

博士論文

Relationships among regional radiation levels, residents' radiation anxiety, and psychological and physical symptoms in Fukushima five years after the Great East Japan Earthquake

(東日本大震災から 5 年後の福島県住民における放射線レベルと放射線不安、精神症状および身体症状との関係)

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## **Abstract**

The present study aimed to examine the effect of radiation exposure on radiation anxiety and psychological and physical symptoms among non-evacuee community residents in Fukushima five years after the nuclear power plant accident. A questionnaire survey was administered in 49 municipalities in Fukushima prefecture, randomly sampling 100 residents from each municipality. Environmental radiation levels after the accident and at the time of the survey were calculated using publicly available data measured by survey meters and monitoring posts, respectively. Radiation anxiety was measured using a seven-item scale, and psychological distress, posttraumatic stress symptoms, and physical symptoms were measured using the K6, the six-item abbreviated version of the Posttraumatic Stress Disorder Checklist-Specific version, and the 10 items from the Physical Stress Reaction subscale of the Brief Job Stress Questionnaire, respectively. Valid responses from 1,521 residents (31.0%) were analyzed using multilevel linear or logistic regression models to explore the determinants of radiation anxiety and psychological and physical symptoms. Environmental radiation levels at the time of the survey and after the accident were associated with the residents' radiation anxiety. Disaster-related experiences, such as direct damage, disaster-related family stress, and fear or anxiety immediately after the accident, and sociodemographic characteristics (e.g., male gender, younger age, low socioeconomic status, and married) were also associated with radiation anxiety. Environmental radiation levels were

not associated with the residents' psychological or physical symptoms, but radiation anxiety was.

## **1. Introduction**

### 1.1. Long-term mental health effects of nuclear power plant accidents

Studies conducted after the previous nuclear power plant accidents at Three Mile Island (TMI) and Chernobyl reported adverse effects on the long-term mental health of the residents of those communities [1,2]. After the TMI accident, mothers of preschool children living within 10 miles of the nuclear power plant were found to have increased levels of anxiety and depression in the survey conducted at nine months to 3.5 years after the accident [3,4]. Among them, some were identified as having high levels of distress for more than 10 years [5]. After the Chernobyl accident, exposed adults exhibited greater psychological distress than non-exposed controls 3.5 to seven years after the accident [6-9]. Furthermore, evacuee mothers with young children reported poorer subjective health and psychological well-being compared to a control group of mothers 11 years and 19 years, respectively, after the accident [10,11].

## 1.2. Risk factors for mental health problems after nuclear power plant accidents

Studies conducted after the TMI and Chernobyl accidents reported risk factors for mental health problems, which included being female [9,12-14], older [9], younger [14], having a lower income or poor financial status [9,14], and being unmarried [9,12]. Other risk factors included having a prior psychiatric history [3,4], poor physical or subjective health [9,14], and poor social support [3]. The severity of the exposure to the accident, that is, the distance of the residence from the nuclear power plant [3,4,12,14] and evacuation experience [5] were also reported to increase the risk of mental health problems.

While these are similar to those reported after other kinds of disasters [15-18], risk factors specific to nuclear power plant accidents have also been found, such as affected people's perceptions of or anxiety about the possible health-related effects of radiation exposure. After the TMI accident, individuals' perceived danger and harm to health were found to be related to their psychological distress six months after the accident [13]. Their perceived harm to health six months after the accident was also related to their psychological distress three years later. The associations of perceived dangerousness of TMI and worries about their own health and that of their children with anxiety symptoms were revealed in a survey conducted 10 years after the accident [19]. Furthermore, Dew and Bromet (1993) [5] reported that an individual's initial perception of the dangerousness of TMI predicted their psychological distress over the following 10 years. Similarly, after the Chernobyl accident,

evacuee community residents who believed their health had been affected by the nuclear power plant accident reported poorer self-rated health and psychological well-being 11 and 19 years, respectively, after the accident [10,11]. In the study conducted 19 years after the accident, evacuee mothers' poorer psychological well-being, compared to that of a control group, became non-significant when their risk perceptions were adjusted [10], which suggests the importance of the perceptions of the effects for the long-term mental health of people affected by nuclear power plant accidents.

### 1.3. Perceptions of and anxiety about the possible health effects of nuclear power plant accidents and their related factors

Community residents' perceptions of and anxiety concerning the possible health consequences of nuclear power plant accidents (hereafter referred to as "radiation anxiety") were assessed using various methods after the TMI and Chernobyl accidents, and their persistence and related factors were reported. Goldstein and Schorr (1982) [20] reported that perceived danger, fear, and negative beliefs about the health-related effects of the TMI accident among the residents did not mitigate or worsened from six months to one year after the accident. Ginzburg (1993) [6] reported that in the survey conducted 3.5 years after the Chernobyl accident, a greater proportion of residents living in the contaminated villages believed they had radiation-related illnesses, as compared to those living in control villages.

A few studies conducted after the TMI accident have explored the factors related to radiation anxiety. Dohrenwend et al. (1981) [12] reported that females, younger people, and those living within five miles of the plant perceived a greater threat to their physical health from the accident and radiation. Goldstein et al. (1989) [13] reported that in a community located within 10 miles of the TMI plant, people with mistrust of the TMI-related authorities, those living near the plant, and females were more likely to perceive danger. Furthermore, people with mistrust of the TMI-related authorities, females, younger people, and those with less education were more likely to perceive their health as having been harmed.

#### 1.4. Fukushima Daiichi Nuclear Power Plant accident

The Great East Japan Earthquake and tsunami, which occurred on March 11, 2011, wreaked havoc on the Pacific coast of Northeast Japan and caused the Fukushima Daiichi Nuclear Power Plant accident. Substantial amounts of radioactive materials were released into the environment [21], and the Japanese government designated as an evacuation zone the area within a 20-kilometer radius of the nuclear power plant and the area where the cumulative exposure to radiation during the one year after the accident was predicted to exceed 20 mSv. Approximately 146,500 residents were forced to evacuate [22] and many residents outside the designated zone also evacuated spontaneously owing to concern about the adverse effects of radiation on their health [23]. In addition to the consequences of the nuclear power plant

accident, in Fukushima prefecture, there was damage caused by the massive earthquake and tsunami. The number of dead and missing in Fukushima prefecture was 1,612 and 202, respectively, and the number of completely and partially destroyed houses was 18,029 and 74,876, respectively [24]. When compared to the neighboring coastal prefectures such as Miyagi and Iwate, the extent of damage caused by the earthquake and tsunami in Fukushima prefecture was not outstanding; however, the consequences of the nuclear power plant accident have been huge and prolonged. One year after the accident, there were approximately 97,900 evacuees living in Fukushima prefecture and about 62,800 had evacuated from Fukushima prefecture. Even five years after the accident, there were approximately 54,000 and 39,200 evacuees living in and outside Fukushima prefecture, respectively [25,26]. Although the radiation exposure of the community residents was very limited, their mental health problems have been of great concern, based on the findings of the studies on the Chernobyl accident [27,28].

#### 1.5. Findings on the community residents' mental health after the Fukushima Daiichi Nuclear Power Plant accident

After the Fukushima Daiichi Nuclear Power Plant accident, the mental health of evacuees from the designated evacuation zone in Fukushima prefecture has been followed by the Fukushima Health Management Survey [29], which reported a high proportion of mental

health problems among them [30,31]. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2013 Report noted that “the most important health effect is on mental and social well-being, related to the enormous impact of the earthquake, tsunami and nuclear accident, and the fear and stigma related to the perceived risk of exposure to ionizing radiation” [32].

Risk factors for mental health problems found in studies after the TMI and Chernobyl accidents have also been reported after the Fukushima nuclear power plant accident. These risk factors include being female [33-36], older [33,35], having lower educational attainment [34,36], being unemployed [34], having a history of mental illness [33,36], and poor social support [35]. In addition, direct disaster damages, which seemed to be caused by the massive earthquake and tsunami, such as the loss of someone close [33,36] and house damage [34,36], were also reported as risk factors for psychological distress. Moreover, other disaster-related experiences, such as the loss of a job [33,36], decreased income [33,36], living in temporary housing or facilities other than one’s own home [33,36], and multiple relocations after the disaster [35], were reported to be associated with psychological distress after the Fukushima nuclear power plant accident. These findings are consistent with those of studies conducted after other kinds of disasters [15-18].

Radiation anxiety and its association with mental health among community residents was also reported after the Fukushima nuclear power plant accident [37]. Karz et al.’s (2014)



[38] narrative survey conducted 2.5 years after the accident reported that fear of radiation pertaining to the safety and health of families was prominent among the community residents in Fukushima. Studies of evacuees reported correlations of risk perceptions (i.e., perceived likelihood of health damage caused by the current level of radiation exposure) with severe psychological distress at one year and for three years after the accident [35,36]. A study of community residents in a prefecture neighboring Fukushima conducted 11 months after the accident also reported a correlation between anxiety about possible radioactive contamination and psychological distress [34].

Concerning the related factors of radiation anxiety, several studies conducted after the Fukushima nuclear power plant accident reported similar factors to those reported after the TMI accident. Among the evacuees, the perceptions of radiation risks for three types of adverse health effects (i.e., immediate health effects, delayed health effects, and genetic effects) were examined approximately one year after the accident [36]. In this study, female gender was associated with a higher perceived risk of delayed health effects and genetic effects, and older age was associated with a higher perceived risk of immediate health effects and genetic effects, whereas younger age was associated with a higher perceived risk of delayed health effects. Lower educational attainment was associated with higher perceived risk of all three types of health effects. Furthermore, disaster-related stressors, such as severe house damage, bereavement, living in facilities other than their own houses, job loss,

decreased income, and living outside Fukushima prefecture were related to higher risk perceptions of at least one of these three types of adverse health effects. In a survey of a nationally representative sample conducted one year after the accident, respondents who were female, married, experienced house damage, and were living in disaster-affected regions or in Kanto region (compared to other regions of Japan) were reported to be more concerned about radiation [39]. Students, however, were less concerned compared to those with income from work. A study of the general population's perceptions of radiation risk regarding health conducted five years after the accident reported that being female, having a spouse, having children, having evacuation experiences, and being mistrustful of the central government were associated with higher perceived risk [40].

#### 1.6. The effects of the environmental radiation level on the mental health of the community residents

As for community residents' mental health after nuclear power plant accidents, the effects of their radiation anxiety have been reported [5,10,11,13,19,34-36]. However, reports on the effects of objective measures of environmental radiation exposure on residents' mental health are limited and their findings are inconsistent. Twenty years after the Chernobyl accident, Beehler et al. (2008) [41] found no associations between the level of caesium-137 ground contamination at the time of the survey and residents' depression and anxiety. In

contrast, Lehmann and Wadsworth (2011) [42] did report an association between area-level dose of caesium-137 at the time of the accident and self-reported poor health 20 years after the Chernobyl accident. Regarding the evacuees of the Fukushima accident, Kunii et al. (2016) [33] reported an ecological association between area-based environmental radiation levels at the time of the survey and the proportion of residents with high levels of psychological distress. However, their study did not account for the residents' individual characteristics. Furthermore, research has not been conducted to determine whether this association is applicable outside the evacuation zone, where the radiation levels were low and the evacuation order was not issued.

It seems reasonable to assume that residents in areas with higher radiation levels perceive more anxiety regarding health effects; however, the relationships between regional radiation levels and residents' radiation anxiety have not been studied. A few studies have examined the relationship between the residents' distance from the nuclear power plant and their radiation anxiety, although their findings were inconsistent. After the TMI accident, Dohrenwend et al. (1981) [12] reported that residents near the plant perceived a greater threat to their physical health. However, Goldstein et al. (1989) [13] reported that even though the residents near the plant were more likely to perceive danger, their distance from the plant was not associated with their perceived harm to their health. A study conducted after the Fukushima accident by Murakami et al. (2016) [40] reported that residents of the prefecture

far from the plant perceived higher radiation risk compared to the non-evacuee residents of Fukushima prefecture.

### 1.7. Research gaps

Radiation anxiety is an important risk factor for long-term mental health after nuclear power plant accidents. Although several factors have been reported to be associated with radiation anxiety, including residents' sociodemographic characteristics and disaster-related experiences [12,13,36,39,40], the effects of objective measures of environmental radiation levels have not been studied. Therefore, the effects of the reported factors after controlling for the environmental radiation levels are still unknown. It is well known that disasters, including nuclear power plant accidents, affect people's mental health and that mental health is affected not only by the severity of the damage experienced but also by demographic characteristics, socioeconomic status, family factors, pre-disaster functioning or mental health problems, and social support [15-18]. However, thus far, only a small number of studies have examined the effect of environmental radiation levels on the mental health of residents affected by nuclear power plant accidents, and their findings have been inconsistent [33,41,42]. Furthermore, those studies did not explore the mechanisms through which environmental radiation levels affect people's mental health.

## 1.8. Aims and hypotheses

In this study, I focused on radiation anxiety among the non-evacuee community residents of Fukushima prefecture five years after the nuclear power plant accident. Since the accident, the levels and effects of radiation exposure have been measured and evaluated scientifically. Based on this evidence, it was reported that the general public's exposure doses have been generally low or very low, and no discernible increase in the incidence of radiation-related health effects were expected among exposed members of the public or their descendants [32,43]. However, radiation anxiety still remains among some people. A survey of evacuees conducted approximately five years after the accident reported that delayed health effects and genetic effects were a concern among 32.5% and 36.1% of respondents, respectively [44]. Whether the radiation anxiety after the nuclear power plant accident is, to some extent, based on objective measures of radiation levels or is completely independent from them is an important issue. If these anxieties are independent from objective measures of radiation exposure, radiation anxiety might not subside even if radiation levels reduce by decontamination efforts, natural decay, or diffusion. Furthermore, the explanations of the health-related effects of radiation by experts, which are aimed to mitigate radiation anxiety based on doses of radiation exposure, might not work. On the other hand, a few studies have suggested the possibility that regional radiation levels affect residents' perceived physical health and mental health [33,42] . It seems reasonable to assume that the regional radiation

levels affect residents' perceived physical or mental health through their radiation anxiety, that is, relatively higher radiation levels increase individuals' radiation anxiety, and their heightened radiation anxiety undermines their mental health. Confirmation of residents' radiation anxiety as one of the paths that connect regional radiation levels and residents' mental health should contribute to the understanding of the affected populations' mental health after nuclear power plant accidents.

This study had three aims. First, it aimed to investigate the association of environmental radiation exposure at the time of the accident and the time of the survey and sociodemographic and disaster-related variables with radiation anxiety among non-evacuee community residents of Fukushima prefecture. Second, the study aimed to investigate the association of environmental radiation exposure at the time of the accident and the time of the survey with residents' mental health, including psychological distress, posttraumatic stress symptoms, and physical symptoms, controlling for sociodemographic and disaster-related variables. Third, the study aimed to clarify the role of radiation anxiety in the relationship between environmental radiation exposure and residents' mental health. I hypothesized that (1) environmental radiation exposure is related to both the residents' radiation anxiety and (2) mental health, and that (3) radiation anxiety mediates the relationship between environmental radiation exposure and residents' mental health.

## 2. Methods

### 2.1. Study design and population

In the present study, the target communities comprised 49 of the 59 municipalities of Fukushima prefecture (Appendix 1), excluding restricted areas close to the nuclear power plant, as designated by the Japanese government. In each municipality, 100 residents aged 20 to 80 years were randomly sampled based on the basic resident registers, with double weighting for residents aged 20 to 39 years; thus, for a total of 4,900 subjects, a cross-sectional questionnaire survey was administered from February to April 2016.

### 2.2. Study variables

#### *2.2.1. Non-specific psychological distress*

Psychological distress was assessed using the K6, a six-item self-administered standardized screening instrument of non-specific psychological distress over the past 30 days [45,46]. Items are rated on a five-point scale from 0 (none) to 4 (all the time), with the total score ranging from 0 to 24. Based on a previous study, I decided that individuals scoring 5 points or more exhibited psychological distress [47]. The cutoff point of 5 on the K6 was also used in previous studies of community residents conducted after the Great East Japan Earthquake [34,48]. However, a study conducted in the United States reported a score of 13 to be the optimal cutoff point [49], and the studies conducted among the evacuees after the

Fukushima nuclear power plant accident also used a score of 13 as a cutoff point [30,31,36].

Therefore, I added the analyses using the score of 13 as a cutoff point instead of 5.

### *2.2.2. Posttraumatic stress symptoms*

Posttraumatic stress symptoms were assessed using the abbreviated version of the Posttraumatic Stress Disorder Checklist-Specific version (PCL-S) [50-52]. The PCL-S is a widely used questionnaire for people who have experienced a specific traumatic event. In this study, the traumatic event specified was the experience of the Great East Japan Earthquake, including the earthquake, tsunami, and nuclear power plant accident. In this study, the six-item abbreviated version developed by Lang and Stein (2005) [53] was used. The items, which measure the degree to which respondents are bothered by symptoms, are rated on a five-point Likert scale from 1 (not at all) to 5 (extremely), with a total score ranging from 6 to 30 points and higher scores indicating higher levels of symptom severity. Based on a previous study, I decided that individuals scoring 17 points or more exhibited posttraumatic stress symptoms [51].

### *2.2.3. Physical symptoms*

Physical symptoms were assessed using the 10 items of the Physical Stress Reaction subscale of the Brief Job Stress Questionnaire (BJSQ) [54]. The items measure the frequency



of experiencing physical symptoms, such as dizziness, joint ache, headache, stiff neck or shoulder, backache, eye strain, heart palpitations or shortness of breath, stomach problems, loss of appetite, and constipation or diarrhea over the past 30 days. Items are rated on a four-point scale from 1 (very few) to 4 (always), with a total score ranging from 10 to 40 points and higher scores indicating higher frequencies of physical symptoms. Cronbach's alpha coefficient of the 10 items in the present study's sample was 0.82. As the cutoff point of the total score of these 10 items has not been examined, in this study I decided to identify the 30% of the participants with higher scores, which corresponded to scores of 19 or above. To confirm whether the results depended on the cutoff point chosen, I repeated the analyses with a cutoff point of 23, which corresponded to 10% of the participants with higher scores. Further, I repeated the analyses using the total score of these 10 items as a continuous variable, instead of identifying the cases with symptoms by a cutoff point.

#### *2.2.4. Radiation anxiety*

Radiation anxiety was defined 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 owing to radiation exposure. Radiation anxiety was assessed using the seven-item Radiation Anxiety Scale developed by Umeda et al. (2014) [55,56]. The items were derived from a qualitative analysis

of descriptions of worry, anxiety, and problems related to radiation exposure by residents evacuated from Fukushima after the nuclear power plant accident. The validity of the scale was confirmed among the non-evacuee adult community residents in one municipality of Fukushima prefecture [55,56]. The following items were used in this study: 1) I am concerned about acquiring a serious illness in the future owing to the effects of radiation; 2) Every time I feel ill, I am afraid it is caused by radiation exposure; 3) I am concerned that radiation effects can be inherited by the next generation, such as children and grandchildren; 4) I feel extreme anxiety when I see news reports concerning the nuclear power plant accident; 5) I have experienced discrimination (or unfair treatment) because I lived in an area that has been reported to have high levels of radiation; 6) I try not to tell others that I am a resident of that area whenever possible; and 7) I have experienced conflicts and trouble with my family members over the health effects of radiation. The items were rated on a four-point Likert scale from 1 (strongly disagree) to 4 (strongly agree), and the items' scores were summed to obtain a total summary score, ranging from 7 to 28, with higher scores indicating higher levels of radiation anxiety. Cronbach's alpha coefficient for the scale has been reported as 0.81 [55,56], and in the present study's sample it was 0.85. A factor analysis suggested a two-factor structure of the scale, with the first factor loaded by items #1-4 for adverse health effects (explaining 48% of the variance) and the second factor loaded by items #5-7 for social and interpersonal conflicts related to radiation (explaining 17% of the variance) [55,56]. Because

the subscale scores corresponding to these two factors were strongly correlated (Pearson's  $r = 0.48$ ) [55,56], I used the scale to represent the single construct of radiation anxiety. I confirmed the results using the adverse health effects subscale score, instead of the total scale score. The adverse health effects subscale score ranges from 4 to 16.

#### *2.2.5. Sociodemographic characteristics*

The sociodemographic characteristics included in this study were gender, age, educational attainment, household income in the past year, number of members living in the household, marital status, living arrangement, working status, and having a chronic physical disease under treatment. Household income in the previous year was measured using five categories (i.e.,  $< 2.5$ ,  $2.5-5.0$ ,  $5.0-7.5$ ,  $7.5-10.0$ ,  $\geq 10.0$  million yen). Based on this information, I generated three categories for household income level that were adjusted by household size, dividing household income by the square root of the number of household members according to a procedure used in a previous study [57]. When the number of household members was one or two, a household income  $< 2.5$  was categorized as low,  $2.5-5.0$  was categorized as middle, and  $\geq 5.0$  as high. When the number of household members was three, household income  $< 2.5$  was categorized as low,  $2.5-7.5$  was categorized as middle, and  $\geq 7.5$  as high. When the number of household members was four or more, household income  $< 5.0$  was categorized as low,  $5.0-10.0$  was categorized as middle, and  $\geq$

10.0 as high.

#### *2.2.6. Disaster-related experiences*

I examined two dimensions of disaster damage experienced by individuals: direct damage and disaster-related family stress. To assess direct damage, four experiences were explored: 1) harm to oneself; 2) harm to or death of family members; 3) loss of job or temporary absence from work; and 4) house damage or loss of property. To assess family stress, two experiences were explored: 1) deterioration of family relationships and 2) family separation. When the individuals reported at least one experience in each category, I designated them as having the experience of direct damage or disaster-related family stress.

The degree of fear or anxiety experienced immediately after the nuclear power plant accident was assessed using a single-item scale with response options ranging from 1 (none) to 5 (extreme).

#### *2.2.7. Social network*

The total score of the Japanese version of the abbreviated Lubben Social Network Scale (LSNS-6) [58,59] was used to measure individuals' social networks. The LSNS-6 consists of six items, including three concerning family network and three concerning non-family network, inquiring about the number of members in each network. Items are rated

on a six-point scale from 0 to 5, with a total score ranging from 0 to 30. Higher scores indicate larger networks.

Membership in associations or groups was also assessed, based on participants' responses to a list of 13 types of associations, such as neighborhood community association, hobby group, industry organization, and religious group. If respondents were members of at least one of those associations, I designated them as belonging to some group or organization.

#### *2.2.8. Environmental radiation levels*

For each municipality, I calculated the average environmental air dose rate of radiation ( $\mu\text{Sv/h}$ ), which was measured one meter above ground at the time of the survey and soon after the Great East Japan Earthquake, using the data obtained from the information-disclosure site of the Japan Atomic Energy Agency. To calculate the average air dose rates at the time of the survey, I used the data of "Measurement results of air dose rates nationwide and in Fukushima prefecture (real-time distribution) daily average" [60]. These air dose rates were measured using monitoring posts. I calculated the yearly average in each municipality using the data from May 1, 2015, to April 30, 2016. Since the fluctuation of monthly averages was large and there is also an annual fluctuation in natural radiation, I used the one-year averages to the time of the survey to obtain stable values for each municipality.

When calculating the average air dose rates soon after the Great East Japan

Earthquake, the data used to calculate the current air dose rate was not available. Therefore, I used the data from the Fukushima prefecture environmental radiation monitoring-mesh investigation, which were measured using a survey meter (ambient dose equivalent rate) [61]. I used the data obtained in the first survey conducted April 12-16, 2011. I used all the data reported at all measuring points in each municipality.

### 2.3. Statistical analysis

First, I calculated descriptive statistics for individual characteristics of the study population and municipality radiation levels. Then, I examined relationships between individual-level independent variables and outcomes. For radiation anxiety, I examined the relationships between the total score on the Radiation Anxiety Scale and the independent variables using t-tests, analysis of variance, or Pearson's correlation coefficients. For psychological distress, posttraumatic stress symptoms, and physical symptoms, I used chi-square tests or t-tests to compare participants who scored above versus below each cutoff point.

Next, because the data had a hierarchical structure, with individuals nested within municipalities, I developed two-level multivariate regression models for each outcome. I used a multilevel multivariate linear regression model for radiation anxiety, and a multilevel multivariate logistic regression model for psychological distress, posttraumatic stress

symptoms, and physical symptoms. In the analytical process, I added independent variables sequentially and examined the change in the macro-level variance. First, I used the model with only the random intercept to assess whether there was a significant variation in each outcome across municipalities and to reveal its size (Model 1). Then I included municipality radiation levels in Model 2 to examine their effects on the outcomes. As municipality radiation levels at the time of the survey and soon after the earthquake were strongly correlated (Pearson's  $r = 0.9142$ ), I added them separately. In Model 3, I added individual-level independent variables to control their effects. As for psychological distress, posttraumatic stress symptoms, and physical symptoms, I constructed Model 4 by adding individual radiation anxiety to Model 3 to examine its effect.

All statistical analyses were performed using Stata 15 for Windows (StataCorp LP, College Station, TX). Statistical significance was set at .05 and all tests were two-tailed.

#### 2.4. Ethical considerations

All procedures followed were in accordance with the Helsinki Declaration and its later amendments. The study protocol was reviewed and approved by the Research Ethics Committee of the University of Tokyo Graduate School of Medicine and Faculty of Medicine (approval number: 3513-(6)). The questionnaire was sent to the study population with a letter explaining the study and asking them to send back the filled questionnaire if they consented to

participate.

### **3. Results**

#### **3.1. Sample characteristics**

Among the 4,900 initial subjects, valid responses were obtained from 2,038 individuals from 49 municipalities (response rate: 41.6%), from which I ultimately used the data of the 1,521 (31.0%) respondents who did not have missing information on any of the study variables.

Table 1 displays descriptive statistics of the individual characteristics of the study population. Regarding disaster-related experiences, 481 (31.6%) individuals had experienced direct damage and 123 (8.1%) had experienced disaster-related family stress. For direct damage, 13 (0.9%) experienced harm to oneself, 64 (4.2%) experienced harm to or death of family members, 231 (15.2%) experienced loss of job or temporary absence from work, and 291 (19.1%) experienced house damage or loss of property. Concerning family stress, 61 (4.0%) experienced deterioration of family relationships and 81 (5.3%) experienced family separation. As for the level of fear or anxiety immediately after the nuclear power plant accident, which was assessed by a five-point scale, 530 (34.9%) respondents scored 5 (extremely) and 339 (22.3%) scored 4 (a lot).



The average score on the Radiation Anxiety Scale was 14.8 (standard deviation = 4.4). The average score on the adverse health effects subscale of the Radiation Anxiety Scale was 10.0 (standard deviation = 3.0). The average score for the K6 was 3.3 (standard deviation = 4.4). The respondents who scored 5 points or above and 13 points or above on the K6 were 443 (29.1%) and 69 (4.5%), respectively. The average score for the abbreviated version of the PCL-S was 8.3 (standard deviation = 3.6). Sixty (3.9%) respondents scored 17 points or above on the abbreviated version of the PCL-S. As for the total score of the 10 items of the Physical Stress Reaction subscale of the BJSQ, the respondents who scored 19 or above and 23 or above were 417 (27.4%) and 155 (10.2%), respectively. The average of the total score of the 10 items was 16.0 (standard deviation = 4.8). The distributions of the scores of these outcomes are shown in Appendix 2.

The extent of overlapping of psychological distress, posttraumatic stress symptoms, and physical symptoms is shown in Appendix 3, in which I used the cutoff point of 5 on the K6, 17 on the abbreviated version of the PCL-S, and 19 on the total score of the 10 items of physical symptoms. Among the 1,521 participants, the respondents who had all three types of symptoms (i.e., psychological distress, posttraumatic stress symptoms, and physical symptoms) was 37 (2.4%), and those who had at least one of them was 614 (40.4%). Among the 443 respondents with psychological distress, 51 (11.5%) had posttraumatic stress symptoms, 251 (56.7%) had physical symptoms, and 178 (40.2%) had only psychological

distress. Among the 60 respondents with posttraumatic stress symptoms, 51 (85.0%) had psychological distress, 41 (68.3%) had physical symptoms, and five (8.3%) had only posttraumatic stress symptoms. Among the 417 respondents with physical symptoms, 251 (60.2%) had psychological distress, 41 (9.8%) had posttraumatic stress, and 162 (38.8%) had only physical symptoms.

### 3.2. Environmental radiation levels

Among the 49 municipalities surveyed, the average air dose rates at the time of the survey ranged from 0.0456  $\mu\text{Sv/h}$  to 0.1931  $\mu\text{Sv/h}$ , with a mean of 0.1003  $\mu\text{Sv/h}$  and a median of 0.0883  $\mu\text{Sv/h}$ . The average air dose rates soon after the Great East Japan Earthquake ranged from 0.0972  $\mu\text{Sv/h}$  to 2.0280  $\mu\text{Sv/h}$ , with a mean of 0.5617  $\mu\text{Sv/h}$  and a median of 0.3216  $\mu\text{Sv/h}$ . The average air dose rates of radiation in each municipality at the time of the survey and soon after the earthquake used in this study are reported in Appendix 1.

### 3.3. Relationships of radiation anxiety with individual-level characteristics

Table 2 reports the relationships of the sociodemographic, disaster-related, and social network characteristics with the level of radiation anxiety. Higher radiation anxiety was observed in young and middle-aged participants, and in those with lower income levels. Being married and having more family members in a household were related to higher

radiation anxiety. Participants who had experienced direct damage, disaster-related family stress, or fear or anxiety immediately after the nuclear power plant accident showed higher radiation anxiety. Almost the same results were obtained in analyses using the adverse health effects subscale score of the Radiation Anxiety Scale instead of the total score (Appendix 4).

### 3.4. Associations of individual-level characteristics and radiation anxiety with psychological and physical symptoms

Table 3 reports the relationships of sociodemographic, disaster-related, and social network characteristics and radiation anxiety with psychological distress, in which I used the cutoff point of 5 on the K6. The group with high psychological distress tended to consist of females and young individuals. Participants in this group were also less likely to be married, had a smaller number of family members in their households, a smaller social network of family or friends, did not belong to groups or organizations, and did not live in their own houses. Furthermore, the high psychological distress group was more likely to have experienced direct damage and disaster-related family stress, to have felt fear or anxiety immediately after the nuclear power plant accident, and to have greater radiation anxiety. Almost the same results were obtained by the analyses using the cutoff point of 13 instead of 5 (Appendix 5).

Table 4 reports the relationships of sociodemographic, disaster-related, and social

network characteristics and radiation anxiety with posttraumatic stress symptoms. The group with severe posttraumatic stress symptoms tended to consist of participants who had a smaller number of family members in their households, a smaller social network of family or friends, and were less likely to belong to groups or organizations. Furthermore, this group was more likely to have experienced direct damage and disaster-related family stress, to have felt fear or anxiety immediately after the accident, and to have greater radiation anxiety.

Table 5 reports the relationships of sociodemographic, disaster-related, and social network characteristics and radiation anxiety with physical symptoms, in which I used the cutoff point of 19 on the total score of the 10 items of the Physical Stress Reaction subscale of the BJSQ. The group with frequent physical symptoms tended to consist of females and the middle aged. This group was more likely to be working, living in a facility other than their own house, and have a smaller social network of family or friends, and did not belong to groups or organizations. Furthermore, this group was more likely to have experienced direct damage and disaster-related family stress, to have felt fear or anxiety immediately after the accident, and to have greater radiation anxiety. Almost the same results were obtained by the analyses using the cutoff point of 23 instead of 19 and the analyses using the total score of the 10 items as a continuous variable (Appendix 6-7).

### 3.5. Determinants of radiation anxiety

The results of the multilevel multivariate linear regression analysis of radiation anxiety are shown in Table 6A. There was significant variability in the level of radiation anxiety across municipalities, as shown in Model 1 (municipality-level variance = 1.60, standard error = 0.44), although its proportion of the total variance was not large (intra-class correlation = 0.08). When I added the municipality radiation levels in Model 2, the air dose rate of radiation at the time of the survey explained 34% of the municipality-level variance. The significant effects of municipality radiation levels at the time of the survey remained after controlling for the individual-level characteristics in Model 3. Among the individual-level predictors, being male, young or middle aged, having a lower educational level or household income, being married, suffering direct damage from the earthquake, experiencing disaster-related family stress, and feeling fear or anxiety immediately after the nuclear power plant accident were significantly associated with higher radiation anxiety. With the full set of individual- and municipality-level variables, 71% of the municipality-level variance was explained, although the unexplained variance remained.

When examining the effects of municipality radiation levels soon after the earthquake, I excluded the respondents who moved or evacuated after the earthquake. This exclusion was because information on the residence of these respondents soon after the earthquake was not available, and their exposed radiation levels after the earthquake could not

be estimated. I repeated the same analyses (as above) for the 1,269 respondents who had not moved since the accident (self-reported on the questionnaire). I also examined the effects of municipality radiation levels at the time of the survey again with this sample to compare them with those soon after the earthquake (Table 6B). Similarly, in Model 1, there was significant variability in the level of radiation anxiety across municipalities (municipality-level variance = 1.17, standard error = 0.37), although the proportion of the total variance was not large (intra-class correlation = 0.06). When I added the municipality radiation levels in Model 2, the air dose rate of radiation at the time of the survey explained 30% of the municipality-level variance (Model 2A) and the air dose rate of radiation soon after the earthquake explained 19% (Model 2B). Although both the air dose rate of radiation at the time of the survey and the air dose rate of radiation soon after the earthquake were significantly associated with individuals' radiation anxiety, the air dose rate at the time of the survey showed the stronger association with individuals' radiation anxiety. The significant effects of municipality radiation levels at the time of the survey and soon after the earthquake both remained after controlling for the individual-level characteristics in Model 3. Among the individual-level predictors, being young or middle-aged, having a lower household income, being married, suffering direct damage from the earthquake, experiencing disaster-related family stress, and feeling fear or anxiety immediately after the nuclear power plant accident were significantly associated with higher radiation anxiety. With the full set of individual- and municipality-level

variables, 68% and 62% of the municipality-level variance was explained in Model 3A and in Model 3B, respectively, although unexplained variance remained. Almost the same results were obtained using the adverse health effects subscale score of the Radiation Anxiety Scale instead of the total score except for the effects of air dose rate of radiation soon after the earthquake, which was not significantly associated with radiation anxiety (Appendix 8-9).

### 3.6. Determinants of psychological distress

The results of the multilevel multivariate logistic regression analysis of psychological distress, in which I used the cutoff point of 5 on the K6, are shown in Table 7A. There was significant but relatively small variability in the proportion of participants with psychological distress across municipalities, as shown in Model 1 (municipality-level variance = 0.15 standard error = 0.06). When municipality radiation levels were added in Model 2, the air dose rate of radiation at the time of the survey was significantly related to individual psychological distress. However, after individual-level characteristics were controlled for in Model 3, it was no longer significantly related to individual psychological distress. In Model 4, I added individual radiation anxiety to Model 3, and it was significantly related to psychological distress. When I added the adverse health effects subscale score of the Radiation Anxiety Scale instead of the total score, the subscale score was also significantly related to psychological distress (Odds Ratio = 1.17, 95% Confidence Interval = 1.11–1.23).

As for the other individual-level predictors, female gender and suffering direct damage from the earthquake were significantly associated with psychological distress. Being married, living in their own houses, and having a broader social network of family and friends were significant protective factors for psychological distress. The results of the multilevel multivariate logistic regression analysis of psychological distress determined by the cutoff point of 13 instead of 5 on the K6 are shown in Table 8A. Almost the same results were obtained except for the non-significant effect of radiation anxiety on psychological distress.

The results of the examination of the effects of municipality radiation levels soon after the earthquake in addition to those at the time of the survey are reported in Table 7B. I used the cutoff point of 5 on the K6 to determine psychological distress. Similarly, there was significant but relatively small variability in the proportion of participants with psychological distress across municipalities, as shown in Model 1 (municipality-level variance = 0.19, standard error = 0.08). When municipality radiation levels were added in Model 2, both the air dose rate of radiation at the time of the survey and air dose rate of radiation soon after the earthquake were significantly related to individual psychological distress. However, after individual-level characteristics were controlled for in Model 3, neither air dose rate of radiation at the time of the survey nor air dose rate of radiation soon after the earthquake was significantly related to individual psychological distress. In Model 4, I added individual radiation anxiety to Model 3, and it was significantly related to psychological distress. The



corresponding results of the multilevel multivariate logistic regression analysis of psychological distress determined by the cutoff point of 13 instead of 5 on the K6 are shown in Table 8B. Almost the same results were obtained.

### 3.7. Determinants of posttraumatic stress symptoms

The results of the multilevel multivariate logistic regression analysis of posttraumatic stress symptoms are shown in Table 9A. There was significant but relatively small variability in the proportion of participants with posttraumatic stress symptoms across municipalities, as shown in Model 1 (municipality-level variance = 0.36, standard error = 0.27). When municipality radiation levels were added in Model 2, the air dose rate of radiation at the time of the survey was significantly related to individual posttraumatic stress symptoms. However, after individual-level characteristics were controlled for in Model 3, it was no longer significantly related to individual posttraumatic stress symptoms. In Model 4, I added individual radiation anxiety, and it was significantly related to posttraumatic stress symptoms. When I added the adverse health effects subscale score of the Radiation Anxiety Scale instead of the total score, the subscale score was also significantly related to posttraumatic stress symptoms (Odds Ratio = 1.24, 95% Confidence Interval = 1.10–1.40). As for the other individual-level predictors, lower educational attainment, suffering direct damage from the earthquake, experiencing disaster-related family stress, and feeling fear or anxiety

immediately after the accident were significantly associated with posttraumatic stress symptoms. Having a larger number of household members and a broader social network of family and friends were significant protective factors for posttraumatic stress symptoms.

The results of the examination of the effects of municipality radiation levels soon after the earthquake in addition to those at the time of the survey are reported in Table 9B. Variability in the proportion of the respondents with posttraumatic stress symptoms between municipalities was not observed (municipality-level variance = 0.33, standard error = 0.34 in Model 1). When municipality radiation levels were added in Model 2, both the air dose rate of radiation at the time of the survey and air dose rate of radiation soon after the earthquake were significantly related to individual posttraumatic stress symptoms. However, after individual-level characteristics were controlled for in Model 3, neither air dose rate of radiation at the time of the survey nor air dose rate of radiation soon after the earthquake was significantly related to individual posttraumatic stress symptoms. In Model 4, I added individual radiation anxiety, and it was significantly related to posttraumatic stress symptoms.

### 3.8. Determinants of physical symptoms

The results of the multilevel multivariate logistic regression analysis of physical symptoms, in which I used the cutoff point of 19 on the total score of the 10 items of physical symptoms, are shown in Table 10A. Variability in the proportion of respondents with physical

symptoms between municipalities was not observed (municipality-level variance = 0.06, standard error = 0.04 in Model 1). When municipality radiation levels were added in Model 2, the air dose rate of radiation at the time of the survey was significantly related to individual physical symptoms. However, after individual-level characteristics were controlled for, it was no longer significantly related to individual physical symptoms (Model 3). Radiation anxiety was significantly related to physical symptoms (Model 4). When I added the adverse health effects subscale score of the Radiation Anxiety Scale instead of the total score, the subscale score was also significantly related to physical symptoms (Odds Ratio = 1.12, 95% Confidence Interval = 1.07–1.18). As for the other individual-level predictors, being female, being young or middle-aged, working, having a chronic disease under treatment, and experiencing disaster-related family stress were significantly associated with physical symptoms. Living in one's own house and having a broader social network of family and friends were significant protective factors for physical symptoms. Almost the same results were obtained by the analyses using the cutoff point of 23 instead of 19 (Table 11A) and the analyses using the multilevel multivariate linear regression models with the total score of the 10 items as an outcome (Table 12A).

The results of the examination of the effects of municipality radiation levels soon after the earthquake in addition to those at the time of the survey are reported in Table 10B. I used the cutoff point of 19 on the total score of the 10 items of physical symptoms. Similarly,

variability in the proportion of the respondents with physical symptoms between municipalities was not observed (municipality-level variance = 0.04, standard error = 0.05 in Model 1). When municipality radiation levels were added in Model 2, both the air dose rate of radiation at the time of the survey and air dose rate of radiation soon after the earthquake were significantly related to individual physical symptoms. However, after individual-level characteristics were controlled for, neither air dose rate of radiation at the time of the survey nor air dose rate of radiation soon after the earthquake was significantly related to individual physical symptoms (Model 3). Radiation anxiety was significantly related to physical symptoms (Model 4). Almost the same results were obtained by the analyses using the cutoff point of 23 instead of 19 (Table 11B) and the analyses using the multilevel multivariate linear regression models with the total score of the 10 items as an outcome (Table 12B).

#### **4. Discussion**

Both the environmental radiation levels at the time of the accident and at the time of the survey significantly accounted for the radiation anxiety of the participants, which supported our hypothesis. After adjusting for the environmental radiation level, being male and younger (compared to aged 65+), having lower educational attainment (compared to university or higher) and low household income (compared to high income), being married,

experiencing disaster-related damage and family problems, and experiencing fear or anxiety immediately after the accident were significantly associated with radiation anxiety. However, the environmental radiation levels at the time of the accident and the survey did not account for the residents' psychological distress, posttraumatic stress symptoms, or physical symptoms, which did not support our hypothesis. Radiation anxiety was significantly associated with psychological distress, posttraumatic stress symptoms, and physical symptoms.

In municipalities with relatively higher radiation levels, individuals were more likely to report higher radiation anxiety. This is consistent with a previous observation from the TMI accident, in which people living near the plant perceived a greater threat to their health from radiation exposure [12]. However, this is inconsistent with the results of a study conducted by Goldsteen et al. (1989) [13] after the TMI accident, in which an association between residents' distance from the plant and perceived harm to their health was not observed. Goldsteen et al. (1989) [13] conducted their study in a community located within 10 miles of the TMI plant, with most residents living within five miles of the plant, that is, almost all their study participants lived near the plant, which may explain the lack of association found between the distance from the plant and participants' perceived harm to their health. In a study conducted five years after the Fukushima accident, Murakami et al. (2016) [40] reported that the

residents of the prefecture located in Western Japan perceived higher radiation risk compared to the non-evacuee residents of Fukushima prefecture. One of the reasons for this counterintuitive finding might be that the residents in Fukushima prefecture who perceived a higher risk had evacuated and were not included in their study's category of non-evacuee residents.

Although both the municipality radiation levels after the accident and at the time of the survey were significantly correlated with respondents' radiation anxiety, the municipality radiation level at the time of the survey was more strongly associated with it. The present study was conducted approximately five years after the accident, when the environmental radiation level in the air had decreased, with the average air dose rate in each municipality at the time of the survey being between 0.0456 and 0.1931  $\mu\text{Sv/h}$ . However, the present findings suggest that current environmental radiation levels still affected residents' radiation anxiety. Community residents in Fukushima prefecture still seem sensitive to variations in these low levels of environmental radiation exposure. These residents, once psychologically sensitized to radiation exposure, may monitor small changes in radiation level from day to day and continue to compare these levels between localities. In each municipality in Fukushima prefecture, several to hundreds of monitoring posts showing the current measurement values still stand at places such as schools, parks, and municipality offices. Furthermore, measured radiation levels are continually reported in local newspapers and on the prefecture's website.

The finding that the current radiation level affected residents' radiation anxiety more strongly than the past radiation level may suggest that these measurement values to which the residents are currently exposed are more likely to cause radiation anxiety. Community residents may become more sensitive to minute fluctuations in reported radiation levels and experience increased anxiety due to the invisibility of radiation. In addition to ongoing monitoring of their health, the continuous explanation of radiation's health effects based on its dose seems to be helpful even several years after the accident. Furthermore, decreases in the environmental radiation levels by continuous decontamination efforts can alleviate residents' radiation anxiety.

In this study, to examine the effects of environmental radiation levels after the nuclear power plant accident on individual radiation anxiety and psychological and physical symptoms, I used the measurement values of the air dose rate of radiation to which the residents were exposed. I thought the examination of the relationships between these values and the residents' radiation anxiety and psychological and physical symptoms was needed first. I did not compare the values of the air dose rate of radiation before the accident with the values of the air dose rate of radiation after the accident. It can be assumed that almost the entire study population lacked knowledge about the air dose rate of radiation and its values before the accident. Therefore, only the measurement values after the accident were thought

to have the potential to affect residents' radiation anxiety and psychological and physical symptoms. In this study, I used both the measurement values of the air dose rate of radiation soon after the earthquake and the air dose rate of radiation at the time of the survey, rather than the changes between these two time points. Using these changes would have been an examination of the effects of the decrease of the air dose rate of radiation due to decontamination efforts or natural decay or diffusion after the accident. If the hypothesis that these changes have an important effect on residents' radiation anxiety or psychological and physical symptoms can be argued theoretically, then these changes require further investigation in future studies.

Disaster-related experiences, that is, direct disaster damage, disaster-related family stress, and fear or anxiety immediately after the nuclear power plant accident, were still significantly associated with radiation anxiety after adjusting for the environmental radiation level. A traumatic experience accompanied by strong feelings of fear or anxiety from the threat of death or health problems owing to the nuclear power plant accident might change the perceptions and cognitions of community residents. Such changes can increase their sensitivity to the possible health effects of radiation exposure, which might persist for many years as a basis for prolonged radiation anxiety. In a previous study, a survey of evacuees in Fukushima also found an association between direct disaster damage, such as house damage



and bereavement, and perceptions of the health effects of radiation exposure [36]. Another study, in which a nationally representative sample was surveyed, also found that the participants who experienced house damage due to the disaster had greater concerns about radiation even after controlling for their residential area [39]. Direct disaster damage, such as injury, bereavement, or house damage, due to the earthquake or tsunami might have also increased fear and anxiety about this traumatic experience related to the threat of death or health problems, although these were not related exclusively to the nuclear power plant accident. These findings suggest that a part of the radiation anxiety after a nuclear power plant accident stems from the traumatic experience in reaction to that accident. This hypothesis should be examined further in future research. Disaster-related family stress, which included deterioration of family relationships and family separation, can also be caused inversely by their radiation anxiety. Different levels of radiation anxiety among family members may cause conflicts among them, or their anxiety about radiation's adverse health effects might encourage them to evacuate only children with their mothers, causing family separation. It should also be noted that our radiation anxiety scale also includes an item on the experience of conflict and trouble within the family in relation to radiation's health effects. Thus, the observed association might be artificial.

Respondents who were married and had lower educational attainment or household

income reported greater radiation anxiety, which is consistent with previous findings [13,36,39,40]. Married residents might have been concerned not only about themselves but also about their families. People with lower educational attainment and lower income may have a relatively limited capacity to access relevant information or assess the possible health effects of a given radiation exposure. In the present study, younger respondents reported more radiation anxiety, which is also consistent with the findings of studies on the TMI disaster [12,13]. A previous study among evacuees of Fukushima reported that younger people perceived the risk of delayed effects as higher and the risks of immediate and genetic effects to be lower [36]. The effect of age on radiation anxiety might depend on the type of concern and context. These groups should be considered high-risk groups that require special attention for relieving their anxiety about radiation's effects.

In this study, males were more likely than females to have high radiation anxiety, which was inconsistent with previous findings. Previous studies conducted in TMI and Fukushima consistently reported that females perceived a greater threat to their health or greater concern about radiation [12,13,36,39,40]. The radiation anxiety scale used in this study included the dimension of social and interpersonal conflict related to radiation in addition to the dimension of adverse health effects. Ad-hoc analyses to examine the relationship between gender and these two dimensions of radiation anxiety separately showed that males were inclined to have higher radiation anxiety, especially concerning social and

interpersonal conflict (coefficient of gender = -0.22, standard error = 0.14,  $p = 0.110$  in Model 3A of radiation anxiety for adverse health effects; coefficient of gender = -0.19, standard error = 0.10,  $p = 0.066$  in Model 3A of radiation anxiety for social and interpersonal conflict). In addition, in our study, the young population aged under 40 was sampled with double weighting. Ad-hoc analyses in each age group showed that males were inclined to have higher radiation anxiety, especially in young respondents (coefficient of gender = -0.17, standard error = 0.30,  $p = 0.059$  in Model 3A among the respondents under 40; coefficient of gender = -0.15; standard error = 0.28,  $p = 0.588$  in Model 3A among the respondents aged 40 or above). The inconsistent result of this study may partly stem from the sampling method or the multidimensionality of the scale used to measure radiation anxiety. Furthermore, when examining the relationship between gender and radiation anxiety in previous studies, other sociodemographic characteristics or disaster-related experiences might not have been fully controlled for.

Environmental radiation levels were not significantly associated with respondents' psychological or physical symptoms. This finding was unexpected and inconsistent with a study conducted 20 years after the Chernobyl accident [42] and an ecological study of evacuees in Fukushima [33]. However, it is in line with another study from the Chernobyl accident [41], which also reported no association. A possible reason for the observed

non-significant associations is that, in the present study, radiation levels were lower (almost < 2  $\mu\text{Sv/h}$  at the time of the accident, and < 0.2  $\mu\text{Sv/h}$  at the time of the survey) at the survey sites that were outside the restricted areas and relatively far from the nuclear power plant. These levels of environmental radiation exposure might not have affected the psychological or physical symptoms of the residents. The other possible reason for the inconsistency in findings among studies is that possible confounders, such as socioeconomic status, disaster-related experiences, and social network characteristics, were not fully controlled for in previous studies. In this study, municipality radiation levels were significantly associated with individuals' psychological and physical symptoms before the individual-level variables were adjusted. It is possible that these individual-level variables, which are known to be related to post-disaster mental health, were correlated with environmental radiation levels incidentally and produced apparent correlations between municipality radiation levels and residents' psychological and physical symptoms. Kunii et al. (2016) [33] reported the ecological correlation between regional radiation levels and the proportion of the residents with psychological distress among evacuees in Fukushima without controlling for individual characteristics. Lehmann and Wadsworth (2011) [42] reported the significant correlation between area-level dose of caesium-137 and self-reported health 20 years after the Chernobyl accident with controlling for individual socio-demographic characteristics. On the other hand, Beehler et al. (2008) [41] reported null-association between the level of ground contamination

by caesium-137 and residents' depression and anxiety with controlling for individual-level variables such as disaster-related relocation, chronic daily strain, negative life events, and mastery/controllability (which is one of the psychological coping resources) in addition to socio-demographic characteristics. The results may depend to some extent on the individual confounders adjusted in each study. The previously reported significant correlations between environmental radiation levels and individual mental health [33,42] might have been partly due to confounding by these individual characteristics.

I did not examine the third hypothesis—that radiation anxiety mediates the relationship between environmental radiation exposure and residents' mental health because the second hypothesis, which was the premise for it, was not supported. Instead, I examined the association of radiation anxiety with psychological distress, posttraumatic stress symptoms, and physical symptoms. Radiation anxiety was significantly associated with all of them, except for psychological distress determined by scoring 13 or above on the K6, in which the odds ratio of radiation anxiety was marginally insignificant (odds ratio = 1.06; 95% confidence interval = 0.99-1.13). These results suggest that while regional radiation levels did not affect the residents' mental health directly, they might have affected their mental health indirectly through their radiation anxiety. In addition, the decrease of the odds ratio of the air dose rate of radiation at the time of the survey by adding radiation anxiety in Model 4 was

large, which was common to the analysis of psychological distress, posttraumatic stress symptoms, and physical symptoms. Although the odds ratio of the air dose rate of radiation in Model 3 was not statistically significant, the commonly observed large decrease of its odds ratio might also suggest the possible mediating effect of radiation anxiety. The role of radiation anxiety in the relationship between regional radiation levels and residents' mental health needs further examination. The results of the multilevel multivariate logistic regression analyses using physical symptoms as a dependent variable indicated that there was almost no variability in physical symptoms between the municipalities. As for psychological distress and posttraumatic stress symptoms, variability between the municipalities was small and disappeared after controlling for the individuals' vulnerabilities and disaster-related experiences. The lack of association between municipality radiation levels and the mental health of individual residents in this study were thought to stem, in part, from the small variability in the residents' mental health across the municipalities.

After controlling for the environmental radiation level and individuals' radiation anxiety, significant associations of being female and unmarried with psychological distress were found and being female and young or middle-aged were associated with physical symptoms. Lower educational attainment and a smaller number of household members were associated with posttraumatic stress symptoms. Living in facilities other than their own

houses was significantly associated with psychological distress and physical symptoms. Having a chronic disease was significantly associated with physical symptoms. Having experienced direct damage from the disaster was significantly associated with psychological distress and posttraumatic stress symptoms. Having experienced disaster-related family stress was significantly associated with posttraumatic stress symptoms and physical symptoms. Fear or anxiety immediately after the nuclear power plant accident was significantly associated with posttraumatic stress symptoms. Having a small social network of family and friends was significantly associated with psychological distress, posttraumatic stress symptoms, and physical symptoms. These findings are in line with those of previous studies conducted after disasters [15-18]. However, the result that working respondents were more likely to report physical symptoms compared to those who were not working at the time of the survey was unexpected. Job loss has been reported as one of the stressors that increase individuals' vulnerability to post-disaster mental health problems [15]. Studies conducted after the Fukushima accident also reported that job loss [33,36] or unemployment [34] were related to poor mental health, and that the working population was more resilient than not-working population [62]. One possible reason is that the scale used to measure physical symptoms in this study was extracted from the questionnaire assessing the physical stress reaction in the BJSQ [54], which was developed for use with working populations. Therefore, it is possible that physical symptoms frequently observed among working people were more likely to be

detected.

## Limitations

The findings are tempered by several methodological limitations. First, the response rate was not very high (31.0%), possibly causing a selection bias. For instance, if subjects with fewer psychological and physical symptoms or lower radiation anxiety, living in a municipality with low radiation levels, were less likely to participate in the study owing to their lack of interest in these problems, the associations observed between environmental radiation levels and these symptoms or radiation anxiety might have been underestimated. Second, participants who lived in municipalities with relatively higher radiation levels and had higher radiation anxiety might have been evacuated prior to the survey, and therefore, not included in this sample. This might have resulted in the underestimation of the association between the environmental radiation level and residents' radiation anxiety. Third, the study was cross-sectional, and a common method bias might have inflated the associations between the variables measured by self-rated scales in the same questionnaire, for example, radiation anxiety and psychological and physical symptoms. Fourth, the measurement of exposure to environmental radiation might not have been precise at the individual level. The average radiation levels were calculated using a municipality as a unit and might have differed from the specific radiation level at the location in which a given respondent lived. It is also possible



that respondents had moved to another municipality temporarily while retaining their registration as residents of the former municipality, and the questionnaire sent to their former address had been transferred to their current address. In this case, the respondent was treated as a resident of a former municipality. These measurement errors could have resulted in an underestimation of the association between radiation levels and radiation anxiety, and psychological and physical symptoms. Fifth, reverse causality might be present in this study. For instance, respondents with more severe psychological or physical symptoms might have had negative cognitions and perceptions of the adverse health effects of radiation, and thus, gave high ratings on the radiation anxiety scale. Sixth, in this study, a full set of factors possibly associated with radiation anxiety and psychological and physical symptoms was not investigated. For example, having a child has been reported to be associated with poor mental health after previous nuclear power plant accidents [1,2,8]. The evacuation experience and distrust of the central government or authorities have been reported to be related to perceptions of radiation-related risks to health [13,40]. However, I did not address these factors. In addition, ongoing efforts to provide education and disseminate information on radiation and health might have reduced radiation anxiety to some extent, and hence, weakened the association between radiation levels and radiation anxiety. Seventh, the radiation anxiety scale used in the present study has not been fully validated, and could be multidimensional, including different aspects of psychosocial problems related to radiation

exposure. Therefore, I repeated the analyses using the four items concerning adverse health effects instead of the total score of the scale, and almost the same results were obtained. Eighth, the 10 items used to measure physical symptoms in this study has not been validated, and these items were developed for assessing job stress, which might have been inadequate in effectively identifying the physical symptoms of the community residents. Ninth, in this study, the study population was randomly sampled with double weighting for the population under 40 years because the pilot survey suggested that mental health problems and radiation anxiety seemed prevalent especially among the younger population [55]. Therefore, the current results may represent the perspectives of the younger population rather than those of the residents actually living in the study area. Future research is needed to replicate the present findings using a prospective study design, accurate measurements of radiation levels from a monitoring post closer to each respondent's residence, and a multidimensional scale of radiation anxiety, considering a more comprehensive set of sociodemographic, disaster-related, and community-level variables, which are potentially associated with radiation anxiety and psychological and physical symptoms.

## Conclusions

In a questionnaire survey of a random sample of non-evacuee community residents of 49 municipalities of Fukushima prefecture five years after the nuclear power plant accident,

respondents' radiation anxiety was affected by environmental radiation levels, as well as by other factors, such as disaster-related experiences and sociodemographic characteristics. The finding that the current radiation level was more strongly associated with residents' radiation anxiety than the level measured soon after the accident suggests the possibility that the decrease in the current radiation level may contribute to the alleviation of residents' radiation anxiety. On the other hand, respondents' psychological and physical symptoms were not associated with radiation levels. However, they were associated with their radiation anxiety.

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Table 1. Socio-demographic, disaster-related, and social network characteristics of the total sample (n=1,521).

	n / mean	% / SD
Socio-demographic characteristics		
Sex		
Men	729	47.9
Women	792	52.1
Age, years		
20-39	747	49.1
40-64	508	33.4
65+	266	17.5
<i>Mean / SD</i>	<i>44.7</i>	<i>16.6</i>
Education attainment		
Junior high school	145	9.5
High school	756	49.7
Junior or technical college	361	23.7
University or graduate school	259	17.0
Level of household income adjusted by household size <sup>1)</sup>		
Low	590	38.8
Middle	712	46.8
High	219	14.4
Marital status		
Married	945	62.1
Separated, divorced, bereaved, unmarried or unknown	576	37.9
No. of family members in a household		
1 (oneself)	149	9.8
2	321	21.1
3	329	21.6
4	311	20.5
5	197	13.0
6 or more	214	14.1
<i>Mean / SD (range: 1-6)</i>	<i>3.5</i>	<i>1.5</i>
Living arrangement		
One's own house	1,233	81.1
Other <sup>2)</sup>	288	18.9
Working status		
Working (employed, self-employed or part-time)	1,140	75.0
Not working <sup>3)</sup>	381	25.1
Chronic disease		
Have a chronic disease under treatment	311	20.5
None	1210	79.6
Disaster-related experiences		
Direct damage <sup>4)</sup>	481	31.6
Disaster-related family stress <sup>5)</sup>	123	8.1
Fear or anxiety immediately after the NPP <sup>6)</sup> accident		
<i>Mean / SD (score range: 1-5)</i>	<i>3.8</i>	<i>1.1</i>
Social network		
Family and friend (LSNS-6 <sup>7)</sup> )		
<i>Mean / SD (score range: 0-30)</i>	<i>14.7</i>	<i>6.0</i>
Belong to some groups or organizations	1,073	70.6

SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6



Table 2. Relationships of socio-demographic, disaster-related, and social network characteristics with radiation anxiety (n=1,521).

	mean / r	SD	t / F	df	p
<b>Socio-demographic characteristics</b>					
Sex					
Men	14.7	4.6	-0.8	1519	0.400
Women	14.9	4.2			
Age, years					
20-39	14.8	4.5	10.2	2, 1518	<0.001
40-64	15.4	4.4			
65+	13.9	4.0			
Education attainment					
Junior high school	14.8	4.4	2.4	3, 1517	0.065
High school	15.0	4.5			
Junior or technical college	14.9	4.3			
University or graduate school	14.2	4.2			
Level of household income adjusted by household size <sup>1)</sup>					
Low	15.1	4.4	3.8	2, 1518	0.022
Middle	14.8	4.5			
High	14.1	4.1			
Marital status					
Married	15.2	4.4	-4.2	1519	<0.001
Separated, divorced, bereaved, unmarried or unknown	14.2	4.4			
No. of family members in a household					
1 (oneself)	13.9	4.3	1.8	5, 1515	0.111
2	14.7	4.2			
3	14.8	4.5			
4	15.0	4.2			
5	15.1	4.7			
6 or more	15.1	4.5			
<i>Pearson's r</i>	0.065				0.011
Living arrangement					
One's own house	14.8	4.4	0.0	1519	0.971
Other <sup>2)</sup>	14.8	4.3			
Work					
Working (employed, self-employed or part-time)	14.9	4.4	-1.2	1519	0.226
Not working <sup>3)</sup>	14.6	4.4			
Chronic disease					
Have a chronic disease under treatment	14.7	4.4	0.6	1519	0.582
None	14.8	4.4			
Disaster-related experiences					
Direct damage <sup>4)</sup>					
Experienced	16.4	4.5	-9.6	1519	<0.001
None	14.1	4.2			
Disaster-related family stress <sup>5)</sup>					
Experienced	17.8	4.3	-8.0	1519	<0.001
None	14.6	4.3			
Fear or anxiety immediately after the NPP <sup>6)</sup> accident					
<i>Pearson's r</i>	0.448				<0.001
Social network					
Family and friend (LSNS-6 <sup>7)</sup> )					
<i>Pearson's r</i>	-0.009				0.724
Belong to some groups or organizations					
Yes	14.9	4.4	-0.9	1519	0.354
No	14.7	4.5			

r, Pearson's correlation coefficient; SD, standard deviation; df, degree of freedom; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 3. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with psychological distress ( $K6 \geq 5$ ) ( $n=1,521$ ).

	Psychological distress				$\chi^2 / t$	df	p
	Low		High				
	n / mean	% / SD	n / mean	% / SD			
Socio-demographic characteristics							
Sex							
Men	541	50.2	188	42.4	7.6	1	0.006
Women	537	49.8	255	57.6			
Age, years							
20-39	506	46.9	241	54.4	14.5	2	0.001
40-64	359	33.3	149	33.6			
65+	213	19.8	53	12.0			
Education attainment							
Junior high school	107	9.9	38	8.6	1.7	3	0.646
High school	527	48.9	229	51.7			
Junior or technical college	255	23.7	106	23.9			
University or graduate school	189	17.5	70	15.8			
Level of household income adjusted by household size <sup>1)</sup>							
Low	404	37.5	186	42.0	2.9	1	0.239
Middle	513	47.6	199	44.9			
High	161	14.9	58	13.1			
Marital status							
Married	705	65.4	240	54.2	16.8	1	<0.001
Separated, divorced, bereaved, unmarried or unknown	373	34.6	203	45.8			
No. of family members in a household							
1 (oneself)	95	8.8	54	12.2	14.1	5	0.015
2	235	21.8	86	19.4			
3	222	20.6	107	24.2			
4	214	19.9	97	21.9			
5	143	13.3	54	12.2			
6 or more	169	15.7	45	10.2			
<i>Mean / SD (range: 1-6)</i>	<i>3.5</i>	<i>1.6</i>	<i>3.3</i>	<i>1.5</i>			
Living arrangement							
One's own house	900	83.5	333	75.2	14.2	1	<0.001
Other <sup>2)</sup>	178	16.5	110	24.8			
Working status							
Working (employed, self-employed or part-time)	811	75.2	329	74.3	0.2	1	0.693
Not working <sup>3)</sup>	267	24.8	114	25.7			
Chronic disease							
Have a chronic disease under treatment	222	20.6	89	20.1	0.0	1	0.825
None	856	79.4	354	79.9			
Disaster-related experiences (ref. none)							
Direct damage <sup>4)</sup>	292	27.1	189	42.7	35.2	1	<0.001
Disaster-related family stress <sup>5)</sup>	63	5.8	60	13.5			
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							
<i>Mean / SD (score range: 1-5)</i>	<i>3.7</i>	<i>1.1</i>	<i>3.9</i>	<i>1.1</i>	<i>-4.0</i>	<i>1,519</i>	<i>&lt;0.001</i>
Social network							
Family and friend (LSNS-6 <sup>7)</sup> )							
<i>Mean / SD (score range: 0-30)</i>	<i>15.7</i>	<i>5.8</i>	<i>12.2</i>	<i>5.7</i>	<i>10.5</i>	<i>1,519</i>	<i>&lt;0.001</i>
Belong to some groups or organizations (ref. no)	800	74.2	273	61.6	23.9	1	<0.001
Radiation anxiety							
<i>Mean / SD (score range: 7-28)</i>	<i>14.2</i>	<i>4.2</i>	<i>16.4</i>	<i>4.5</i>	<i>-9.3</i>	<i>1,519</i>	<i>&lt;0.001</i>
Radiation anxiety for adverse health effects							
<i>Mean / SD (score range: 4-16)</i>	<i>9.6</i>	<i>2.9</i>	<i>10.9</i>	<i>2.9</i>	<i>-8.2</i>	<i>1,519</i>	<i>&lt;0.001</i>

SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Table 4. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with posttraumatic stress symptoms (n=1,521).

	Posttraumatic stress symptoms				$\chi^2 / t$	df	p
	Low		High				
	n / mean	% / SD	n / mean	% / SD			
Socio-demographic characteristics							
Sex							
Men	703	48.1	26	43.3	0.5	1	0.467
Women	758	51.9	34	56.7			
Age, years							
20-39	715	48.9	32	53.3	0.5	2	0.777
40-64	489	33.5	19	31.7			
65+	257	17.6	9	15.0			
Education attainment							
Junior high school	137	9.4	8	13.3	7.7	3	0.053
High school	720	49.3	36	60.0			
Junior or technical college	348	23.8	13	21.7			
University or graduate school	256	17.5	3	5.0			
Level of household income adjusted by household size <sup>1)</sup>							
Low	567	38.8	23	38.3	0.5	1	0.793
Middle	682	46.7	30	50.0			
High	212	14.5	7	11.7			
Marital status							
Married	914	62.6	31	51.7	2.9	1	0.088
Separated, divorced, bereaved, unmarried or unknown	547	37.4	29	48.3			
No. of family members in a household							
1 (oneself)	136	9.3	13	21.7	13.2	5	0.021
2	306	20.9	15	25.0			
3	316	21.6	13	21.7			
4	301	20.6	10	16.7			
5	193	13.2	4	6.7			
6 or more	209	14.3	5	8.3			
<i>Mean / SD (range: 1-6)</i>	<i>3.5</i>	<i>1.5</i>	<i>2.9</i>	<i>1.5</i>	<i>3.2</i>	<i>1,519</i>	<i>0.002</i>
Living arrangement							
One's own house	1,190	81.5	43	71.7	3.6	1	0.058
Other <sup>2)</sup>	271	18.6	17	28.3			
Working status							
Working (employed, self-employed or part-time)	1,097	75.1	43	71.7	0.4	1	0.549
Not working <sup>3)</sup>	364	24.9	17	28.3			
Chronic disease							
Have a chronic disease under treatment	299	20.5	12	20.0	0.0	1	0.930
None	1162	79.5	48	80.0			
Disaster-related experiences (ref. none)							
Direct damage <sup>4)</sup>	443	30.3	38	63.3	29.0	1	<0.001
Disaster-related family stress <sup>5)</sup>	106	7.3	17	28.3	34.4	1	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							
<i>Mean / SD (score range: 1-5)</i>	<i>3.7</i>	<i>1.1</i>	<i>4.4</i>	<i>1.0</i>	<i>-4.5</i>	<i>1,519</i>	<i>&lt;0.001</i>
Social network							
Family and friend (LSNS-6 <sup>7)</sup> )							
<i>Mean / SD (score range: 0-30)</i>	<i>14.8</i>	<i>5.9</i>	<i>12.1</i>	<i>7.4</i>	<i>3.5</i>	<i>1,519</i>	<i>0.001</i>
Belong to some groups or organizations (ref. no)	1,140	71.2	33	55.0	7.3	1	0.007
Radiation anxiety							
<i>Mean / SD (score range: 7-28)</i>	<i>14.6</i>	<i>4.3</i>	<i>19.3</i>	<i>4.8</i>	<i>-8.1</i>	<i>1,519</i>	<i>&lt;0.001</i>
Radiation anxiety for adverse health effects							
<i>Mean / SD (score range: 4-16)</i>	<i>9.9</i>	<i>2.9</i>	<i>12.3</i>	<i>3.0</i>	<i>-6.3</i>	<i>1,519</i>	<i>&lt;0.001</i>

SD, standard deviation; df, degree of freedom; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 5. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with physical symptoms (the total score of the 10 items  $\geq 19$ ) (n=1,521).

	Physical symptoms				$\chi^2 / t$	df	p
	Low		High				
	n / mean	% / SD	n / mean	% / SD			
Socio-demographic characteristics							
Sex							
Men	570	51.6	159	38.1	22.1	1	<0.001
Women	534	48.4	258	61.9			
Age, years							
20-39	534	48.4	213	51.1	27.0	2	<0.001
40-64	344	31.2	164	39.3			
65+	226	20.5	40	9.6			
Education attainment							
Junior high school	109	9.9	34	8.6	2.6	3	0.462
High school	536	48.6	220	52.8			
Junior or technical college	264	23.9	97	23.3			
University or graduate school	195	17.7	64	15.4			
Level of household income adjusted by household size <sup>1)</sup>							
Low	437	39.6	153	36.7	2.6	1	0.275
Middle	503	45.6	209	50.1			
High	164	14.9	55	13.2			
Marital status							
Married	680	61.6	265	63.6	0.5	1	0.483
Separated, divorced, bereaved, unmarried or unknown	424	38.4	152	36.5			
No. of family members in a household							
1 (oneself)	104	9.4	45	10.8	5.6	5	0.351
2	228	20.7	93	22.3			
3	236	21.4	93	22.3			
4	220	19.9	91	21.8			
5	153	13.9	44	10.6			
6 or more	163	14.8	51	12.2			
<i>Mean / SD (range: 1-6)</i>	3.5	1.5	3.4	1.5	1.9	1,519	0.059
Living arrangement							
One's own house	922	83.5	311	74.6	15.7	1	<0.001
Other <sup>2)</sup>	182	16.5	106	25.4			
Working status							
Working (employed, self-employed or part-time)	808	73.2	332	79.6	6.7	1	0.010
Not working <sup>3)</sup>	296	26.8	85	20.4			
Chronic disease							
Have a chronic disease under treatment	225	20.4	86	20.6	0.0	1	0.916
None	879	79.6	331	79.4			
Disaster-related experiences (ref. none)							
Direct damage <sup>4)</sup>	322	29.2	159	38.1	11.2	1	0.001
Disaster-related family stress <sup>5)</sup>	60	5.4	63	15.1	38.1	1	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							
<i>Mean / SD (score range: 1-5)</i>	3.7	1.1	4.0	1.1	-4.7	1,519	<0.001
Social network							
Family and friend (LSNS-6 <sup>7)</sup> )							
<i>Mean / SD (score range: 0-30)</i>	15.0	5.9	13.7	6.1	4.0	1,519	<0.001
Belong to some groups or organizations (ref. no)	803	72.7	207	64.8	9.3	1	0.002
Radiation anxiety							
<i>Mean / SD (score range: 7-28)</i>	14.3	4.2	16.3	4.6	-8.1	1,519	<0.001
Radiation anxiety for adverse health effects							
<i>Mean / SD (score range: 4-16)</i>	9.6	2.9	10.9	2.9	-7.4	1,519	<0.001

SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Table 6A. The association between individual-level characteristics and regional radiation levels with radiation anxiety applying multilevel linear regression analysis. (n=1,521)

	Model 1		Model 2		Model 3			
	Coef.	SE	Coef.	SE	p	Coef.	SE	p
Intercept	14.85	0.21	12.82	0.53		4.78	0.77	
Compositional effect								
Sex (ref. men)						-0.41	0.20	0.046
Age (ref. 65+)								
20-39 years old						1.20	0.36	0.001
40-64 years old						1.24	0.33	<0.001
Education attainment (ref. University or graduate school)								
Junior high school						0.98	0.42	0.019
High school						0.70	0.28	0.011
Junior or technical college						0.62	0.31	0.048
Level of household income adjusted by household size (ref. High) <sup>1)</sup>								
Low						0.85	0.31	0.007
Middle						0.55	0.29	0.058
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)								
Married						0.61	0.22	0.007
No. of family members in a household						0.10	0.07	0.156
Living arrangement (ref. Other <sup>2)</sup> )								
One's own house						-0.04	0.26	0.867
Working status (ref. Not working <sup>3)</sup> )								
Working (employed, self-employed or part-time)						0.03	0.24	0.907
Chronic disease (ref. none)								
Effects by the Great East Japan Earthquake (ref. none)						0.11	0.27	0.684
Direct damage <sup>4)</sup>						1.09	0.22	<0.001
Disaster-related family stress <sup>5)</sup>						1.84	0.36	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident						1.57	0.09	<0.001
Social network								
Family and friend (LSNS-6 <sup>7)</sup> )						-0.02	0.02	0.163
Belong to some groups or organizations						0.04	0.23	0.846
Contextual effect								
Air dose rate of radiation at the time of the survey			20.16	4.99	<0.001	12.62	3.79	0.001
Random parameters								
Community level variance / Standard Error	1.60	0.44	1.05	0.33		0.46	0.18	
Within group variance / Standard Error	17.75	0.65	17.76	0.65		13.51	0.50	
Intra-class correlation: ICC	0.08		0.06			0.03		
Proportional changes in variance: PCV (compared to null model)			0.34			0.71		

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Table 6B. The association between individual-level characteristics and regional radiation levels with radiation anxiety applying multilevel linear regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B			Model 3A		Model 3B				
	Coef.	SE	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p			
Intercept	14.59	0.20	12.98	0.52		14.03	0.29		4.77	0.82		5.54	0.75	
Compositional effect														
Sex (ref. men)									-0.41	0.22	0.064	-0.41	0.22	0.064
Age (ref. 65+)														
20-39 years old									1.24	0.38	0.001	1.25	0.38	0.001
40-64 years old									1.03	0.34	0.002	1.03	0.34	0.002
Education attainment (ref. University or graduate school)														
Junior high school									0.87	0.45	0.051	0.84	0.45	0.059
High school									0.48	0.31	0.120	0.46	0.31	0.130
Junior or technical college									0.37	0.35	0.289	0.36	0.35	0.292
Level of household income adjusted by household size (ref. High) <sup>1)</sup>														
Low									1.08	0.33	0.001	1.08	0.33	0.001
Middle									0.62	0.31	0.045	0.62	0.31	0.047
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)														
Married									0.73	0.24	0.003	0.74	0.24	0.002
No. of family members in a household														
									0.09	0.07	0.237	0.08	0.07	0.255
Living arrangement (ref. Other <sup>2)</sup> )														
One's own house									-0.05	0.29	0.866	-0.04	0.29	0.881
Working status (ref. Not working <sup>3)</sup> )														
Working (employed, self-employed or part-time)									0.13	0.25	0.607	0.13	0.26	0.619
Chronic disease (ref. none)														
									0.16	0.29	0.583	0.16	0.29	0.586
Effects by the Great East Japan Earthquake (ref. none)														
Direct damage <sup>4)</sup>									1.26	0.24	<0.001	1.28	0.24	<0.001
Disaster-related family stress <sup>5)</sup>									1.87	0.53	<0.001	1.84	0.53	0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident														
									1.55	0.10	<0.001	1.55	0.10	<0.001
Social network														
Family and friend (LSNS-6 <sup>7)</sup> )									-0.01	0.02	0.498	-0.01	0.02	0.496
Belong to some groups or organizations									-0.01	0.25	0.983	-0.02	0.25	0.937
Contextual effect														
Air dose rate of radiation at the time of the survey			16.34	4.97	0.001				11.39	3.90	0.004			
Air dose rate of radiation soon after the Great East Japan Earthquake						1.04	0.42	0.013				0.69	0.33	0.036
Random parameters														
Community level variance / Standard Error	1.17	0.37	0.82	0.30		0.95	0.33		0.37	0.18		0.44	0.19	
Within group variance / Standard Error	17.08	0.69	17.09	0.69		17.09	0.69		13.03	0.53		13.03	0.53	
Intra-class correlation: ICC	0.06		0.05			0.05			0.03			0.03		
Proportional changes in variance: PCV (compared to null model)			0.30			0.19			0.68			0.62		

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Table 7A. The association between individual-level characteristics and regional radiation levels with psychological distress ( $K6 \geq 5$ ) applying multilevel logistic regression analysis. (n=1,521)

	Model 1		Model 2		Model 3		Model 4					
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI				
Intercept	0.40	0.35	0.47	0.23	0.15	0.34	0.38	0.15	0.95	0.22	0.09	0.57
Compositional effect												
Sex (ref. men)							1.35	1.05	1.75	1.44	1.11	1.88
Age (ref. 65+)												
20-39 years old							1.64	1.02	2.64	1.45	0.89	2.35
40-64 years old							1.45	0.94	2.24	1.28	0.82	1.99
Education attainment (ref. University or graduate school)												
Junior high school							1.22	0.71	2.08	1.10	0.63	1.90
High school							1.24	0.87	1.77	1.16	0.81	1.66
Junior or technical college							1.14	0.76	1.69	1.07	0.71	1.60
Level of household income adjusted by household size (ref. High) <sup>1)</sup>												
Low							0.99	0.66	1.47	0.89	0.59	1.33
Middle							1.02	0.70	1.49	0.95	0.65	1.38
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)												
Married							0.74	0.56	0.97	0.68	0.51	0.90
No. of family members in a household							0.99	0.91	1.08	0.98	0.89	1.07
Living arrangement (ref. Other <sup>2)</sup> )												
One's own house							0.71	0.52	0.97	0.71	0.52	0.98
Work (ref. Not working <sup>3)</sup> )												
Working (employed, self-employed or part-time)							0.97	0.72	1.31	0.97	0.71	1.31
Chronic disease (ref. none)							1.38	0.97	1.95	1.37	0.96	1.96
Effects by the Great East Japan Earthquake (ref. none)												
Direct damage <sup>4)</sup>							1.83	1.40	2.38	1.64	1.25	2.15
Disaster-related family stress <sup>5)</sup>							1.75	1.15	2.65	1.42	0.93	2.18
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							1.27	1.13	1.43	1.07	0.94	1.21
Social network												
Family and friend (LSNS-6 <sup>7)</sup> )							0.90	0.88	0.92	0.90	0.88	0.92
Belong to some groups or organizations							0.82	0.62	1.08	0.80	0.61	1.07
Radiation anxiety										1.12	1.08	1.16
Contextual effect												
Air dose rate of radiation at the time of the survey				313.31	6.60	14875.87	8.52	0.23	321.18	2.66	0.06	115.46
Random parameters												
Community level variance / Standard Error	0.15	0.06		0.10	0.05		0.03	0.04		0.04	0.05	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 7B. The association between individual-level characteristics and regional radiation levels with psychological distress ( $K6 \geq 5$ ) applying multilevel logistic regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B		Model 3A		Model 3B		Model 4A		Model 4B								
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI							
Intercept	0.40	0.34	0.48	0.23	0.14	0.38	0.32	0.25	0.42	0.43	0.15	1.20	0.50	0.19	1.30	0.25	0.09	0.73	0.28	0.10	0.75
Compositional effect																					
Sex (ref. men)										1.32	0.99	1.76	1.32	0.99	1.76	1.40	1.04	1.87	1.40	1.04	1.87
Age (ref. 65+)																					
20-39 years old										1.74	1.03	2.93	1.75	1.04	2.94	1.51	0.89	2.57	1.52	0.89	2.58
40-64 years old										1.27	0.79	2.03	1.27	0.79	2.03	1.13	0.70	1.83	1.13	0.70	1.83
Education attainment (ref. University or graduate school)																					
Junior high school										1.12	0.62	2.03	1.12	0.62	2.03	1.02	0.56	1.87	1.02	0.56	1.87
High school										1.15	0.77	1.72	1.15	0.77	1.72	1.09	0.72	1.64	1.09	0.72	1.64
Junior or technical college										1.04	0.67	1.64	1.05	0.67	1.64	1.01	0.64	1.59	1.01	0.64	1.59
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																					
Low										0.91	0.59	1.41	0.91	0.59	1.40	0.80	0.51	1.24	0.79	0.51	1.24
Middle										1.00	0.66	1.51	1.00	0.66	1.50	0.92	0.60	1.39	0.92	0.60	1.39
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																					
Married										0.80	0.58	1.09	0.80	0.58	1.09	0.73	0.53	1.01	0.73	0.53	1.01
No. of family members in a household										1.00	0.91	1.10	1.00	0.91	1.10	0.99	0.90	1.09	0.99	0.90	1.09
Living arrangement (ref. Other <sup>2)</sup> )																					
One's own house										0.70	0.49	1.00	0.70	0.49	1.00	0.70	0.49	1.02	0.71	0.49	1.02
Work (ref. Not working <sup>3)</sup> )																					
Working (employed, self-employed or part-time)										0.97	0.70	1.36	0.97	0.70	1.35	0.95	0.68	1.33	0.95	0.68	1.33
Chronic disease (ref. none)										1.30	0.88	1.93	1.31	0.88	1.93	1.29	0.87	1.93	1.29	0.87	1.93
Effects by the Great East Japan Earthquake (ref. none)																					
Direct damage <sup>4)</sup>										2.09	1.54	2.83	2.11	1.56	2.86	1.86	1.36	2.53	1.87	1.37	2.55
Disaster-related family stress <sup>5)</sup>										2.48	1.30	4.71	2.46	1.30	4.68	2.02	1.05	3.87	2.01	1.05	3.86
Fear or anxiety immediately after the NPP <sup>6)</sup> accident										1.30	1.14	1.48	1.30	1.14	1.48	1.10	0.95	1.26	1.10	0.95	1.26
Social network																					
Family and friend (LSNS-6 <sup>7)</sup> )										0.90	0.88	0.92	0.90	0.88	0.92	0.90	0.87	0.92	0.90	0.87	0.92
Belong to some groups or organizations										0.74	0.54	1.00	0.73	0.54	1.00	0.73	0.53	1.00	0.72	0.53	0.99
Radiation anxiety																1.12	1.08	1.16	1.12	1.08	1.16
Contextual effect																					
Air dose rate of radiation at the time of the survey				264.61	2.48	28221.46				8.42	0.11	627.79				3.18	0.04	273.47			
Air dose rate of radiation soon after the Great East Japan Earthquake							1.51	1.03	2.22				1.11	0.78	1.58				1.05	0.73	1.50
Random parameters																					
Community level variance / Standard Error	0.19	0.08		0.15	0.08		0.16	0.08		0.06	0.06		0.06	0.06		0.07	0.06		0.07	0.06	

OR, odds ratio; CI, confidence interval; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6



Table 8A. The association between individual-level characteristics and regional radiation levels with psychological distress (K6 ≥ 13) applying multilevel logistic regression analysis (n=1,521).

	Model 1		Model 2		Model 3		Model 4					
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI				
Intercept	0.05	0.03	0.06	0.02	0.01	0.05	0.01	0.00	0.13	0.01	0.00	0.10
Compositional effect												
Sex (ref. men)							1.85	1.05	3.28	1.89	1.07	3.35
Age (ref. 65+)												
20-39 years old							9.23	2.24	38.02	8.31	2.02	34.16
40-64 years old							6.11	1.58	23.63	5.47	1.41	21.28
Education attainment (ref. University or graduate school)												
Junior high school							3.27	1.21	8.88	3.12	1.14	8.56
High school							0.98	0.47	2.07	0.97	0.46	2.04
Junior or technical college							0.63	0.26	1.56	0.62	0.25	1.53
Level of household income adjusted by household size (ref. High) <sup>1)</sup>												
Low							1.09	0.42	2.82	1.01	0.39	2.62
Middle							1.43	0.58	3.57	1.36	0.55	3.40
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)												
Married							0.77	0.43	1.41	0.75	0.41	1.36
No. of family members in a household							0.99	0.81	1.21	0.99	0.81	1.21
Living arrangement (ref. Other <sup>2)</sup> )												
One's own house							0.81	0.43	1.49	0.83	0.45	1.55
Work (ref. Not working <sup>3)</sup> )												
Working (employed, self-employed or part-time)							0.79	0.44	1.44	0.78	0.43	1.42
Chronic disease (ref. none)							1.88	0.90	3.90	1.81	0.86	3.79
Effects by the Great East Japan Earthquake (ref. none)												
Direct damage <sup>4)</sup>							1.43	0.82	2.49	1.33	0.76	2.35
Disaster-related family stress <sup>5)</sup>							2.14	1.06	4.34	1.93	0.94	3.97
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							1.29	1.01	1.65	1.19	0.92	1.55
Social network												
Family and friend (LSNS-6 <sup>7)</sup> )							0.83	0.78	0.87	0.83	0.78	0.87
Belong to some groups or organizations							0.67	0.38	1.19	0.68	0.39	1.21
Radiation anxiety										1.06	0.99	1.13
Contextual effect												
Air dose rate of radiation at the time of the survey				526.65	0.94	294344.40	22.31	0.02	22789.26	15.52	0.01	17473.94
Random parameters												
Community level variance / Standard Error	0.13	0.18		0.04	0.16		0.00	0.00		0.00	0.00	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 8B. The association between individual-level characteristics and regional radiation levels with psychological distress ( $K6 \geq 13$ ) applying multilevel logistic regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B		Model 3A		Model 3B		Model 4A		Model 4B								
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI							
Intercept	0.04	0.03	0.06	0.02	0.01	0.05	0.03	0.02	0.05	0.02	0.00	0.22	0.02	0.00	0.26	0.01	0.00	0.15	0.02	0.00	0.17
Compositional effect																					
Sex (ref. men)										2.62	1.34	5.13	2.60	1.33	5.09	2.75	1.40	5.42	2.73	1.39	5.38
Age (ref. 65+)																					
20-39 years old										6.27	1.39	28.27	6.11	1.36	27.50	5.65	1.26	25.34	5.50	1.23	24.65
40-64 years old										5.14	1.26	21.04	5.06	1.24	20.66	4.74	1.16	19.47	4.67	1.14	19.14
Education attainment (ref. University or graduate school)																					
Junior high school										3.19	1.04	9.72	3.11	1.02	9.47	2.96	0.96	9.15	2.90	0.94	8.93
High school										0.76	0.31	1.89	0.76	0.31	1.87	0.73	0.29	1.82	0.73	0.29	1.80
Junior or technical college										0.55	0.19	1.57	0.54	0.19	1.56	0.52	0.18	1.51	0.52	0.18	1.51
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																					
Low										1.70	0.51	5.72	1.70	0.50	5.70	1.48	0.44	5.05	1.47	0.43	5.00
Middle										2.11	0.65	6.90	2.11	0.64	6.91	1.96	0.60	6.43	1.95	0.60	6.40
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																					
Married										1.00	0.50	2.01	1.00	0.50	2.01	0.95	0.47	1.91	0.95	0.47	1.91
No. of family members in a household																					
No. of family members in a household										0.90	0.71	1.14	0.90	0.71	1.14	0.90	0.71	1.14	0.90	0.71	1.14
Living arrangement (ref. Other <sup>2)</sup> )																					
One's own house										0.73	0.35	1.51	0.73	0.35	1.51	0.76	0.36	1.58	0.76	0.36	1.59
Work (ref. Not working <sup>3)</sup> )																					
Working (employed, self-employed or part-time)										0.71	0.37	1.39	0.72	0.37	1.39	0.66	0.34	1.29	0.66	0.34	1.30
Chronic disease (ref. none)																					
Chronic disease (ref. none)										1.45	0.61	3.43	1.44	0.61	3.40	1.36	0.57	3.27	1.35	0.56	3.24
Effects by the Great East Japan Earthquake (ref. none)																					
Direct damage <sup>4)</sup>										1.92	1.01	3.64	1.93	1.02	3.66	1.74	0.91	3.33	1.74	0.90	3.34
Disaster-related family stress <sup>5)</sup>										2.75	1.05	7.16	2.69	1.03	7.03	2.50	0.95	6.58	2.45	0.93	6.46
Fear or anxiety immediately after the NPP <sup>6)</sup> accident																					
Fear or anxiety immediately after the NPP <sup>6)</sup> accident										1.33	1.00	1.77	1.34	1.00	1.78	1.20	0.89	1.63	1.20	0.89	1.63
Social network																					
Family and friend (LSNS-6 <sup>7)</sup> )										0.82	0.77	0.87	0.82	0.77	0.87	0.82	0.77	0.87	0.82	0.77	0.87
Belong to some groups or organizations										0.44	0.22	0.86	0.43	0.22	0.84	0.44	0.22	0.87	0.43	0.22	0.86
Radiation anxiety																					
Radiation anxiety																1.08	1.00	1.16	1.08	1.00	1.16
Contextual effect																					
Air dose rate of radiation at the time of the survey			972.65	0.70	1357750.00					62.78	0.02	219230.00				44.94	0.01	185140.50			
Air dose rate of radiation soon after the Great East Japan Earthquake						1.87	1.06	3.29					1.35	0.71	2.56				1.33	0.70	2.54
Random parameters																					
Community level variance / Standard Error	0.09	0.22		0.04	0.22		0.03	0.22		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 9A. The association between individual-level characteristics and regional radiation levels with posttraumatic stress symptoms applying multilevel logistic regression analysis. (n=1,521)

	Model 1		Model 2		Model 3		Model 4					
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI				
Intercept	0.04	0.02	0.05	0.01	0.01	0.03	0.00	0.00	0.02	0.00	0.00	0.01
Compositional effect												
Sex (ref. men)							1.05	0.58	1.89	1.14	0.62	2.08
Age (ref. 65+)												
20-39 years old							1.14	0.39	3.31	0.80	0.27	2.36
40-64 years old							0.94	0.35	2.51	0.67	0.24	1.84
Education attainment (ref. University or graduate school)												
Junior high school							7.51	1.74	32.39	6.59	1.47	29.50
High school							5.13	1.49	17.70	4.53	1.29	15.93
Junior or technical college							3.89	1.03	14.76	3.62	0.93	14.03
Level of household income adjusted by household size (ref. High) <sup>1)</sup>												
Low							0.89	0.34	2.35	0.74	0.27	2.06
Middle							1.27	0.51	3.16	1.08	0.42	2.78
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)												
Married							0.73	0.39	1.37	0.62	0.32	1.19
No. of family members in a household							0.79	0.64	0.98	0.78	0.62	0.97
Living arrangement (ref. Other <sup>2)</sup> )												
One's own house							0.84	0.42	1.66	0.83	0.40	1.69
Work (ref. Not working <sup>3)</sup> )												
Working (employed, self-employed or part-time)							0.83	0.43	1.61	0.81	0.41	1.59
Chronic disease (ref. none)							0.94	0.43	2.09	0.85	0.37	1.93
Effects by the Great East Japan Earthquake (ref. none)												
Direct damage <sup>4)</sup>							2.83	1.59	5.05	2.18	1.20	3.99
Disaster-related family stress <sup>5)</sup>							3.48	1.78	6.78	2.51	1.25	5.05
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							1.95	1.41	2.68	1.48	1.06	2.08
Social network												
Family and friend (LSNS-6 <sup>7)</sup> )							0.94	0.89	0.99	0.94	0.89	0.99
Belong to some groups or organizations							0.59	0.32	1.09	0.62	0.33	1.17
Radiation anxiety										1.20	1.11	1.29
Contextual effect												
Air dose rate of radiation at the time of the survey				16045.22	10.09	25500000.00	35.32	0.02	57934.27	16.80	0.01	38318.32
Random parameters												
Community level variance / Standard Error	0.36	0.27		0.19	0.22		0.00	0.00		0.00	0.00	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low incudes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle incudes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high incudes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 9B. The association between individual-level characteristics and regional radiation levels with posttraumatic stress symptoms applying multilevel logistic regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B		Model 3A		Model 3B		Model 4A		Model 4B									
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI								
Intercept	0.03	0.02	0.05	0.01	0.00	0.04	0.02	0.01	0.04	0.01	0.00	0.09	0.01	0.00	0.11	0.00	0.00	0.04	0.00	0.00	0.05	
Compositional effect																						
Sex (ref. men)									1.44	0.70	2.94	1.45	0.71	2.97	1.48	0.72		3.05	1.49	0.72	3.08	
Age (ref. 65+)																						
20-39 years old									0.94	0.27	3.35	0.97	0.27	3.42	0.67	0.18		2.45	0.67	0.18	2.46	
40-64 years old									0.67	0.22	2.06	0.68	0.22	2.10	0.49	0.15		1.58	0.49	0.15	1.59	
Education attainment (ref. University or graduate school)																						
Junior high school									3.86	0.85	17.59	3.85	0.85	17.56	3.34	0.69		16.09	3.31	0.69	15.90	
High school									1.97	0.54	7.20	1.98	0.54	7.23	1.75	0.47		6.52	1.74	0.47	6.51	
Junior or technical college									2.48	0.63	9.76	2.46	0.63	9.69	2.51	0.62		10.12	2.50	0.62	10.08	
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																						
Low									0.77	0.24	2.44	0.75	0.24	2.40	0.55	0.16		1.83	0.54	0.16	1.79	
Middle									1.24	0.43	3.61	1.22	0.42	3.55	0.95	0.32		2.84	0.94	0.32	2.79	
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																						
Married									0.73	0.34	1.58	0.73	0.34	1.58	0.58	0.26		1.29	0.58	0.26	1.30	
No. of family members in a household									0.62	0.47	0.82	0.61	0.46	0.81	0.59	0.44		0.80	0.59	0.44	0.79	
Living arrangement (ref. Other <sup>2)</sup> )																						
One's own house									1.16	0.48	2.82	1.19	0.49	2.87	1.18	0.47		2.97	1.19	0.47	3.01	
Work (ref. Not working <sup>3)</sup> )																						
Working (employed, self-employed or part-time)									1.17	0.52	2.61	1.16	0.52	2.59	1.12	0.49		2.54	1.11	0.49	2.52	
Chronic disease (ref. none)																						
Effects by the Great East Japan Earthquake (ref. none)									1.10	0.42	2.85	1.10	0.43	2.85	1.07	0.40		2.85	1.07	0.40	2.84	
Direct damage <sup>4)</sup>									3.63	1.81	7.28	3.76	1.88	7.55	2.85	1.38		5.87	2.92	1.41	6.03	
Disaster-related family stress <sup>5)</sup>									8.81	3.65	21.24	8.73	3.62	21.05	6.96	2.80		17.31	6.90	2.78	17.15	
Fear or anxiety immediately after the NPP <sup>6)</sup> accident									1.83	1.28	2.63	1.83	1.28	2.63	1.40	0.95		2.05	1.40	0.95	2.05	
Social network																						
Family and friend (LSNS-6 <sup>7)</sup> )									0.93	0.88	0.99	0.93	0.88	0.99	0.93	0.88		0.99	0.93	0.88	0.99	
Belong to some groups or organizations									0.52	0.25	1.09	0.52	0.25	1.08	0.51	0.24		1.10	0.51	0.24	1.09	
Radiation anxiety																						
Radiation anxiety															1.20	1.10		1.30	1.20	1.10	1.30	
Contextual effect																						
Air dose rate of radiation at the time of the survey				16066.37	2.24	115000000.00				45.15	0.00	517955.70					15.86	0.00	268637.40			
Air dose rate of radiation soon after the Great East Japan Earthquake								2.05	1.01	4.15			1.14	0.55	2.35					1.11	0.52	2.34
Random parameters																						
Community level variance / Standard Error	0.33	0.34		0.22	0.29		0.23	0.29		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 10A. The association between individual-level characteristics and regional radiation levels with physical symptoms (the total score of the 10 items  $\geq 19$ ) applying multilevel logistic regression analysis. (n=1,521)

	Model 1		Model 2		Model 3		Model 4						
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI					
Intercept	0.38	0.33	0.43	0.23	0.16	0.33	0.06	0.02	0.15	0.04	0.01	0.10	
Compositional effect													
Sex (ref. men)							1.82	1.41	2.35	1.91	1.47	2.48	
Age (ref. 65+)													
20-39 years old							2.37	1.44	3.89	2.13	1.29	3.51	
40-64 years old							2.61	1.66	4.10	2.37	1.50	3.74	
Education attainment (ref. University or graduate school)													
Junior high school							1.52	0.89	2.61	1.40	0.81	2.42	
High school							1.23	0.86	1.75	1.16	0.81	1.65	
Junior or technical college							0.92	0.62	1.37	0.88	0.59	1.31	
Level of household income adjusted by household size (ref. High) <sup>1)</sup>													
Low							1.05	0.71	1.57	0.98	0.65	1.47	
Middle							1.33	0.92	1.93	1.27	0.88	1.85	
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)													
Married							1.23	0.93	1.62	1.17	0.89	1.56	
No. of family members in a household													
Living arrangement (ref. Other <sup>2)</sup> )							0.94	0.86	1.03	0.93	0.86	1.02	
One's own house							0.66	0.49	0.91	0.66	0.48	0.90	
Work (ref. Not working <sup>3)</sup> )													
Working (employed, self-employed or part-time)							1.52	1.12	2.06	1.53	1.12	2.08	
Chronic disease (ref. none)													
Effects by the Great East Japan Earthquake (ref. none)							1.58	1.12	2.23	1.56	1.10	2.21	
Direct damage <sup>4)</sup>							1.25	0.96	1.63	1.14	0.87	1.49	
Disaster-related family stress <sup>5)</sup>							2.41	1.62	3.60	2.09	1.39	3.14	
Fear or anxiety immediately after the NPP <sup>6)</sup> accident													
Social network													
Family and friend (LSNS-6 <sup>7)</sup> )							0.96	0.94	0.99	0.97	0.95	0.99	
Belong to some groups or organizations							0.77	0.58	1.01	0.76	0.57	1.01	
Radiation anxiety													
1.08										1.08	1.05	1.12	
Contextual effect													
Air dose rate of radiation at the time of the survey				115.69	4.62	2895.20	10.69	0.39	293.41	4.56	0.16	131.51	
Random parameters													
Community level variance / Standard Error	0.06	0.04		0.02	0.04		0.00	0.00		0.00	0.00		

OR, odds ratio; CI, confidence interval; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Table 10B. The association between individual-level characteristics and regional radiation levels with physical symptoms (the total score of the 10 items  $\geq 19$ ) applying multilevel logistic regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B		Model 3A		Model 3B		Model 4A		Model 4B								
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI							
Intercept	0.34	0.30	0.40	0.23	0.16	0.34	0.28	0.23	0.35	0.05	0.02	0.15	0.06	0.02	0.16	0.04	0.01	0.12	0.04	0.02	0.12
Compositional effect																					
Sex (ref. men)									1.95	1.46	2.60	1.95	1.46	2.60	2.00	1.50	2.68	2.00	1.50	2.68	
Age (ref. 65+)																					
20-39 years old									2.52	1.44	4.41	2.50	1.43	4.38	2.34	1.34	4.10	2.32	1.32	4.07	
40-64 years old									2.62	1.59	4.31	2.62	1.59	4.32	2.48	1.50	4.09	2.48	1.50	4.09	
Education attainment (ref. University or graduate school)																					
Junior high school									1.25	0.68	2.29	1.24	0.68	2.27	1.19	0.65	2.19	1.18	0.64	2.18	
High school									1.12	0.75	1.69	1.12	0.74	1.68	1.09	0.72	1.64	1.08	0.72	1.64	
Junior or technical college									0.85	0.54	1.34	0.85	0.54	1.34	0.83	0.53	1.32	0.83	0.53	1.32	
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																					
Low									1.07	0.68	1.68	1.07	0.68	1.68	1.00	0.64	1.58	1.01	0.64	1.59	
Middle									1.43	0.95	2.18	1.43	0.94	2.17	1.38	0.91	2.10	1.38	0.91	2.10	
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																					
Married									1.31	0.95	1.80	1.32	0.96	1.81	1.27	0.92	1.74	1.27	0.92	1.75	
No. of family members in a household									0.93	0.84	1.03	0.93	0.84	1.03	0.93	0.84	1.02	0.93	0.84	1.02	
Living arrangement (ref. Other <sup>2)</sup> )																					
One's own house									0.69	0.48	0.98	0.69	0.48	0.98	0.69	0.48	0.98	0.69	0.48	0.98	
Work (ref. Not working <sup>3)</sup> )																					
Working (employed, self-employed or part-time)									1.52	1.07	2.14	1.51	1.07	2.14	1.51	1.07	2.13	1.51	1.07	2.13	
Chronic disease (ref. none)									1.70	1.16	2.51	1.71	1.16	2.52	1.68	1.14	2.48	1.68	1.14	2.48	
Effects by the Great East Japan Earthquake (ref. none)																					
Direct damage <sup>4)</sup>									1.22	0.90	1.65	1.20	0.89	1.63	1.13	0.83	1.54	1.11	0.81	1.52	
Disaster-related family stress <sup>5)</sup>									3.97	2.13	7.41	3.97	2.13	7.41	3.60	1.92	6.77	3.60	1.91	6.78	
Fear or anxiety immediately after the NPP <sup>6)</sup> accident									1.25	1.10	1.42	1.25	1.10	1.43	1.15	1.00	1.32	1.15	1.00	1.33	
Social network																					
Family and friend (LSNS-6 <sup>7)</sup> )									0.96	0.94	0.99	0.96	0.94	0.99	0.96	0.94	0.99	0.96	0.94	0.99	
Belong to some groups or organizations									0.67	0.49	0.92	0.67	0.49	0.92	0.67	0.48	0.91	0.66	0.48	0.91	
Radiation anxiety															1.06	1.02	1.10	1.06	1.02	1.10	
Contextual effect																					
Air dose rate of radiation at the time of the survey				63.33	1.55	2591.92				13.77	0.30	642.29				8.13	0.17	391.85			
Air dose rate of radiation soon after the Great East Japan Earthquake							1.47	1.10	1.98				1.32	0.97	1.80				1.28	0.93	1.75
Random parameters																					
Community level variance / Standard Error	0.04	0.05		0.02	0.05		0.02	0.05		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income  $<2.5$  if headcount in a household was three or less and  $<5.0$  if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income  $>5.0$  if headcount in a household was one or two,  $>7.5$  if three, and  $>10.0$  if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 11A. The association between individual-level characteristics and regional radiation levels with physical symptoms (the total score of the 10 items  $\geq 23$ ) applying multilevel logistic regression analysis (n=1,521).

	Model 1		Model 2		Model 3		Model 4					
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI				
Intercept	0.11	0.09	0.13	0.10	0.06	0.16	0.03	0.01	0.13	0.02	0.01	0.09
Compositional effect												
Sex (ref. men)							2.15	1.46	3.17	2.24	1.52	3.32
Age (ref. 65+)												
20-39 years old							1.69	0.83	3.45	1.47	0.72	3.01
40-64 years old							2.21	1.16	4.23	1.94	1.01	3.74
Education attainment (ref. University or graduate school)												
Junior high school							3.73	1.79	7.79	3.39	1.61	7.13
High school							1.34	0.76	2.34	1.25	0.71	2.21
Junior or technical college							1.01	0.54	1.89	0.96	0.51	1.80
Level of household income adjusted by household size (ref. High) <sup>1)</sup>												
Low							1.05	0.57	1.92	0.96	0.52	1.78
Middle							1.32	0.74	2.33	1.25	0.70	2.23
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)												
Married							1.15	0.76	1.73	1.10	0.73	1.66
No. of family members in a household							1.03	0.90	1.17	1.02	0.90	1.16
Living arrangement (ref. Other <sup>2)</sup> )												
One's own house							0.66	0.43	1.03	0.66	0.42	1.03
Work (ref. Not working <sup>3)</sup> )												
Working (employed, self-employed or part-time)							1.28	0.83	1.99	1.27	0.82	1.97
Chronic disease (ref. none)							1.79	1.12	2.85	1.77	1.10	2.83
Effects by the Great East Japan Earthquake (ref. none)												
Direct damage <sup>4)</sup>							1.30	0.89	1.90	1.16	0.78	1.71
Disaster-related family stress <sup>5)</sup>							2.80	1.70	4.60	2.34	1.40	3.89
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							1.20	1.02	1.43	1.05	0.88	1.27
Social network												
Family and friend (LSNS-6 <sup>7)</sup> )							0.95	0.92	0.98	0.95	0.92	0.98
Belong to some groups or organizations							0.46	0.31	0.69	0.46	0.31	0.68
Radiation anxiety										1.09	1.04	1.14
Contextual effect												
Air dose rate of radiation at the time of the survey				4.66	0.04	582.34	0.28	0.00	41.31	0.13	0.00	21.18
Random parameters												
Community level variance / Standard Error	0.06	0.08		0.05	0.08		0.01	0.08		0.01	0.08	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 11B. The association between individual-level characteristics and regional radiation levels with physical symptoms (the total score of the 10 items  $\geq 23$ ) applying multilevel logistic regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B			Model 3A		Model 3B		Model 4A		Model 4B							
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI					
Intercept	0.10	0.08	0.12	0.08	0.04	0.14	0.09	0.06	0.12	0.02	0.00	0.10	0.02	0.00	0.09	0.01	0.00	0.07	0.01	0.00	0.06
Compositional effect																					
Sex (ref. men)									2.35	1.49	3.70	2.35	1.49	3.70	2.45	1.55	3.88	2.45	1.55	3.87	
Age (ref. 65+)																					
20-39 years old									1.77	0.77	4.05	1.76	0.77	4.04	1.58	0.68	3.65	1.57	0.68	3.64	
40-64 years old									2.25	1.08	4.66	2.24	1.08	4.66	2.06	0.99	4.32	2.07	0.99	4.32	
Education attainment (ref. University or graduate school)																					
Junior high school									4.53	1.84	11.18	4.53	1.83	11.17	4.28	1.72	10.62	4.28	1.73	10.63	
High school									1.72	0.82	3.61	1.72	0.82	3.60	1.65	0.79	3.47	1.65	0.79	3.47	
Junior or technical college									1.27	0.57	2.84	1.27	0.57	2.84	1.25	0.56	2.81	1.26	0.56	2.82	
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																					
Low									1.10	0.53	2.28	1.10	0.53	2.28	0.99	0.47	2.06	0.99	0.48	2.07	
Middle									1.42	0.71	2.82	1.42	0.71	2.82	1.33	0.67	2.66	1.34	0.67	2.67	
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																					
Married									1.06	0.66	1.71	1.06	0.66	1.71	1.00	0.62	1.62	1.00	0.62	1.62	
No. of family members in a household									0.97	0.84	1.13	0.97	0.84	1.13	0.97	0.83	1.12	0.97	0.83	1.12	
Living arrangement (ref. Other <sup>2)</sup> )																					
One's own house									0.58	0.34	0.98	0.58	0.34	0.97	0.58	0.34	0.98	0.58	0.34	0.98	
Work (ref. Not working <sup>3)</sup> )																					
Working (employed, self-employed or part-time)									1.40	0.84	2.33	1.40	0.84	2.33	1.36	0.82	2.26	1.36	0.81	2.26	
Chronic disease (ref. none)									2.46	1.43	4.21	2.45	1.43	4.21	2.43	1.41	4.19	2.42	1.40	4.18	
Effects by the Great East Japan Earthquake (ref. none)																					
Direct damage <sup>4)</sup>									1.43	0.91	2.23	1.42	0.91	2.22	1.26	0.80	2.00	1.25	0.79	1.98	
Disaster-related family stress <sup>5)</sup>									3.67	1.79	7.53	3.66	1.78	7.52	3.20	1.54	6.63	3.20	1.55	6.64	
Fear or anxiety immediately after the NPP <sup>6)</sup> accident									1.30	1.07	1.59	1.30	1.07	1.59	1.17	0.95	1.44	1.17	0.95	1.44	
Social network																					
Family and friend (LSNS-6 <sup>7)</sup> )									0.95	0.91	0.98	0.95	0.91	0.98	0.95	0.91	0.98	0.95	0.91	0.98	
Belong to some groups or organizations									0.35	0.22	0.57	0.35	0.22	0.57	0.35	0.22	0.56	0.35	0.22	0.56	
Radiation anxiety															1.08	1.03	1.14	1.08	1.03	1.14	
Contextual effect																					
Air dose rate of radiation at the time of the survey				16.61	0.05	5146.13				1.14	0.00	449.44				0.64	0.00	284.64			
Air dose rate of radiation soon after the Great East Japan Earthquake							1.32	0.83	2.09				1.05	0.65	1.70				1.02	0.62	1.66
Random parameters																					
Community level variance / Standard Error	0.08	0.11		0.08	0.11		0.08	0.11		0.03	0.11		0.03	0.12		0.03	0.12		0.03	0.12	

OR, odds ratio; CI, confidence interval; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6



Table 12A. The association between individual-level characteristics and regional radiation levels with physical symptoms (continuous variable) applying multilevel linear regression analysis (n=1,521).

	Model 1		Model 2		Model 3			Model 4			
	Coef.	SE	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Intercept	16.02	0.15	12.10	3.62		12.44	0.86		11.61	0.86	
Compositional effect											
Sex (ref. men)						1.59	0.25	<0.001	1.67	0.24	<0.001
Age (ref. 65+)											
20-39 years old						1.43	0.43	0.001	1.18	0.43	0.006
40-64 years old						1.54	0.39	<0.001	1.30	0.39	0.001
Education attainment (ref. University or graduate school)											
Junior high school						1.13	0.50	0.024	0.94	0.50	0.058
High school						0.40	0.33	0.235	0.26	0.33	0.425
Junior or technical college						0.17	0.38	0.660	0.06	0.37	0.882
Level of household income adjusted by household size (ref. High) <sup>1)</sup>											
Low						-0.22	0.37	0.549	-0.37	0.37	0.313
Middle						0.31	0.35	0.368	0.21	0.35	0.537
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)											
Married						0.58	0.27	0.032	0.47	0.27	0.081
No. of family members in a household						-0.09	0.08	0.266	-0.11	0.08	0.173
Living arrangement (ref. Other <sup>2)</sup> )											
One's own house						-1.01	0.31	0.001	-1.01	0.31	0.001
Working status (ref. Not working <sup>3)</sup> )											
Working (employed, self-employed or part-time)						0.96	0.29	0.001	0.96	0.28	0.001
Chronic disease (ref. none)						1.00	0.33	0.003	0.96	0.33	0.003
Effects by the Great East Japan Earthquake (ref. none)											
Direct damage <sup>4)</sup>						0.78	0.26	0.003	0.56	0.26	0.031
Disaster-related family stress <sup>5)</sup>						2.22	0.43	<0.001	1.86	0.43	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident						0.59	0.11	<0.001	0.30	0.12	0.011
Social network											
Family and friend (LSNS-6 <sup>7)</sup> )						-0.11	0.02	<0.001	-0.11	0.02	<0.001
Belong to some groups or organizations						-0.67	0.28	0.015	-0.68	0.27	0.013
Radiation anxiety									0.18	0.03	<0.001
Contextual effect											
Air dose rate of radiation at the time of the survey			12.10	3.62	0.001	4.66	3.27	0.154	2.31	3.25	0.477
Random parameters											
Community level variance / Standard Error	0.33	0.22	0.11	0.18		0.00	0.00		0.00	0.00	

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Table 12B. The association between individual-level characteristics and regional radiation levels with physical symptoms (continuous variable) applying multilevel linear regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B			Model 3A			Model 3B			Model 4A			Model 4B			
	Coef.	SE	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Intercept	15.80	0.15	14.81	0.41		15.36	0.22		12.53	0.93		12.79	0.88		11.92	0.93		12.08	0.89	
Compositional effect																				
Sex (ref. men)									1.64	0.26	<0.001	1.64	0.26	<0.001	1.70	0.26	<0.001	1.70	0.26	<0.001
Age (ref. 65+)																				
20-39 years old									1.56	0.46	0.001	1.55	0.46	0.001	1.37	0.46	0.003	1.37	0.46	0.003
40-64 years old									1.54	0.41	<0.001	1.54	0.41	<0.001	1.39	0.41	0.001	1.39	0.41	0.001
Education attainment (ref. University or graduate school)																				
Junior high school									0.81	0.53	0.126	0.80	0.53	0.132	0.68	0.53	0.197	0.68	0.53	0.203
High school									0.22	0.37	0.549	0.21	0.37	0.561	0.15	0.37	0.681	0.15	0.37	0.691
Junior or technical college									0.08	0.41	0.848	0.08	0.41	0.847	0.03	0.41	0.940	0.03	0.41	0.939
Level of household income adjusted by household size (ref. High) <sup>1)</sup>																				
Low									-0.05	0.40	0.893	-0.05	0.40	0.891	-0.19	0.40	0.629	-0.19	0.40	0.628
Middle									0.47	0.37	0.203	0.47	0.37	0.208	0.39	0.37	0.289	0.39	0.37	0.294
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)																				
Married									0.61	0.29	0.036	0.62	0.29	0.034	0.51	0.29	0.076	0.52	0.29	0.073
No. of family members in a household									-0.15	0.09	0.093	-0.15	0.09	0.091	-0.16	0.09	0.066	-0.16	0.09	0.065
Living arrangement (ref. Other <sup>2)</sup> )																				
One's own house									-0.99	0.35	0.004	-0.99	0.35	0.004	-0.98	0.34	0.004	-0.98	0.34	0.004
Working status (ref. Not working <sup>3)</sup> )																				
Working (employed, self-employed or part-time)									0.86	0.31	0.005	0.85	0.31	0.005	0.85	0.30	0.006	0.84	0.30	0.006
Chronic disease (ref. none)									1.17	0.35	0.001	1.17	0.35	0.001	1.13	0.35	0.001	1.14	0.35	0.001
Effects by the Great East Japan Earthquake (ref. none)																				
Direct damage <sup>4)</sup>									0.84	0.29	0.003	0.84	0.29	0.003	0.67	0.29	0.021	0.66	0.29	0.022
Disaster-related family stress <sup>5)</sup>									3.19	0.64	<0.001	3.18	0.64	<0.001	2.92	0.64	<0.001	2.92	0.64	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident									0.58	0.11	<0.001	0.59	0.11	<0.001	0.37	0.13	0.003	0.37	0.13	0.003
Social network																				
Family and friend (LSNS-6 <sup>7)</sup> )									-0.11	0.02	<0.001	-0.11	0.02	<0.001	-0.11	0.02	<0.001	-0.11	0.02	<0.001
Belong to some groups or organizations									-0.84	0.30	0.005	-0.84	0.30	0.005	-0.84	0.30	0.005	-0.84	0.30	0.005
Radiation anxiety															0.13	0.03	<0.001	0.13	0.03	<0.001
Contextual effect																				
Air dose rate of radiation at the time of the survey			10.18	4.02	0.011				4.81	3.60	0.182				3.24	3.60	0.368			
Air dose rate of radiation soon after the Great East Japan Earthquake						0.82	0.33	0.012				0.40	0.29	0.175				0.30	0.29	0.303
Random parameters																				
Community level variance / Standard Error	0.25	0.24	0.11	0.21		0.12	0.21		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

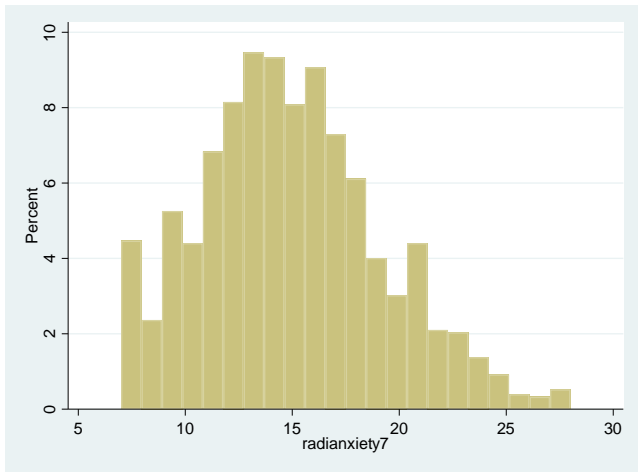
6) nuclear power plant

7) Lubben Social Network Scale -6

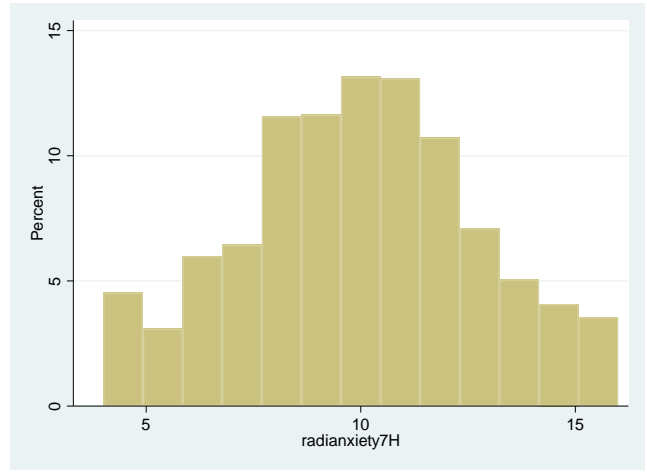
Appendix 1. Average air dose rate of radiation in each municipality used in this study.  
(N=49)

Municipality	Average air dose rate after the earthquake ( $\mu\text{Sv/h}$ )	Average air dose rate at the time of the survey ( $\mu\text{Sv/h}$ )
Fukushima-city	1.2038	0.1446
Aizuwakamatsu-city	0.2380	0.0834
Koriyama-city	0.8245	0.1560
Iwaki-city	0.5122	0.0926
Shirakawa-city	0.7460	0.1266
Sukagawa-city	0.9772	0.1293
Kitakata-city	0.2092	0.0772
Soma-city	0.9952	0.1230
Nihonmatsu-city	1.4969	0.1931
Tamura-city	0.6561	0.1232
Minamisoma-city	2.0280	0.1908
Date-city	1.4870	0.1690
Motomiya-city	1.6750	0.1413
Kori-town	1.4100	0.1423
Kunimi-town	1.2525	0.1240
Otama-village	0.9650	0.1764
Kagamiishi-town	0.4738	0.1095
Ten-ei-village	0.7808	0.1070
Shimogou-town	0.0986	0.0457
Hinoemata-village	0.1025	0.0523
Tadami-town	0.0972	0.0642
Minamiaizu-town	0.1090	0.0546
Kitashiobara-village	0.2947	0.0855
Nishiaizu-town	0.1197	0.0582
Bandai-town	0.3414	0.0707
Inawashiro-town	0.2431	0.0679
Aizubange-town	0.2778	0.0883
Yugawa-village	0.5200	0.0803
Yanaizu-town	0.2225	0.0720
Mishima-town	0.2170	0.0688
Kaneyama-town	0.1342	0.0636
Showa-village	0.1625	0.0607
Aizumisato-town	0.2621	0.0746
Nishigo-village	0.8931	0.1219
Izumizaki-village	0.5545	0.1088
Nakajima-village	0.2700	0.0884
Yabuki-town	0.3615	0.1013
Tanagura-town	0.5100	0.1045
Yamatsuri-town	0.1700	0.0687
Hanawa-town	0.2567	0.0828
Samegawa-village	0.3216	0.0812
Ishikawa-town	0.2644	0.0790
Tamagawa-village	0.3157	0.0903
Hirata-village	0.3047	0.0791
Asakawa-town	0.3033	0.0750
Furudono-town	0.3029	0.0817
Miharu-town	0.7822	0.1448
Ono-town	0.3024	0.0832
Shinchi-town	0.4757	0.1090

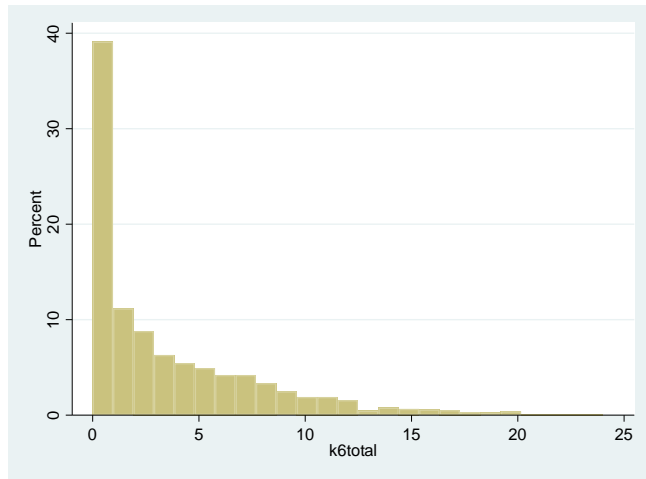
Appendix 2. Distributions of the scores of outcomes.



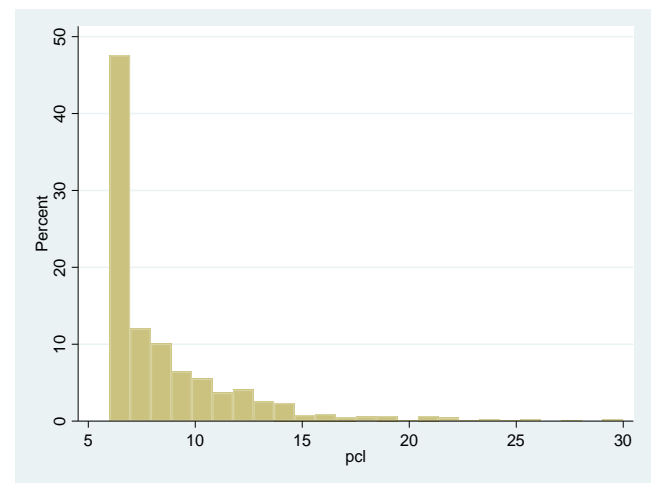
Radiation Anxiety Scale



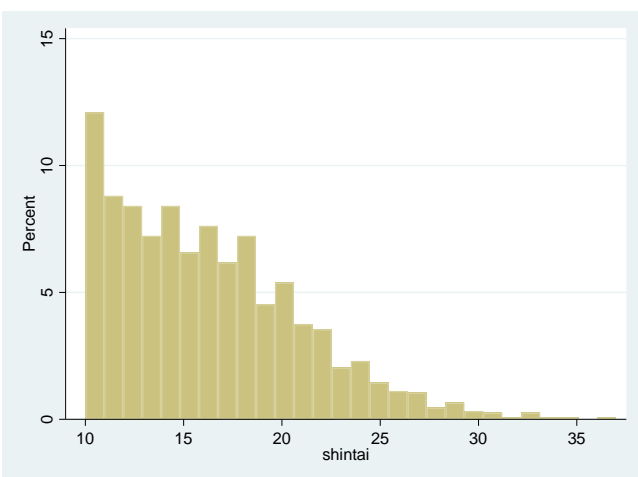
Adverse health effects subscale of the Radiation Anxiety Scale



K6



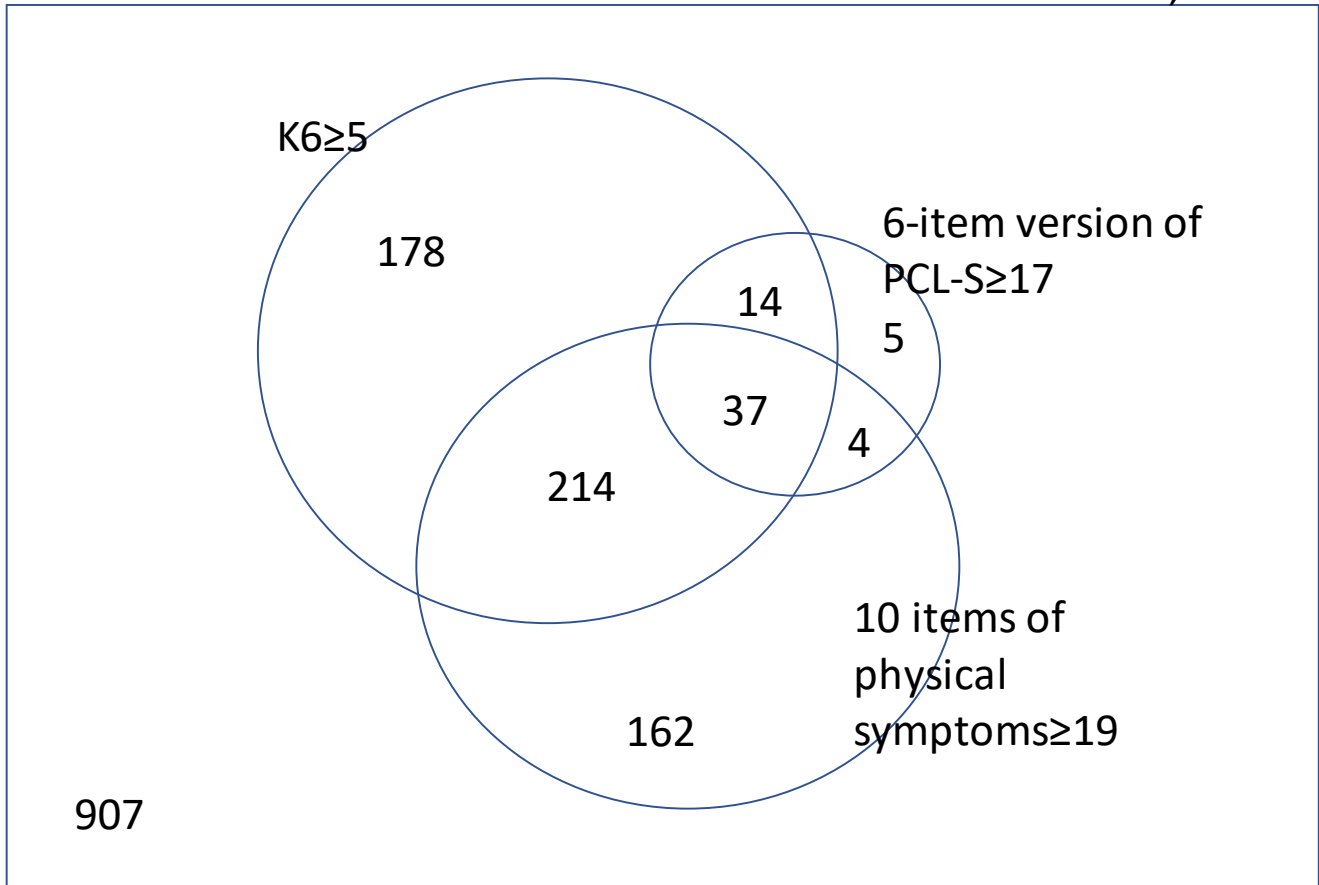
Six-item abbreviated version of the Posttraumatic Stress Disorder Checklist-Specific version (PCL-S)



The total score of the 10 items of the Physical Stress Reaction subscale of the Brief Job Stress Questionnaire (BJSQ)

Appendix 3. Overlapping of psychological distress, posttraumatic stress symptoms and physical symptoms in this study

N=1,521



Appendix 4. Relationships of socio-demographic, disaster-related, and social network characteristics with radiation anxiety for adverse health effects (n=1,521).

	mean / r	SD	t / F	df	p
Socio-demographic characteristics					
Sex					
Men	9.9	3.1	-1.5	1519	0.140
Women	10.1	2.9			
Age, years					
20-39	9.9	3.1	7.2	2, 1518	<0.001
40-64	10.3	2.9			
65+	9.5	2.8			
Education attainment					
Junior high school	10.1	2.9	5.0	3, 1517	0.002
High school	10.1	3.0			
Junior or technical college	10.1	2.9			
University or graduate school	9.3	3.0			
Level of household income adjusted by household size <sup>1)</sup>					
Low	10.2	3.0	6.2	2, 1518	0.002
Middle	9.9	3.0			
High	9.4	2.9			
Marital status					
Married	10.2	2.9	-4.6	1519	<0.001
Separated, divorced, bereaved, unmarried or unknown	9.5	3.0			
No. of family members in a household					
1 (oneself)	9.4	3.0	1.5	5, 1515	0.181
2	9.9	2.9			
3	10.0	3.1			
4	10.0	2.8			
5	10.1	3.0			
6 or more	10.2	3.0			
<i>Pearson's r</i>	0.058				0.024
Living arrangement					
One's own house	10.0	3.0	-0.2	1519	0.869
Other <sup>2)</sup>	9.9	2.8			
Work					
Working (employed, self-employed or part-time)	10.0	3.0	-0.7	1519	0.489
Not working <sup>3)</sup>	9.9	3.0			
Chronic disease					
Have a chronic disease under treatment	9.9	3.0	0.3	1519	0.768
None	10.0	3.0			
Disaster-related experiences					
Direct damage <sup>4)</sup>					
Experienced	10.8	2.9	-7.9	1519	<0.001
None	9.6	2.9			
Disaster-related family stress <sup>5)</sup>					
Experienced	11.4	2.6	-5.6	1519	<0.001
None	9.8	3.0			
Fear or anxiety immediately after the NPP <sup>6)</sup> accident					
<i>Pearson's r</i>	0.473				<0.001
Social network					
Family and friend (LSNS-6 <sup>7)</sup> )					
<i>Pearson's r</i>	0.007				0.799
Belong to some groups or organizations					
Yes	10.0	2.9	-0.9	1519	0.387
No	9.9	3.0			

r, Pearson's correlation coefficient; SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Appendix 5. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with psychological distress ( $K6 \geq 13$ ) ( $n=1,521$ ).

	Psychological distress				$\chi^2 / t$	df	p
	Low		High				
	n / mean	% / SD	n / mean	% / SD			
Socio-demographic characteristics							
Sex							
Men	701	48.3	28	40.6	1.6	1	0.211
Women	751	51.7	41	59.4			
Age, years							
20-39	703	48.4	44	63.8	10.3	2	0.006
40-64	486	33.5	22	31.9			
65+	263	18.1	3	4.4			
Education attainment							
Junior high school	134	9.2	11	15.9	5.0	3	0.173
High school	721	49.7	35	50.7			
Junior or technical college	350	24.1	11	15.9			
University or graduate school	247	17.0	12	17.4			
Level of household income adjusted by household size <sup>1)</sup>							
Low	561	38.6	29	42.0	1.1	1	0.571
Middle	679	46.8	33	47.8			
High	212	14.6	7	10.1			
Marital status							
Married	915	63.0	30	43.5	10.7	1	<0.001
Separated, divorced, bereaved, unmarried or unknown	537	37.0	39	56.5			
No. of family members in a household							
1 (oneself)	135	9.3	14	20.3	11.5	5	0.042
2	310	21.4	11	15.9			
3	314	21.6	15	21.7			
4	296	20.4	15	21.7			
5	188	13.0	9	13.0			
6 or more	209	14.4	5	7.3			
<i>Mean / SD (range: 1-6)</i>	<i>3.5</i>	<i>1.5</i>	<i>3.1</i>	<i>1.5</i>	<i>1.9</i>	1,519	0.054
Living arrangement							
One's own house	1,185	81.6	48	69.6	6.2	1	0.013
Other <sup>2)</sup>	267	18.4	21	30.4			
Working status							
Working (employed, self-employed or part-time)	1,092	75.2	48	69.6	1.1	1	0.291
Not working <sup>3)</sup>	360	24.8	21	30.4			
Chronic disease							
Have a chronic disease under treatment	296	20.4	15	21.7	0.1	1	0.785
None	1156	79.6	54	78.3			
Disaster-related experiences (ref. none)							
Direct damage <sup>4)</sup>	451	31.1	30	43.5	4.7	1	0.030
Disaster-related family stress <sup>5)</sup>	109	7.5	14	20.3	14.5	1	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							
<i>Mean / SD (score range: 1-5)</i>	<i>3.8</i>	<i>1.1</i>	<i>3.9</i>	<i>1.2</i>	<i>-1.2</i>	1,519	0.230
Social network							
Family and friend (LSNS-6 <sup>7)</sup> )							
<i>Mean / SD (score range: 0-30)</i>	<i>14.9</i>	<i>5.8</i>	<i>8.7</i>	<i>5.7</i>	<i>8.7</i>	1,519	<0.001
Belong to some groups or organizations (ref. no)	1,014	71.7	32	46.4	20.3	1	<0.001
Radiation anxiety							
<i>Mean / SD (score range: 7-28)</i>	<i>14.7</i>	<i>4.4</i>	<i>16.6</i>	<i>5.0</i>	<i>-3.4</i>	1,519	0.001
Radiation anxiety for adverse health effects							
<i>Mean / SD (score range: 4-16)</i>	<i>9.9</i>	<i>3.0</i>	<i>10.8</i>	<i>3.2</i>	<i>-2.3</i>	1,519	0.022

SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Appendix 6. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with physical symptoms (the total score of the 10 items  $\geq 23$ ) (n=1,521).

	Physical symptoms				$\chi^2 / t$	df	p
	Low		High				
	n / mean	% / SD	n / mean	% / SD			
Socio-demographic characteristics							
Sex							
Men	677	49.6	52	33.6	14.3	1	<0.001
Women	689	50.4	103	66.5			
Age, years							
20-39	673	49.3	74	47.7	5.0	2	0.081
40-64	446	32.7	62	40.0			
65+	247	18.1	19	12.3			
Education attainment							
Junior high school	120	8.8	25	16.1	10.6	3	0.014
High school	678	49.6	78	50.3			
Junior or technical college	328	24.0	33	21.3			
University or graduate school	240	17.6	19	12.3			
Level of household income adjusted by household size <sup>1)</sup>							
Low	528	38.7	62	40.0	1.1	1	0.581
Middle	637	46.6	75	48.4			
High	201	14.7	18	11.6			
Marital status							
Married	848	62.1	97	62.6	0.0	1	0.903
Separated, divorced, bereaved, unmarried or unknown	518	37.9	58	37.4			
No. of family members in a household							
1 (oneself)	135	9.9	14	9.0	2.0	5	0.852
2	286	20.9	35	22.6			
3	294	21.5	35	22.6			
4	276	20.2	35	22.6			
5	178	13.0	19	12.3			
6 or more	197	14.4	17	11.0			
<i>Mean / SD (range: 1-6)</i>	<i>3.5</i>	<i>1.5</i>	<i>3.4</i>	<i>1.5</i>	<i>0.7</i>	<i>1,519</i>	<i>0.467</i>
Living arrangement							
One's own house	1,119	81.9	114	73.6	6.4	1	0.012
Other <sup>2)</sup>	247	18.1	41	26.5			
Working status							
Working (employed, self-employed or part-time)	1,022	74.8	118	76.1	0.1	1	0.721
Not working <sup>3)</sup>	344	25.2	37	23.9			
Chronic disease							
Have a chronic disease under treatment	271	19.8	40	25.8	3.0	1	0.081
None	1095	80.2	115	74.2			
Disaster-related experiences (ref. none)							
Direct damage <sup>4)</sup>	419	30.7	62	40.0	5.6	1	0.018
Disaster-related family stress <sup>5)</sup>	93	6.8	30	19.4	29.5	1	<0.001
Fear or anxiety immediately after the NPP <sup>6)</sup> accident							
<i>Mean / SD (score range: 1-5)</i>	<i>3.7</i>	<i>1.1</i>	<i>4.0</i>	<i>1.1</i>	<i>-2.7</i>	<i>1,519</i>	<i>0.007</i>
Social network							
Family and friend (LSNS-6 <sup>7)</sup> )							
<i>Mean / SD (score range: 0-30)</i>	<i>14.9</i>	<i>5.9</i>	<i>12.7</i>	<i>6.0</i>	<i>4.2</i>	<i>1,519</i>	<i>&lt;0.001</i>
Belong to some groups or organizations (ref. no)	988	72.3	85	54.8	20.5	1	<0.001
Radiation anxiety							
<i>Mean / SD (score range: 7-28)</i>	<i>14.6</i>	<i>4.3</i>	<i>16.8</i>	<i>4.7</i>	<i>-5.9</i>	<i>1,519</i>	<i>&lt;0.001</i>
Radiation anxiety for adverse health effects							
<i>Mean / SD (score range: 4-16)</i>	<i>9.8</i>	<i>3.0</i>	<i>11.1</i>	<i>2.9</i>	<i>-4.8</i>	<i>1,519</i>	<i>&lt;0.001</i>

SD, standard deviation; df, degree of freedom; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6



Appendix 7. The relationships of socio-demographic, disaster-related, and social network characteristics and radiation anxiety with physical symptoms (continuous variable) (n=1,521).

	mean / r	SD	t / F	df	p
Socio-demographic characteristics					
Sex					
Men	15.1	4.5	-6.8	1519	<0.001
Women	16.8	5.0			
Age, years					
20-39	16.1	4.8	15.1	2, 1518	<0.001
40-64	16.6	4.9			
65+	14.6	4.6			
Education attainment					
Junior high school	15.9	5.8	2.4	3, 1517	0.292
High school	16.1	4.9			
Junior or technical college	16.3	4.5			
University or graduate school	15.5	4.5			
Level of household income adjusted by household size <sup>1)</sup>					
Low	15.8	4.8	0.8	2, 1518	0.455
Middle	16.2	5.0			
High	15.9	4.6			
Marital status					
Married	16.1	4.8	-1.3	1519	0.188
Separated, divorced, bereaved, unmarried or unknown	15.8	5.0			
No. of family members in a household					
1 (oneself)	16.4	4.8	1.6	5, 1515	0.164
2	15.9	5.0			
3	16.3	4.9			
4	16.2	4.9			
5	15.5	4.7			
6 or more	15.5	4.6			
<i>Pearson's r</i>	-0.051				0.048
Living arrangement					
One's own house	15.7	4.7	4.4	1519	<0.001
Other <sup>2)</sup>	17.1	5.1			
Work					
Working (employed, self-employed or part-time)	16.2	4.8	-2.9	1519	0.004
Not working <sup>3)</sup>	15.4	4.8			
Chronic disease					
Have a chronic disease under treatment	16.0	5.2	-0.1	1519	0.882
None	16.0	4.8			
Disaster-related experiences					
Direct damage <sup>4)</sup>					
Experienced	16.9	5.1	-4.8	1519	<0.001
None	15.6	4.7			
Disaster-related family stress <sup>5)</sup>					
Experienced	18.9	5.5	-7.1	1519	<0.001
None	15.8	4.7			
Fear or anxiety immediately after the NPP <sup>6)</sup> accident					
<i>Pearson's r</i>	0.175				<0.001
Social network					
Family and friend (LSNS-6 <sup>7)</sup> )					
<i>Pearson's r</i>	-0.149				<0.001
Belong to some groups or organizations					
Yes	15.7	4.6	3.8	1519	<0.001
No	16.7	5.4			
Radiation anxiety					
<i>Pearson's r</i>	0.252				<0.001
Radiation anxiety for adverse health effects					
<i>Pearson's r</i>	0.231				<0.001

r, Pearson's correlation coefficient; SD, standard deviation; df, degree of freedom; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

Appendix 8. The association between individual-level characteristics and regional radiation levels with radiation anxiety for adverse health effects applying multilevel linear regression analysis. (n=1,521)

	Model 1		Model 2		Model 3			
	Coef.	SE	Coef.	SE	p	Coef.	SE	p
Intercept	9.99	0.13	8.91	0.35		2.89	0.52	
Compositional effect								
Sex (ref. men)						-0.22	0.14	0.110
Age (ref. 65+)								
20-39 years old						0.84	0.24	<0.001
40-64 years old						0.77	0.22	<0.001
Education attainment (ref. University or graduate school)								
Junior high school						0.90	0.28	0.001
High school						0.67	0.19	<0.001
Junior or technical college						0.66	0.21	0.002
Level of household income adjusted by household size (ref. High) <sup>1)</sup>								
Low						0.74	0.21	<0.001
Middle						0.42	0.20	0.031
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)								
Married						0.46	0.15	0.003
No. of family members in a household						0.03	0.05	0.516
Living arrangement (ref. Other <sup>2)</sup> )								
One's own house						-0.01	0.18	0.950
Working status (ref. Not working <sup>3)</sup> )								
Working (employed, self-employed or part-time)						-0.03	0.16	0.835
Chronic disease (ref. none)						0.10	0.18	0.594
Effects by the Great East Japan Earthquake (ref. none)								
Direct damage <sup>4)</sup>						0.52	0.15	<0.001
Disaster-related family stress <sup>5)</sup>						0.66	0.25	0.007
Fear or anxiety immediately after the NPP <sup>6)</sup> accident						1.16	0.06	<0.001
Social network								
Family and friend (LSNS-6 <sup>7)</sup> )						-0.01	0.01	0.434
Belong to some groups or organizations						0.00	0.16	0.978
Contextual effect								
Air dose rate of radiation at the time of the survey			10.80	3.26	0.001	6.59	2.56	0.010
Random parameters								
Community level variance / Standard Error	0.58	0.17	0.43	0.14		0.21	0.08	
Within group variance / Standard Error	8.23	0.30	8.23	0.30		6.17	0.23	
Intra-class correlation: ICC	0.07		0.05			0.03		
Proportional changes in variance: PCV (compared to null model)			0.27			0.64		

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

- 1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.
- 2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house
- 3) Leave of absence, student, full-time housewife or seeking employment
- 4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property
- 5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation
- 6) nuclear power plant
- 7) Lubben Social Network Scale -6

Appendix 9. The association between individual-level characteristics and regional radiation levels with radiation anxiety for adverse health effects applying multilevel linear regression analysis with the respondents who had not moved or evacuated after the accident. (n=1,269)

	Model 1		Model 2A		Model 2B			Model 3A		Model 3B				
	Coef.	SE	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p			
Intercept	9.87	0.13	9.05	0.36		9.61	0.20		2.91	0.56		3.28	0.51	
Compositional effect														
Sex (ref. men)									-0.24	0.15	0.101	-0.24	0.15	0.101
Age (ref. 65+)														
20-39 years old									0.89	0.26	0.001	0.90	0.26	0.001
40-64 years old									0.70	0.23	0.003	0.70	0.23	0.003
Education attainment (ref. University or graduate school)														
Junior high school									0.81	0.30	0.007	0.80	0.30	0.008
High school									0.51	0.21	0.015	0.50	0.21	0.016
Junior or technical college									0.46	0.23	0.052	0.46	0.23	0.052
Level of household income adjusted by household size (ref. High) <sup>1)</sup>														
Low									0.81	0.23	<0.001	0.81	0.23	<0.001
Middle									0.44	0.21	0.038	0.44	0.21	0.038
Marital status (ref. Separated, divorced, bereaved, unmarried or unknown)														
Married									0.53	0.16	0.001	0.53	0.16	0.001
No. of family members in a household														
									0.03	0.05	0.560	0.03	0.05	0.582
Living arrangement (ref. Other <sup>2)</sup> )														
One's own house									-0.01	0.20	0.954	-0.01	0.20	0.969
Working status (ref. Not working <sup>3)</sup> )														
Working (employed, self-employed or part-time)									-0.02	0.17	0.927	-0.02	0.17	0.917
Chronic disease (ref. none)														
									0.09	0.20	0.671	0.09	0.20	0.666
Effects by the Great East Japan Earthquake (ref. none)														
Direct damage <sup>4)</sup>									0.66	0.17	<0.001	0.68	0.17	<0.001
Disaster-related family stress <sup>5)</sup>									0.65	0.36	0.071	0.64	0.36	0.077
Fear or anxiety immediately after the NPP <sup>6)</sup> accident														
									1.17	0.06	<0.001	1.17	0.06	<0.001
Social network														
Family and friend (LSNS-6 <sup>7)</sup> )									0.00	0.01	0.981	0.00	0.01	0.988
Belong to some groups or organizations									-0.06	0.17	0.739	-0.06	0.17	0.712
Contextual effect														
Air dose rate of radiation at the time of the survey			8.29	3.45	0.016									
Air dose rate of radiation soon after the Great East Japan Earthquake						0.49	0.29	0.086				0.29	0.23	0.195
Random parameters														
Community level variance / Standard Error	0.49	0.16	0.40	0.15		0.44	0.15		0.20	0.09		0.22	0.09	
Within group variance / Standard Error	8.10	0.33	8.11	0.33		8.11	0.33		6.01	0.24		6.01	0.24	
Intra-class correlation: ICC	0.06		0.05			0.05			0.03			0.04		
Proportional changes in variance: PCV (compared to null model)			0.19			0.10			0.59			0.55		

Coef., coefficient; CI, confidence interval; SE, standard error; ref., reference

1) Category of low includes household income <2.5 if headcount in a household was three or less and <5.0 if headcount in a household was four or more. Category of middle includes household income 2.5-5.0 if headcount in a household was one or two, 2.5-7.5 if three, and 5.0-10.0 if four or more. Category of high includes household income >5.0 if headcount in a household was one or two, >7.5 if three, and >10.0 if four or more.

2) Rented house, temporary house, disaster restoration house or acquaintance's or relative's house

3) Leave of absence, student, full-time housewife or seeking employment

4) Correspond to any of the following: 1. Harm to oneself, 2. Harm to or death of family members, 3. Loss of job or temporary absence from work, or 4. House damage or loss of property

5) Correspond to any of the following: 1. Deterioration of family relationships, or 2. Family separation

6) nuclear power plant

7) Lubben Social Network Scale -6

## 日本人のしあわせと健康についての調査

ID : □□□□□

### 《ご記入にあたってのお願い》

- 1) この調査は、宛名の方ご本人様にご記入をお願いいたします。  
ご回答は個人のお名前と切り離して処理いたしますので、プライバシーが侵されることはありません。  
また、ご回答内容が研究目的以外に使用されることは一切ありません。
- 2) ご回答は、あてはまる番号を○印で囲んでください。また、内には具体的な数値を記入してください。
- 3) 「その他」をお答えになった場合は、( ) 内に具体的な内容をご記入ください。
- 4) 一部の方だけにお答えいただく質問もあります。その場合は、矢印( → ) や質問文前の指示に従ってお答えください。指示のない質問については全員がお答えください。
- 5) ご回答に迷う場合は、できるだけ近いものを選ぶようにしてください。

### 《ご記入が終わりましたら…》

- ◎ ご記入が終わりましたら、もう一度、回答漏れがないかお確かめください。
- ◎ ご記入いただきました調査票は、○月○日(○)までに投函してください。

### 《この調査に関するお問い合わせは…》

- ◎ <研究責任者・調査センター>

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研究室ホームページ: <http://plaza.umin.ac.jp/heart/>

1. あなたの健康状態について

1) 最近1か月間のあなたの身体的な健康状態は次のどれにあたりますか。最もあてはまるもの1つに○を付けてください。

1 きわめて良い	2 とても良い	3 良い
4 まあまあ	5 不健康	

2) あなたは高血圧、糖尿病、心臓病、脳卒中、がんなどの慢性的な病気で治療を受けていますか。

1 はい  
↓  
2 いいえ → 「3」へ進んでください。

2-1) 震災前から治療を受けている病気があれば、いくつでもお答えください。(○はいくつでも)

1 高血圧	6 悪性新生物(ガン)
2 脳卒中など脳血管疾患	7 パーキンソン病等の神経難病
3 心臓病(狭心症・心筋梗塞)	8 骨折・外傷
4 呼吸器系の疾患	9 その他( )
5 関節リウマチ・関節炎	

2-2) 震災後に治療を受けはじめた病気があれば、いくつでもお答えください。(○はいくつでも)

1 高血圧	6 悪性新生物(ガン)
2 脳卒中など脳血管疾患	7 パーキンソン病等の神経難病
3 心臓病(狭心症・心筋梗塞)	8 骨折・外傷
4 呼吸器系の疾患	9 その他( )
5 関節リウマチ・関節炎	

(全員の方に)

3) 最近1か月間のあなたの健康状態についてうかがいます。最もあてはまるものに○を付けてください。

(○はそれぞれ1つずつ)

	ほとんど なかった	ときどき あった	しばしば あった	いつもあ った
ア) めまいがする	1	2	3	4
イ) 体のふしぶしが痛む	1	2	3	4
ウ) 頭が重かったり頭痛がする	1	2	3	4
エ) 首筋や肩がこる	1	2	3	4
オ) 腰が痛い	1	2	3	4

カ) 目が疲れる	1	2	3	4
キ) 動悸や息切れがする	1	2	3	4
ク) 胃腸の具合が悪い	1	2	3	4
ケ) 食欲がない	1	2	3	4
コ) 便秘や下痢をする	1	2	3	4

4) 最近1か月間のあなたの精神的な健康状態は次のどれにあたりますか。最もあてはまるもの1つに○を付けてください。

1 きわめて良い	2 とても良い	3 良い
4 まあまあ	5 不健康	

5) あなたは現在、うつ病や不安障害などの何かの心の病気で治療を受けていますか。

1 はい                      2 いいえ → 「6)」へ進んでください。



4-1) 震災前から治療を受けている心の病気がありますか。

1 はい	2 いいえ
------	-------

4-2) 震災後に治療を受けはじめた心の病気がありますか。

1 はい	2 いいえ
------	-------

(全員の方に)

6) 最近1か月間の間に、どれくらいの頻度で次のことがありましたか？あてはまるものに○を付けてください。

(○はそれぞれ1つずつ)

	全くない	少しだけ	ときどき	たいてい	いつも
ア) 神経過敏に感じましたか。	0	1	2	3	4
イ) 絶望的だと感じましたか。	0	1	2	3	4
ウ) そわそわ、落ち着かなく感じましたか。	0	1	2	3	4
エ) 気分が沈み込んで、何が起こっても気が晴れないように感じましたか。	0	1	2	3	4
オ) 何をするのも骨折りだと感じましたか。	0	1	2	3	4
カ) 自分は価値のない人間だと感じましたか。	0	1	2	3	4

4. 生活のご様子について

1) あなたは、自転車・車・バス・電車を使って、ひとりで外出できますか。杖や歩行器（手押し車）など、歩行補助具を用いても構いません。

1 はい                      2 いいえ

2) 現在、あなたはどの程度幸せですか。

1 とてもそう思う      2 ややそう思う      3 あまりそう思わない      4 全くそう思わない

3) あなたには、生きがいや充実感を感じられるものがありますか。

とてもそう思う              ややそう思う              あまりそう思わない              全くそう思わない

1 とてもそう思う      2 ややそう思う      3 あまりそう思わない      4 全くそう思わない

4) あなたの生活習慣について

(1) 汗がでるくらいの運動やスポーツを、1カ月に平均何回くらいしましたか。（○は1つ）

1 していない      2 1～3回      3 4～7回      4 8～15回      5 15回より多い

(2) 現在、ほぼ毎日、たばこを吸っていますか。（○は1つ）

1 吸っている      2 吸っていない      3 以前吸っていたがやめた

(3) 缶ビールで2本以上（ビール大瓶なら1本、日本酒なら1合、焼酎なら0.7合、ウイスキーなら小さなグラス2杯、ワインならグラス2杯以上に相当）のお酒・アルコールを毎日飲んでいますか。

（○は1つ）

1 はい                      2 いいえ                      3 以前飲んでいましたがやめた

(4) 健康を維持するために大事にしている生活習慣は何ですか。（○はいくつでも）

- |            |                               |
|------------|-------------------------------|
| 1 運動・スポーツ  | 6 お酒を飲み過ぎない                   |
| 2 休養       | 7 体重に気をつける                    |
| 3 睡眠       | 8 ストレスをためない                   |
| 4 食事       | 9 その他（                      ） |
| 5 たばこを吸わない | 10 特にない                       |

## 5. あなたの家族や親戚・友人関係について

あなたの家族や親戚・友人関係について伺います。次のア)～カ)の質問にあてはまる人数に○をつけてください。(○はそれぞれ1つずつ)

1) 【家族】ここでは、家族や親戚などについて考えます。

	いない	1人	2人	3、4人	5～8人	9人以上
ア) 少なくとも月に1回、会ったり話したりする家族や親戚は何人いますか。	1	2	3	4	5	6
イ) あなたが、個人的なことでも話することができるくらい気楽に感じられる家族や親戚は何人いますか。	1	2	3	4	5	6
ウ) あなたが、助けを求めることができるくらい親しく感じられる家族や親戚は何人いますか。	1	2	3	4	5	6

2) 【友人関係】ここでは、近くに住んでいる人を含むあなたの友人全体について考えます。

	いない	1人	2人	3、4人	5～8人	9人以上
エ) 少なくとも月に1回、会ったり話したりする友人は何人いますか。	1	2	3	4	5	6
オ) あなたが、個人的なことでも話することができるくらい気楽に感じられる友人は何人いますか。	1	2	3	4	5	6
カ) あなたが、助けを求めることができるくらい親しく感じられる友人は何人いますか。	1	2	3	4	5	6

## 6. あなたの住んでいる地域について

1) あなたの住んでいる地域の人々についてどう感じていますか。(○はそれぞれ1つずつ)

	強くそう思う	どちらかといえばそう思う	どちらともいえない	どちらかといえばそう思わない	全くそう思わない
ア) 今住んでいる地域の人々はお互いに助け合っている。	1	2	3	4	5
イ) 今住んでいる地域の人々は信頼できる。	1	2	3	4	5
ウ) 今住んでいる地域の人々はお互いにあいさつをしている。	1	2	3	4	5
エ) 今住んでいる地域で問題が生じた場合、人々は力を合わせて解決しようとする。	1	2	3	4	5



2) あなたは次のような会や組織にはいつていますか。(○はいくつでも)

1 町内会・自治会	8 市民運動・消費者運動のグループ
2 婦人会、老人クラブ、青年団	9 ボランティアのグループ
3 P T A	10 政治関係の団体や会
4 スポーツ関係のグループやクラブ	11 業界団体・同業者団体
5 趣味の会（コーラス・写真・山歩きなど）	12 宗教の団体や会
6 学習活動の会	13 同窓会
7 消費生活協同組合（生協）	14 どれにもはいつていない

3) あなたは次にあげるア)～コ)の組織や制度、事がらをどの程度信用しますか。

(○はそれぞれ1つつ)

	非常に 信頼する	やや 信頼する	あまり 信頼しない	全く 信頼しない
ア) 宗教団体	1	2	3	4
イ) 法律や裁判の制度	1	2	3	4
ウ) 新聞、テレビ	1	2	3	4
エ) 警察	1	2	3	4
オ) 国の行政	1	2	3	4
カ) 国会	1	2	3	4
キ) NPO, NGO (非営利組織や非政府組織)	1	2	3	4
ク) 社会福祉施設	1	2	3	4
ケ) 国連	1	2	3	4
コ) 科学技術	1	2	3	4

4) 福島県に住み続けたいと思いますか。

1 とてもそう思う	2 ややそう思う	3 あまりそう思わない	4 全くそう思わない
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7. 東日本大震災に関連した経験についてお伺いします。

1) 東日本大震災（原発事故を含む）のために、以下のようなことを経験されましたか。あてはまるもの全てに○をつけてください。（○はいくつでも）

- |                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1 あなた自身がケガをした</p> <p>2 あなたのご家族・ご親戚がケガをしたり、亡くなった</p> <p>3 失業した、またはしばらく仕事を休業した</p> <p>4 あなた自身の家が壊れたり、財産を失った</p> <p>5 家族の関係が悪くなった</p> <p>6 家族と離れて生活するようになった</p> <p>7 自分自身に精神的な不調やアルコール問題がおきた</p> <p>8 家族に精神的な不調やアルコール問題がおきた</p> <p>9 どれも無い</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

2) 以下は、東日本大震災（地震、津波、原発事故）などストレスの多い経験（以下「ストレス体験」という。）をした際、時々起こる問題や訴えのリストです。この1か月の間、その問題にどのぐらい悩まされていたかについて、あてはまるものに○をつけてください。（○はそれぞれ1つずつ）

	全くなかった	少しあった	中程度であった	かなりあった	非常にあった
ア) そのストレス体験の、心をかき乱すような記憶、考え、イメージ（光景など）を繰り返し思い出す	1	2	3	4	5
エ) 何かのきっかけでそのストレス体験を思い出したとき、非常に動揺する	1	2	3	4	5
キ) そのストレス体験を思い出させられるため、特定の活動や状況を避ける	1	2	3	4	5
コ) 他の人々から距離を感じたり疎外されているように感じたりする	1	2	3	4	5
セ) イライラしたり、怒りが爆発したりする	1	2	3	4	5
ソ) 物事に集中できない	1	2	3	4	5

3) 福島第一原発の事故がおきた直後、あなたは、どのくらい怖かったり、不安に感じましたか。（○は1つ）

- |                                                                        |
|------------------------------------------------------------------------|
| <p>1 全くない</p> <p>2 少ししかない</p> <p>3 いくらか</p> <p>4 たくさん</p> <p>5 非常に</p> |
|------------------------------------------------------------------------|

4) あなたとあなたの家族は、放射線を避けるために、もとの住所地から転居されましたか。1つに○をつけてください。(○は1つ)

1 自分および家族がともに転居した	4 自分または家族が震災直後に一時的に避難した
2 自分のみ転居した	5 放射線以外の理由(自宅が壊れた等)のために転居した
3 家族のみ転居した	6 転居していない(→「5」に進んでください)

4-1) もとの居住地に戻られましたか、あるいは戻られる意向がありますか。(○は1つ)

1 もとの居住地に戻った	2 将来戻る意向がある	3 将来も戻る意向はない	4 分からない
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(全員に)

5) 原子力発電所の事故による放射線の影響について感じていらっしゃることや、経験されたことについて伺います。それぞれの文章を読んで、あてはまるものに○をつけてください。(○はそれぞれ1つずつ)

	とても そう思 う	ややそ う思 う	あまり そう思 わない	全くそ う思 わない
ア) 将来、放射線の影響で深刻な病気にかかるのではないかと心配している。	1	2	3	4
イ) 体の具合が悪くなるたびに、放射線を浴びたせいではないかと不安になる。	1	2	3	4
ウ) 放射線の影響が子どもや孫など次の世代に遺伝するのではないかと心配している。	1	2	3	4
エ) 原子力発電所の事故に関する報道を見ると、とても不安になる。	1	2	3	4
オ) 放射線が高いといわれる地域に住んでいたために、他の人から差別された(不公平な扱いを受けた)経験がある。	1	2	3	4
カ) その地域の住民であることを、なるべく人に話さないようにしている。	1	2	3	4
キ) 放射線が健康に与える影響について、家族と意見が対立して、もめた経験がある。	1	2	3	4
ク) 飲み水や食品中の放射性物質による内部被ばくが心配だ。	1	2	3	4
ケ) 原発事故の後、水道や井戸の水を飲まなくなった。	1	2	3	4

6) 震災以後に、健康診断または放射線関連の講習会・説明会を利用されたかどうかがあります。

(1) 健康診断について

①震災以後に、健康診断を受けましたか

1 受けた                      2 受けない      → 「(2)」へ進んでください。



②健康診断について、受けたものに○をしてください (○はいくつでも)。

ア) 自治体が行う健康診査

イ) 個人線量計による外部被ばく線量 (ガラスバッチ) 測定

ウ) 内部被ばく線量 (ホールボディカウンター) 測定

エ) その他の健康診断

③一番最近に健康診断を受けたのはいつですか。

1 1年以内	2 1年より前～2年以内	3 2年より前～3年以内
4 3年より前～4年以内	5 4年以上前	

(2) 講習会・説明会について

①これまでに放射線についての講習会・説明会を受けましたか

1 受けた                      2 受けない      → 「(3)」へ進んでください。



②それぞれの講習会・説明会について、受けたものに○をしてください (○はいくつでも)。

ア) 集団で講義を聞く形式の講習会・説明会

イ) 個人での健康相談会

ウ) 参加者同士の話し合いのある説明会

エ) 「相談員制度」による相談員への相談

③一番最近に講習会・説明会を受けたのはいつですか。

1 1年以内	2 1年より前～2年以内	3 2年より前～3年以内
4 3年より前～4年以内	5 4年以上前	

(3) 健康診断や講習会・説明会の会場への行きやすさについて

受けた、受けないに係わらず、健康診断や講習会・説明会の会場は、あなたの住んでいる場所からどれくらい離れていましたか。複数ある場合には、一番近い場所までの距離を教えてください。だいたいの距離で結構です。どうしてもわからない場合には 999 を選んでください

キロメートルくらい      999 わからない

8. 最後に、あなたご自身、あるいはご家庭の基本的なことがらについて伺います。立ち入った質問もありますが、正確な結果を出すためにうかがうことが必要です。よろしくお願いします。

1) あなたの性別を教えてください。

1 男性	2 女性
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2) あなたの現在の年齢を教えてください。

	歳
--	---

3) あなたは現在ご結婚されていますか。(○は1つ)

1 結婚している	2 別居している	3 離婚している
4 死別している	5 結婚したことはない	6 わからない・答えたくない

4) あなたの最終学歴は次のどれですか。(○は1つ)

1 中学まで	2 高校卒	3 短大・専門学校卒	4 大学卒	5 大学院卒
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5) 震災などの影響で所得が下がることも健康に影響を与える可能性があります。世帯全体での昨年1年間の収入(税込み)はおおよそいくらでしたか。(○は1つ)

1 250万円より少ない
2 250万円以上500万円未満
3 500万円以上750万円未満
4 750万円以上1000万円未満
5 1000万円以上

6) 生計をともにされているご家族はあなたを含めて何人ですか。

	人
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7) 現在のお住まいは次のどれにあたりますか。1つ選んで○をつけてください。(○は1つ)

1 自宅(持ち家や分譲マンション)	5 恒久住宅・復興住宅
2 借家や賃貸アパート	6 知人・親戚の家
3 仮設住宅	7 その他 (                      )
4 借り上げ住宅	

