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Determinants of intention to leave among non-medical employees after a nuclear disaster: a cross-sectional study

Saeka Takeda,[1] Makiko Orita,[1] Yoshiko Fukushima,[2] Takashi Kudo,[3] Noboru Takamura[1]

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[1]Department of Global Health, Medicine, and Welfare, Atomic Bomb Disease Institute, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan
[2]Department of Nursing, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan
[3]Department of Radioisotope Medicine, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan

Correspondence to
Dr Noboru Takamura;
takamura@nagasaki-u.ac.jp

ABSTRACT

Objective: To conduct a survey among non-medical employees working at the time of the Fukushima Daiichi Nuclear Power Station accident, in order to determine the factors associated with their intentions to leave their jobs during the nuclear disaster.

Participants: We asked 287 employees (166 men and 121 women) in the study.

Methods: We asked about their intentions to leave their jobs after the nuclear disaster. We also asked about relevant factors, including the participants' demographic factors, living situations and working environments.

Results: We found that in employees younger than 40 (OR=4.73, 95% CI 1.74 to 12.85, p=0.002), being married (OR=3.18, 95% CI 1.03 to 9.79, p=0.044), measurements of the ambient dose rates in their homes after the accident (OR=5.32, 95% CI 1.65 to 17.14, p=0.005), anxiety about their relationships with their colleagues after the accident (OR=3.91, 95% CI 1.51 to 10.16, p=0.005) and the influence of radiation on the workplace (OR=0.33, 95% CI 0.14 to 0.80, p=0.014) were independently associated with the non-medical employees' intentions to leave their jobs after the nuclear disaster.

Conclusions: Our results suggest the need for continuous risk communication regarding such factors and the provision of information about the health effects of radiation exposure to non-medical employees after nuclear disasters.

Strengths and limitations of this study

- This is the first study to clarify the factors related to intention to leave the job after the nuclear disaster in non-medical employees.
- This study was not a multi-institutional study, and we were unable to include employees who had already left the company after the Fukushima Daiichi Nuclear Power Station (FDNPS) accident.
- In the questionnaire, we asked the employees about their intentions to leave (ITL) at several points, and this may have caused a recall bias on the part of the study participants.
- We may have missed including other factors that are associated with ITL.

INTRODUCTION

The nuclear accident at the Fukushima Daiichi Nuclear Power Station (FDNPS) following the Great East Japan Earthquake occurred at 14:46 on 11 March 2011. As a result, many radioactive materials were released from FDNPS. At 20:50 the same day, the Governor of Fukushima Prefecture issued instructions for the evacuation of settlements within 2 km of FDNPS. At 21:23, the Director-General of the Nuclear Emergency Response Headquarters (Prime Minister) ordered the evacuation of individuals within 3 km of FDNPS and that others within a 10 km radius remain sheltered indoors. At 18:25 on 12 March the evacuation radius was expanded to 20 km. On 15 March instructions were issued for all people living between 20 and 30 km from FDNPS to shelter indoors.[1 2] Consequently, about 110 000 residents were evacuated from their hometowns. Many residents living outside Fukushima Prefecture voluntarily evacuated as well due to fear of radiation exposure. As of February 2016, 43 139 of these residents had been evacuated to other prefectures.[3]

Alpine Electronics (hereafter 'Alpine') is based in Iwaki city, which is located in the 30–60 km radius from FDNPS. The total number of employees in this company was 1450 as of June 2016. To evaluate the internal radiation exposure doses by radiocesium and to mitigate anxiety among company employees and their families, the company evaluated internal exposure doses of radiocesium using a whole body counter (WBC). We recently screened internal radiation exposure doses at Alpine and confirmed that the committed effective doses were sufficiently low.[4] Nevertheless, several employees left their jobs at Alpine after the accident.

Recently, we investigated the factors associated with nurses' intentions to leave (ITL) their jobs after the accident in Fukushima, and found that the anxiety regarding external and internal radiation exposure and the possibility of evacuation after the accident was associated with their ITL.[5] Until now, however, there have not been any studies to identify the factors associated with the ITL of non-medical employees after the accident at FDNPS.

In this study, we conducted a survey of employees who were working at Alpine at the time of the accident to determine the factors associated with their ITL.

METHODS

Study participants

The study was conducted from October 2014 to June 2015 at Alpine in Iwaki city, which is located in the 30–60 km radius from FDNPS. In this study, we included Alpine employees who were working at the time of the accident (March 2011) and who underwent WBC during the study period. We directly asked 1000 employees who were waiting to be evaluated with the WBC to participate in the study. Among them, 343 employees agreed to participate and answered questionnaires. Once the participants completed the questionnaires, we reviewed the responses and asked them to revise any incomplete answers. We excluded 112 employees who answered that they had ITL before the accident, and we included 287 employees (166 men and 121 women) in the analysis.

Written informed consent was obtained from each study participant prior to the study.

Questionnaire

The questionnaire for this study was based on that used in previous research targeting nurses working at Fukushima Medical University Hospital during the accident at FDNPS.[5] In the questionnaire, we asked the employees about their ITL within 1 week after the accident, within 2–3 weeks after the accident, within 3 weeks to 1 year after the accident, within 1–2 years after the disaster, and at the time of the study. Additionally, we asked the employees for their demographic details, including sex, age, birthplace, tenure as an employee, tenure as an employee in Iwaki city, marital status and pregnancy status. We also enquired regarding the employees' living situations, working status, work environment and possible health effects of radiation among the employees, their children and other residents of Fukushima (see tables 1–3).

Statistical analysis

We defined ITL (+) as 'employees who intended to leave their jobs at any period after the accident' and ITL (−) as 'employees who did not intend to leave their jobs at any period after the accident'.

We identified the factors associated with ITL after the accident using the χ^2 test. We then used logistic regression analysis and calculated the ORs to identify the factors independently associated with ITL after the accident. p Values <0.05 were considered significant. Statistical analyses were performed using IBM SPSS Statistics V.19 software.

RESULTS

Employees' backgrounds by ITL after the nuclear disaster

Demographic data of the study participants are shown in table 1. Among the study participants, 68 (23.7%) had ITL after the disaster (ITL (+)) and 219 (76.3%) did not have ITL at any time after the accident (ITL (−)). In the ITL (+) group, 20 (29.4%) had ITL within 1 week

Table 1 Employees' backgrounds by intentions to leave (ITL) after the nuclear disaster

Responses	ITL (+) (n=68)	ITL (−) (n=219)	p Value
Age, 20–39 years (%)	34 (50.0)	74 (33.8)	0.066
Male, n (%)	44 (64.7)	122 (55.7)	0.066
Tenure as an employee for <10 years, n (%)	27 (39.7)	65 (29.7)	0.082
Tenure as an employee at Iwaki city for <10 years, n (%)	25 (36.8)	50 (22.8)	0.021
Living outside Fukushima Prefecture	33 (48.5)	82 (37.4)	0.012
Married, n (%)	57 (83.8)	152 (72.7)	0.013
Pregnant, n (%)	0 (0)	3 (3.1)	0.512

Table 2 Employees' living situations by intentions to leave (ITL) after the nuclear disaster

Questions	ITL (+) (n=68)	ITL (−) (n=219)	p Value
Do you have any children?	43 (63.2)	128 (74.9)	0.289
Do you live with preschoolers?	20 (29.4)	32 (14.6)	0.007
Did you feel anxious about daily life in Iwaki city after the accident?	33 (48.5)	51 (23.3)	0.001
Did you measure the ambient dose rate in your house after the accident?	57 (83.8)	148 (67.6)	0.006
Do you feel possible health effects from radiation around Iwaki city?	20 (29.4)	25 (11.4)	0.001
Do you see possible health effects from radiation in children around Iwaki city?	34 (50.0)	51 (23.3)	0.028

Number of employees who answered 'yes' (%).

Table 3 Employees' work environment by ITL after nuclear disaster

Questions	ITL (+) (n=68)	ITL (−) (n=219)	p Value
Did you feel that your workload increased after the accident?	20 (29.4)	39 (57.3)	0.369
Did you feel anxious about your relationships with your colleagues after the accident?	22 (32.4)	35 (16.0)	0.003
Did you feel sick after the accident?	15 (22.1)	18 (8.2)	0.037
Did you feel anxious about working in Iwaki city because of the possible effects of radiation?	35 (51.5)	16 (7.3)	0.000
Did you feel considerable effects of radiation while at work?	27 (39.7)	43 (19.6)	0.000
Did you feel unsafe about the effects of radiation while at work?	12 (17.6)	12 (5.5)	0.003
Did you feel reassured by the internal radiation exposure measurements once there was a WBC in the company?	42 (61.8)	147 (67.1)	0.141
Do you have someone in the company whom you can consult about radiation?	11 (16.2)	67 (30.6)	0.020
Did you feel reassured after consulting with radiation experts in the company?	42 (61.8)	134 (61.2)	0.296

Number of employees who answered 'yes' (%).
ITL, intentions to leave; WBC, whole body counter.

after the accident, 10 (14.7%) had ITL within 2–3 weeks after the accident, 26 (38.2%) had ITL within 3 weeks to 1 year after the accident, 8 (11.8%) had ITL within 1–2 years after the disaster and 3 (4.4%) had ITL at the time of the study.

Table 1 shows that when compared with their ITL (−) counterparts, the ITL (+) group had had significantly shorter tenures as employees (36.8% vs 22.8%, p=0.021). The percentage of employees based outside Fukushima Prefecture was higher for ITL (+) than ITL (−) (48.5% vs 37.4%, p=0.012).

Employees' living situations by ITL after the nuclear disaster

A significantly higher percentage of employees among the ITL (+) group than the ITL (−) group were married (83.3% vs 72.2%, p=0.013) and living with preschoolers (29.4% vs 14.6%, p=0.007). The following percentages were also significantly higher among the ITL (+) group than the ITL (−) group: those who felt anxious about life in Iwaki city after the accident (48.5% vs 23.3%, p=0.001), those who measured the ambient dose rate in their homes after the accident (83.8% vs 67.6%, p=0.006), those who felt possible health effects from radiation in Iwaki city (29.4% vs 11.4%, p=0.001), and those who saw possible health effects from radiation in children around Iwaki city (50.0% vs 23.3%, p=0.028; table 2).

Employees' work environment by ITL after nuclear disaster

With respect to the employees' work environment after the accident, compared with the ITL (−) group, a significantly higher percentage of the ITL (+) group felt anxious about their relationships with their colleagues after the accident (32.4% vs 16.0%, p=0.003). Furthermore, more people in the ITL (+) group felt anxious about working in Iwaki city due to the effects of radiation (51.5% vs 7.3%, p≤0.001), felt considerable effects of radiation in the company (39.7% vs 19.6%, p≤0.001) and did not feel safe about the effects of radiation in the company (17.6% vs 5.5%, p=0.003; table 3).

Independently associated with ITL after the accident

Logistic regression analysis revealed that for people younger than 40 years of age (OR=4.73, 95% CI 1.74 to 12.85, p=0.002), being married (OR=3.18, 95% CI 1.03 to 9.79, p=0.044), the measurement of the ambient dose rate in their homes after the accident (OR=5.32, 95% CI 1.65 to 17.14, p=0.005), anxiety about their relationships with their colleagues after the accident (OR=3.91, 95%

Table 4 Logistic regression analysis for ITL

Variables	Unit	OR	95% CI	p Value
Age	<40 years/>40 years	4.73	1.74 to 12.85	0.002
Born in Fukushima	Yes/no	1.30	0.51 to 3.32	0.580
Marital status	Married/not married	3.18	1.03 to 9.79	0.044
Living with preschoolers	Yes/no	0.67	0.21 to 2.16	0.504
Measurement of the ambient dose rate in the house after the accident	Yes/no	5.32	1.65 to 17.14	0.005
Anxiety about relationships with colleagues after the accident	Yes/no	3.91	1.51 to 10.16	0.005
Influence of radiation on the workplace	A little/a lot	0.33	0.14 to 0.80	0.014
A person to consult about radiation in the workplace	Exist/not exist	0.43	0.13 to 1.45	0.173

CI 1.51 to 10.16, p=0.005) and the influence of radiation on the workplace (OR=0.33, 95% CI 0.14 to 0.80, p=0.014) were independently associated with ITL after the accident (table 4).

DISCUSSION

The Fukushima Health Management Survey estimated external radiation doses based on questionnaires of self-reported behaviours following the FDNPS accident.[6] The survey covered 25% of the 350 000 residents of Iwaki city and showed that the external effective dose during the period 11 March to 11 July 2011 was estimated at <1 mSv in 99.1% of individuals, with a maximum value of 5.9 mSv.[7] The environmental radioactivity level in Iwaki city was relatively low compared with other regions of Fukushima.[8]

Previous studies targeting nurses have indicated that demographic factors such as age, being single, workplace, job position, tenure at place of employment and employment status are associated with ITL.[5 9–19] On the other hand, Kudo *et al*[14] reported that intention to stay on the job was higher among nurses who were older and more satisfied with their working conditions and their work as specialists. We recently investigated ITL among nurses after the FDNPS accident and found that younger age and shorter tenure were associated with ITL.[5]

To the best of our knowledge, this is the first study to clarify the factors associated with ITL after a nuclear disaster in non-medical employees. We found that the highest rate of ITL (38.2%) was in the 3-week to 1-year period after the accident, which suggests that this is the most impactful time frame for risk communication in addition to immediate and continued risk communication. We also found that several demographic factors, including tenure as an employee in Iwaki city and living outside Fukushima Prefecture, were associated with non-medical employees' ITL after the FDNPS accident. In addition, logistic regression analysis showed that younger age, being married, measurement of the ambient dose rate at home after the accident, anxiety about relationships with colleagues after the accident and feeling the influence of radiation at the workplace were associated with ITL.

In general, the younger employees in our study felt more stress, received lower salaries and had a lower social status, all of which were associated with ITL. In addition to these factors, anxiety about radiation exposure might also affect ITL. Since the married employees were more likely to have children, they had more anxiety about the health effects from radiation exposure on their children as well as themselves, which may also be related to ITL. On the other hand, previous studies targeting nurses reported that married nurses had lower ITL.[10 11 15 18] Liou and Cheng[13] also reported that nurses who were younger than 25 years of age and those who had worked for <1 year at their current hospital had lower ITL. Nevertheless, these results were probably due to the fact that married and/or younger employees prefer 'stable' lives. During nuclear disasters, young workers may select to continue having 'stable' lives, thus causing higher ITL.

We also found that several living situation factors, including anxiety about living with preschoolers, and about life and health effects from radiation around Iwaki city in children and themselves, were associated with ITL after the FDNPS accident. Our previous study surveying nurses working in a tertiary hospital in Fukushima Prefecture showed that anxiety regarding external and internal radiation exposure and the possibility of evacuation after the accident was associated with the nurses' ITL,[5] which is consistent with our current results. Regardless of professional status (medical or non-medical), anxiety about children being exposed to radiation was strongly associated with ITL during radiation emergencies. The distribution of accurate information on the health effects of radiation through appropriate risk communication is definitely needed during nuclear disasters.

We also found that factors related to employees' working environments, such as increased workloads after the accident, anxiety about the health effects of radiation and safety in the company, availability of radiation experts in the company, and relationships with colleagues, were associated with employees' ITL. Logistic regression analysis showed that anxiety about relationships with colleagues after the accident was independently associated with ITL. We recently reported that nurses were anxious about their relationships with their colleagues after the accident at Fukushima,[5] which is also consistent with our current results. In previous studies, improvements in relationships with colleagues have been reported to reduce ITL.[9 10 19] It is suggested that building good relationships with one's colleagues is an important step in reducing ITL even after a nuclear disaster.

There are several limitations in this study. In the questionnaire, we asked the employees about their ITL at several points, and this may have caused a recall bias on the part of the study participants. In addition, we might not have included other factors that are associated with ITL.

CONCLUSION

In conclusion, age, being married, employees' anxiety about their relationships with their colleagues after the accident and the influence of radiation on the workplace, and measurement of the ambient dose rate around employees' homes after the accident were independently associated with ITL. Continuous risk communication needs to take such factors into account and is definitely needed to provide information about the health effects of radiation exposure to non-medical employees after a nuclear disaster.

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Competing interests None declared.

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