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Association Between Radiation Risk Perception Related to the Fukushima Nuclear Disaster and Traumatic Stress Symptoms Induced by Media Reports of the Russian Invasion of Ukraine

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Original Research

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Abstract

Objectives: The Russian–Ukrainian War of 2022 (RUW-2022) was accompanied by the subsequent risk of accidents at a nuclear power plant in Ukraine. This study investigated posttraumatic stress (PTS) symptoms related to media reports of an attack on a Ukrainian nuclear power plant during the RUW-2022 among victims of the Fukushima nuclear disaster and revealed their association with radiation risk perception (RRP) of the accident.

Methods: This cross-sectional study targeted 1193 residents of Naraha Town in Fukushima Prefecture. PTS symptoms were measured using the Japanese version of the Impact of Events Scale-Revised (IES-R). Univariate and multivariate analyses explored the association between IES-R scores and background factors, particularly RRP.

Results: Participants with higher RRP showed significantly higher IES-R scores; furthermore, the proportion of disruption because of radiation anxiety was significantly larger among higher RRP residents. Radiation anxiety mediated the association between RRP and PTS symptoms (total IES-R score and sub-item of intrusion).

Conclusions: People with higher RRP in Fukushima may continue to be at risk of persistent, unwanted PTS symptoms due to future nuclear crises. Therefore, mental health practitioners need to continue providing support in affected areas for a longer period than anticipated. Moreover, a population-based approach to cope with these stressors from media reports is essential.

On February 24, 2022, Russia initiated a huge military offensive in Ukraine. One year later, the Office of the High Commissioner for Human Rights (OHCHR) reported over 20 000 civilian casualties, including over 8000 deaths.[1] Ukrainian official reports of the assault on the Zaporizhzhia nuclear power plant on March 4, 2022, shook global public.[2]

The negative psychological effects of conflicts and wars on human beings are huge and diverse.[3] Several reports on the mental health crisis associated with the Russian–Ukrainian War of 2022 (RUW-2022) have been compiled. It has affected people in both the warring nations and the surrounding countries,[4,5] adults and children alike,[6] as well as psychiatric patients.[7] Psychological symptoms induced by the RUW-2022 include posttraumatic stress (PTS), depressive tendency, and anxiety.[8] The effects of the RUW-2022 on mental health have also been reported in Japan. Among the Japanese population, those with longer exposure to media reports of the RUW-2022 showed higher scores for depression and anxiety.[9] Shigemura et al. reported similar PTS symptoms in a Japanese community in Russia.[10]

Compared with other countries, Japan has been concerned about the specific and undesirable influence of the RUW-2022 on domestic mental health because of experiencing the Great East Japan Earthquake (GEJE) and the subsequent Fukushima Daiichi Nuclear Power Plant (FDNPP) accident on March 11, 2011.[11] Among the residents of disaster-affected Fukushima prefecture, the prefectural government launched the Fukushima Health Management Survey (FHMS) to assess their post-disaster psychological distress, including PTS symptoms continually.[12,13] Regarding the risk perception of radiation health effects, victims who believed that exposure to radiation due to the FDNPP accident was likely to affect their future health status showed higher psychological distress.[14,15] Furthermore, Miura et al. reported that psychological distress among women exposed to higher doses of radiation increased owing to the risk perception of radiation.[16] Although more than 10 years have passed since the FDNPP accident, some victims still perceive a high risk of

radiation health effects.[13] Therefore, sustainable monitoring and mental health support are essential.

The actual damage or the fear of nuclear disasters/wars and its impact on mental health have been explored worldwide during the World War II (Hiroshima and Nagasaki),[17,18] the Cold War,[19] the Persian Gulf War,[20] and the current RUW-2022.[4] However, there is a lack of research focusing on whether and how nuclear crises in specific countries affect foreign individuals who have directly experienced a different nuclear accident, such as the Fukushima nuclear disaster. Considering previous mental health surveys in Fukushima, we were strongly concerned about severe psychological stress arising from media exposure to the RUW-2022 among citizens in Fukushima with sensitive radiation risk perception (RRP) on health. Furthermore, such apprehension must be studied not only among the Japanese but also among victims of previous and similar disasters worldwide. For instance, post-disaster depression or PTS symptoms among several victims—especially evacuees—of the Chernobyl nuclear disaster persisted for decades.[21] To tackle a possible second mental health crisis due to the RUW-2022 and the subsequent risk of nuclear disasters, which can be regarded as similar types of CBRNE (chemical, biological, radiological, nuclear, and explosive) disasters, understanding the psychological damage caused by media reports of the RUW-2022 is important.

In view of the FDNPP accident among residents in the former evacuation zone of Fukushima, this study aimed to assess how RRP and anxiety are associated with psychological effects, especially PTS symptoms caused by media reports of the RUW-2022, including Russian attacks on nuclear power plants in Ukraine.

Method

The current study is a collaborative project with Naraha Town in Fukushima Prefecture. Naraha town is located about 15 kilometers away from the FDNPP and within the Soso area; its residents suffered due to the FDNPP accident in 2011 and were mandatorily evacuated at that time. The proportion of older adults in the town tended to have increased and residents over 65 years old occupied over a quarter of the population in 2010, before the FDNPP accident. In September 2015, evacuation orders were lifted and the residents began returning. At present, over 6000 residents are included in the Basic Resident Registration and over 4000 people live in the town. About one fourth of the residents are older adults over 65 years of age.

This study adopted a cross-sectional design. Participants were residents who had attended mass health checkups in the town from September 5 to 12, 2022. In collaboration with public health nurses working in the town office, we sent our questionnaire along with health checkup files and the town's own mental health questionnaire to 2141 target residents. Questionnaires were collected at the time of the health checkups. We entered the personal ID registered by the town for all residents before our questionnaire and later combined the data with the town's questionnaire data using the ID. In all the collected questionnaires, a total of 1288 residents' sheets were responded to. We excluded 15 and 16 responses with missing ID from our questionnaires and the town's mental health questionnaire, respectively. We also excluded 64 responses in which answers for the primary study outcome were insufficient (more than 10 items were blank). Finally, 1193 residents were included for analysis.

As the primary outcome, we adopted the Japanese version of the Impact of Event Scale-Revised (IES-R), which has been widely used by clinical practitioners to assess patients' parts of the PTS symptoms. These consist of 3 symptom clusters (intrusion, avoidance, and hyperarousal) per the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV).[22,23] Participants answered all the 22 items of PTS signs that they experienced during the past 7 days (including the day of response) with regard to the RUW-2022, particularly concerning the attack on the nuclear power plant, with five answer items (0 = not at all, 1 = a little, 2 = moderately, 3 = considerably, 4 = enormously). In this study, we described and further analyzed the total score by dividing it into 3 sub-items, as mentioned above.

We measured residents' RRP on health effects with the following questions: "What is the likelihood of damage to your health (e.g., cancer onset) in later life as a result of radiation exposure in March 2011?" and "What is the likelihood that the health of your future (i.e., as yet unborn) children and grandchildren will be affected because of radiation exposure in March 2011?" The Japanese version of the original questions (Lindell's questions)[24] has already been used in the FHMS,[13] and the town municipality modified them for the current survey. In each question, "your current level of radiation exposure" was replaced with "radiation exposure in March 11" and the phrase "how much," which was included in the original Japanese questionnaire and conveyed a sense of possibility, was omitted. Each question had 4response options ranging from 1 "very unlikely" to 4 "very likely," with no specific descriptions for options 2 and 3. For the analyses, we dichotomized the responses of 3 and 4 as "likely" (higher RRP) and 1 and 2 as "unlikely" (lower RRP).

We also assessed residents' radiation anxiety using the following question: "To what extent has your daily life been affected in the past month by anxiety about radiation?" There were 4response options: "never happened," "rarely happened," "happened sometimes," and "happened often." These options were also dichotomized by classifying the latter 3items as confirming radiation anxiety ("yes") for the analyses. This question was also addressed in the FHMS. We adopted this item in the current survey both as a factor associated with PTS symptoms and as a mediator between RRP and PTS symptoms.

The other covariates (demographic characteristics and conceivable confounding factors) were as follows: age, sex, current address, depressive symptoms, psychological resilience measured by the 10-item Connor-Davidson Resilience Scale (CD-RISC-10),[25] opportunities to talk to people, hobbies, and level of trust in each media outlet, which was measured using questions in the survey on information and communication media usage time and information behavior conducted by Japan's Ministry of Internal Affairs and Communications. Depressive symptoms were assessed using a 5-point Likert scale questionnaire prepared by the town to assess "depressed mood" and "loss of interest." It contained questions that were answered on a scale of "no," "yes (for a few days)," "yes (for more than half of the month)," and "yes (almost every day)." For the analysis, individuals who answered "yes" to either of the 2questions were defined as having "depression," and the group was divided into 2 categories. We also assessed the participants' opportunities to talk to people with the following question: "Do you talk to people at least once a day?" 4 responses were prepared: "almost every day," "once to five times a week," "once to three times a month," and "almost never." We dichotomized the answers into the first 2 and second 2 responses.

Before the following analyses, we performed multiple imputations using the chained equation to deal with the missing variables.[26] After the imputations, univariate regression analyses were conducted to explore the factors, including RRP and radiation anxiety, that might be associated with the IES-R scores. We also examined the association between RRP and radiation anxiety by the

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same method. A multiple linear regression analysis was performed using the following procedure: 1) confirming the association between the IES-R score and RRP by controlling for covariates that were associated with the IES-R score in the univariable analyses; 2) performing a regression analysis by incorporating both RRP and radiation anxiety and confirming their association with the IES-R score. R (version 4.2.2) was used for all the analyses.

Ethical Considerations, Registration, and Approval

This was joint research conducted with the Naraha town government and was formally approved by the ethical committee of Fukushima Medical University (No. 2022-089). This study was performed in accordance with the Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects. Along with the questionnaire, we sent a letter describing the overview of the study and requesting the participation of the target residents. Returning a completed questionnaire was considered as providing informed consent to participate in the study.

Results

Participants' Characteristics

Descriptions of the participants' demographic characteristics are presented in Table 1. The mean age of the population was 63.81 years (standard deviation [SD]: 14.34), and the proportion of female participants (56.2%) was higher than that of male participants (43.8%). Over half of the participants (67.2%) had returned to and lived in Naraha.

Overall, the participants' mean score on the IES-R was 14.53 (SD: 13.73) and those of the subscales—intrusion, avoidance, and hyperarousal—were 5.37, 5.97, and 3.20, respectively. Approximately 20% of the participants answered "likely" or "very likely" and were concerned about the radiation health effects on both themselves and future generations because of the FDNPP. Furthermore, 15.5% of the participants felt that their daily lives were disrupted owing to radiation anxiety.

Univariate analysis of participants' characteristics

The results of the univariate analysis are shown in Table 2. Both RRP and radiation anxiety factors were significantly associated with all IES-R scores. Namely, participants who were concerned about the health effects due to FDNPP or experienced radiation anxiety showed higher PTS symptoms induced by media reports of the RUW-2022, including attacks on nuclear power plants.

Other factors that showed significant associations with the total score and all IES-R subscales were age, depressive symptoms, and opportunities to talk to people. Participants' sex and total score on the CD-RISC were only associated with the hyperarousal subscale.

Association between RRP and radiation anxiety. As shown in Table 3, the univariate regression analysis revealed that both risk perceptions were significantly associated with radiation anxiety. Participants who perceived significant health effects of radiation on themselves or their spouses tended to experience disruptions in their daily lives owing to radiation anxiety.

Multivariable analyses of patient backgrounds. Table 4 shows the results of multiple regression analyses with the entry of exposure

Table 1. Descriptive characteristics of the participants (N = 1193)

			n (%) or Mean (SD)
Age (years; Mean [SD])			63.81 (14.34)
Sex		Male	522 (43.8)
		Female	671 (56.2)
Address		Within Naraha town	802 (67.2)
		Outside Naraha town and within the Fukushima prefecture	388 (32.5)
		Outside the Fukushima prefecture	3 (0.3)
IES-R (Mean [SD])		Total (/88)	14.53 (13.73)
		Intrusion (/32)	5.37 (5.20)
		Avoidance (/32)	5.97 (5.66)
		Hyperarousal (/24)	3.20 (3.88)
CD-RISC (Mean [SD])			21.48 (8.17)
Confidence in the media	Newspaper	Completely reliable	121 (10.4)
		Mostly reliable	715 (61.7)
		Somewhat reliable	276 (23.8)
		Partially unreliable	38 (3.3)
		Completely unreliable	9 (0.8)
	Television	Completely reliable	79 (6.7)
		Mostly reliable	639 (54.5)
		Somewhat reliable	372 (31.7)
		Partially unreliable	74 (6.3)
		Completely unreliable	9 (0.8)
	Magazine	Completely reliable	15 (1.3)
		Mostly reliable	148 (13.1)
		Somewhat reliable	601 (53.2)
		Partially unreliable	318 (28.2)
		Completely unreliable	47 (4.2)
	Internet	Completely reliable	13 (1.2)
		Mostly reliable	172 (16.1)
		Somewhat reliable	488 (45.7)
		Partially unreliable	335 (31.3)
		Completely unreliable	61 (5.7)
Depressive tendency		Depressive mood	174 (15.2)
		Anhedonia	142 (12.4)
Opportunities to talk with people		Almost everyday	961 (81.9)
		Between 1and 5times per week	178 (15.2)
		Between 1and 3times per month	20 (1.7)
		Almost never	15 (1.3)

(*Continued*)

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Table 1. (*Continued*)

		n (%) or Mean (SD)
Community participation	Almost everyday	7 (0.6)
	Between 1and 5times per week	89 (7.6)
	Between 1and 3times per month	298 (25.4)
	Almost never	504 (43.0)
	Never	275 (23.4)
Hobbies	Yes	416 (36.6)
	No	720(63.4)
Radiation risk perception of delayed health effects	1 (Very unlikely)	436 (37.3)
	2	480 (41.5)
	3	189 (16.3)
	4 (Very likely)	53 (4.6)
Radiation risk perception of health effects across generations	1 (Very unlikely)	429 (37.3)
	2	487 (42.4)
	3	181 (15.8)
	4 (Very likely)	52 (4.5)
Disruption to daily life because of radiation anxiety	Never	971 (84.4)
	Rarely	120 (10.4)
	Sometimes	45 (3.9)
	Often	14 (1.2)

Note. IES-R: Impact of Events Scale-Revised; CD-RISC: Connor-Davidson Resilience Scale.

(RRP) and confounders. Regression models for both the inclusion and non-inclusion of radiation anxiety (as a mediator) were performed. In the non-inclusion model, RRP across generations was still detected as a factor associated with the IES-R total score and the intrusion subscale (i.e., participants with stronger concern about the health effects among the next generation due to FDNPP showed higher PTS symptoms). Furthermore, after entering radiation anxiety in the inclusion model, these associations became statistically insignificant and each of the regression coefficients showed a reduction (total: B 3.75 to 2.44, intrusion: B 1.52 to 0.99). Other variables that were significantly associated with the IES-R scores were age, depressive tendency (total and all sub-items), and sex (female participants tended to show higher IES-R scores for the hyperarousal sub-item).

Discussion

After multivariable analyses, we found that individuals with higher RRP of health across generations significantly showed stronger PTS symptoms (total score and especially intrusion symptoms) that had been induced by media reports about attacks on overseas nuclear power plants during the RUW-2022. Furthermore, using a regression model that included the distribution of daily life due to radiation anxiety as a covariate, we considered this factor as a mediator of the relationship between RRP and PTS symptoms.

Citing the COVID-19 pandemic as another CBRNE disaster after the FDNPP accident, several researchers have focused on the effects of such an invisible crisis, similar to the circumstances of Fukushima.[27,28] Hori et al. reported that patients who had been suffering from the fear of COVID-19 were triggered by the tragic memories of the GEJE.[29,30] Moreover, counselors in the affected local governments, who engaged in mental health support for survivors of the FDNPP disaster by visiting them, stated that the number of consultations (including by telephone) had increased since the COVID-19 pandemic.[31] In addition to these reports, practitioners who provided psychological support for residents suggested similar assistance methods that had been adapted to the pandemic.[28,32] Looking outside the Fukushima, Ben-Ezra et al. performed a survey about PTSD symptoms referring to the GEJE and FDNPP accident, and revealed that these symptoms were higher among participants with radiation stigma (Hibakusha) in Hiroshima or Nagasaki.[33] Contrary to these reports, our study provided additional knowledge that not only radiation stigma as Hibakusha but also RRP (including a risk-analytic perspective) is associated with PTS symptoms. Furthermore, such association could be confirmed not only by national CBRNE disasters but also by media reports of overseas disasters.

We hypothesized the types of distributions that exist in daily life due to radiation anxiety among residents with sensitive perceptions of radiation risks. One potential factor is their own sentiments as well as subsequent information-seeking behavior, which may expose them to the shocking media coverage of the RUW-2022. Previous research on the psychological impacts of FDNPP accidents revealed that the duration, sources, and types of media coverage are linked to mental health issues, including anxiety.[34-36] Similar findings were observed for the media coverage of the COVID-19 pandemic in other countries, where prolonged and frequent media exposure and the use of new media, such as social media, were associated with increased anxiety.[37] Based on previous research on CBRNE disasters, we suggest that radiation anxiety triggers negative information-seeking behaviors, such as prolonged media exposure or social media usage. Therefore, increased exposure to tragic media coverage of the Russian attack on the Ukrainian nuclear power plant led to PTS symptoms among residents with negative risk perceptions. The finding that the avoidance score on the IES-R was not associated with RRP may also support this hypothesis.

Another hypothesis stated that residents with unstable perceptions of radiation risk may avoid going outside and instead rely on media exposure. Scientifically validated advice, including measures such as radiation shielding or refraining from going outside on dry and windy days, was provided by both governmental and non-governmental organizations in 2011 to address residents' anxiety regarding external radiation exposure.[38] In many areas of Fukushima, radiation doses have significantly decreased owing to decontamination efforts or natural attenuation, resulting in levels comparable to those found in Tokyo and other major cities worldwide. However, approximately one-quarter of the residents who had been living in the affected areas of Fukushima on March 11, 2011, reported that their daily lives were disrupted because of anxiety related to radiation.[39] Residents with high anxiety may have reduced the frequency of their outings. Furthermore, the recent COVID-19 pandemic and the subsequent "stay-at-home" orders may have accelerated such behavior. Tsutsui reported an association between individuals' perceptions of radiation risk and their awareness of infection vulnerability, suggesting that those who perceived themselves as more vulnerable to infection may also experience greater psychological distress in the event of a nuclear disaster.[40] Stay-at-home measures taken to avoid excessive exposure to radiation or infection may have led to increased media

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Table 2. Results of the univariate analysis

			IES-R score (Mean [SD])			
			Total	Intrusion	Avoidance	Hyperarousal
Age			***	***	***	***
Sex		Male	13.63 (13.29)	5.13 (5.11)	5.65 (5.53)	2.84 (3.62)
		Female	15.25 (14.03)	5.55 (5.27)	6.2 (5.75)	3.48 (4.06)*
Address		Within Naraha town	14.07 (13.61)	5.22 (5.13)	5.79 (5.64)	3.07 (3.87)
		Outside Naraha town	15.45 (13.93)	5.66 (5.34)	6.32 (5.68)	3.46 (3.91)
CD-RISC						*
Confidence in the media	Newspaper	Completely reliable	15.29 (15.45)	5.79 (5.60)	6.12 (6.16)	3.38 (4.41)
		Mostly reliable	14.47 (13.05)	5.31 (4.92)	6.08 (5.60)	3.08 (3.65)
		Somewhat reliable	14.51 (13.95)	5.39 (5.41)	5.73 (5.45)	3.38 (4.04)
		Partially unreliable	13.92 (19.50)	5.14 (7.42)	5.36 (7.32)	3.42 (5.43)
		Completely unreliable	9.00 (12.36)	2.75 (4.30)	3.75 (5.78)	2.50 (2.83)
	Television	Completely reliable	15.23 (15.61)	5.88 (5.73)	5.97 (6.31)	3.37 (4.26)
		Mostly reliable	14.18 (13.12)	5.23 (4.92)	5.98 (5.58)	2.98 (3.66)
		Somewhat reliable	15.26 (13.93)	5.70 (5.36)	6.05 (5.61)	3.51 (4.03)
		Partially unreliable	13.46 (15.70)	4.54 (5.95)	5.68 (6.14)	3.24 (4.53)
		Completely unreliable	6.12 (7.30)	1.62 (2.92)	2.50 (3.12)	2.00 (2.33)
	Magazine	Completely reliable	12.07 (13.31)	4.80 (4.75)	4.67 (5.79)	2.60 (3.27)
		Mostly reliable	13.67 (14.63)	5.11 (5.33)	5.70 (6.01)	2.85 (3.99)
		Somewhat reliable	14.24 (13.71)	5.24 (5.16)	5.84 (5.64)	3.16 (3.86)
		Partially unreliable	14.91 (12.88)	5.45 (5.03)	6.13 (5.49)	3.33 (3.79)
		Completely unreliable	15.43 (17.17)	5.80 (6.65)	6.27 (6.64)	3.36 (4.63)
	Internet	Completely reliable	18.23 (20.85)	6.38 (6.79)	7.23 (7.93)	4.62 (6.86)
		Mostly reliable	13.14 (13.63)	4.80 (4.99)	5.72 (5.91)	2.63 (3.57)
		Somewhat reliable	13.36 (12.89)	4.88 (4.89)	5.58 (5.47)	2.90 (3.59)
		Partially unreliable	14.13 (13.54)	5.22 (5.15)	5.70 (5.51)	3.21 (3.97)
		Completely unreliable	16.93 (15.45)	6.43 (6.01)	6.71 (6.27)	3.79 (4.19)
Depressive tendency		No	13.09 (12.69)	4.85 (4.78)	5.54 (5.48)	2.70 (3.39)
		Yes	19.90 (15.44)***	7.18 (5.95)***	7.58 (5.85)***	5.13 (4.86)***
Opportunities to talk with people		Yes	14.20 (13.38)	5.24 (5.07)	5.86 (5.58)	3.10 (3.78)
		No	20.21(19.20)**	7.42 (7.52)*	7.91 (6.77)*	4.88 (5.68)*
Community participation		Yes	15.04 (13.95)	5.61 (5.24)	6.35 (5.95)	3.08 (3.71)
		No	14.11 (13.44)	5.18 (5.12)	5.72 (5.45)	3.21 (3.92)
Hobbies		Yes	13.68 (13.20)	5.07 (5.03)	5.70 (5.62)	2.91 (3.73)
		No	14.87 (13.89)	5.46 (5.23)	6.07 (5.67)	3.33 (3.94)
Radiation risk perception of delayed health effects		Unlikely	13.39 (12.82)	4.88 (4.79)	5.62 (5.50)	2.89 (3.60)
		Likely	18.33 (15.94)***	6.95 (6.14)***	7.13 (6.03)**	4.25 (4.68)***
Radiation risk perception of health effects across generations		Unlikely	13.10 (12.60)	4.78 (4.71)	5.52 (5.41)	2.81 (3.55)
		Likely	19.43 (15.91)***	7.37 (6.09)***	7.53 (6.15)***	4.52 (4.61)***
Disruption to daily life because of radiation anxiety		Never	12.63 (12.49)	4.58 (4.66)	5.34 (5.40)	2.70 (3.49)
		Feel disruption	22.57 (15.63)***	8.67 (6.01)***	8.56 (5.93)***	5.34 (4.65)***

Note. Univariate linear regression model was adopted for the analysis.
CD-RISC: Connor-Davidson Resilience Scale.
*P<0.05,
**P<0.005,
***P<0.001

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Table 3. Association between RRP and radiation anxiety

		Disruption to daily life because of radiation anxiety N (%)		
		Never	Feel disruption	*P* value
Radiation risk perception of delayed health effects	Unlikely	803 (70.9)	98 (8.7)	<0.001***
	Likely	153 (13.5)	78 (6.9)	
Radiation risk perception of health effects across generations	Unlikely	809 (71.9)	90 (8.0)	<0.001***
	Likely	140 (12.4)	86 (7.6)	

Note. Univariable logistic regression model adopted for the analysis.
RRP: radiation risk perception.
*P<0.05,
**P<0.005,
***P<0.001.

Table 4. Results of multivariable analysis

	Total						Intrusion					
	Non-inclusion			Inclusion			Non-inclusion			Inclusion		
	B	SE	*P*	B	SE	*P*	B	SE	*P*	B	SE	*P*
Age	0.25	0.03	<0.001***	0.22	0.03	<0.001***	0.10	0.01	<0.001***	0.09	0.01	<0.001***
Depressive tendency (Yes)	6.63	1.02	<0.001***	6.18	1.01	<0.001***	2.33	0.40	<0.001***	2.15	0.39	<0.001***
Opportunities to talk with people (No)	3.31	2.11	0.117	3.45	2.09	0.100	1.10	0.80	0.516	1.15	0.79	0.442
Radiation risk perception of delayed health effects (Likely)	1.32	1.44	0.359	0.81	1.42	0.567	0.64	0.55	0.741	0.43	0.54	1
Radiation risk perception of health effects across generations (Likely)	3.75	1.48	0.012*	2.44	1.48	0.100	1.52	0.57	0.023**	0.99	0.57	0.250
	Avoidance						Hyperarousal					
	Non-inclusion			Inclusion			Non-inclusion			Inclusion		
	B	SE	*P*	B	SE	*P*	B	SE	*P*	B	SE	*P*
Age	0.09	0.01	<0.001***	0.08	0.01	<0.001***	0.06	0.01	<0.001***	0.05	0.01	<0.001***
Sex (Female)							0.75	0.22	0.002**	0.79	0.22	0.001**
CD-RISC							–0.02	0.01	0.212	–0.02	0.01	0.212
Depressive tendency (Yes)	1.99	0.44	<0.001***	1.85	0.45	<0.001***	2.19	0.31	<0001***	2.07	0.30	<0.001***
Opportunities to talk with people (No)	1.21	0.90	0.540	1.26	0.90	0.487	1.08	0.63	0.260	1.12	0.62	0.217
Radiation risk perception of delayed health effects (Likely)	0.29	0.62	1	0.13	0.61	1	0.36	0.42	1	0.22	0.42	1
Radiation risk perception of health effects across generations (Likely)	1.26	0.64	0.148	0.84	0.64	0.571	0.98	0.42	0.064	0.62	0.43	0.438

Note. Multiple linear regression model was adopted for the analysis.
*P<0.05,
**P<0.005,
***P<0.001.

exposure at home, potentially contributing to higher levels of PTS symptoms.

Implications and Concerns for Future Clinical Practice

The results are highly discouraging regarding the future mental status of the victims of the Fukushima disaster, citizens of Japan, and individuals with vulnerability worldwide because of 2 prominent concerns regarding the effects of the tragic media reports. One is the risk of extraordinary negative psychological impacts, prolonged by multiple man-made CBRNE disasters. Even a single nuclear disaster incident can have psychological impacts that last for several decades, requiring continuous care and attention.[41,42] Hence, to provide adequate and long-term mental health care to victims of the FDNPP accident, especially evacuees, professional organizations were established to continuously manage various types of consultations or visiting services.[43] To prevent further unintended psychological effects on victims of FDNPP accidents in the event of future nuclear crises, it is crucial to implement preventive measures. However, it must be untenable for mental health practitioners to be obligated to provide their services in response to unforeseen, man-made CBRNE disasters with massive death tolls such as the RUW-2022.

Another concern is the risk not only to the victims of the FDNPP accident but also to the wider Japanese population outside Fukushima Prefecture, to victims of previous CBRNE disasters outside

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Japan, and to other people worldwide. According to reports from the Japanese Ministry of the Environment, more than 40% of Japanese residents have misconceptions about the intergenerational health effects of radiation following the FDNPP accident.[44] Given the current unsettled period, Japanese residents with such risk perceptions may be particularly vulnerable to the possibility of severe CBRNE accidents such as a nuclear crisis in the future. Moreover, some people, not only in Japan but around the world, are highly fearful of radiation. Former clean-up workers who had been recruited after the Chernobyl nuclear disaster and people who had been evacuated by the accident have been reported as the population with a relatively higher "hypertrophied perception of radiation risk."[45] In addition, Perko reported that the general population (not the victims of the nuclear disaster) showed a higher risk perception of radiation, especially nuclear waste and facilities, compared to professionals working in nuclear research centers.[46]

As national and global practitioners, we must provide additional support for the psychological impact on possible future victims of more CBRNE-type crises, including the aforementioned nuclear accidents, as well as the direct stress of the FDNPP accident and related radiation risk perception.

Limitations

First, a major limitation was that we could not assess the effects of the FDNPP accident on future PTS symptoms induced by media reports of the risk of another nuclear crisis. This was because we could not set the evacuation due to the FDNPP accident as an exposure variable and residents who had lived outside Fukushima as a control group. Second, the target population must be defined as "residents" of the town who were originally within the evacuation zone, rather than as "victims" or "evacuees" of the FDNPP. That is, a very small portion of residents who were living in Naraha town at the time of the survey might have been living outside Fukushima before the FDNPP accident and moved to Naraha town after the disaster. Although this study did not aim to uncover whether the experiences of the evacuation itself affected the PTS symptoms associated with media reports of the war, we should consider the differences in context between people who had consistently resided in the town and immigrants who moved to the town after the disaster. Third, although we hypothesized that the current RPP regarding the FDNPP affects the RUW-2022-associated PTS symptoms, the cross-sectional study design makes us reconsider the possibility of reverse causation. In other words, we must consider that exposure to media reports of RUW-2022, including the nuclear power plant crisis, triggered the relapse of evacuees' radiation anxiety and further made the RPP of the FDNPP unstable. Fourth, because we measured the reliability of the media (not the exact duration of media exposure), part of the hypothesized distribution of daily life owing to radiation anxiety as a mediator (the mechanism of increasing media exposure) could not be assessed in greater statistical detail. Fifth, although we could grasp PTS symptoms with regard to specific traumatic events by using the IES-R, a possibility that participants could not reveal which of the past traumatic events were associated with current psychological symptoms exists. As clinicians, we could not consider the original traumatic experiences of those residents with PTS symptoms such as having great hardship in regulating emotions or severe physical symptoms (e.g., palpitation, respiratory discomfort). Finally, we must refer to differences in diagnostic criteria between DSM-IV and DSM-5-TR, which is the latest version. While the prior version defines the 3main symptom clusters, the latter version includes the disorder's aspects of dysphoric condition as a sign. The negative alternation in cognitions and mood have been added to the criteria, therefore expanding the symptom clusters from 3 to 4. Due to such a methodological limitation, we could not grasp the above-mentioned symptom or elucidate the effect of RRP upon it.

Conclusion

The current study revealed an association between the RRP regarding the FDNPP accident and PTS symptoms arising from media coverage of a Russian attack on a Ukrainian nuclear power plant among citizens who lived in the former evacuation zone in Fukushima. Furthermore, the impact of radiation anxiety on daily life mediated the association between risk perception and PTS symptoms. Therefore, it is essential to establish community and clinical practices to address residents' sensitive risk perceptions and reduce the psychological stress caused by unintended triggers. Simultaneously, it is important to gain a more detailed understanding of the detected mediation structure to tackle the chain of trauma caused by the continuous occurrence of CBRNE disasters worldwide.

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Author contribution. T.T. ensured complete access to all study data, taking accountability for data integrity and precision in data analysis. The study was conceptualized and designed by T.T. and Y. Kunii. All authors participated in data acquisition, analysis, and interpretation. The initial manuscript was drafted by T.T. and Y. Kawasaki, and all authors contributed to its revision for substantial intellectual content. Statistical analysis was conducted by T.T., T.K., and T.H. The entire process was supervised by H.Y. and I.M.

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