellectual content. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

REFERENCES

1. Bromet EJ, Havenaar JM, Guey LT. A 25-year retrospective review of the psychological consequences of the Chernobyl accident. *Clin Oncol. (R Coll Radiol.)* 2011;23:297-305. doi: 10.1016/j.clon.2011.01.501.
2. Bromet EJ. Emotional consequences of nuclear power plant disasters. *Health Phys.* 2014;106:206-210.
3. Dew MA, Bromet EJ. Predictors of temporal patterns of psychiatric distress during 10 years following the nuclear accident at Three Mile Island. *Soc Psychiatry Psychiatr Epidemiol.* 1993;28:49-55.
4. Goldsteen R, Schorr JK, Goldsteen KS. Longitudinal study of appraisal at Three Mile Island: implications for life event research. *Soc Sci Med.* 1989;28:389-398.
5. Adams RE, Guey LT, Gluzman SF, et al. Psychological well-being and risk perceptions of mothers in Kyiv, Ukraine, 19 years after the Chernobyl disaster. *Int J Soc Psychiatry.* 2011;57:637-645. doi: 10.1177/0020764011415204.
6. Bromet EJ, Gluzman S, Schwartz JE, et al. Somatic symptoms in women 11 years after the Chernobyl accident: prevalence and risk factors. *Environ Health Perspect.* 2002;110:625-629. doi: 10.1289/ehp.02110s4625.
7. Bromet EJ, Litcher-Kelly L. Psychological responses of mothers of young children to the Three Mile Island and Chernobyl nuclear plant accidents one decade later. In: Havenaar JM, Cwikel JG, Bromet EJ, eds. *Toxic Turmoil: Psychological and Societal Consequences of Ecological Disasters.* New York: Springer Science+Business Media; 2002:69-84.
8. Fukasawa M, Kawakami N, Umeda M, et al. Environmental radiation level, radiation anxiety, and psychological distress of non-evacuee residents in Fukushima five years after the Great East Japan Earthquake: multilevel analyses. *SSM Popul Health.* 2017;3:740-748. doi: 10.1016/j.ssmph.2017.09.002.
9. Miura I, Nagai M, Maeda M, et al. Perception of radiation risk as a predictor of mid-term mental health after a nuclear disaster: The Fukushima Health Management Survey. *Int J Environ Res Public Health.* 2017;14:E1067. doi: 10.3390/ijerph14091067.
10. Niitsu T, Takaoka K, Uemura S, et al. The psychological impact of a dual-disaster caused by earthquakes and radioactive contamination in Ichinoseki after the Great East Japan Earthquake. *BMC Res Notes.* 2014;7:307. doi: 10.1186/1756-0500-7-307.
11. Oe M, Maeda M, Nagai M, et al. Predictors of severe psychological distress trajectory after nuclear disaster: evidence from the Fukushima Health Management Survey. *BMJ Open.* 2016;6:e013400.
12. Oe M, Takahashi H, Maeda M, et al. Changes of posttraumatic stress responses in evacuated residents and their related factors: a 3-year follow-up study from the Fukushima Health Management Survey. *Asia Pac J Public Health.* 2017;29:182S-192S. doi: 10.1177/1010539516680733.

13. Suzuki Y, Yabe H, Yasumura S, et al. Psychological distress and the perception of radiation risks: the Fukushima Health Management Survey. *Bull World Health Organ*. 2015;93:598-605.
14. Suzuki Y, Takebayashi Y, Yasumura S, et al. Changes in risk perception of the health effects of radiation and mental health status: the Fukushima Health Management Survey. *Int J Environ Res Public Health*. 2018;15: E1219. doi: 10.3390/ijerph15061219.
15. Murakami M, Nakatani J, Oki T. Evaluation of risk perception and risk-comparison information regarding dietary radionuclides after the 2011 Fukushima nuclear power plant accident. *PLoS One*. 2016;11:e0165594. doi: 10.1371/journal.pone.0165594.
16. Nakayama C, Sato O, Sugita M, et al. Lingering health-related anxiety about radiation among Fukushima residents as correlated with media information following the accident at Fukushima Daiichi Nuclear Power Plant. *PLoS One*. 2019;14:e0217285. doi: 10.1371/journal.pone.0217285.
17. Shirai K, Yoshizawa N, Takebayashi Y, et al. Modeling reconstruction-related behavior and evaluation of influences of major information sources. *PLoS One*. 2019;23:e0221561. doi: 10.1371/journal.pone.0221561.
18. Sugimoto A, Nomura S, Tsubokura M, et al. The relationship between media consumption and health-related anxieties after the Fukushima Daiichi nuclear disaster. *PLoS One*. 2013;8:e65331. doi: 10.1371/journal.pone.0065331.
19. Yumiya Y, Murakami M, Takebayashi Y, et al. Unreliable information as a risk factor for worse mental fatigue among residents in Fukushima after the nuclear power station accident. *Tohoku J Exp Med*. 2019;248:261-272. doi: 10.1620/tjem.248.261.
20. Maeda M, Oe M. Mental health consequences and social issues after the Fukushima disaster. *Asia Pac J Public Health*. 2017;29:36S-46S. doi: 10.1177/1010539516689695.
21. Ohto H, Yasumura S, Maeda M, et al. From devastation to recovery and revival in the aftermath of Fukushima's nuclear power plant's accident. *Asia Pac J Public Health*. 2017;29:10S-17S. doi: 10.1177/1010539516675700.
22. Sawano T, Nishikawa Y, Ozaki A, et al. The Fukushima Daiichi Nuclear Power Plant accident and school bullying of affected children and adolescents: the need for continuous radiation education. *J Radiat Res*. 2018;59:381-384. doi: 10.1093/jrr/rry025.
23. Kuroda Y, Iwasa H, Orui M, et al. Association between health literacy and radiation anxiety among residents after a nuclear accident: comparison between evacuated and non-evacuated areas. *Int J Environ Res Public Health*. 2018;15:E1463. doi: 10.3390/ijerph15071463.
24. Umeda M, Sekiya Y, Kawakami N, et al. Reliability and validity of radiation anxiety scale developed for Fukushima community residents. The 24th Annual Scientific Meeting of the Japan Epidemiological Association, Sendai, Japan, 2014. [In Japanese]
25. Kawakami N. Investigation of current condition of and development of effective interventions for anxiety over radiation effect on health in the Fukushima Prefecture. In: *Report on the research project on the health effects of radiation organized by Ministry of the Environment*, Japan. Published March, 2013: 175–194. [In Japanese] https://www.env.go.jp/chemi/rhm/reports.html. Accessed November 15, 2019.
26. Brenkert-Smith H, Dickinson KL, Champ PA, et al. Social amplification of wildfire risk: the role of social interactions and information sources. *Risk Anal*. 2013;33:800-817. doi: 10.1111/j.1539-6924.2012.01917.x.
27. Binder AR, Scheufele DA, Brossard D, et al. Interpersonal amplification of risk? Citizen discussions and their impact on perceptions of risks and benefits of a biological research facility. *Risk Anal*. 2011;31:324-334. doi: 10.1111/j.1539-6924.2010.01516.x.
28. Goodwin R, Palgi Y, Hamama-Raz Y, et al. In the eye of the storm or the bullseye of the media: social media use during Hurricane Sandy as a predictor of post-traumatic stress. *J Psychiatr Res*. 2013;47:1099-1100. doi: 10.1016/j.jpsychires.2013.04.006.
29. Ohmori M. Looking back on media reports on the nuclear accident. *Ann ICRP*. 2016;45(2 Suppl):33-36. doi: 10.1177/0146645316666757.
30. Pfefferbaum B, Newman E, Nelson SD, et al. Disaster media coverage and psychological outcomes: descriptive findings in the extant research. *Curr Psychiatry Rep*. 2014;16:464. doi: 10.1007/s11920-014-0464-x.